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AND A RECORD OF CURRENT RESEARCHES RELATING TO

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Development & Retrogression of the Fat Cell.

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TRANSACTIONS OF THE SOCIETY.

XIX.—*On the Development and Retrogression of the Fat-cell.*

By GEORGE HOGGAN, M.B., and FRANCES ELIZABETH HOGGAN, M.D.

(*Read 12th March,* 1879.)

PLATES XIII. AND XIV.

PART I.—*Development of the Fat cell.*

IF in the animal body there be one element whose simple struc-
ture and generally accessible position would lead us to expect that
its life-history could easily be traced, and that consequently a
general unanimity of opinion regarding it must necessarily exist

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DESCRIPTION OF THE PLATES.

PLATE XIII.—DEVELOPMENT OF FAT-CELLS.

FIG. 1.—First deposition of fat in wandering cells retracted into a globular
form, from broad ligament of pregnant mouse. *a.* First appearance of fat in a
cell as two minute oil-globules. *b, c, d, e, f.* Cells in which gradual increase of
contained fat can be traced towards the capillary. *g.* Cells similar to *a* in which
no fat has as yet been deposited. All the above cells lie beneath the endothelium
and in the matrix of the membrane. *h.* A wandering cell with constricted
nucleus lying in one of the holes in the membrane, and therefore on the free
surface; it is evidently only a younger form of *g* and *h.* *i, j.* Still younger spe-
cimens of wandering cells lying on the free surface of the membrane; *i* has two
nuclei. *k.* Nuclei of the endothelium covering both surfaces of the membrane.

FIG. 2.—Relation of fat-tracts to wandering cells, from mesentery of rat.
d, e. Members of a shoal of wandering cells lying on free surface of endothelium.
a. A member of the same kind of cells, but lying beneath the surface of the
endothelium. *b, c.* Cells similar to the above, but further advanced, lying also
underneath the endothelium and becoming fat-cells; *b* has already two fat-
globules within it, and has attached itself to the group of fat-cells of which *f* is
a fully developed specimen. Only the cell-markings of the upper surface endo-
thelium are drawn, except at *a*, where the dotted line marks the lower surface
cell-markings.

FIG. 3.—First deposition of fat in wandering cells fixed in their branched con-
dition, from the broad ligament of a pregnant mouse. All these cells lie in the
matrix of the membrane. Nuclei of endothelium not inserted.

FIG. 4.—Fat-cells developing centrally as regards the blood-vessel, from the
broad ligament of a pregnant rat. *g, g.* Fat beginning to be deposited in cells
close to the blood-vessel. *a, a.* Cells fully distended with fat, lying farther away
from blood-vessel; in these cells the fat has been slowly and steadily accumu-
lating. *b, b.* Cells containing many fat-globules, the result of rapid deposition.

FIG. 5.—From the mesentery of a rat found starving, to which plenty of rich

amongst observers, we might certainly suppose that the fat-cell was that element.

Instead of this unanimity, however, we find the most opposite opinions held at the present day as to its origin alone, while about its disappearance, so far as we can discover, nothing really definite is known. We therefore propose in this paper to trace the life-history of the fat-cell from its origin in the wandering cell, its development, its decline, and its final disappearance from the stage under the same form in which it made its first appearance there.

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food was given, and the animal killed twenty hours afterwards. Tissue treated with silver, osmic acid, and logwood solutions. *b, c, d.* Cells in which many globules of fat have been deposited rapidly. These cells were probably previously fat-cells from which the fat had been absorbed, as seen in Figs. 9 and 10. *f, g.* Cells from which fat had not only been absorbed, but whose protoplasm had been disintegrating by granular exodus, as seen in Figs. 10, 12, and 13. The return of nutriment sent the granules back to the cell, where they now stain so intensely as in most cases to hide the nucleus. In *g* the nucleus is visible, and although stained as deeply as the nuclei of the neighbouring cells, it appears almost colourless as compared with the intense blue of the clustering granules round it. *a.* Vein. *h, h.* Nuclei of the endothelium.

Fig. 6.—Margin of a group of fully developed fat-cells, as they are generally seen, from the mesentery of a guinea-pig, treated with silver and logwood solutions and mounted in varnish, showing the effect of compression in making them assume a polyhedral shape. *a, a.* Fat-cells whose free borders still retain the circular form. *b, b.* Fat-cells assuming the polyhedral form through pressure of neighbouring fat-cells. This is the form in which they are found in nine cases out of ten.

Fig. 7.—Fat becoming absorbed from fat-cells. From the omentum of a young man who died of cancer and much emaciated. More than one-half of the contained fat has been absorbed from the cells.

Fig. 8.—Fat-absorption in a further advanced stage than Fig. 7, from the subcutaneous tissue of a young man who died of Eastern leprosy, much emaciated. Tissue treated with osmic acid and picro-carmine. Some of these cells still retain the angular form they possessed when fully distended with fat and compressed by neighbouring fat-cells.

PLATE XIV.

Fig. 9.—Still further advanced stage of fat-absorption, from the broad ligament of a pregnant mouse, found almost dead from starvation. In this specimen the first stage of retrogression—that of fat-absorption—is seen completed. *a, a.* Monoglobular fat-cells, once fully distended, by fat now undergoing absorption. *b, b.* Multiglobular fat-cells undergoing fat-absorption in the multiglobular condition. *c, c.* Fat-cells from which all the fat has been absorbed. *d, d.* Nuclei of the surface endothelium. *e, e.* Edge of dense tract of exhausted fat-cells lying along lines of great blood-vessels. *f.* Capillary blood-vessel. No difference is traceable between the fat-cells in man and those of the smaller mammals.

Fig. 10.—From the same preparation as Fig. 9, showing the commencement of the second stage in retrogression of the fat-cell, when the cell-substance breaks up and moves off in the form of granules. *h.* Group of exhausted fat-cells from which all the fat has become absorbed. *a.* General break up of one of the cells of the group; the granules are seen passing away from it in every possible direction. *b, c.* Similar cells, in which the break-up is even further advanced. *f.* Spindle-shaped cell belonging to a capillary now broken up. *k.* Nuclei of surface endothelium.

Fig. 11.—From the same animal as Fig. 5, where fat has been deposited in cells similar to those seen in group *h*, Fig. 10. These cells had undergone granular change but not exodus, so that the newly formed fat-globules appear

This task proves much simpler than might have been expected, considering the opposite opinions held on the subject, partly owing to the modifications we have introduced into methods of preparation of tissues for examination, and partly because we find that the opposite opinions referred to are due principally to the fact that observers have regarded the same cell element from different points of view, in different shapes, and under different aliases; so that, while those who have examined it from the front have insisted that the fat was first developed in a flat or round cell, those who have

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imbedded in a granular matrix, unlike that in Fig. 5, which is transparent and had not retrograded so far as in this figure. *a, a.* Exhausted and granular fat-cells in which fat has been re-deposited. *b.* Similar cell, from which some of the fat has been extruded, but its protoplasm, having been previously fixed by silver and osmic acid, has not contracted. *c.* Granular cells which had under-gone exodus, but to which the granules have returned. *d.* Wandering cell. Preparation stained with logwood.

FIG. 12.—Preparation from a rat which died of old age, showing a mass of fat-cells undergoing granular exodus and moving off *en masse* from the bed where they had been formed. *a.* Wandering cell. *b.* Exhausted fat-cells which have not undergone granular exodus. *c, c.* Fat-cells undergoing granular exodus and moving off *en masse.* Preparation treated with silver, osmic acid, and picro-carmine.

FIG. 13.—From the same preparation as Figs. 9 and 10 ; shows the end of the second stage of retrogression of the fat-cell. *a, a.* Fat-cells in a much farther advanced stage of exodus than those in Figs. 10 and 12. *b.* Cell in the last stage of granular exodus, nucleus and cell-outline again becoming distinct. *d, d.* Group of cells in a branched condition, and still containing a few granules. They appear to be the wandering cells, resulting from original fat-cells, lying in the same position as the group *e. f.* Spindle-shaped cells, resulting from the break-up of capillaries that were distributed to the now absorbed fat-tract. *g.* Large blood-vessel, now contracted and about to break up into spindle-cells. *h.* Nuclei of surface endothelium.

FIG. 14.—From the same animal as Fig. 12 ; shows different stages in retro-gression of fat-cells, where the granules have returned, consequently upon some short return of nutrition. *e, e.* Cells in a fat-tract which have not yet undergone granular break-up. *c, c.* Cells undergoing granular exodus. *b, b.* Cells which have undergone granular exodus, but to which the granules have returned. *a.* A cell midway in condition between *b* and *c,* and which is assuming the branched or wandering condition. *f.* Nuclei of surface endothelium. *d.* Capillary of fat-tract. Preparation treated with silver, osmic acid, and logwood.

FIG. 15.—From the mesentery of young rat weaned naturally by its mother about a week previously, consequently upon which, although well supplied with food, it had become very lean, and showed granular cells in the branched or wandering condition. *a, a.* Branched granular cells lying alongside a blood-vessel, to be compared with the ordinary branched cells, *b, b,* commonly called connective-tissue cells, but virtually wandering cells.

FIG. 16.—From the same animal as Fig. 15, showing granular cells *a, a,* lying amidst a group of ordinary wandering cells *b, b,* in a natural hole of the broad ligament of the liver, and, therefore, on its free surface, which they probably reached as seen in Fig. 15. These cells are now in the condition of cell *h,* Fig. 1, with which we commenced, and in the same preparation different stages of the granular cells may be traced, until they end in the ordinary wandering cells.

All these drawings have been made by the camera lucida, under the same power of 800 diameters, reduced afterwards one-half except Figs. 9 and 11 reduced to one-third. When not otherwise stated, the tissues have been fixed by silver, stained by pyrogallate of iron, and mounted in glycerine.

seen it edgeways have as stoutly maintained that it was developed from a branched or spindle cell.

Thus it is that Flemming, whose researches, published nine years ago, are probably the most extensive on this subject, not only insists that fat-cells are developed from the branched fixed cells of the connective tissue alone, but he emphasizes this opinion by declaring that he commenced his investigations in the full belief that fat-cells were developed from wandering cells, and that his investigations forced him to give up this his original idea. Klein also, whose opinions on this question are probably the latest that have appeared in English, does not seem to have worked out the question for himself, but accepts and teaches Flemming's conclusions, with the exception of the one where Flemming holds that the fat-cells are developed from the adventitia of blood-vessels.

He also specially refers his readers to the branched cells of the fossa infraorbitalis of rabbits as the most suitable in which to study the development of fat-cells, and states "that he thinks it unnecessary to warn his readers against the possible assumption that the lymph-corpuscles are the elements which become converted into fat-cells."

Ranvier, in his 'Traité d'Histologie,' now being published, states distinctly that fat-cells are developed from round cells (corps globuleux), and gives drawings which are characteristically clear and trustworthy. He states that he is entirely opposed to Flemming's ideas, and holds that the round cells from which fat-cells are developed are special in their character even from their origin. Of other observers we may briefly note that Rollett holds the opinion that fat-cells are developed from small round granular cells. Virchow and Frey say that in the embryo they are developed from round cells, but they agree with Von Wittich and Foerster that in the intermuscular connective tissue and in pathological formations they are developed from spindle and branched cells. Czajewicz holds that they are developed from small, delicate, flattened cells, which look like spindle-cells when seen edgeways, but he does not even mention the wandering cells, although they were well known when he wrote. Toldt, again, believes that fat-tracts are glandular in their nature; and Ranvier agrees with him so far as to call a fat-cell a unicellular gland. According to Toldt, these glands (fat-tracts) develop from special centres in the embryo, whereas in the adult fat-cells are only developed from pre-existing fat-cells.

Turning now to our own researches, we wish first to state that we can see no reason for specially studying the growth of fat-cells in the embryo. They are not embryonic structures in the ordinary sense of the term, but are merely adjuncts to the processes of nutrition, whether found in adult or embryo, the process of development being similar in both; and in studying their life-history under the

Microscope we are studying physiological changes rather than special anatomical elements, changes which, in the space of a few days, may pass from the first appearance of fat in a cell to its full development, and subsequent decline and disappearance.

While the conclusions of many of the observers we have enumerated have been arrived at on the bodies of fishes, frogs, porpoises, &c., we have specially drawn our conclusions from investigations carried out on the smaller mammals, as bearing more directly upon man, and wherever possible we have compared these with preparations from the human body, with the result of finding complete identity throughout. Contrary, however, to the opinion of many authorities, we have found the serous membranes the most useful for our investigation, being enabled to utilize these by virtue of special methods of our own, which we shall describe. Of these membranes the most serviceable is the growing broad ligament of pregnant rats and mice; for the growth of this thin structure during their short term of gestation is so rapid, that the developing cells and other structures remain isolated, having no time to form themselves into the dense masses which seem to have foiled other observers. Indeed, confining one's examinations to sections of tissue, as

A, Upper ring; B, Lower ring; C, Membrane between them.

recommended, would render it impossible to see the most interesting of the phenomena in the life of the fat-cell, which can only be recognized in uninjured membranes, and at the extremes of cell promontories or isolated cell groups or islands in such membranes.

Before ever the membrane is excised from the body of the animal, it must be evenly stretched once for all, so as to keep the lines of vessels apart from each other, and consequently the tracts of fat-cells which lie close to them clear for examination. Moreover, while the various reagents are gently applied, and the membrane is being continually subjected to examination under the Microscope, no fold must ever ruffle its surface, nor any object be touched by it until it is permanently put up as a preparation.

These desiderata are obtained by using the histological rings invented by us, of which we show specimens. They will be found to be most simple and useful adjuncts in the biological laboratory. These rings are always made in pairs, one fitting tightly upon the other, with a certain amount of taper in each; and when a piece of membrane is jammed between them, the whole has the appearance of a tambourine. They ought always to be made of vulcanite, as metals are acted upon by acids; bone, ivory, and other animal substances throw down salts like chloride of gold from their solutions;

while glass, wood, &c., are too fragile for use. We have them made of all diameters, but the most useful size for ordinary glass slides is seven-eighths of an inch in diameter.

When, therefore, we wish to examine the serous membranes, the animal must be killed gently by chloroform; indeed, as soon as it is insensible it ought to be even drenched with the anæsthetic, which seems, when thus given in excess, to anæsthetize the individual cells as well as the animal. No time should be lost by injecting the animal, as by doing so at first we missed some most valuable indications; but immediately after death the abdomen should be opened up to the fullest extent, a portion of the uterus or intestine seized with the forceps, and gently lifted up, so as to stretch the membrane which attaches it to the back of the abdominal wall. Upon one surface of this membrane the smaller ring of the pair is applied, and upon the opposite surface the larger ring is adapted, and pressed gently with a slight circular motion upon the smaller ring, so as not to rupture the delicate membrane, until it jams itself upon that smaller ring, with the membrane lying between them. It may now be snipped off with fine scissors external to the rings, thus separating it from the rest of the body of the animal; and we have then a miniature tambourine formed, in which condition the membrane remains until finally disposed of.

Our next step is to apply to either or both surfaces, with the greatest care and without any preliminary washing, a half per cent. solution of nitrate of silver in distilled water, and after a few instants' exposure to its influence, the preparation is carefully washed with distilled water, and exposed for a short time to a dull northern light, until the desired action of the silver has been obtained, as shown under the Microscope. We may now expect that not only have the various cells forming the membrane been fixed in the condition or shape they possessed during life, but that the shoals of wandering cells, which are continually groping over the free surfaces of the abdominal organs, will, as far as they existed upon the free surface of our piece of membrane, be firmly fixed *in situ*, and the whole may now be subjected to various staining processes.

Of these, by far the most suitable and generally used by us for such tissues is the process invented by one of us, and described three years ago in the Journal of the Quekett Club.

The tambourine membrane is first soaked for a few minutes in spirit, to deprive it of water, and a 2 per cent. solution of perchloride of iron in spirit is filtered upon it. After the lapse of a few minutes a few drops of a 2 per cent. solution of pyrogallic acid in spirit is likewise filtered upon it, and in a few minutes more, according to the depth of tint required, the whole may be washed in ordinary household water; a few drops of glycerine placed upon the membrane render it transparent, and it is

now ready for examination, or for being mounted permanently as a preparation.

Although this process of staining is by far the quickest and best for showing the development of fat in cells, it will be found advisable, more especially when studying their disappearance, to reverse the method, and, after treatment with silver solution, to treat the membrane first with osmic acid, to render the fat quite black, and then with logwood solution, to render the cells and their nuclei evident. But whatever processes the membrane may be subjected to, it will always be advisable to examine it from time to time under the Microscope, the membranous surface of the tambourine being placed uppermost on the stage; and, as may easily be conceived, it may thus be continually subjected to examination without touching anything or its receiving any injury whatever.

Instead of commencing with the ancestry of the fat-cell, we find it more convenient to start from the first appearance of fat-globules within one, and to trace their gradual increase until we reach the fully charged fat-cell. This condition is well shown in Fig. 1, from the broad ligament of the uterus in a well-nourished pregnant mouse. At *a* we see the first sign of fat making its appearance, as two minute oil-globules within a cell, one on each side of the cell-nucleus. At *b* we have a stage further advanced, and notice three fat-globules within a cell, each of the globules being larger than either of the two globules seen in the cell last described. In this way we may trace the progressive development of fat in *c, d, e,* and *f,* where the large fat-globules which fill the cells are on the point of running together to form the fully developed fat-cells seen in Figs. 4 and 6. Let us now return to cell *a,* and proceed in the opposite direction. All the cells we have referred to lie between the layers of endothelium covering both surfaces of the membrane, or, in other words, in the substance of the membrane itself. Now, there can be no doubt that cell *a* is of the same nature as cell *g,* in which no fat-globules have as yet appeared, and which lies like the rest in the substance of the membrane. But *g* is evidently similar to cell *h,* which is certainly a wandering cell lying external to the membrane, for it has placed itself in one of the natural holes which are so plentifully found in such membranes; it is evidently similar to the group of wandering cells seen near cell *e,* all of which, by the binocular Microscope, may be seen to lie on the free surface of the endothelium, over which they were travelling when the silver solution killed and fixed them in that position. Other minor features stamp these as being wandering cells; thus cell *i* possesses two nuclei, *h* has a purse-shaped nucleus where the one is about to become two, while at *j* we have the early stage or type of the newly born wandering cell; so that even without going further we might venture to conclude that fat-cells are developed from wandering cells

in the substance of the membrane (in this case), and that these ancestral cells are not special in their nature, as held by Ranvier, but are purely and simply wanderers.

The relationship between the fat-cells and wandering cells may be even more clearly traced in Fig. 2, from the mesentery of a rat, where, lying between, or rather opposite the space between, two groups of fat-cells, we see a portion of one of those shoals of wandering cells, which may always be found on the free surface of such membranes, lying sometimes like the lines of drift rubbish from a receding tide, and at other times in clusters or buds attached by a pedicle, if sufficient care has been taken not to rub or ruffle the surface of the membrane or rudely to wash them away.

The fact that these cells are to be found scattered over the free surface of such membranes, and unconnected with other structures, is clear proof of their being wandering cells; and when we can trace identity between them and similar cells becoming, or about to become, fat-cells lying between the endothelium-covered surfaces, the direct relationship between the two becomes evident.

In Fig. 2, with three or four exceptions, all the wandering cells depicted there lie on the upper free surface of the membrane; on the opposite free surface of the membrane there were quite as many, but to prevent confusion we have not drawn them. For the same reason, we have only drawn the endothelium outlines on the upper surface, except at cell *a*, where we have inserted in dotted lines the outline markings of the endothelium on the lower surface of the membrane, in order to show clearly that cell *a* lies between the surfaces in the substance of the membrane, and that it is identical with cells *c* and *d* lying on the free surface, and forms a link between these and cell *b* lying, like itself, between the endothelium-covered surfaces, and which, as is shown by the two fat-globules within it, is rapidly becoming a fat-cell belonging to the group of which cell *f* is a fully developed fat-cell.

It has been urged as a reason for holding the progenitor of the fat-cell to be a special form, distinct from the wandering cell, that the latter is globular and the former flat and round; but a glance at such a group of wandering cells as is shown in Fig. 2 lets us see both forms, with every variety of gradation between them. Young wandering cells like *d* have so little protoplasm round their nucleus, that they retain the globular form when exposure to cold or to silver solution has forced them to retract their amœboid processes and die on the spot.

Full-grown wandering cells, on the other hand, with abundance of protoplasm round their nucleus, like cells *c*, *c*, remain spread over a certain extent of surface when subjected to the same conditions as those affecting cells *d*, *d*. Every gradation of form may be seen between these two extreme types, and we may also note that, when-

ever a wandering cell is about to become a fat-cell, it develops a considerable amount of protoplasm or cell-substance proper, which increases likewise *pari passu* with the growth of the fat within it, so as to form a strong envelope for the great globe of fat in the fully developed fat-cell.

Wandering cells, therefore, like *e* and *f* and especially *a*, with a comparatively large amount of protoplasm, although apparently round when viewed from the front, are also flat, and when viewed edgeways they appear like long or spindle-shaped cells, thus causing and accounting for a certain amount of confusion in the views and descriptions of different observers; for in the thick subcutaneous tissue (unlike this thin membrane) in which it has been recommended to study the development of fat-cells, these cells are seen as often edgeways as any other way.

If we have succeeded in showing that fat-cells are developed from wandering cells, and that the hastily assumed difference between globular and flat round cells gives no ground for supposing that the progenitors of the fat-cell were special even from their origin, and if we have also succeeded in reconciling the views of Rollett, Ranvier, Czajewicz, and others, who have held respectively that fat-cells were developed from flat and from round cells, are we therefore to hold that Flemming and others, who have insisted that fat was developed in branched cells, are wrong in their views? By no means; and we hope to be able to show that they also are correct, and that perhaps the chief cause of disagreement between observers lies in the fact that, by different methods or modifications in methods of preparation, the same elements were shown in all the different forms referred to. Even at the risk of appearing prolix, we shall point out how slight modifications in preparation have changed our views slightly, and appear to justify the opposite opinions held by different observers.

When we first commenced this research some years ago, we were careful to bleed the animal to death, after making it insensible by chloroform, and after the blood had been withdrawn as much as possible, the blood-vessels were filled with a coloured injection, and the body was left to cool before we opened it to procure the membranes for our preparations. In this way the preparations from which Figs. 1, 2, and 4 were drawn, were made, and we believed that fat-cells were specially developed from round or flattened wandering cells. Some time afterwards, being in a hurry, we dispensed with the preliminary bleeding, injecting, and cooling, and found that we thus obtained singularly beautiful and illustrative specimens, especially when the animal had been drenched with chloroform after it was insensible. The vessels were still distended by fluid blood, and all the wandering cells within the membrane were found in a more or less branched condition, even when a large

number of fat-globules had become developed within them. In this way the preparation from which Fig. 3 has been drawn was made from the broad ligament of a pregnant mouse; and as an example of the rapidity with which such a specimen can be made by our special process, we may remark that within twenty minutes after the animal had been brought to us to be destroyed, it was killed by chloroform, opened, the membrane stretched on rings, silvered and stained black, clarified, and mounted as a permanent preparation.

Strange to say, when the first modification (by injection) was practised, the wandering cells were found in great numbers on the free surfaces of the membranes, as if during bleeding, injecting, and cooling they had endeavoured to make their way from the blood-vessels or their neighbourhood to the serous cavities; on the contrary, when the animal was quickly killed by chloroform and opened, they were seldom seen on the free surfaces. In this case, the jamming of the one ring upon the other keeps the blood-vessels distended by fluid blood, and the first preparation thus obtained is generally faultless, yet the very act of excising the rings with membrane attached opens the blood-vessels left behind, and thus a thin sheet of blood-corpuscles, scarcely noticeable to the naked eye, comes to be spread on the surface of the remaining membrane, and when silver solution is applied, the sheet of red blood-corpuscles becomes fixed *in situ*, and completely obscures the preparation. If, however, a jet of water is directed upon this membrane before applying the silver, these will all be washed away, but of course leaving the various cells in an altered condition, to be fixed by the subsequent application of silver. This shows the great advantage to be gained by using the silver on clean preparations, without preliminary washing, as this not only washes away the cells on free surfaces, but it also alters the forms of those left behind.

Fig. 3 may therefore be regarded as a typical specimen of wandering cells fixed in their branched condition, and in that condition they are becoming fixed cells wherever fat is seen developing within them. We there see the various stages of the development of fat within branched cells as clearly as they were seen within round cells in Fig. 1, and the different amounts of protoplasm developed round the branched wandering cells is as varied and distinctive as in the round wandering cells seen in Fig. 2. In short, we claim not only to have shown that fat-cells are specially developed from wandering cells, but that these wandering cells may appear to be round or branched cells, according to the process or modifications of processes by which they have been prepared; and we believe we have thus reconciled the views of different observers, as far as the shape of the parent-cell of the fat-cell is concerned, those views being erroneous principally because they

were too exclusive in their limitation to only one form of the parent-cell.

When, however, we pass from the mere expression of shape to the opposite opinions held by different observers regarding the essential nature of the parent-cells, we find it impossible either to reconcile these opinions or to agree with any one of them. We agree as little with Ranvier in supposing those parent-cells to be special in their nature, as we do with Toldt in supposing that only fat-cells can give origin to future fat-cells. Klein's idea of peri-lymphangeal nodules developing into fat-tracts, and fat-tracts being appanages of the lymphatic system, appears to us too far-fetched, so that there only remains for us to discuss how far it is correct to consider fat-cells as developed from the fixed cells of the connective tissue or from the adventitia of blood-vessels.

What is the connective tissue, and what are its branched cells? These are questions which we admit we are unable to answer, unless it be to the effect that we believe both terms to be no longer applicable to the cells or tissue to which they were at one time attached.

The term connective tissue, since it was first applied by Johannes Müller, has been modified out of all its original meaning by succeed-ing histologists, until at the present day no two histologists of eminence are agreed upon what constitutes that tissue.

Held at one time to include such structures as cartilage and bone, in whose fixed cells no one ever supposed fat to be normally developed, it is now almost confined to gelatinous, or what are called fibrous tissues in general, such as tendons, the subserous and subcutaneous tissues, &c. For our part, even if we acknowledge the branched cells in tendon, the cornea, and similar structures to be fixed cells, yet here also no one supposes that they can normally become fat-cells; and as regards the subcutaneous and subserous tissues in which fat-cells are generally found, we cannot admit that the branched cells found there are anything other than wandering cells, moving through the soft gelatinous matrix to enter into the formation of blood-vessels, fat-cells, or any of the other definite fixed cells found there, or leaving them in retrogression when that phase supervenes. Even should the term connective tissue be retained for the matrix or tissue referred to, we must hold the term fixed branched cells to be incorrect and inapplicable, and so far we are at variance with Flemming, Klein, and others, who speak of these as fixed branched cells. But in so far as we believe the wander-ing cells and the branched cells they refer to to be identical, we agree with them as to the parent-cells of the fat-cells. It is rather a curious commentary on the term fixed branched cell of the connec-tive tissue that Ranvier, one of the latest and best of histologists, entirely denies the existence of such a cell, and endeavours to show

that the fixed cell of the connective tissue is a broad flat cell, "*cellule plate*," which, when applied to fibres, has the appearance, but only the appearance, of being a branched cell. Of course we are equally at issue with him in his conception of a fixed cell of the connective tissue, and believe that his "cellule plate" is only an exhausted fat-cell, such as we have drawn in Figs. 9, 10, and 11; and if anyone takes the trouble to compare our drawings with the drawings given by Ranvier at page 340 of his ' Traité d'Histologie ' of his "cellule plate" (of which we have seen the original), he will see a wonderful identity between them, an identity which does not stop with appearance, but is continuous even in the physiological attributes he ascribes to it.

All these considerations show how dangerously vague a term is that of the connective tissue, and as we have already held that in those divisions of it which we have been considering there are no special fixed branched cells, it is clear that in our opinion no fat-cells can be formed from them.

The hypothesis advanced by Flemming that fat-cells are developed from the branched cells of the adventitia of the blood-vessels, seems to have met with general and, it seems to us, unmerited condemnation, for we have evidently here only an error of name and not of fact.

In the first place, as Flemming is not responsible for the term *adventitia of blood-vessels*, let us inquire what really constitutes this adventitia. Anyone who studies silvered preparations of the skin in mammals, cannot fail to be struck by the numerous and well-marked branched cells which lie specially upon the veins forming their so-called adventitia and stretching out from them for a considerable distance into the neighbouring gelatinous matrix, or, as it is called, white fibrous tissue.

The number of these branched cells seems to be considerably affected by various pathological conditions, so much so that we feel unable to admit that they are anything else than wandering cells clustering about the vein as if they were either about to enter or to leave it.

That fat should be developed in such wandering cells lying in so close proximity to nutrition, is not only reasonable, but in general accordance with our observations; for, as a matter of fact, fat-cells in a fat-tract found close to the lines of blood-vessels, seem to be developed from the wandering cells nearest to the vessel, and which would probably be called cells belonging to the adventitia of the vessel.

In Fig. 5 we have an illustration of the manner in which a fat-tract extends along a blood-vessel. In the cells there shown, the fat seen within them had been deposited to our certain knowledge within a period of twenty-four hours, and, although deposited in

previously existing exhausted fat-cells, it shows well the general plan of development. These fat-cells had developed peripherally along the blood-vessel *a*, first as a single row of cells *b, b*, lying along or upon the vessel, and afterwards externally to that single file as in the case of cells *c, c* and *d, d*.

The branched wandering cells from which these cells had originally been developed, might fairly have been considered as belonging to the so-called adventitia, although at the same time they were only wandering cells clustering round the vessel. So far, therefore, we are inclined to agree with Flemming in the identity of the cells and locality he refers to, although we cannot agree with him in holding that these are fixed branched cells, or that the development of fat-cells only takes place in the so-called adventitia, and in being too exclusive as to the locality of development; for, as seen in our drawings, fat-cells may develop either singly (Figs. 1, 3), or in islands (Figs. 7, 9, and 11) unconnected with any vessel whatever, although it is quite possible that the parent-cells only a short time previously formed part of the so-called adventitia of the nearest veins.

It is a matter of common observation that the tracts or masses of fat-cells lie close to the lines of blood-vessels, or, in other words, close to the centres of nutrition, and considerable importance has been attached to the question of the direction in which their development proceeds. This we consider to be a wholly unnecessary question, only brought forward by way of supporting certain erroneous hypotheses, and we only now notice it lest our silence be mistaken for acquiescence in them.

Laying aside Toldt's idea that the fat-tracts are developed as glands from special centres in the embryo, as being too extreme and palpably incorrect for serious discussion, let us pass to Flemming's hypothesis * that the fat-cells near blood-vessels develop first close to the vessels and are then pushed to the periphery by the growth of succeeding fat-cells, in other words, that development is from the centre of nutrition to the periphery. This view seems to be insisted

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* Since the above was written, we have found that Flemming has recently published another article on fat-cells in vol. xii. for 1876 of the ' Archiv für Mikroskopische Anatomie.' That article seems to be in great part a defence of his former opinions, which had been attacked by Klein and others. He has, however, modified his views as to the development of fat-cells close to and from the adventitia of blood-vessels, in somewhat the same sense as we have put it. He also acknowledges that he was wrong in speaking of the whole of the proto-plasma of the fat-cell outside the fat-globule as the cell-wall, and he corrects himself so far as to speak of it only as protoplasm, outside of which, however, he describes in very vague terms another, or, as he calls it, a secondary cell-wall or membrane not always necessarily present. In short, he has adopted Ranvier's idea of a fat-cell-wall, pure and simple, in which what remains of the original proto-plasm is still to be seen on its internal surface, only he describes it differently as a secondary membrane formed outside of the protoplasm, a condition even more complicated and more untenable than his former opinion.

upon as a necessary corollary to his hypothesis that fat-cells are developed from the adventitia of blood-vessels, and Fig. 4 gives fair support to it, where cells *g, g,* in the early stage of development into fat-cells, lie at the very centre of nutrition, while the fully developed fat-cells *a, a* lie at the periphery. That this mode of development should be very common is easily accounted for by the fact that both wandering cells and surplus nutrition are most plentiful immediately external to the blood-vessels, from which they indeed probably come, and consequently fat-cells may most readily be developed there. But Fig. 1 shows equally well the more advanced fat-cells lying nearest the vessels, and the earliest stages of development of fat in cells at the periphery. All this shows that it is incorrect to limit the direction of development to one course as Flemming has done, or indeed to make a special question of direction of development, as we have shown that it may proceed from opposite directions or from any direction.

In Fig. 4 it will be observed that the fat is developing or being formed in two different conditions within cells, that while in cells *a, a* and *g* only one large globule exists, in cells *b, b* we have a large number of comparatively small globules appearing within one cell.

This really points to an important difference in the time or manner of fat formation within cells, which we did not perceive when the drawing was made, but which subsequent observations explained. If in a fat-cell the fat is slowly but steadily deposited, or has existed there for a long time, even if originally deposited in globules which have subsequently run together, we find in such cases only one large fat-globule filling and distending the cell. If, however, nutrition has been excessive and fat rapidly formed, we generally find it deposited as numerous globules, more especially if the cells in which it is deposited possess much protoplasm or were previously existing fat-cells which had become exhausted. Fig. 5 is an example of this condition, in which the exhausted fat-cells were probably in the condition of those shown in Fig. 9; but if the cells have passed into the granular condition shown in Fig. 10, the globules then appear to be imbedded in a granular matrix, as shown in specimens which we exhibit under the Microscope.

We mention these points on account of the importance they may have in medico-legal cases, such as the late Penge case; for the appearance of the globule not only gives us an idea of the quickness of its formation, but the pellucid or granular character of the matrix in which the globules are imbedded gives us an idea of the degree of exhaustion which had preceded the re-development of fat.

The latter conditions are very common in mice which have entered a trap while in a starving condition, and afterwards gorged themselves on the bait employed. In this way we have procured several specimens similar to Fig. 5, where in no case had

the trap been set above ten hours previously, showing how rapidly fat may become formed within previously exhausted fat-cells in these little animals.

It may also be well to state here that the normal shape of a fat-cell, when it is not distorted by the pressure of contiguous structures or fat-cells, is generally oval and sometimes round, as shown in Figs. 4 and 6, the irregularly polyhedral shape drawn and insisted upon by Ranvier being due entirely to distortion by pressure of contiguous cells, and therefore in no way representing the normal shape. The influence of pressure in distorting fat-cells may easily be traced in Fig. 6, where cells *a, a, a,* at the border of a fat-tract lying along the blood-vessels in the mesentery of a guinea-pig, have their free borders rounded off, while on the sides pressed upon by contiguous fat-cells *b, b,* they are becoming angular and irregularly polyhedral in shape, of the form indeed in which they are generally represented.

Hitherto there has been no question of a cell-wall or membrane, for all histologists agree that the wandering cell does not possess one, and indeed it is generally presented as the type (often under some other of its names) of a wall-less cell, whereas the fat-cell is almost invariably presented as the type of an animal cell possessing a true wall or membrane, and it therefore becomes of importance to inquire how far we are justified in accepting it as such a type. Ranvier and others, in tracing the development of the fat-cell from a wall-less cell, go so far as to localize the time when the wall is formed, and state that it is only when the fat-globules have pushed the nucleus from the centre of the cell to its periphery that the cell-wall begins to be formed.

Now, with all due deference to the opinions of other observers, we feel called upon to state that, even after careful searching and studying the fat-cell in all its phases, we find no evidence whatever of the existence of a special cell-wall, that is to say, in the sense in which the term is generally understood. We cannot admit that there is any change whatever in the nature of the cell-substance or protoplasm, although in fully developed fat-cells like those in Fig. 6 it has become so distended and attenuated by the mass of fat growing within it, that it appears to surround the latter like a thin sheet. Still that thin sheet is only unaltered protoplasm, and we shall afterwards see that, when absorption of the fat from the fat-cell occurs, the so-called membrane contracts upon the lessening fat, becoming thicker as the fatty contents become smaller in a way a formed membrane would not do, and when the fat wholly disappears, the cell-substance remains behind in the same protoplasmic condition in which it existed in the parent-cell. If any observer has observed before us the behaviour of the cell-protoplasm during absorption of fat, we cannot understand how he could reconcile

that behaviour with the existence of a formed cell-membrane, and indeed no better proof could be required of the entire ground-lessness of the belief in a cell-membrane than that afforded by fat-absorption. This belief in a cell-membrane has arisen and been maintained by false analogy and erroneous histological methods, or through the interpretation of the appearances they produced. As a vegetable cell often possessed a cell-wall, so it was supposed that an animal cell ought to possess one, although the complete organisms of plant and animal are entirely unlike. Histologically it was, or rather it is at the present time, considered sufficient to treat fat-cells with ether, which dissolves out the fat from the fat-cells and leaves the empty envelopes behind, and these are held to be complete evidences of the existence of a cell-wall. It is somewhat surprising to find histologists at the present day, who make a *sine quâ non* of the use of fixing agents, admitting such a proof. Ether, like alcohol, is a fixing agent which first fixes the protoplasmic envelope and destroys its power of contraction, then dissolves out the fat within it.

Certainly the histologist in this case has made a membrane where one did not naturally exist, but the explanation is so simple that it is surprising that no one ever noticed the worthlessness of the test. Ranvier, while saying that this test is perfectly demonstrative, adds another of his own invention, which is equally misleading. By his well-known method of interstitial injection of a solution of nitrate of silver among the fat-cells lying in the subcutaneous tissue, he holds that he has been able to demonstrate the existence of a cell-membrane external even to the protoplasm distended round the fat. Under this treatment a dark membranous layer seems indeed to surround the cell, but here too the appearances are deceptive and the interpretation incorrect. When a solution of silver is allowed to come into direct contact with such cells, it forms such a layer where none existed before. This may easily be demonstrated upon an endothelium-covered membrane, as we have often done. If at one part the endothelium be removed where it covers fat-cells, and the silver solution be then applied, it will be found that the unprotected fat-cells show the dark pseudo-membrane where the silver solution had come in contact with them, while the contiguous fat-cells which were protected by endothelium show no such membrane, thereby proving that the supposed membrane is only an artificial production. Where the silver has thus only penetrated to a certain distance into the protoplasmic wall, the unaffected portion retains its normal appearance, and thus gives rise to the supposition that a part of the original protoplasm may often be seen lying on the inner surface of the supposed membrane.

The expression referred to, that the cell-wall only gets formed when the fatty contents have pushed the protoplasm and nucleus

to the periphery, is inaccurate, from the fact that protoplasm and nucleus are always peripheral to any fat-globule within the cell; and when by excessive distension the nucleus and protoplasm appear like a signet ring, the relation between the two still remains the same, and after absorption of the contained fat the nucleus appears to return to the centre of the cell-substance, as seen in Figs. 7, 8, 9, 10, and 11, although in reality the relationship has never altered throughout the cell life. We have now traced the fat-cell into its fully developed condition, as shown in Fig. 6, and seen that its parent-cell was the wandering cell, under which name we of course include white - blood cells, lymph, lymphoid, or lymphatic cells, migratory cells, embryonic cells, leucocytes, amœboid cells, and to these, by our own showing, the so-called fixed branched cells of the connective tissue and of the adventitia of blood-vessels; and we have also seen that these cells may be either globular, round, flat, spindle-shaped or branched, according to the position in which they are viewed, or whether they are fixed before or after they have had time to contract or retract their pro-cesses. With the fully developed fat-cell we reach the end of the first half of our studies, a task which ought to have been simple and short, but for the fact that it was encumbered with the diver-gent opinions of different observers. We have endeavoured to reconcile those opinions where possible, by explaining the causes of divergence, and in this, we believe, we have been not unsuccessful.

We now pass on to the second part of our studies, to show how the fully developed fat-cell returns into its original condition of a wandering cell, a task which will prove much easier and interesting than that of following development, for few observers have traced even the first part of the decline of the fat-cell, and none to our knowledge have witnessed the interesting appearances which herald its disappearance, so that we shall here only require to state the appearances observed by ourselves, and not to reconcile the divergent opinions expressed by others.

Part II.—*Retrogression of the Fat-cell.*

During the development of fat-cells we noticed that, as the fat increased within the cell, the cell-substance also increased *pari passu* with the amount of fat which it had to envelope. In absorption or retrogression of the fat-cell, we have thus two substances to get rid of before the cell can return into its original condition; but although these two substances, namely, fat and excess of cell-substance, de-veloped at the same time, their absorption occurs separately; indeed the decline or break up of the cell-substance does not commence until some time after the complete disappearance of the cell-con-tained fat.

Both processes in retrogression can best be studied in the bodies of rats and mice or other small mammals; indeed the latter process can only be studied well in such subjects. Flemming and others have starved dogs and other large mammals for a long period, with the result that they have failed to observe the most interesting and essential part of the process. In rats and mice, more especially the latter, which are often trapped in a starving condition, the system seems to be so exceedingly sensitive to excess or deficiency of nutrition, that they may either fatten or starve within the space of twenty-four hours; the little animal from which Figs. 9, 11, and 12 were drawn, was found almost dead in a jar, into which it had fallen, and in which it could not have remained above twenty-four hours, yet the whole of the different stages of retrogression in fat-cells could be followed upon one preparation of its mesentery.

This great susceptibility to variation in nutrition is apt to introduce an element of uncertainty or confusion into the study of the process of retrogression upon them, for it often happens that the remains of fat-cells, which had been broken up some time previously, are to be found in a preparation where well-developed fat-tracts point to even excessive nutrition. The first changes, during the absorption of the contained fat, seem to occur in the condition of the fat itself, which, from being of a yellowish-white colour and thick consistency, becomes more transparent, watery, and slightly red in colour. These changes have been previously noted by other observers, who have compared the resulting fluid or fat to serum, although there is nothing of the nature of serum about it, for we find that under the action of osmic acid it blackens even more intensely than in the case of newly formed fat. When once absorption has fairly commenced, if nutrition continues deficient, it follows a steady course, characterized by diminution of the fatty contents and the contraction and thickening of the protoplasmic envelope containing them *pari passu* with each other. This process is illustrated by Figs. 7, 8, 9, and 10, showing different stages in different animals of the process of fat-absorption from fat-cells, and it will be found that in all the mammalia the process and appearances are the same throughout. Fig. 7 is from the body of a young man who died of cancer of the skin, under the care of one of us, at St. John's Hospital. He had entered the hospital only two months before his death, a plump and well-nourished individual, and said that previously he had never had a single day's sickness. His downward progress was rapid, as the whole of the skin of the left side of the thorax became gangrenous, and during the last few days of life he was kept under the influence of morphia, on account of his sufferings, and as he took little or no food latterly, he died much emaciated. Fig. 7 represents a part of his omentum, taken by permission immediately after death, and stained by silver and

pyrogallate of iron. It may be taken as a typical specimen of steady and unbroken absorption of fat from fat-cells, and it will be noticed that, owing to the locality and the absence of distorting pressure from neighbouring cells, as well as from their lying parallel to the surface, all the cells are assuming the oval, almond-like shape.

Fig. 8, again, is from the subcutaneous tissue of the body of a young man, who died after an illness of thirteen years and in the last stage of leprosy. It is prepared by treatment with osmic acid and picro-carminate of ammonia. It represents a more advanced condition of fat-absorption than that seen in Fig. 7; and although selected from a spot in a perpendicular section, where the fat-cells were by no means closely packed, yet evidence of distortion (rapidly disappearing, it is true) is to be seen in the angular shape of one or two of the cells. At other parts of the group not included in the drawing, many fat-cells were seen entirely destitute of fat. In neither case had the disease under which the patients suffered affected in any way the fat-cells. Although some observers have tried to make out a distinction between the fat-cells found under the skin and those found in serous membranes, recommending only the former for examination, yet it will be seen that the fat-cells in Fig. 8 only differ from those in Fig. 7 inasmuch as the former have been distorted by pressure of contiguous structures, while the latter show the normal and true shape of the fat-cells. Fig. 9, from the broad ligament of the mouse formerly referred to, shows a still further stage of absorption of fat, which has entirely disappeared from several of the cells *c, c* in the drawing. Some of these cells also have been exposed to some slight distorting pressure, and it will be specially observed that in general appearance they are identical with the fat-cells of the human body, as seen in Fig. 7, they having been prepared by the same process.

Certain observers have also stated that the difference between the fat-cells in man and the smaller mammals was so great, that the latter could not be taken as types of the former. To this statement we wish to give a complete denial; we have never been able to detect any difference whatever, not even sufficient to enable us to tell which animal they belonged to.

As from several of the cells shown in Fig. 9 the fat has completely disappeared, we may consider that in them we have reached the end of the first stage in the retrogression of the fat-cell, that, namely, which concerns the absorption of fat only; so before passing on to the second stage, let us make a few remarks relative to fat-absorption.

We find no reason to suppose that the different stages seen in the development of fat are represented in its absorption. We saw,

for example, that fat was first deposited in several or many globules within one cell, which afterwards ran or melted into one mass in the fully distended fat-cell.

In absorption of fat we find no breaking up into several globules of the one mass; but where the fat-cells contained only one mass, the mass grew smaller, but did not break up into globules, as seen in most of the cells of Fig. 7. When, however, the fat-cells were only in course of development when nutrition failed, as seen in several of the cells in Figs. 9 and 10, where the developing globules had not melted into one mass, these globules diminished together; in other words, single masses diminished as single masses, and multiple globules diminished as multiple globules.

The course or direction of absorption among fat-cells is better marked than the direction of development. The fat-cells of the mesentery, and more especially at the upper part near the pancreas, become empty before the fat-cells of the broad ligament, while in each membrane the cells farthest from the blood-vessels and from the neighbourhood of the parts of the blood-vessels farthest from the centre of the circulation, are the first to become emptied of fat. After the fat has disappeared from the cells, and the first stage of decline is completed, a period of quiescence ensues, during which little change appears in the condition of the exhausted cells.

It may be observed, however, that they seem to diminish slightly in size; they become more regularly oval or almond-shaped, and when viewed edgeways the fat-cell is seen to have become thicker in the centre, like an almond viewed edgeways.

Within the cell-substance the granules are seen becoming better defined from the transparent matrix containing them, and at the same time increasing in number. Suddenly, and without any particular change or warning, the granules begin to leave the cell in every direction, as if they had become endowed with the power of automatic locomotion which their mother-cell had lost on becoming a fat-cell. Not only does the sharp oval outline become lost in that mother-cell, but the nucleus also becomes nearly hidden by the mass of granules clustering round it like a swarm of bees round their queen. The swarm passes away on every side and in apparently no definite direction, the granules becoming fewer and more isolated the farther they pass away from the mother-cell.

This condition is well seen in Fig. 10, from the same animal as Fig. 9. We have there a small group of fat-cells forming an island apart from the great fat-tracts that lie along the contiguous blood-vessels. While the fat has disappeared from all the cells of the group, three of them, *a*, *b*, and *c*, have entered upon the condition of granular exodus, and the granules may be seen passing away from them in every possible direction. We see none of that appearance shown in drawings of an ovum which has been burst

by mechanical pressure, and where the vitellus is seen pouring out through the rent in the vitelline envelope. On the contrary, there is clearly no membrane here to rupture, and the granules appear to emerge from every point of the surface of the mother-cell; and we here desire to state that each of the departing granules has been drawn *in situ* by the aid of the camera lucida, and that we have in no way drawn upon our imagination in depicting this phenomenon. In Fig. 10 it will also be observed that there are stages in the granular exodus; cell *b*, for example, has retrograded further than cell *a*, and cell *c* further than cell *b*; or, in other words, the granular exodus has been going on longer, and a greater number of granules have left cells *c* and *b* than cell *a*, but the continuous change onwards in absorption can be better studied in Fig. 13, from the same animal and preparation as Figs. 9 and 10. In this Plate we are brought to what may be considered as the last chapter in the life-history of the fat-cell. In it the least advanced in retrogression are cells *a, a*, still undergoing the granular exodus. Cell *b*, however, has almost reached the last stage of this process, and in it a definite outline is again appearing, and the nucleus is again becoming distinct, being no longer hidden by the swarm of granules clustering round it, as in the case of the less advanced cells. Beyond cell *b* we have a group of cells *e*, which have probably belonged to a group of fat-cells similar to that seen in Fig. 10. From them the granules have almost entirely departed, leaving them in the condition of branched wandering cells, similar to those seen in Fig. 3, the faintly tinted protoplasm in both cases being almost destitute of granules, and visible apparently more in consequence of difference of refraction between them and the gelatinous matrix in which they lie than by any distinct colour or tint.

In fact, we have now come upon debatable ground, where there is room for discussing whether such branched cells are really the offspring or result of the granular exodus from fat-cells or *bonâ fide* wandering cells.

A certain number of granules can still be detected here and there within their protoplasm, but it is difficult to say whether these are a residuum of the original fat-cell or eaten as pabulum by the wandering cell. By long and careful examination, we have come to the conclusion that those cells *e, e*, are the remains of the fat-cells which we have thus traced back to their original condition, but we have considered it advisable to place the *contras* as well as the *pros* of the question before our readers.

It ought also to be borne in mind that other cells besides these contain granules, and that granular exodus is not confined to fat-cells, which are shown here as typical of a condition, and not as undergoing a change special to themselves. The blood capillaries

and vessels which had developed *pari passu* with the outlying groups of developing fat-cells, as indeed the special nutritive adjuncts of the latter, have no longer any *raison d'être* when their nurslings perish, and they consequently obliterate their canal, and the constituent cells separate and undergo a similar granular exodus to that seen in the retrograding fat-cells, although in a much smaller and otherwise almost imperceptible degree, as at *f, f.*

During the process of granular exodus in the fat-cell, a change was taking place in the condition of the nucleus, which only becomes apparent when, as shown in cell *b*, the greater part of the granules which obscured the nucleus have left and allowed the nucleus to become visible.

In the wandering cell, the nucleus stains intensely by colouring agents, and is generally more or less globular in shape, except when proliferating. When the wandering cell becomes a fat-cell, we see that, as the protoplasm becomes distended by the fat within, the nucleus also seems to become stretched out into a flat circular or oval form, being thinner if greater in superficies, and staining much less intensely than formerly by staining agents. Even in retrogression the nucleus maintains its flat and circular condition, as it seems to pass back to a position in the centre of the cell-substance, and continues in that condition till the granular exodus obscures it. When it next appears, as in cell *b*, it has become globular, and smaller in superficies, and begins to stain more intensely, comes back indeed to the condition of the nucleus of the wandering cell, so that no distinction can be made between them.

The point of greatest importance in this inquiry is the nature or character of those granules which we see leaving the cells and travelling through the gelatinous matrix of the membrane, apparently by virtue of their own power of locomotion. Indeed the end of these studies only opens out to us the commencement of other more minute, more delicate, and more important researches. What, in the first place, is the typical shape of the granules? The powers of the Microscope used in making the drawings 800 diameters, only showed them as bright refringent points, staining slightly by the black staining fluid used in the cases mentioned.

Moreover, to be able to fix their natural shape, they ought to be studied in their living condition, upon the warm stage under the Microscope, to see if, like wandering cells, they alter their shape during life or during their locomotion, if such can be observed. Even during their dead condition (chloroform having been plentifully used in killing the animal, so that we might hope that, like the wandering cells, they were fixed in their living shape), with specially high powers of the Microscope, we can see that many of them are oblong in shape but round when seen edgeways, and sometimes two or three are attached together like beads. All these

points, however, ought to come into a special inquiry into their life-history, so that we have considered it advisable at present merely to draw them in their general positions, shape, and size, as seen under the power used in making all the drawings in this research.

But of far greater importance than their shape is the character of the substance composing these granular bodies, and this, we think, we have been able to ascertain satisfactorily, as far as their biological character is concerned.

As may well be conceived, the first point of importance to settle was whether these were fatty or protoplasmic in their nature. If, as was likely, they were fat-granules, little importance was to be attached to them; but if, on the contrary, they were protoplasmic in character, they were all-important as a key to the past and an explanation of the future.

To decide this point we had to vary our methods of preparation and, instead of using the pyrogallate of iron, we treated our membranes with ether, logwood, carmine, indigo, purpurine, and eosine, with and without osmic acid, and the result was unmistakable. Osmic acid did not blacken, while colouring agents stained, logwood being prominent among the rest in the intensity of its staining, showing that these granules were protoplasmic in character and not fatty.

The character stamped upon them by staining tests, as well as the power they appeared to possess of moving off at pleasure from the parent-cells by their own inherent power, and as we shall afterwards see of probably moving back again when the conditions were reversed, show us that we have here to do with something specific in biology, something vastly more minute, and a stage more elementary than the composite body called a cell; something which lives and moves and has its being independently of the cell, and to which we are called upon to assign a specific sphere in nature. Have we here germs, the micrococci, the zoogloea, the spores, fungi, bacteria, or the spores from which bacteria are developed in these living atoms? It is impossible to evade the conclusion that had these been observed in sections of tissues, where their connection with the cell or its nucleus could not be traced, more especially in any specific disease, they would indubitably have been ascribed to some of the foregoing classes, and (perhaps not without reason) the most serious conclusions might be drawn from their presence. We have no doubt that they furnish a key to the alleged discoveries of some of the above-named classes of organisms in certain specific or infective diseases in the past, and they may probably furnish an explanation of many infective processes in the future.

We may also mention here, with reference to a recent biological mistake in the character of germs that, whether treated with or

without alcohol, and indeed by all kinds of modifications of method, the result was always the same. At page 13 of his work 'On the Lower Organisms,' in endeavouring to account for the presence of bacteria within the living body, Dr. Bastian says:—" We must imagine that when the vital activity of any organism, whether simple or complex, is on the wane, its constituent particles (being still portions of living matter) are capable of individualizing themselves, and of growing into the low organisms in question. Just as the life of one of the cells of a higher organism may continue for some time after the death of the organism itself, so in accordance with this latter view, may one of the particles of such a cell be supposed to continue to live after even cell life is impossible."

This hypothesis of Dr. Bastian's is so exactly applicable to the granular bodies we have described, that we have ventured to quote him, as he expresses even better than we could ourselves the opinions we hold and wish to put on record.

We believe that in them we supply the missing link between cellular and germ pathology, and its bearing on the causation of disease will become more apparent when, at another time and place, we have an opportunity of showing that granular exodus is not confined to healthy cells, but that at least in one virulent disease we have characteristic granular breaking up of its cells throughout the body, and in that the explanation of its eminently contagious character.

But the interesting phenomena to be observed in the life-history of these organisms by no means cease with their leaving the parent-cell in the condition of the wandering cells seen in Fig. 13. Even in that direction they may pass beyond the stage seen there, and thus we find that the whole of the fat-cells forming a great fat-tract may pass away, leaving the vascular network which supplied them still existing, or they may still be observed there as numerous granular patches, each with its own nuclear centre which it is about to leave, and which in turn is about to leave the neighbourhood of the blood-vessels, as in Fig. 12.

Even at this juncture, if nutrition becomes again abundant, a complete change takes place in the action or plans of those granules. In that case they seem at once to return to the nucleus they were leaving or had left. They surround that nucleus on every side, and, when logwood staining is used, we find that, although that nucleus (where it can be seen) is stained as intensely as the neighbouring nuclei, yet the clustering granules stain so intensely purple as completely to hide the nucleus from view, as shown in Figs. 5 and 14. Then comes another consideration: the granular cells staining intensely by logwood come to be seen not only near vessels where no fat-cells had ever existed, but also far away even from vessels, in the centre of non-vascular tracts, which they could only have reached

by journeying as wandering cells. That they have this property, we think we can demonstrate satisfactorily by means of specimens which we show to-night.

If, in the first place, we start with cell *a*, Fig. 10, which seems to have left the group of fat-cells shown there, we can pass on to another example, Fig. 16, where four of such granular cells can be seen lying within a natural hole of a membrane, like cell *h*, Fig. 1, and lying, moreover, within a group of wandering cells for which they cannot possibly be mistaken; for the large oval contour filled with granules, a nucleus sharply defined and of a reddish colour (when stained by pyrogallate) contrasts strongly with the blue-black polynuclear condition of the wandering cells surrounding them.

Only one link is missing, and that also we supply, by showing in *a*, Fig. 15, such granular cells in the branched condition, moving along by the side of blood-vessels, and contrasting strongly with the transparent delicate branched cells *b, b,* near them.

It would, therefore, appear that when from a fat-cell all the fat has become absorbed and it has passed into granular retrogression, the faculty of locomotion is restored to it, that indeed it is in the condition of a wandering cell, plus the granules which it contained. But it would further appear that, while wandering and while its own granules are moving off from it, a supply of nutrition checks the granular exodus without checking the cell wandering (or exodus as regards the fat-tract), and then the granules may cluster round the nucleus in every possible form of irregularity, looking like the peripheral crystals in a lump of sugar. Gradually, however, these granules seem to melt into the substance of the cell, and it is again finally seen as a round or oval flat cell with sharp border and granular contents, which gradually become less granular, until the granular cell, the quondam fat-cell, becomes indistinguishable in appearance from any other wandering cells and, as we already have seen from its presence in the natural hole of a membrane and therefore on its free surface, it has also the same nomadic faculty, and indeed with that faculty we see no reason why it should not be discovered within blood-vessels where we have not yet looked for it. The time taken to effect all these changes is comparatively long, and we have not yet been able to fix a limit. We believe that a fortnight is not sufficient, and this fact is apt, as we have already noted, to introduce a complication into the study of this question; for just as it seems the rule that a mouse may be reduced often to the point of starvation while at large, the vestiges of such granular cells are scarcely ever entirely absent from some preparation, although we are able to show two or three in which they have not been found to exist. When, moreover, we take into consideration the fact that other cells beside fat-cells have the power

or fate to become granular, and, moreover, that other processes besides starvation will reduce even the fat-cell into the granular condition, we may form a fair idea of the difficulties surrounding this research and the liability to errors which it possesses.

Apart from the question of disease, if a tame rat be put into a cage with some strangers, these latter, if they are powerful enough, will often so maltreat the new-comer as to reduce it to a skeleton, or even kill it outright, and then the same phenomena of fat-cell absorption may be witnessed. Although young rats while they are being suckled are generally plump and fat, they rapidly become lean when weaned and forced to provide for themselves instead of being dependent on the mother's milk. In such cases, even although food had been continuously supplied, we have found the fat-cells exhausted and granular cells abundant, which could only be accounted for by the change in nutrition subsequent to weaning. Even more interesting is the condition of the fat-cells during excessive lactation, and the bearing which this has upon the same condition in the human female. In rats and mice, pregnancy is accompanied by a great accumulation of fat in the tracts near the blood-vessels, as if in preparation for the demands about to be made upon the mother by her nurslings. A short time ago a female mouse, having been trapped, was brought to us to be destroyed, and we afterwards noticed that it was extremely lean, and that its teats were pendent and flaccid, as if it were nourishing a large litter of well-grown young ones, which we afterwards proved to be a fact. From this animal's broad ligament and mesentery specimens were prepared which showed all the stages of retrogression, similar to those seen in Figs. 9, 10, and 13, although, from the immense number of exhausted fat-cells near the lines of blood-vessels, it was evident that, shortly before, the animal had been extremely fat, but it had been brought down to a condition identical with that found in starvation, by the excessive demands of its young upon it. We have thought it unnecessary here to enter upon any speculation as to the channels by which the granules of protoplasm move off from their parent-cell; by the aid of the binocular Microscope and one preparation whose endothelium is marked by silver on both surfaces, it is easy to decide that the granules are moving off through the soft gelatinous matrix which forms the membrane. They move off in every direction and by no definite channel, and lest some one should invoke the presence of lymphatic radicles as a channel of exodus, we can only say that, after having made a speciality of the search for lymphatic radicles or vasa serosa, such channels are purely mythical, and have no foundation in fact. They may possibly pass away finally by the blood-vessels or lymphatics, or even more probably they may be absorbed or appropriated by the wandering cells, and we can from this easily imagine

how, by the absorption of granules from diseased cells by wandering cells, a specific disease might quickly become generalized throughout the system.

One word more as to the behaviour of the exhausted fat-cells not yet passed into granular exodus, when nutrition again becomes abundant. If in the condition of the cells seen in Fig. 9, they simply fill the already prepared mass of protoplasm with numerous fat-globules, as seen in Fig. 5. But if the cells have become granular, like those seen in Fig. 10, when about to break up, then they still fill up, as in Fig. 5, only that in this case the fat-globules seem imbedded among granules. Of this condition we show a specimen, Fig. 11, which affords inverse proof of the connection between granular cells and fat-cells.

In terminating this long paper, we wish to observe that we do not pretend to have completed this question of retrogression, but rather to have only opened it out. Conscious of our many imperfections, we are prepared to find our conclusions modified or reversed subsequently by others or by ourselves. We are also aware that several collateral conditions remain to be investigated; such, for example, as whether the supply or deprivation of water affects the retrogression of the fat-cells in starvation, or whether gradual or sudden deprivation of nutrition has the same result or effect on the fat-cells. These are points which would require to be settled by direct experiment, if one has not the patience to wait for accidental circumstances. We have the patience to wait rather than experiment, and when opportunity offers and we find anything new or anything incorrect, we shall not be so tardy in making it known as we have been with this research, which has been spread over an interval of above four years, but which we have endeavoured to bring up to date.*

While the foregoing was passing through the press, two remarkable communications were made on May 6th and 20th to the Pathological Society. The first of these, "On the Occurrence of Micrococci underneath Antiseptic Dressings," by Mr. Cheyne, a pupil of Mr. Lister, and supported by him, mainly concerned the cultivation in vegetable infusion of micrococci from the matter obtained from wounds treated antiseptically, while the second was the report of the Committee on Pyæmia, and was largely illustrated by microscopical specimens of tissue in that.

In the preceding pages we have spoken vaguely of the identity of the granules we have described with many of the so-called specific organisms, because we were aware that different people held different opinions as to what constituted those supposed organisms. The high authorities who brought micrococci before the Society, however, gave us a definite standard of comparison, and we now assert with confidence that all those micrococci were nothing other than the

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* A short account of this research with microscopical demonstrations was given by Mrs. Hoggan before the Naturforscher Versammlung at Cassel in September, 1878, and her remarks were published *in extenso* next day, on pp. 56 and 57 of the 'Tagblatt.'

granules formed from cell protoplasm in the manner we have described. The specimens illustrating pyæmia especially, showed micrococci both in free masses and within cells of the kidney, almost identical with those shown in our preparations.

In the discussion of the questions referred to, it was assumed that the so-called micrococci were specific independent organisms from without the body, and the chief interest turned on such questions as how they managed to enter underneath the dressing or into the body, whether they could exist in the body, or what specific influence, if any, they might have there.

All reasoning therefore might, however, seem superfluous if it could be shown that, instead of being specific independent organisms from without, the so-called micrococci were merely minute atoms of the protoplasm of the cells within the body, formed as we have described, and that according as they were the result of a physiological or a pathological process, so would their effect be when introduced into the system. In more specific terms we might consider that the particles resulting from the disintegration of the protoplasm of fat-cells would be harmless, while those resulting from the protoplasm of cells in glanders, where we have also observed this process, would be most malignant in their effect when introduced into the system; and the same might be said of those particles so clearly shown within and outside the cells in pyæmia.

XX.—*On some Applications of Osmic Acid to Microscopic Purposes.*

By T. Jeffery Parker, B.Sc., F.R.M.S.

(*Read 12th March*, 1879.)

Since the introduction of osmic acid amongst the reagents of the histologist, it has been used for very various purposes. Its chief virtue depends on the fact that it kills and hardens protoplasmic structures with the least possible amount of shrinkage, and that it stains fat of an intense black colour. The former property has rendered it of great value in embryology, in the study of *Infusoria*,* and for many of the more delicate animal tissues; the latter gives it its pre-eminence in bringing out the ramifications of the finer medullated nerves, and the structure of adipose tissue.

Recently, as the Fellows of this Society are aware, Graber has made use of osmic acid for the preparation of insect structures, with very signal success; Flesch, also, recommends the employment of a mixture of it with chromic acid for preparations of the cochlea and retina; and Dr. Marshall has used a similar mixture for the preservation of chick embryos.

I must apologize for bringing my very limited experiences before the Society, but as some of my osmic acid preparations seem more successful than those of similar objects prepared in any other way, I venture to think that some account of my experiments may not be without interest.

Perhaps the most successful preparations I have yet succeeded in making with the aid of osmic acid, are entire specimens of a little glass-crab (*Phyllosoma*), the larva of the macrurous genus *Scyllarus*. The specimens were sent last July to Professor Huxley, by Mr. Lloyd, of the Crystal Palace Aquarium, where the larvæ were hatched out.

In the case of these *Phyllosomæ*, ten minutes' immersion in a 1 per cent. solution of osmic acid, and subsequent treatment with alcohol of gradually increasing strength, commencing with 50 per cent., and ending with absolute, served not only to harden the tissues, but to differentiate them in a very striking manner. The immense central nervous system was stained jet black, and stood out with diagrammatic clearness; the muscles, glands, &c., assumed a greyish-brown colour, the striæ of the muscle-fibres becoming remarkably distinct. An immersion of five minutes was in some respects still more successful, although less striking; the nervous system in this case took the same grey-brown colour as the other soft parts, the fibrillation of the nerves and the nuclei

* Apropos of Dr. Pelletan's paper reprinted in this Journal, vol. i. p. 189, I may mention that osmic acid is recommended for the instantaneous killing of Infusoria in Huxley and Martin's 'Elementary Biology,' p. 94.

of the nerve-cells becoming very clear. The cells of the liver and green glands, and those of the hypodermis were also brought into view in a manner that left little to be desired for clearness.

By no means the least important point about these larvæ is that, delicate as they were, they could, after the treatment described, be clarified with oil of cloves and mounted in Canada balsam, with little or no shrinking or distortion.

For *Daphnia*, I have lately found the same treatment a decided success. The heart, alimentary canal, ovary, and appendages are well brought out; the nervous system not so well, owing, I suppose, to its containing less fatty matter than that of Phyllosoma, and consequently not being acted upon to the same extent by the acid. For entire specimens an exposure of ten minutes to half an hour in 1 per cent., or of twelve to twenty-four hours in $\frac{1}{10}$ per cent. is sufficient; but for dissected specimens, to show the separated appendages, a day in 1 per cent. is not too much, the chitin becoming stained of a light brown colour by the long exposure. In one specimen acted on for this time I was fortunate enough to get the heart dissected out of its pericardium, and found that the organ showed very perfectly the beautiful arrangement of muscular fibres figured by Claus.[*] It must be remembered that after twenty-four hours' exposure to a 1 per cent. solution of the acid, the Daphniæ appear perfectly black to the naked eye.

For *Cypris, Cyclops*, &c., the same process is equally good for the preparation of specimens for dissection; but very little is shown when the animals are mounted whole.

The acid is a great success for preparing the mouth parts and other appendages of *Asellus aquaticus.* The animals should be placed entire in a 1 per cent. solution for about a day, and then treated with alcohol of gradually increasing strength. They become jet black to all appearance; but when the appendages are dissected off, clarified, and mounted in balsam, they are seen to be stained of a rich brown colour, their muscles are brought out with perfect clearness, and their finest setæ well shown up. The same specimens unstained are so transparent as to be almost invisible, and such colouring matters as carmine and hæmatoxylin are anything but successful.

I have made very few experiments with insects, but those I have are sufficient to show how valuable this method is for the preparation of mouth parts, salivary glands, Malpighian tubules, &c., and how it ought, for the former, entirely to replace the somewhat barbarous method of treatment with potash or with turpentine.

The only other application of osmic acid to which I have to draw attention, is for the preparation of delicate vegetable structures. The most important experiments I have made in this direction are on the

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[*] 'Zeitschr. f. wiss. Zool.,' xxvii. pl. 26.

terminal bud of *Chara*; and for this I have found it so successful, that I have no doubt of its usefulness for other structures of a like nature. The buds were placed in acid until they appeared black, and were then treated with alcohol as described above. They were then clarified with oil of cloves, and imbedded in cacao butter, and the sections cut were mounted in balsam. The method is extremely good for the younger parts of the bud, such as the apical cell, smallest leaves, &c.; but the oil of cloves and balsam cause a good deal of shrinking of the older cells: it might possibly be better to imbed in glycerine jelly, and to mount the section in glycerine. The staining of these objects is very successful; the acid seems to have been taken up by each granule of the protoplasm, and there to have been decomposed, giving the granule the characteristic grey colour. A mixture of osmic and chromic acids (chromic acid, 0·25 p. c., 9 parts; osmic acid, 1 p. c., 1 part) answers, in some respects, even better than osmic acid alone for this purpose.

In this, as in all the former instances, one great advantage of the method is that hardening and staining are performed in one operation.

XXI.—*Is not the Rotiferous Genus Pedalion of Hudson synonymous with Hexarthra of Ludwig Schmarda?*

By Julien Deby, F.R.M.S.

(Read 8th January, 1879.)

Looking lately through the plates illustrating Ludwig Schmarda's 'Zur Naturgeschichte Ægyptens' (Vienna, 1854), I fell accidentally upon the figure of an extraordinary rotifer which reminded me forcibly of Dr. Hudson's *Pedalion*. From the imperfect figure, plate iii. fig. 1, of Schmarda's work, I referred to the text for fuller details, which are to be found on p. 15. We see there that the rotifer called *Hexarthra polyptera* was discovered by Schmarda on the 19th of March, 1853, in a small pool near the ruins of El Kab, in Egypt. The water was brackish to the taste, and the animal lived in it in shoals or "swarms." Although at the first aspect Schmarda thought he had to do with some small crustacean, he soon discovered the true position of his animal in the family Hydatinea.

His examination, although insufficient for clearly establishing identity of generic characters between *Hexarthra* and *Pedalion*, is, however, sufficiently detailed to allow of great doubts being expressed as to the right of existence of the latter name. The differences between Hudson's and Schmarda's descriptions reside principally in the incompleteness of the details given by the latter, and are consequently differences of omission rather than anything else. Schmarda's work being rather difficult of access, I have translated therefrom his description in full of *Hexarthra polyptera*, which I reproduce for the sake of comparison with Dr. Hudson's careful and elaborate papers, published in 'Month. Micr. Journ.,' vol. vii., 1871, p. 121; in 'Quart. Journ. Micr. Sc.,' vol. xii., 1872, p. 333; and in 'Month. Micr. Journ.,' vol. viii., 1872, p. 209:—

"The body is transparent, colourless, and represents a blunt cone, at the broad end of which are situated the rotary organs. These last are large, with numerous long cilia, and are so attached as to form a right and a left group. Two globular red eyes are seen in the middle of the forehead, not far asunder. The digestive apparatus is very distinct; an undulating (flimmernde) slit (mundspalte) leads into a conical œsophagus, moved by four muscles, and carrying two semicircular jaws, each of which is furnished with seven teeth. The build of the masticating apparatus has some resemblance to that of Triarthra. The stomach is short, but rather broad, and leads into a cylindrical, many times constricted intestine, which narrows at its lower end. The absorption of carmine was easily obtained. At the upper portion of the intestine two pancreatic glands, which are divided into two lobes, are seen to open. The organs of respira-

tion consist in two long, winding vessels on the sides of the body. At the anterior extremity exists another system of vessels, forming a great vascular ring, from which branches are thrown out. As regards organs of generation, the ovary alone was recognized with certainty. A second small, bladder-like organ is perhaps the testicle. Eggs of various sizes and stages of development were contained in the ovary. The ripe eggs were light green, and were carried about at the posterior end of the body. The motions of the embryo, the vibration of its cilia, and the motions of its jaws, were frequently observed before leaving the egg-shell. The organs of the senses consist in two round eyes, filled with a carmine-coloured pigment.

The organs of locomotion are very peculiar and complicated. They consist in three pair of oars or fins. The first pair is the most powerful, and takes its origin high up on the outside of the abdominal face. It is conically pointed, has centrally on each side four teeth, and divides at the tip into five pair of small plumed appendages or fins. Two clearly marked muscles, striated transversely, run through the whole length, giving off branches to the appendages. The second pair of limbs is somewhat smaller in all its dimensions, and is inserted deeper and more inwardly. The eight teeth on the sides are shorter, and the tips only carry eight appendages.

These limbs only carry a single central muscle. The third pair springs from near the middle line of the body; on its lower third, it is the smallest and weakest of the whole, and only one muscle is discernible in each limb. The motion of these organs is very active and energetic, as well as various in direction. Not only do these animals swim with great swiftness, but, just as in Polyarthra, Triarthra, and others, they have the power of leaping. Besides these oar-like organs and the rotary organs, both long and circular muscles aid the movements of the body. I kept the creatures alive until the beginning of April."

I advise those interested in the study of the Rotatoria to have a look at these figures of Schmarda's, as no types of this class of animals are more interesting from an evolutional point of view than Pedalion or Hexarthra,[*] if this latter be really distinct from it.

* Schmarda's original work was laid before the members of the Society by M. Deby.

XXII.—*Note on M. Deby's Paper.*

By C. T. Hudson, LL.D., V.P.R.M.S.

(*Read 9th April*, 1879.)

In the above paper M. Deby says:—" The differences between Hudson's and Schmarda's descriptions reside principally in the

Fig. 1.
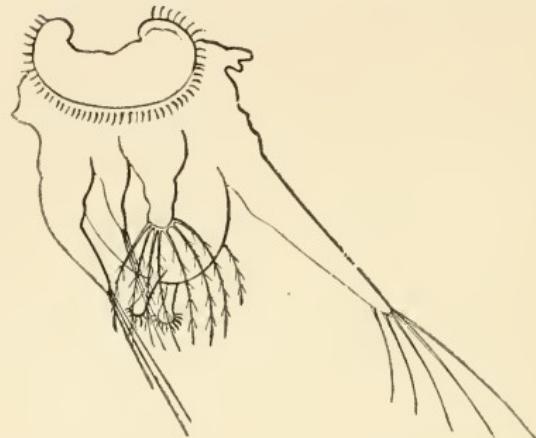
Fig. 2.
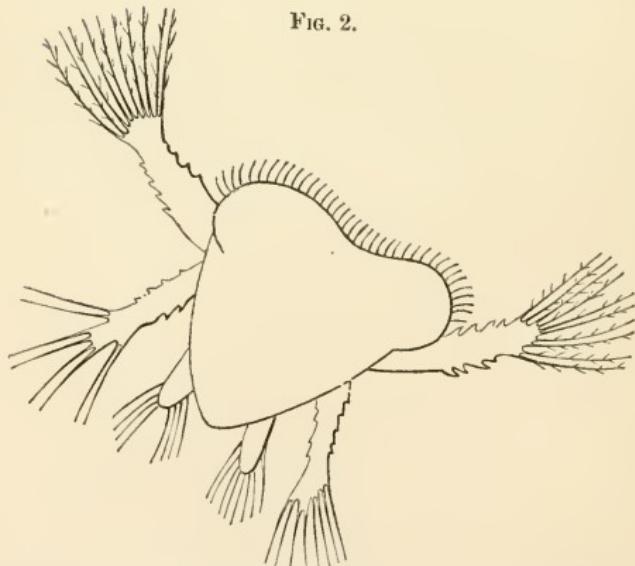
incompleteness of the details given by the latter, and are consequently differences of omission rather than anything else."

An examination, however, of the two figures here placed side

by side, mine (Fig. 1) of Pedalion, and M. Schmarda's (Fig. 2) of Hexarthra, will show that M. Deby's statement cannot be maintained, especially as M. Schmarda's written description exactly tallies with his figure in the points to which I wish to call attention.

These are, that both M. Schmarda's description and his figure represent his rotifer as having *two* limbs of equal size much bigger than the rest, and that all six spring from the *same side* of the rotifer.

Now, Pedalion has *one* of its six limbs much bigger than all the rest, and it is situated on the *opposite side* to the other five.

M. Schmarda's drawings are probably but rough ones; but making every allowance for this, it is surely impossible that he could have been guilty of two such blunders as M. Deby gives him credit for.

No doubt the two creatures belong to the same family; but they are generically distinct.

I strongly suspect M. Schmarda's "great vascular ring" to be nothing but the muscles at the neck, and the "testicle" he speaks of, to be probably the contractile vesicle; but it is of little use to criticize hypothetical mistakes, so I will not pursue the matter further.

XXIII.—*An Illuminating Traverse-Lens.* By Robert B. Tolles, of Boston, Mass., U.S.

(*Read 9th April*, 1879.)

With the advent of objectives of increased interior angle of aperture, the indispensableness of equivalent accessory means for the illumination of the object became immediately evident.*

In my first construction of such object-glasses, I therefore required to provide means which proved so suitable that I have adhered to their use to the present time.

The first appliance was a deep plano-convex lens, centrally mounted below the object and having its centre of curvature in the object-place. Afterwards, I adopted a plano-cylindrically convex lens, equal to a hemisphere less the thickness of the object-slide, which was placed in immersion contact with the base of the slide so that the object itself formed the centre of curvature of this illuminating lens. Around the convex surface of this central lens moved a shutter to regulate and limit the access of light, and it was provided also with a small plano-concave lens which, applied by its concave to the convex surface of the larger lens by immersion contact, cancelled the refracting surfaces and allowed a perpendicular *beam* of light to reach the suitably immersed object without refraction.†
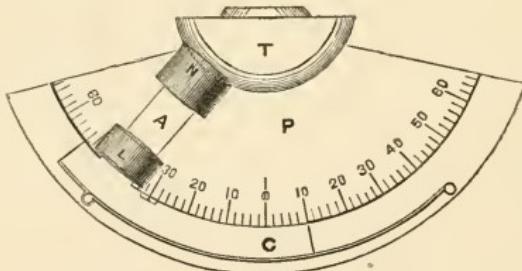
The device in a more complete form is represented in the annexed figure, where P is the basilar plate of the whole traverse system, having a circular groove and track in which the carriage C moves. On a projecting arm A of the carriage C are mounted whatever appliances are to be used to modify or direct the light upon the traverse lens T in the direction of the object at the centre of the system.

In the figure the concave lens N is shown in position on the arm. Thus situated, the interior convex and concave surfaces being of no effect, the two exterior plane surfaces of *the traverse system* constitute it a prism, and every slightest movement of this

concave facet lens on the traverse lens T would *give a different prism* to infinite variety. In this arrangement, the concave mirror can be used in the ordinary manner and condense light enough upon the object for all ordinary purposes. The full interior aperture of a dry objective would be reached at the very convenient obliquity of 41°, i.e. at less than the critical angle, or angle of total internal reflection between crown-glass and air. L is a double-convex condensing lens, that may be placed at about its principal focal distance from the object.

For a condenser, with the size of apparatus as drawn in the figure, a simple lens of 1¼ inch focus and about ten (10°) degrees of aperture is convenient, and if the lens is movable along the arm A, it can be focussed readily on the object, the position being fixed by inspection. This would be well for parallel rays. If diverging rays are used another lens of two or three inches focus, mounted on the arm A, will conveniently take up the rays from the radiant at the distance of the focus of this supplementary lens.

The plate P is graduated on its circular edge, as in the figure, to two degrees, and the arm A has a swing of seventy degrees of arc each way from the axis of the Microscope. An index-line is marked on the bevelled edge of the carriage 10° from the axis of the condenser, which must be added to or subtracted from the real obliquity of the illuminating rays.

It is obvious that any observation made and duly recorded as to its conditions, as of obliquity of incidence of illuminating pencil or ray, form of the pencil or beam, focal length and distance of the condenser, such observation could be successfully repeated. The record of the obliquity of the most oblique rays reaching the object directly and giving view of it at the eye-piece with luminous field, would express the "balsam" aperture, or more correctly, the half interior aperture of the objective when the front lens of the objective and the traverse system are of glass of similar refraction.

Having thus the "balsam" angle we readily calculate or learn the corresponding angle for glycerine, or water, or any medium of which we have the index of refraction. A corresponding notation, perhaps for air, might be engraved in juxtaposition on the basilar plate.

XXIV.—*On the Occurrence of Recent Heteropora.*
By Arthur Wm. Waters, F.G.S.

(*Read 14th May,* 1879.)

Plate XV.

In looking through some of the British Museum recent Bryozoa, I several times came across portions of round branches from the neighbourhood of Japan, and upon examination some were seen to be Myriozoum; but the structure of others, similar in form, was upon first sight a puzzle, for broken sections seemed to show transverse markings like septa, so that I was in doubt as to what this might be, and it was necessary to make transparent sections before the appearance was explained, but then the tubular cyclostomatous nature was quite clear, and it was interesting to find a Cheilostomatous (*Myriozoum subgracile* d'Orb.) and a Cyclostomatous Bryozoon from the same locality, so similar in habit that they were placed together as the same species, not in one case only, but in several.

As is the case in all Cyclostomata, the shell-walls are perforated by small holes, and the shell thickening between these holes gives sometimes a beaded appearance (Fig. 4) to a section of a cell-wall; and it is to the irregular thickening of the shell causing well-like depressions round these holes that the peculiar appearance of transverse lines is due.

Mr. Busk, in the 'Crag Polyzoa,' page 122, speaks of partial transverse nearly equidistant septa in Heteropora, and Mr. J. Haime figures most distinct septa in his *H. pustulosa.** These

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EXPLANATION OF PLATE XV.

Fig. 1.—*Heteropora pelliculata*, natural size. (The upper branches are drawn slightly too long.)

Fig. 2.—Longitudinal section of ditto, × 25. (This is drawn with the growing end downwards, and the structure is perhaps shown better in consequence.)

Fig. 3.—Transverse section of ditto, × 25.

Fig. 4.—Portion of same, magnified fifty times.

Fig. 5.—Operculum of *Myriozoum subgracile* d'Orb., × 85.

Fig. 6.—Operculum of Cellepora (Fig. 8), × 85.

Fig. 7.—Surface of *Heteropora pelliculata*; *b*, portion with the thin covering removed.

Fig. 8.—Cellepora from Australia.

Fig. 9.—*Heteropora cervicornis* d'Orb.

Fig. 10.—Surface of ditto.

Fig. 11.—Ditto, with covering removed.

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* 'Mém de la Soc. Géol. de France,' ser. 2me, vol. v. pl. xi. The name *H. pustulosa* was employed by Haime five years previous to the publication of the 'Crag Polyzoa,' and therefore the same name given by Mr. Busk as a new species will require to be changed. Haime's specific name *pustulosa* had been employed by Michelin and d'Orbigny for his species, though the generic name they used was Ceriopora.

Fig. 1. nat. size

Fig. 2.
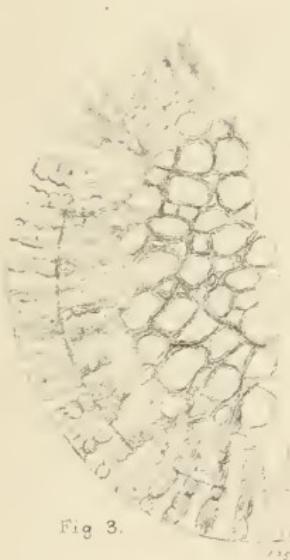
Fig. 3.
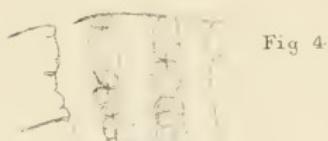
Fig. 4.

Fig. 5.   Fig. 6.

Fig. 8.

Fig. 9.

Fig. 7.   b

Fig. 10.

Fig. 11.

A. W. Waters lith.   Mintern Bros imp.
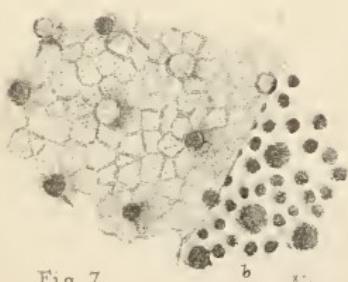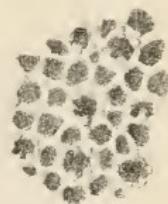
1. 2. 3. 4 & 7. Heteropora pelliculata.
5. Operculum of Myriozoum subgracile.
6. Operculum of Cellepora. 8. Cellepora, sp.
9. 10. 11. Heteropora cervicornis, d'Orb.

Mr. Busk explains by considering the septa to represent the remains of hymen-like lids, which have been left behind at successive stages of growth. I have not found this to be the case in this species or fossil ones examined, but suppose it must occur in other species.

The pore-tubes can be seen in the transverse sections, Figs. 3 and 4; in Fig. 4, they are shown passing through the zooecial walls; this structure is the same as we find in all Cyclostomata, and the inner portion of Fig. 4 would represent equally well Idmonea, Hornera, &c., for in all of this sub-order numerous minute pores occur in the walls, as is also shown in the longitudinal section, Fig. 2, which may also be considered as a characteristic section of the shell structure of the group. In the Cheilostomata, on the other hand, numerous perforations are exceptional, but in the cell-walls of most are comparatively large disks, called rosette-plates, having one or numerous apparent perforations. In *H. pelliculata* the interior of the zooecial tubes has delicate longitudinal markings, with occasional faint transverse lines of growth (see Fig. 2).

The external surface can best be studied with a calcined fragment. In a piece thus prepared, the calcareous base of a thin pellicle is seen to cover nearly all the surface. The zooecial apertures are nearly equidistant and have sometimes a thin cover, as is the case with most of the Cyclostomata; * surrounding each cell are about eight cancelli, covered, as already pointed out, and in these coverings are several perforations round which the white calcareous film is thicker, thus giving the appearance of raised warts, and, in fact, until the organic matter is removed this structure cannot be correctly appreciated. The openings of the cancelli are usually much smaller than the zooecial apertures, though in some cases they are nearly as large.

I have been unable to identify it with any fossil form, and therefore call it

Heteropora pelliculata, nov.

Zooarium erect, branches cylindrical, frequently dividing dichotomously, ends of branches sometimes taper, at others swelling out into a subglobular termination. Zooecia; parallel tubes, perforated with minute depressed pores. Zooecial orifices circular, interstitial orifices subcircular, disposed round the zooecial orifices. Surface covered with a thin calcareous and organic pellicle, cover of cancelli numerously perforated.

Hab.—The Gulf of Tartary and the neighbourhood of the island of Saghalien and Japan, between the latitudes 41°–46° N.,

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* Such covers of the Cyclostomatous Bryozoa are specially worthy of note, for in Polypora and other Carboniferous fossils belonging to the Fenestellidæ similar closures have been pointed out by Mr. John Young.

and longitudes 141°–143° E., in from fourteen to thirty-seven fathoms.*

The next instance of the occurrence of Heteropora is interesting, as being found under somewhat parallel circumstances.

In the Australian seas there is a Cellepora, probably common, as I have seen it in several collections. It grows round the stalks of seaweeds, &c., and is raised into ridges irregularly encircling the zoarium (Fig. 8), with zooecia on each face of the ridge, so that it may be said to have in part a biserial growth, and this is known in Mesenteripora, Reticulipora, Eschara, Flustra, Biflustra, &c.

I have not been able yet† to identify it with any described species, and in my own collection distinguish it as *C. repleta* (thus in part retaining the meaning of the generic name Plethopora).

It is not, however, with this we have now to deal, but with a Bryozoon (Fig. 9) of quite similar mode of growth, found in a small boxful of the Celleporæ, just mentioned, which my sister picked up on the Semaphore near Adelaide; however, as soon as it is put under the Microscope, it is seen to be a Cyclostomatous Bryozoon, and I do not at present see any reason for placing it in any other genus than Heteropora.

The zooecial apertures (Fig. 10) are more irregularly placed than in the last species, in which the region of the aperture was only slightly raised; but here it is elevated in a tubular form, and the walls of the cancelli are also elevated. The perforations of the cancelli covers are larger, with the white rim round each hole very distinct. Where this film is removed (Fig. 11) there are spinous protuberances round the aperture.

This is apparently the *Plethopora cervicornis* d'Orb., 'Pal. Fr.,' pl. 799, figs. 4, 5, found in the Sénonien, and which is placed by him among the Cyclostomatous forms, but until I discovered this recent one I had always supposed the figure represented a worn specimen of Cellepora, similar to the one already mentioned.

Heteropora cervicornis d'Orb.

Plethopora cervicornis d'Orb., 'Pal. Fr.,' vol. v. p. 1045, pl. 799, figs. 4, 5.

Zoarium incrusting stalk of seaweed, raised into irregular ridges. Zooecial aperture crateriform ; cancelli, mostly one series round the zooecium, covers perforated with few large holes.

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* There are from the same locality stems of varying sizes, some not more than half the diameter figured, but whether they are all the same species I cannot say with certainty. If the material had been my own, I should have chipped fragments off all and made detail examination, but this could hardly be allowed in a national collection, and I have to thank the Museum authorities for allowing me to make sections of a broken fragment.

† I take this opportunity of saying I hope shortly to carefully study the Australian recent and tertiary Bryozoa, and shall be glad of any assistance that naturalists can give me.

Hab.—Chalk. Environs de Tours (d'Orb.). Recent. Adelaide.

The genus Heteropora has been found in the Jurassic of England and France, and the external appearance of *H. lepida* Novak.,* is much the same as that of the recent species. The genus was also frequent in the Maestricht chalk. *Heteropora dichotoma* and two other species are mentioned by Reuss and Manzoni, from the Miocene of Austria and Hungary. Busk mentions several species from the Crag, and the American tertiaries have also yielded it, but it does not appear to have been previously found recent.

Besides the interest of the genus occurring recent, the striking similarity in shape of *H. pelliculata* and *cervicornis* to Cheilostomata taken in the same hauls is a most curious fact.

* "Beit. z. Kennt. der Bry. der böhm. Kreid.," 'Denk. k. k. Ak. Wissensch. Wien,' 1877, vol. xxxvii.

XXV.—*Note on Homogeneous Immersion Object-glasses.*
By F. H. Wenham, F.R.M.S.

(Read 14th May, 1879.)

As the homogeneous immersion object-glass is revived as a recent idea, I quote from a paper contributed by me to the 'Monthly Microscopical Journal,' June 1st, 1870, the following comment in favour of homogeneous immersion. "One advantage in the immersion objective is, that it almost prevents the loss of light from the reflection of the upper surface of the cover and front of lens, and in part neutralizes any error of figure and polish that may exist between them. There is also another condition annexed; it has the singular property of *a front lens of adjustable thickness,* and therefore can be set to the utmost nicety to balance the aberrations. Of course there is no optical advantage attendant upon the use of *water.* If a medium of the same refractive power as the glass were to be employed, the result would be better. Water having a low refractive index, an adjustment is required for each thickness of cover, and a difference of adjustment is not so marked and sensitive as in the ordinary dry objectives; but if a medium of similar refraction to the glass were to be used, no adjustment would be required for any thickness of cover, supposing the test objects to be mounted thereon (which they generally are); for, in fact, we should then view them all with a front of the same thickness—considering the cover, the front lens, and the interposing medium as one." *

[Since the above was read, Mr. Wenham has sent us the following additional note on this subject.—Ed. 'J.R.M.S.']

In the 'Quarterly Journal of Microscopical Science,' No. 11, 1855, p. 303, I described as part of the system of an object-glass, a front lens connected with the slide by an intermedium of Canada balsam; of this I say, "It will be seen from the position of the object, that each ray of light passing from that point through the surface of the hemisphere, will be transmitted in straight lines in a radial direction without undergoing any refraction; the consequence of which is, that the full and undiminished aperture of the object-glass is made to bear upon the object." Of the actual performance obtained by this object-glass (a $\frac{1}{5}$), I say on the next page: "When an object is seen under these circumstances, it at once shows the great increase of distinctness that is to be obtained in the structure of the more difficult Diatomaceous tests when they are thus viewed in Canada balsam with the full aperture of the object-glass. Markings which in the neighbouring dry objects of the same character are scarcely discernible, are sharply and distinctly visible under the balsam hemisphere, with the same illumination."

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* The discussion on this Note will be found at p. 494.

NOTES AND MEMORANDA.

ZOOLOGY.

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

Primitive Stripe in the Chick.—The so-called primitive stripe, or groove, had a future ascribed to it by the earlier embryologists, which the more modern authors regard as belonging to a different set of embryonic structures : to the elucidation of this question, Dr. Mathias Duval has lately * devoted himself. Messrs. Foster and Balfour, in their ' Elements of Embryology,' remark that " by the earlier observers the primitive groove was supposed to become converted into the medullary canal. Dursy (' Der Primitivstreif des Hühnchens ') was the first to give a correct account of its disappearance ; and the distinction between it and the medullary groove has since been fully recognized by many observers." In addition to information which confirms this view of Dursy's, M. Duval describes the characters of the adjoining regions.

Bearing in mind the difficulty as to the exact stage at which an embryo may be found to have arrived, a difficulty which is not lessened but rather increased by information as to the exact length of the incubation period, M. Duval has not contented himself with merely stating the number of hours. Imagine two embryos found at exactly the same stage of development, but that one has been seventeen and the other twenty-one hours in incubation. It is obvious that the ready method, ordinarily adopted, of regarding the one as being some stages behind the other, would easily lead to a belief in the succession of certain changes, such as that which was asserted to obtain with regard to the primitive groove. Another method of examination had therefore to be adopted. Having obtained a series of blastoderms, of which he had registered the length of the incubation period, M. Duval examined them by surface view, and chose them out by pairs ; of each pair one remained intact and easily adapted to inspection, while the other was hardened and stained,—and cut into sections ; these sections, again, were not registered as being cut from an embryo of a definite age, but from one (A, B, and so on) of which he had a corresponding and intact example.

The developmental period which was studied, was found to be divisible into three groups ; one was from the fourteenth to the twenty-second hour of incubation ; the second from the twenty-second to the thirty-second ; and the third from the thirty-second to the fiftieth hour.

In the first period, inspection reveals the presence of an embryonic " spot," which may be divided into two regions ; to the more anterior and smaller part the name of *tergal zone* is given, while the rest forms the *primitive line*, and, later on, the *primitive groove ;* the zone grows but little during this period ; in it the epiblast is alone well defined

* ' Ann. Sci. Nat. (Zool.),' vii. (1878) Nos. 5–6.

the remaining parts forming merely a series of irregular masses of small spheres, in which, in fact, the processes of segmentation are being still carried on.

The history of the primitive line during this period is altogether different; not only does it increase in size three or four times, but it presents an altogether distinct hypoblast-layer, while the epiblast is seen to be connected with cells, which will ultimately form the mesoblast; at the fourteenth hour the primitive line is simple and homogeneous, and it is with difficulty that a faint depression can be observed; at the nineteenth hour the pit of the fourteenth has become a long groove. Running along this line or groove there may be observed a delicate filament, for which the name of *epiaxial filament* is now proposed; for this structure Dursy had proposed the name of *axial*, and his observations are quoted and corrected in some details, the correct apprehension of which the French embryologist ascribes to the use of osmic acid.

In the second period the primitive groove undergoes no changes of any importance, but in the tergal zone certain modifications obtain, which lead to the formation of the medullary groove and of the dorsal cord; these changes commence with the great increase in size of this region; the cells of the mesoblast extend outwards towards the sides of the embryo, and also form a condensed mass at the level of the bottom of the medullary groove; this mass is the future chorda dorsalis. Much of what happens in this period, as in the succeeding one, could only be rendered intelligible by the aid of a number of figures.

Of the third period, the most important characters are the continuation of the metamorphoses of the tergal zone, and the retrograde development of the primitive groove; the author refers to what he has already stated as to the fourth ventricle of the brain, and the so-called rhomboidal sinus, and insists on the fact that the medullary groove is completely closed along its whole extent, so that the two regions just mentioned owe their origin to modifications of the central canal of this part.

Dr. Duval concludes his paper with three statements; the first, in which he definitely states that the primitive groove ought to be absolutely distinguished from the medullary groove, and that these parts have different periods of, and different regions for, their development, is accompanied by a detailed criticism of the works and statements of earlier embryologists; in the second, he deals with the history of the three layers of the embryo, and shows that the course of development of these three is different in the tergal zone to what it is in the parts posterior to it; and he brings this to bear on the statements of Remak, Waldeyer, Goette, Balfour, and Durante, who assert that the mesoblast is developed from the hypoblast; of Kölliker, who ascribes to the former of these two layers a purely ectodermal origin; and of His, who would regard the epiblast and hypoblast as both being the seat of origin of the mesoblast.

The third statement is that the chorda dorsalis is solely formed from the tergal zone and in front of the primitive groove, and that it is formed from the hypoblast, or at any rate has the same origin as

the mesoblast, with which layer its earlier stages of development are most intimately bound up.

Evolution of the Male and Female Genital Glands of Mammalia.—M. Ch. Rouget gives * a short account of his work on this subject, from which there is so much still to be learnt that is of great importance in any comprehensive or correct account of the structure and relations of the group.

So soon as the common rudiment of the genital glands gives rise to those peritoneal cells which invest the genital layer, and these cells thicken (twelfth day in the rabbit), a number of cylindrical cells with large nuclei are found among them (primordial ovules); gradually they pass inwards and become connected with the so-called *segmental cords*, in which they form lines, the separate elements of which are separated from one another by masses of small cells. The first sign of sexual differentiation is the disappearance of the ovules of the epithelial layer, and the formation of the earliest rudiments of the *tunica albuginea*. From the sixteenth to the twentieth day the number of ovules increases rapidly, and that the more in the male; the primitive cells, with an ovoid nucleus, form a reticulum for the ovules in the female, and seem to be the rudiments of the flattened cells of the primordial follicles. In the cortical portion there are small cells, which increase very rapidly in the male; the ovules persist even during infancy in the male glands, and appear to form the large cells, to which La Valette St. George has given the name of *spermatogonia*. The important point, then, that the ovules are essential elements of the testicle, which was first shown by Balbiani to be true of the Plagiostomous Fishes (and more recently of a young sheep), may be fairly extended to all mammals at any rate, as M. Rouget has observed them in the human embryo, in rabbits, cats, and dogs.

Natural Science Prizes of the Brussels Academy.—The subjects for the Natural Science prizes of the Brussels Academy for 1880 are the following :—

1st. (A geological subject.)

2nd. " Explain the history of the germinative vesicle in ova capable of developing by parthenogenesis." The author to choose the object of his essay amongst the different species of animals in which parthenogenetic development has been positively established.

3rd. " New observations are required on the relations of the pollen-tube with the ovule in one or more phanerogams."

The value of the medals to be awarded are 800 francs each, and the essays must be written in French, Flemish, or Latin.

Cells and Nuclei.—Dr. Klein continues, in the ' Quarterly Journal of Microscopical Science,' † his observations on the structure of cells and nuclei, forming Part II., and dealing with the epithelial and gland-cells of mammals. This was written before the appearance of Professor W. Flemming's article on the same subject in the ' Archiv

* ' Comptes Rendus,' lxxxviii. (1879) 602.
† ' Q. Journ. Micr. Sci.,' xix. (1879) 125.

f. Mikr. Anatomie,' * which is referred to by Dr. Klein in a postscript, in which he points out that Flemming's views on the structure of cells and nuclei and the relation of the two do not in some respects coincide with those already expressed by himself. In the third and concluding part of his observations, he proposes to discuss in detail these differences.

B. INVERTEBRATA.

Invertebrates of Kerguelen's Land.—Professor Studer gives some account † of the results of his stay in this island, the fauna of which appears to offer some very interesting peculiarities; four new species of *Cladocera* are described and figured, one of the *Ostracoda*, and two *Copepods;* some remarks are made on the anatomy of *Brada mammillata* Grube, which, it is concluded, belongs to the *Pheruseidæ* of Grube, although it differs from them in the want of tentacles and branchiæ; its coiled enteric canal, the gastric cæcum, and the white excretory glands are all points of resemblance; the animal is distinguished by the presence of tubercular skin-glands, which form a secretion by which particles of sand are united together to form a closely fitting investment for the animal. A new species of the interesting Chætopod genus *Ophryotrocha* is also described (the specific name proposed is *Claparedii*); the two segments next to the head carry no appendages, and are merely provided with a circlet of cilia; the next following all carry lateral foot-stumps; the labrum was simple and toothless, while the lower jaws carried seven projecting tooth-like ridges; the cephalic lobes have only one band of cilia; this latter is of especial interest, as being an organ which has not been lost, as it has been in most annelids, during the passage of the creature from its larval to its adult state; the condition of maturity was indicated by the presence of ova.

In a later contribution,‡ Studer gives a list, with bibliographical and other remarks, of all the animals known to live in Kerguelen's Land and the surrounding sea.

Mollusca.

Blood-cells of the Acephala.—The cells of the blood of *Unio* are ordinarily found to be amœboid in character, and provided with a large number of sharply-pointed pseudopodia; the plasma is colourless and not highly refractive; they vary in size in various Lamellibranchs within comparatively wide limits; they are generally provided with a single nucleus, which is small as compared with the size of the cell, and is granular; a number will be observed to contain fatty matter. The most striking point, however, is their tendency to develop long processes, while under observation, and with these pseudopodia they may manage to unite themselves into masses of a considerable size. To the question as to how far this was a natural occurrence, Flemming has addressed himself.§ A drop taken by the aid of a pipette from a

* See this Journal, ii. 137.
† 'Arch. f. Naturgeschichte,' xliv. (1878) 102.
‡ Ibid., xlv. (1879) 104.
§ 'Archiv f. Mikr. Anat.,' xv. (1878) 243.

fresh pulsating heart did not present any blood-cells with processes of any great length, but in about a minute observation revealed their presence; the same results were obtained with blood taken from the vessels, and the conclusion is arrived at that in the circulating blood the cells only give off a few and those short processes; it is obvious that the presence of large conglomerate masses would effectually stop up the smaller blood-vessels, and it is observed that it is rare for such masses to be observed in fresh blood.

At times a few immobile bodies without processes, and of a smaller size, were also observed; these might be rounded or formless, and present or not present distinct nuclei.

Later Stages in the Development of Fresh-water Mussels.—M. Blanchard gives * an account of Max Braun's observations.† These were rendered successful by cutting up the gills of a female Anodon, and so separating the embryos therein contained, and placing them in an aquarium in which were a number of fish; on these Vertebrates the embryos soon fixed themselves and attained their adult stage in something over seventy days. Having fixed themselves by their byssus-threads, the so-called *Glochidia* fasten their shells into the fins or other parts of their hosts; the inflammation so started gives rise to a proliferation of epithelial cells, in which the larvæ are soon encysted. As may be imagined, observations on their development were thus rendered easy, and Braun is able to state that the byssus-gland soon disappears, that the single adductor muscle of the valves, having become double, soon makes way for other organs, while the permanent adductors become developed; the foot appears at first as a cone situated in the middle of the larva, and the pedal ganglia become evident; the median portion of the enteric tube gives rise to two hepatic cæca; the mantle of the embryo, which consists of large cylindrical cells, disappears, and the new mantle, which is made up of small cubical cells, takes its place. This absorption is accompanied by that of the bony ray of the fin to which the embryo had become attached, and the calcareous salts from it appear to go to form the shell of the adult. The generative organs are not developed till later, and when the young is set free from the cyst.

Locomotion of the Terrestrial Gasteropoda.—Heinrich Simroth has an interesting article on this subject,‡ which is one on which little has been done of late, and the views of Bergmann and Leuckart are still accepted by most zoologists. According to these observers the mechanism of locomotion in the common garden snail is essentially the same as in a number of apodal insect-larvæ, with this exception, that the number of waves which pass over the body are much more numerous, and the attachment of the foot to the surface moved over is more complete. There is, of course, no doubt that locomotion is effected by the waves which pass over the foot from behind forwards,

* 'Rev. Internat. des Sci.,' ii. (1878) 634.
† 'Verh. Phys.-Med. Gesellsch. Würzburg,' xiii.; SB., p. xxiv. (4th May, 1878).
‡ 'Zeitsch. f. wiss. Zool.,' xxx. Suppl. (1878) 166.

and that it is more rapid in proportion as these succeed one another more rapidly; but these waves do not seem to be locomotive when the animal is placed on a glass, as it was in Bergmann and Leuckart's experiments, and the only change which then occurs is in the coloration of the organ. So long as the animal is at rest, the foot is all of the same colour, but when it begins to crawl the transverse bands become darker (*Helix*, *Arion*), or of an ashy hue (*Limax*). In *Helix* the waves pass over the whole of the foot anteriorly, and over the great part of it posteriorly; in *Limax* and *Arion* they are limited to the median third.

Some three hundred experiments of the following character were made:—A snail was made to crawl up a glass cylinder and the following points were observed:—(1) The length of the animal; (2) the length of the passage; (3) the number of waves in an equal period of time; (4) how often a wave passed during the experimental period; (5) the length of the period; (6) the weight of the body; and (7) the weight of the foot. Calculations based on these observations lead to the conclusion that "the smaller animals have the greater power of locomotion, and that this law does not apply merely to the smaller genera and species, but also to the smaller and younger individuals of the same species." It is, however, to be noted that in *Helix pomatia* and *H. hortensis* the waves succeed one another less rapidly in the smaller than in the larger examples; and it is concluded that the most successful number of undulations are those of from 30 to 40 centimetres in length. It follows from other measurements that the body moves more rapidly up to a certain point, and that after this an increase in the number of waves is of less use, while it is shown that the smaller number of undulations in smaller animals is, within the limits of this law, of greater physiological value than the higher number observed in the larger forms. The next law stated is now easily comprehensible—the physiological value of the individual waves is inversely proportional to the number of waves which pass over the foot in a given period. From experiments in which the animals had a weight to carry, it is found that within limits they are able easily to do so, inasmuch as the unloaded snails are not able to make use of all their activity.

The voluntary muscles of the *Gasteropoda* are those in the dermomuscular tubes, and those derived therefrom (m. columellaris, and muscles of the tentacles); in formation these seem to be intermediate between the smooth and the striped elements found in the *Vertebrata;* these are the *retractile* muscles, by which the different parts of the body are brought into relation; while the *protrusile* muscles, or those by which locomotion is effected, are the longitudinal muscular fibres of the foot. In *Helix* these extend over the whole of the breadth of that organ with the exception of a small marginal portion; in *Arion* and *Limax*, as might be supposed from what has been already stated, they are confined to the median third. In addition to these there are other fibres which run in various directions, and there is a special layer around the pedal gland, and above it there is a covering of transverse muscular fibres; in the upper half of the hinder portion there is a

longitudinal layer connected with the columella, and of function in withdrawing the animal into its shell.

The retractile bundles are chiefly innervated by the pedal ganglia, which are, moreover, the chief centre for the locomotor muscles also; these pass in two parallel rows into the foot, and are given off to the muscles by pairs, and at regular distances from one another. When a motor nerve is stimulated the muscle-serum becomes less capable of dissolving myosin, and the consequent coagulation, which is always associated with extension of the protrusile muscle, causes a change in the characters of the light reflected from the foot; with each stimulation this coagulated spot varies in position according as different nerve-branches are excited, and this coagulation extends from behind forwards. For further details the paper, which is a very valuable contribution to this branch of physiology, must be consulted; but we may point out that Herr Simroth observes that the difference noted between the living protrusile and retractile fibres is evident also in the dead animal, the former being elongated, and the latter greatly contracted.

Auditory Organs of the Heteropoda.—Professor Claus opposes[*] the views of Professor Ranke on three points: (1) According to this latter observer there are only four auditory cells, in addition to the large central cell; Claus thinks that there are a large number. (2) The structures regarded by Ranke as ganglionic are the concentrically arranged auditory cells in the thickened sensory epithelium, into which the fibres of the auditory nerve pass. (3) There is not a single plate in the relatively large cavity between the central cell and the outer auditory cells, but four large indifferent supporting cells. It is of course impossible to make the differences plain without reproducing the figures, and we must be content with drawing attention to the subject.

Peculiarity in Littorina.—In a paper " On some Australian Littorinidæ "[†] the Rev. J. E. Tennison-Woods says that there is one peculiarity in some members of this genus to which attention has not been drawn by any naturalist, and it is so very common and so peculiar that it must have some relation to the animal economy. It consists of a spiral white or yellow line or groove, which lines the interior of the shell and arises from the anterior aperture, or at the lower part of the labrum or outer lip. Along the groove the organs of reproduction are always exserted whether they be male or female. It is not easy to explain why this portion of the shell is differently coloured, unless it is in keeping with what is noticed in the colouring of certain flowers, butterflies, &c. The whole of the *Littorinæ* have the aperture of dark colour though highly enamelled, and this whitish line is a conspicuous diversity in the appearance, though it would be a very narrow view of the operations of nature to say that its only purpose was to attract.

The author also establishes that the Australian Littorinidæ so

* 'Arch. f. Mikr. Anat.,' xxv. (1878) 341.
† 'Proc. Linn. Soc. N.S.W.,' iii. 55.

closely resemble the European genus *Littorina*, that they cannot be
generically separated from it; that the genus *Risella* should be sup-
pressed as no permanent generic character can be defined in it; that
Tectaria pyramidalis is merely Littorina with a double line of granules,
and that all the Australian species have the groove or line above
mentioned, which is in some way connected with the organs of repro-
duction.

Structure and Physiology of the Octopus.— An extended series
of observations made on this animal at Roscoff are published by the
Royal Academy of Belgium.* Attention has been already drawn in
this journal (pp. 164–166) to the new substance which M. Fredericq
has found in the blood and to the action of the chromatophores; we
may now add an account of the vascular, excretory, and other systems.

Circulatory Organs.—Examined under water, and after the removal
of a small portion of the ventral wall of the mantle and of the visceral
sac, the rhythm of the heart is easily observed; the contraction com-
mences in the peritoneal vessels and vena cava, and passes onwards to
the "venous hearts" at the base of the branchiæ, thence to the
auricles, and thence to the arterial ventricle or heart proper. About
thirty-five pulsations can be counted per minute, and as each takes
about $\frac{1}{35}$ of a minute the contractions overlap more or less. The
action of this organ is not affected by the removal of the peri-
œsophageal ganglion, the section of the pallial nerves, or the extirpation
of the pallial ganglia, and this evidence on the one hand, as well as
the fact that different parts removed from the organism, or the whole
heart removed from water, still continue to beat for a time, point
to the presence of exciting centres in the cardiac region itself. The
contact of the air, mechanical, and still more electrical excitation,
accelerate the action of the heart, on which also certain nerves from
the œsophageal collar seem to have an accelerating or a depressing
action; the former run along the great vena cava, and the moderator
fibres are found in the trunks of the visceral nerves, as was first shown
by Paul Bert.

The latter seem to resemble very closely the pneumogastric
nerves of the *Vertebrata*, inasmuch as section of them increases the
number of pulsations, while weak excitation diminishes them, and
strong excitation brings the heart to a standstill in diastole.

But rhythmical contractility is not confined to the heart and its
neighbouring vessels; the veins, even in their furthest ramifications,
present the same character, as may be well seen by examining an
Octopus into which a little colouring matter has been introduced; two
large veins may then be seen in any one of the arms, which anasto-
mose largely with a number of smaller subcutaneous venous ramules;
along their whole length a wave of contraction may be seen to pass,
which, though apparently irregular for the whole, is quite regular and
rhythmical in any given portion; these beats are altogether inde-
pendent of the central nervous system.

The pressure of the blood in the arteries appears to be very great,

* 'Bull. Acad. Roy. Belg.,' xlvi. (1878) 710.

as it is shown to be equal to 8 centimetres of mercury, whereas in *Testudo* it is only from 30 to 50 mm., and only 70 mm. in *Coluber natrix.*

The lacunæ so common in the vascular system of other Mollusca are here replaced by capillaries, and there does not seem to be in the *Cephalopoda* any means by which the sea-water is enabled to mix itself with the blood.

Excretory Organs —The *Octopus* is provided with peritoneal cæca, which contain a clear, and at times viscid, liquid, which holds in suspension a number of brownish granular bodies, crystals of carbonate of calcium, epithelial cells (and parasites, the most interesting of which is the curious *Dicyema typus* of Van Beneden). There is no reason for supposing that these structures belong to an aquiferous system, as their orifices are ordinarily closed, and the contained liquid is a secretion from the glandular appendages of the veins, and is of the nature of an effete body. M. Fredericq has been unable to find the uric acid which Harless and Bert had found in *Sepia*, but he has discovered in its place the presence of guanine, and he gives, as we need not do, the method by which he proceeded.

Respiratory System.—To deal with the nerves by which the alternate opening and closing of the muscular mantle around the respiratory cavity is effected : all these are given off from the sub-œsophageal ganglionic mass, as may be shown experimentally by first removing the whole of the head, when the respiratory movements cease altogether, and then removing the supra-œsophageal ganglia, when they are in nowise affected. These movements appear to be reflex, as the author states that the pallial nerves also supply the integument of the mantle, and that section completely destroys all sensibility in these parts. Excitation of the peripheral end of the pallial nerve or direct irritation of the pallial ganglia produces energetic contractions, while excitation of the central end of the nerve gives rise to symptoms of distress. Section of the visceral nerves ordinarily arrested the respiratory movements immediately, but excitation of the central end, if sufficiently strong, produced a temporary reaction; this excitation seems to pass to the sub-œsophageal mass, and thence by the pallial nerves ; the former or visceral set seem, among other things, to give sensibility to the branchiæ, and the constancy of the respiratory movements seems to depend largely, if not entirely, on their integrity ; these movements then are reflex, whereas M. Fredericq, like most modern physiologists, regards the action in the Mammalia as *automatic.* The question now arises, how does the respiratory centre, if there is one, of the Cephalopoda act under the irritation of alterations in the characters of its air-supply ? The answer is very remarkable : interruption of the cephalic circulation diminishes and slows the respiratory movements, a stay in poorly aerated water has the same effect, and a return to water from air is not accompanied by an increase, but by a decrease in the number of the respiratory movements.

Digestive Organs.—The contents of the intestine, the secretion of the salivary glands and of the liver, are distinctly acid ; the aqueous infusion of the fresh salivary gland has no action on starch,

whereas that of the liver converts it into glucose, and, in an acid solution, digests fibrin; this latter organ contains no traces of bile acids or pigments, and yet M. Fredericq is unwilling to propose any alteration in its name.

Nervous and Muscular Systems.—M. Fredericq is of opinion that the supra-œsophageal ganglia are the seat of psychical processes and ought to be compared to the cerebral hemisphere of the *Vertebrata;* he states that the sub-œsophageal masses contain the centres for the respiratory movements, the chromatic function, and for the movements of the various muscles of the body; he comes to the same conclusion as Colesanti as to the physiological similarity of a single arm and a decapitated frog; there are in it no true voluntary movements, but the reflex ones are manifested much more energetically.

In chemical composition the muscles seem to resemble those of the *Vertebrata;* the aqueous extract contains an enormous quantity of taurine, and the so-called *idio-muscular contraction* can be very easily caused to appear in the muscles of the mantle.

Neomenia and the other Amphineura. — Dr. Jhering gives * an abstract of the work lately done on this subject, and does good service in pointing out that the name *Solenopus* Sars was published without any description, and that therefore it cannot take the place of Tullberg's name—*Neomenia.* The heart is found to have a similar position—median and dorsal—to that of the same organ in Chiton, but the view that *Neomenia* is hermaphrodite does not find acceptance with Jhering. The observations of Graff on the nervous system appear to point to the natural character of the group *Amphineura,* in the opinion of its founder, who takes occasion to point out that Mr. Dall's palæontological researches confirm his views of the phylo-genetic relations of the *Patellidæ* with the *Tecturidæ.* It may be of interest to note that Koren states that he has known this remarkable *Neomenia* for the last thirty years.

Anatomy of Chiton.—H. von Jhering describes † the results of his own observations on some points in the structure of these eminently interesting Mollusca, and gives a critical revision of the statements of previous authorities. Looked at from his point of view, as, indeed, from any, the importance of these forms cannot be overestimated; our author regards the Chitons as intermediate between the Mollusca proper and the Annelides, and is of opinion that their developmental history is much more similar to that of the just-mentioned *Vermes* than to that of the *Gasteropoda.* It is, indeed, only of late years that these forms have found their proper place in the zoological system; Latreille, in 1820, placed them with the *Trilobites,* and de Blainville, in 1825, with the *Cirripedia.* The observation of Herr Jhering was chiefly turned to the generative and renal organs and the histological charac-ters of the muscular system, during his late stay at the Zoological Station at Trieste; these are his conclusions :—

1. The Chitonidæ are diœcious.

2. The ovarian eggs are enclosed in a follicle; in *C. squamosus* this secretes a spiny chorion.

* 'Morphol. Jahrbuch,' iv. (1878) 147.　　　† Ibid. 128.

3. The ova are fertilized in the ovary.

4. The kidney is a ramified gland, placed at the base of the cœlom, and invested by a ciliated epithelium; it gives off a median and unpaired efferent duct, which opens below the anus.

5. The secreting vesicles of the renal organ are developed in the nucleus of the kidney-cells, and not, as in most Mollusca, in the protoplasm of these elementary parts.

6. The muscular fibres form fibrillar bundles, which are enclosed in a nucleated sarcolemma.

7. These fibrillæ are simple in the pedal muscles, but in those which form the buccal mass there is an anisotropic substance which forms sarcous elements, and these are separated from one another by isotropic substance. The separate fibrillæ do not correspond to one another, so that the " striation " which has been observed in the same region in the *Gasteropoda* cannot be said to exist here.

It is of interest to observe that M. Jhering states that there are striped or unstriped fibrillæ in the adductor muscles of the Anodonta, the portion which *is* striped appearing to be that which effects the rapid closure of the shell.

The paper is illustrated by a plate of sixteen figures.

Phenomena which precede the Segmentation of the Ovum in Helix aspersa.—M. Perez thus describes these phenomena in a paper to the Bordeaux Society : *—The ovarian ova meet, in the diverticulum, the spermatozoids which fecundate them. The germinal spot, at first clear and homogeneous, assumes a cloudy aspect, and two small nucleoli become vaguely visible. Later on, the spot becomes pale and diffluent and the germinal vesicle disappears.

Around the freed nucleoli a radial system is formed of the fusiform body and the two suns (soleils) known to embryologists. The two nucleoli enlarge, and soon acquire a vesicular envelope. It is not long before they are divested of the radial system which they had formed by the contractions of the vitelline mass, which pushes outwards (under the form of polar globules) the radial substance, which is more fluid than the vitellus.

But the two cellular bodies thus enucleated remain in the vitellus, where they are shown with the utmost ease by reagents in the place formerly occupied by the germinal vesicle. They rapidly increase in size as they approach the centre of the vitellus; and at the same time their nucleus decomposes into a great number of nucleoles of unequal size. Then one of them is completely destroyed. The other, undergoing very nearly the same fate as the germinal vesicle, disappears, leaving as its only trace two of the nucleoli which it enclosed. These, becoming free by the destruction of the cell-wall, give rise to a new radial system similar to the first, which becomes the " point de départ " of the segmentation.

Liver and Digestion of the Cephalopodous Mollusca. — From experiments made by M. Jousset de Bellesme on the liquid secreted by the liver of *Octopus vulgaris*, obtained by cutting a perispherical

* 'Rev. Internat. Sci.,' iii. (1879) 280.

portion of the gland and hollowing out in it a cavity, in which the liquid accumulated, he arrives at the conclusion * that the gland called *liver* among the Cephalopods has no functional analogies with the liver of Vertebrates. It is a digestive gland, destined to transform the albuminoid matters *alone*, which these animals make their usual food, and is without action on the fatty and amylaceous matters. He pointed out the same fact some years ago in *Carcinus mœnas* and *Astacus fluviatilis*, and since then M. Plateau has arrived at the same results in his researches on the Arachnida and Myriapoda, so that it may now be considered to be established that the liver of the higher Vertebrata is not represented in the Invertebrata.

The communication of M. Jousset de Bellesme confirms in some respects the researches of Krukenberg on the same subject,† and those of Fredericq.‡ The infusion of the hepatic tissue (of the Poulp), Fredericq says, digests fibrine both in acid and in alkaline solutions, and transforms starch into glucose. Therefore we have here a diastatic ferment, and another ferment acting on the albuminoids which is neither pepsine nor thrypsine (it is a mixture of both, according to Krukenberg), and he reiterates what he previously said of the liver of the slug : § " The so-called liver of the Poulp is a digestive gland, which could be better compared with the pancreas of the Vertebrata." The opinion of M. Jousset de Bellesme differs from the preceding in that he rejects the idea of any action of the liver of the Poulp on amylaceous and fatty matters.‖

In regard to digestion, M. Jousset de Bellesme (in a subsequently published note ¶) says that the superior salivary glands of the Poulp do not exercise any digestive action ; their liquid only serves in mastication and deglutition. As for the inferior salivary glands, their function would be to dissolve the connective tissue without attacking the muscular fibres themselves ; whilst the liquid of the liver, on the contrary, digests the albuminoid matters. The author adds : " After numerous attempts, operating sometimes on fasting animals, sometimes on animals which were digesting, I became convinced that none of the liquids supplied by the glandular appendages are capable of emulsionating fats and transforming starch into glucose. We therefore have to do with an animal which only possesses the power of digesting albuminoid and connective matters, and the fact is all the more remarkable as some of its own organs, the liver, for instance, contain a large proportion of fatty matters." This would be a convincing argument in favour of the opinion that living beings may form fatty matters by the disassimilation of albuminoid matters; but M. Fredericq shows that the liver of the Poulp transforms starch, and emulsionates fatty substances.**

* ' Comptes Rendus,' lxxxviii. (1879) p. 304.
† " Versuche zur vergleichenden Physiologie der Verdauung," in ' Unters. aus dem Physiol. Instit. der Univers. Heidelberg,' i. (1878) 327.
‡ ' Bull. Acad. Sci. Belgique,' xlvi. (1878) 761.   § Ibid. 213.
‖ ' Rev. Internat. Sci.,' ni. (1879) 263.
¶ ' Comptes Rendus.' lxxxviii. (1879) 428.
** ' Rev. Internat. Sci.,' iii. (1879) 271.

Molluscoida.

New Tunicata.—Professor Heller, in continuation of his previous papers on the Tunicate fauna of the Adriatic and Mediterranean, now describes * a number of new species from the Atlantic and Indian Oceans, from the South Sea, and the Antilles ; these, of which there are thirty, belong to the following genera :—*Ascidia* (6), *Rhodosoma* (1), *Cynthia* (6), *Microcosmus* (5), *Polycarpa* (8), *Styela* (3), and *Boltenia* (1). He owes his opportunities to the kindness of Professors Schmarda and Möbius, and to the director of the Museum Godeffroy at Hamburg.

He appears to have been especially struck by the extraordinary similarity of the forms from these very different regions ; not only do all the species belong to known genera, representatives of which are to be found in the European seas, but many of the species examined were absolutely identical with such. Thus, *Ciona intestinalis* was brought from Sydney, as was also the *Styela grossa*, which is not rare at Trieste, while *Cynthia dura*, another Adriatic form, was collected in the Antilles and off New Zealand. The *Microcosmus claudicans*, so common in all European seas, was found in the whole extent of the Indian Ocean and of the South Seas, while it does not appear to be absent from the West Indian region ; and the same remark applies to *Polycarpa pomaria* and *P. varians*. The paper is illustrated by six plates of thirty-two figures.

Arthropoda.

Gall-making Aphides.—The life-history and agamic multiplication of the Aphididæ have always excited the interest of entomologists, and have even attracted the attention of some of the most eminent of our naturalists. With all their vast numbers and their universality, their life-history has, however, baffled the skill of many an observer, and this has been especially the case in the gall-making forms which so disfigure our trees. Researches carried on into the life of the Phylloxera have, however, somewhat cleared the way, and Dr. Riley begins, vol. v. for 1879, of the 'Bulletin of the United States Geological Survey' with some biological notes, in which he recounts the following most remarkable history : It will be remembered that destructive as these insects are, they are most fragile, and languish in confinement, so to trace out all their daily history for a space of over ten months was a labour requiring diligence and perseverance—one that probably would not have been successful had not Dr. Riley been helped by an enthusiastic lady friend. The first species studied is known as *Schizoneura americana*. It infests the leaves of the American elm, sometimes in such numbers as to cause all the leaves to fall. If during the winter the cracks in the bark of an American elm that was badly infested with this leaf-curling species the previous summer be examined, there will pretty surely be found here and there a small dull yellow coloured egg, about ·5 mm. long, probably still covered with the remains of the female's body, quite dried up. Out from this egg will in the early spring be hatched the little crawling creature

* 'SB. Akad. Wien,' lxxvii. (1878) 83.

which constitutes the first generation in a very remarkable series, settling upon the tender opening leaves. This " stem-mother " begins to feed, causing the leaf to swell up and pucker until it at last curls over the tiny form. After three moults, and the temperature being warm, it commences to people the leaf with young at the rate of about one every six or seven hours. The second generation, though they never grow to be at all as large as the stem-mother, are like her in many respects. They accumulate in vast numbers, some of which, scattering, form new colonies. Their issue forms the third generation which are destined to become winged. These winged forms are short-lived, but they lay twelve or more pseudova at average intervals of about half an hour. The young plant-lice from these form the fourth generation, the members of which are very active, running swiftly. They are of a brown colour, and are somewhat like in general appearance to those of the second generation. In this stage they swarm over every portion of the tree, and their necessities cause them to migrate, in which effort masses of them get destroyed. The fifth generation is very similar to the fourth. It gives rise to forms like the fourth, but without wings. These give origin to the sixth generation. All of these acquire wings. These abound in the latter end of June and early part of July. They congregate on the bark, seeking out sheltered cracks or crevices, in which they deposit their young. These form the seventh generation, and are sluggish, of the colour of the bark, the females a little larger than the males. They have no mouth. They live for several days without motion. The female seems to increase in size by the enlargement of her one single egg. Both sexes soon perish, leaving among their shrivelled bodies the shining, brownish, winter egg with which we started; so, after a long series of vegetative reproductions, at last the time comes for the renewing of the race by this zygospore-like body. Surely in this lies a hint to our plant-growers. It would be easier to destroy a single egg than stop a stream of agamic-produced forms extending to six generations.[*]

Buzzing of Insects.—In a supplementary communication on this subject (see vol. i. pp. 276 and 373), M. Perez says that he does not agree with M. de Bellesme in thinking that a conical movement (mouvement conique) of the thorax can produce a sound, because, on fixing the animal with a pin, the movements are very attenuated, without the movements of the wings and the buzzing being destroyed or even weakened. These movements cannot therefore explain the buzzing.[†]

Larval Cases of Phryganeidæ.—Several new forms of *Phryganeidæ*, exhibiting interesting modifications of the larval cases, have been discovered in Brazil by Fritz Müller, who describes them in a letter to his brother Hermann Müller.[‡] He says, " I have lately found several new larvæ of *Phryganeidæ*. The group of *Hydroptilidæ* seem particularly rich in this place in peculiarly shaped larva-cases. Hagen

* 'Times,' 12th March, 1879.
† 'Rev. Internat. Sci.,' iii. (1879) 281.
‡ 'Zool. Anzeiger,' ii. (1879) 38.

only knew of four of these cases. I have already found nine, which must be classed under six quite distinct genera :—

I. Cases resembling mussel-shells, with narrow slit-like anterior and posterior apertures (as *Hydroptila*). They are carried on the sharp edge. (They look particularly like mussels when they are formed of rod-shaped diatoms, which then represent as it were the lines of growth.)

1. Upper and under edges parallel, almost straight ; coated outside with fine sand. Larvæ with three caudal tracheal gills.

2. Of a similar shape but made of algæ or diatoms. Larvæ without gills.

3. The dorsal angle strongly arched ; the case made without the aid of foreign materials.

II. Case formed of diatoms, the sides pressed together, with a narrow anterior and posterior slit ; the edge of the back has two funnels (I call them for the present *Dicaminus*). For entering the pupa stage they are fixed upright, and sometimes whole villages of these cases are found attached to stones. The use of the funnels is evident, viz. to give free entrance to the water necessary for respiration. The larvæ in the small mussel-like cases which have no such tubes, are seen to make, almost continuously, brisk serpentine movements in their cases with the posterior part of their body—with the result of introducing fresh water. The *Dicaminus* larva never does this.

III. Almost cylindrical, coated externally with fine sand. Diminutive tubes, only 2 mm. long and about ·5 mm. in diameter.

IV. Cases attached to movable stalks.

V. Scutiform cases, fastened all round, similar to an egg-case of *Nephelis*, with a small hole at each end.

VI. Flask-shaped cases (*Lagenopsyche* nov. gen.). These are especially remarkable. In distinction to almost all the known cases of *Hydroptilidæ*, the anterior and posterior ends of which are equally and uniformly made use of for the larvæ to creep both in and out of, the cases of the *Lagenopsyche* differ greatly at the two ends, the anterior opening being round, and the posterior a long narrow slit. All the other *Phryganeidæ* look out of the last formed and wide part of their tubes ; *Lagenopsyche* out of the first formed neck of the flask. I know no other instance of the change in position of the pupa in its case (what for it is front, above, and below, for the larva was behind, right, and left). The imago usually creeps out in the first hour or two of the afternoon."

Development of the Silkworm.—A preliminary account of his researches on this subject is published, by A. Tichomiroff,[*] whose chief results are as follows :—

1. The author was able to confirm Bobretsky's observation as to the passage of amœboid cells from the interior to the periphery of the egg, in order to form the blastoderm. This process was best seen on the second day after the eggs were laid. There was no evidence to show whether these amœboid cells originated, according to Bobret-

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[*] 'Zool. Anzeiger,' ii. (1879) 64.

sky's hypothesis, from the egg-nucleus, but it seemed probable that they were formed freely in the interior of the egg after fecundation; in sections of the new-laid egg, small lumps of protoplasm were found, the appearance of which convinced the author that in them the future amœboid germ-cells were to be sought.

2. Tichomiroff differs from former workers at the embryology of insects, in denying the formation of the muscular layer by an invagination of the ectoderm. He states that a temporary sinking in of the outer layer takes place in the position of the future dorsal groove, but that he has never observed a true invagination. The cells of the muscular layer are formed by division from those of the ectoderm, the process taking place at any point in the germ-lamella, and not only in the middle.

The yolk-spheres, with their numerous nuclei, which are seen in all stages of development up to hatching, are true formative cells, at the cost of which the mesoderm grows. They also give rise to migratory cells, the latter being not unfrequently found in the interior of the yolk-cells.

4. To the endoderm, i. e. the epithelium of the midgut, the author assigns a very remarkable origin. When the mesoderm has undergone segmentation, it undergoes complete solution of continuity along the middle line of the germinal streak, so that two distinct mesodermal plates are formed, as in Worms and in some Vertebrates. These mesoderm plates then begin to grow towards the dorsal side of the embryo, forming a pair of lamellæ, which soon separate from the rest of the mesoderm as midgut-plates (Mitteldarmlamellen), and then grow ventralwards as well as dorsalwards. At the same time their most superficial layer of cells become so differentiated as to form the flattened epithelium of the future midgut: the remaining cells become the thin muscular layer. The two midgut-lamellæ then begin to approach each other both dorsally and ventrally: ventrally they soon unite, and so close in the gut below; dorsally, on the other hand, they remain separate for a long time, and undergo an extraordinary change in their mode of growth. Their outer or muscular layer, in fact, begins to grow faster than the inner or epithelial layer, and soon extends beyond the latter, so that now each midgut-lamella consists of two parts—a ventral two-layered plate, united with its fellow below, and a dorsal purely muscular band. The two muscular bands thus differentiated from the midgut lamellæ grow upwards, diverging somewhat from one another, until they are in close contact with the dorsal wall of the embryo, when they curve inwards towards one another and unite completely. In this manner a double tube is produced, having, in cross section, the form of the figure 8. Of the two tubes, which are at first in free communication with one another, the ventral one, composed of an outer muscular, and an inner epithelial layer, becomes the midgut: the dorsal tube, wholly muscular, becomes the dorsal vessel of the insect's blood-system.

5. The silk glands take their origin simultaneously with the tracheæ, and in their earlier stages resemble the latter completely.

6. There are no cephalic tracheæ, the invaginations of the ecto-

derm which take place in the head being the foundations of the internal cephalic skeleton. The latter consists, firstly, of a hollow rod bridging over the occipital foramen, and, secondly, of the chitinous bands which stretch from the foramen to the angle of the clypeus. These bands are hollow, and in the region of the brain are dilated into a vesicle which communicates with the exterior by a tolerably wide aperture.

7. There is a true lower lip which must be looked upon as the serial homologue of the labrum.

8. The thin inner egg-membrane, lying beneath the chorion, is quite evident even in the youngest stages, before the formation of the blastoderm.

9. The cells of amniotic epithelium often send out processes which meet and fuse with the cells of the epiblast, and so form strongish bands connecting the epiblast with the amnion.

10. The tergum of the embryo is formed by a gradual narrowing of the root of the amnion, as a result of which process the cells of the tergal epiderm long resemble the flat amniotic cells.

11. Large cells become separated off from the epiderm, and remain unchanged to the end of the embryonic development, even existing in the young larvæ as lateral cell-aggregations (Zellencomplexe).

12. In the epidermis itself very large nucleated cells are found among the ordinary small cells: probably these have some relation to the development of hairs.

Venomous Caterpillars.—Mr. E. D. Jones, C.E., Corr. Memb. of the Literary and Philosophical Society of Liverpool, relates, in the Proceedings of the Society,* an experiment he made with a caterpillar in Brazil, on 28th February, 1878. The species is not given, but it is described (with a plate) as $1\frac{1}{2}$ inch long, very thick in proportion to its length, and the whole body covered with long red-brown hairs, which grow in tufts arising from the centre of each segment, and at the base of the long hairs are bunches of venomous spines which are quite concealed by the hairs. The body is very soft and fleshy, and of a paler colour than the hairs. The head is very small, and is when eating quite covered with a fleshy mantle formed by the first segments of the body.

Feeling certain it was an exceedingly venomous caterpillar, he determined to sting himself with it.

At 11 A.M. he applied the back of the caterpillar to the back of his left hand, with sufficient pressure to feel the pricking of the spines. In ten minutes he had violent pain in the hand, and the place of contact had swelled up into a white lump surrounded by a dark-red inflamed patch. A few minutes later, violent pain set in under the armpit. At 11.30 a red rash appeared on the inside of the elbow, and this gradually extended up to the shoulder, along the biceps, and down the arm to the place of injection on the hand. The rash was slight, excepting just at the elbow. Soon after 12 there was a sensible weakness of the hand and arm, either an effect of the extreme pain or a distinct effect of the poison. At 12.15 the rash

* xxxii. (1878) p. cii.

began to disappear, and the pain under the arm sensibly diminished. The affected area on the hand began to perspire considerably, and the pain in the injected spot was as violent as ever, burning horribly like a scald. At 1 the armpit pain had nearly ceased, the rash had disappeared, but the pain in the hand was so bad that he could hardly bear it. Boring a hole with a red-hot iron came nearest to the effect in his imagination. At 5, 6, 8.30, and 10, there was diminished pain, though at 1.30 A.M. he awoke with it. Next day it was gone, but the soreness not until the day after. The marks of the points of the thirty-six spines were still visible when he wrote (16th March).

Abortion of the Hairs on the Legs of certain Caddis-flies, &c.— Mr. C. Darwin, writing to 'Nature,' says [*] that several of the facts given in the following letter from Fritz Müller, appear to him very interesting. Many persons have felt much perplexed about the steps or means by which structures rendered useless under changed conditions of life, at first become reduced, and finally quite disappear. A more striking case of such disappearance has never been published. Several years ago some valuable letters on this subject by Mr. Romanes (together with one by himself) were inserted in the columns of 'Nature.' Since then various facts have often led him to speculate on the existence of some inherent tendency in every part of every organism to be gradually reduced and to disappear, unless in some manner prevented. But beyond this vague speculation he could never clearly see his way. As far, therefore, as he can judge, the explanation suggested by Fritz Müller well deserves the careful consideration of all those who are interested on such points, and may prove of widely extended application. Hardly anyone who has considered such cases as those of the stripes which occasionally appear on the legs and even bodies of horses and apes—or of the development of certain muscles in man which are not proper to him, but are common in the Quadrumana—or again, of some peloric flowers—will doubt that characters lost for an almost endless number of generations, may suddenly reappear. In the case of natural species we are so much accustomed to apply the term reversion or atavism to the reappearance of a lost part, that we are liable to forget that its disappearance may be equally due to this same cause.

In the letter (written from Brazil), Fritz Müller says that there is there a locality in which a peculiar fauna lives, viz. the rocks of waterfalls, which are of very frequent occurrence. On these rocks, along which the water is slowly trickling down, or which are continually wetted by the spray of the waterfall, there live various beetles not to be met with anywhere else, larvae of diptera and caddis-flies.

The pupae of these caddis-flies, as well as those living in Bromeliae, are distinguished by a very interesting feature. In other caddis-flies the feet of the second pair of legs (and in some species those of the first pair also) are fringed in the pupae with long hairs, which serve the pupa, after laying its case, to swim to the surface of the water for its final transformation. Now neither on the surface of bare or moss-covered rocks, nor in the narrow space between the

leaves of Bromeliæ, the pupæ have any necessity, nor would even be able, to swim, and in the four species living in such localities which he examined, and which belong to as many different families, the feet of the pupæ are quite hairless, or nearly so, while in allied species of the same families or even genera (*Helicopsyche*) the fringes of the legs, used for swimming, are well developed.

This abortion of the useless fringes is of considerable interest, because it cannot be considered, as in many other cases, as a direct consequence of disuse ; for at the time when the pupæ leave their cases and when the fringes of their feet are proving either useful or useless, these fringes, as well as the whole skin of the pupa, ready to be shed, have no connection whatever with the body of the insect ; it is therefore impossible that the circumstance of the fringes being used or not for swimming, should have any influence on their being developed or not developed in the descendants of these insects. As far as he can see, the fringes, though useless, would do no harm to the species, in which they have disappeared, and the material saved by their not being developed appears to be quite insignificant, so that natural selection can hardly have come into play in this case. The fringes might disappear casually in some individuals ; but, without selection, this casual variation would have no chance to prevail. There must be some constant cause leading to this rapid abortion of the fringes on the feet of the pupæ in all those species in which they have become useless, and he thinks this may be atavism. For caddis-flies, no doubt, are descended from ancestors which did not live in the water, and the pupæ of which had no fringes on their feet. Thus there may even now exist in all caddis-flies an ancestral tendency to the production of hairless feet in the pupæ, which tendency in the common species is victoriously counteracted by natural selection, for any pupa, unable to swim, would be mercilessly drowned. But as soon as swimming is not required and the fringes consequently become useless, this ancestral tendency, not counterbalanced by natural selection, will prevail, and lead to the abortion of the fringes.

Comparative Embryology of the Insecta.—Professor Graber in a preliminary article * gives a brief history of the results of his observations, which appear to be of considerable importance. An examination of the ovarian cell at an early period has revealed the presence, in the centre of the yolk, of a number of amœboid cells, which appear to have been formed by the division of the germinal vesicle ; these " primary embryonic cells " have a relatively large nucleus and a number of nucleoli ; several may be seen to unite with one another by means of their pseudopodia, and they may also be observed to undergo division. The blastosphere always consists of a single cell-layer, and always undergoes " emboly " ; its first differentiation is into two layers only, or, in other words, there is no independent appearance of the mesoderm, which in these forms at any rate always owes its origin to the endoderm (endoblast). The internal germinal cells arise in two ways, some independently of the

* 'Arch. f. Mikr. Anat.,' xv. (1878) 630.

blastoderm, and others from the endoderm; this is well shown in the diagram.

Germinal vesicle
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Germinal cells

Outer germinal cells   Inner germinal cells
(blastoderm)   (primary)

Ectoderm   Endoderm (endoblast)

Mesoderm   Inner germinal cells
(secondary)
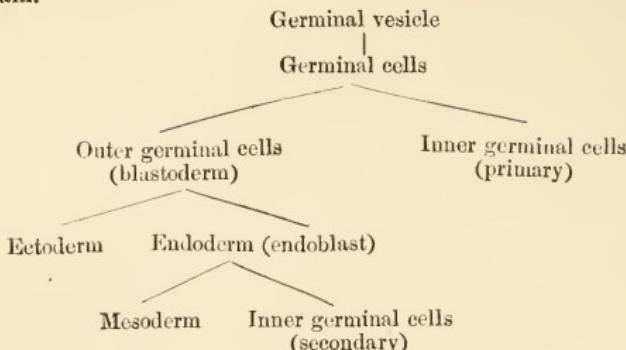
The inner germinal cells, which evidently correspond to the migratory cells of earlier embryologists, may not be observed till a very late stage in development; similar bodies have been seen in the spiders, where they appear to represent the germ of the enteric gland (liver-germ), which is only distinctly differentiated after the embryonic stage is passed.

Investing Elements.—In all the insects examined by Graber, the blastoderm was seen to develop an investing segment, and also to give rise to a cuticle, so that at a certain stage nine layers may be made out in the embryo :—

(1) Tertiary investment of the ovum. Remains of the epithelium of the ovarian follicle.
(2) Chorion. Secondary investment. Cuticle of ovarian follicle.
(3) Vitelline membrane. Primary investment of the ovum. Cuticle of the yolk.
(4) Cuticular investment of the germ. Cuticle of (5) ⎫
(5) External cellular germ-membrane   ⎪ Derivates
(6) Internal   ,,   ,,   ⎬ of the
(7) Ectoderm ⎫   ⎪ Blastoderm.
(8) Mesoderm ⎬ Embryo   ⎪
(9) Endoderm ⎭   ⎭

In some insects (*Butterflies, Carabus*) cavities may be observed between the layers numbered 3 and 4, and between the inner germ-membrane and the peripheral yolk, and these are filled with a substance different to, but developed from, the ordinary yolk.

Tracheal System of Glomeris.—In the first of a series of papers on the morphology and anatomy of the *Julidæ*,[*] Dr. Ernst Voges, of Göttingen, describes the arrangement of the tracheæ in the genus *Glomeris.*

The stigmata, which are situated, in pairs, immediately in front of the attachments of the legs, have a biscuit-shaped aperture, with tumid edges, produced into numerous spiniform prolongations, which form a sort of grating over the aperture.

* 'Zool. Anzeiger,' i. (1878) 361.

Each stigma leads into a backwardly directed tube, which soon divides into two branches. Of these, the inner and smaller is directed forwards, and passes immediately into a trachea: while the outer and larger passes obliquely outwards, backwards, and upwards, and becomes continuous, in like manner, with a large trachea.

The tubes which put the tracheæ in communication with the stigmata differ from the stigmatic pouches of *Julus*, in that the latter are directed forwards from the external aperture. The tubes are probably metamorphosed portions of tracheal stems.

Structure of the Hydrachnida. — Croneberg gives[*] a brief account of his observations, which were originally published in Russian. In all species which he has examined he has found a chitinous framework internal to the labium, which consists of two pieces which bend forwards and unite above the mouth ; these form a chitinous groove which is connected with a system of muscles, all of which go to make up a powerful suctorial apparatus. Above the mouth there are two other chitinous ridges, which enclose the commencement of the two primary trunks of the tracheal system.

The œsophagus passes through the ganglion and then widens out into a large stomach ; it is provided with a number of cæcal sacs, which vary in number from five to thirty-four ; these are all connected together and are invested by an epithelium, which consists of large brown cells, and represents the liver. The fatty body seems to be represented by a layer of smaller and more transparent cells, covering the stomach and the excretory organs. These latter, in all cases, end by a portion which passes directly to the anus, which persists even where the rectum is absent, and the midgut ends blindly.

The buccal glands are arranged in three groups, of which two are racemose and one tubular ; they all three have a common duct. The generative glands vary greatly in character and position ; in *Eylais* they consist of a system of communicating longitudinal and transverse canals, which form a network around the stomach ; there is a single orifice. In *Nesæa* and *Hydrachna* the ovaries are circular in form, but the testes consist of five large pyriform tubes united at their base (*Nesæa*), or of a number of smaller and pedunculated saccules. In all three cases the seminal duct passes into a muscular bulb, and the oviducts run into a wide, muscular vagina.

Acarina found parasitic in the Cellular Tissue and Air-sacs of Birds.—To the general rule that the superficial or cutaneous parasites of animals—the so-called Epizoa—belong to the group of the *Articulata*, and that the internal parasites are *worms*, there are, as might be expected, some not inconsiderable exceptions ; thus there are *Filariæ* which infest the skin, and there are insects (*Œstrida*) to be found in the stomach of the horse, the pharynx of the deer, and in the cranial sinuses of the sheep. M. Megnin, in writing on this subject,[†] makes but brief reference to the *Linguatulidæ*, but these Arachnoids, as they are ordinarily considered, may be referred to in a little more detail as

[*] 'Zool. Anzeiger,' i. (1878) 316.
[†] 'Journ. Anat. et Phys.' (Robin), xv. (1879) 123.

indicating the slight value which can be attached to such broad generalizations as that just stated.

Ludwig Graff, in his work on *Myzostoma* (Leipzig, 1877) proposes to unite that form with the Linguatulida and Tardigrada into a group, intermediate between Arthropods and Vermes, for which he suggests the name *Stelechopoda*. So much on the one hand: on the other, a larval *Pentastomum* (the most important, if not the only genus among Linguatulids) has been found in the human liver, and others in that of the hare and like forms, while the nostrils of dogs and the lungs of the boa are also well-known homes for these curious forms. In the paper now to be examined, descriptions are given of several species of Acari, which have been found in the more internal organs and tissues of birds; the first to describe any of these forms was the Italian zoologist Géné, who, in 1845, gave an account of a form which infested every specimen of *Strix flammea* found in the neighbourhood of Turin; the number found in the tissue underlying the skin appears to have been enormous, but no lesions could be discovered by which they might have entered; the skin, curiously enough, retained its natural colour, and the superjacent feathers exhibited no alteration of form or colour. To this form Géné gave the name *Sarcoptes strigis*, and he compared it with the form, *S. nidulans*, described by Nitzsch; this comparison was not very full, but this again is hardly a matter for astonishment, as it has since been shown that Nitzsch's form was not a *Sarcoptes* at all. The parasite on the Turin *Strix* is described as being only $\frac{1}{10}$ of a line in length, of a pearly white, with the body convex superiorly, and flattened inferiorly.

In 1866 another form was described by Mr. Robertson, of the University Museum, Oxford, who discovered it in the pigeons which were provided for the instruction of the students of that Institution; this was said to be visible to the naked eye, white and vermiform; its chief abode was the subcutaneous connective tissue around the great veins of the neck, and the region of the pericardium. A critical study has shown that Robertson's form was described by Filippo de Filippi in the year 1861, under the name of *Hypodectes nycticoracis;* in 1872 M. Slosarski, of the University of Warsaw, examined the parasite of the pigeon, and, while giving a new name, confirmed the statements of the Oxford anatomist as to the absence of distinct internal organs, and of the large quantity of granular vesicular sarcode which filled its interior.

The observations of M. Megnin himself were commenced at the instigation of M. Alph. Milne-Edwards, in the same year (1872), and the bird examined was *Lophyrus coronatus*. Here the forms described by Robertson and Slosarski and by Professor Géné appear to have been found together. As it is impossible to give a detailed account of his observations, we will deal with the more interesting of the two; this was not half the size of the other, the mouth was much more rudimentary, the integument smooth and diaphanous, and no trace of an anus was evident; this curious form can only be explained by reference to the life-history of the *Acarina*, in which there are a succession of stages, which are nothing less than

veritable metamorphoses; when the larva is on the point of passing to its second stage, it becomes altogether inert, all the internal organs become resolved into a semi-fluid substance, which envelops a kind of *blastodermic membrane*, which behaves exactly as the blastoderm of the eggs, and gives rise to swellings which develop into new appendages, and which are themselves arranged just as are the appendages of the developing larva; soon casting its envelope, a new and larger Acarus appears, but the rejected envelope exhibits all the former organs of the larva, empty and discoloured; this curious rejuvenescence may be effected in the space of twenty-four hours.

In the normal course these changes, the essential characters of which are the same in all moults, pass through the following cycle: ovum, larva, normal nymph, sterile female, ovigerous female. When the course is altered in any way, the form in most cases dies down at once, but there are certain species which escape, thanks to a method to which M. Megnin, its discoverer, has given the name of *adventitious metamorphosis*.

This is what occurs with *Pterolichus falciger*, a form which infests pigeons; when the pigeon moults with great rapidity, and loses nearly all its feathers, the normal nymph, instead of becoming a male or sterile female, gives rise to a worm-like form, and passes to the cellular or peritracheal tissue, which is especially loose in these birds; here it lives for a time and increases in size, passing again towards the integumentary tissue only when the ordinary conditions of its existence are re-established. It was apparently forms which in this stage which fell under the observation of Messrs. Robertson and Filippi.

After a description of acarine parasites of the gallinaceous birds, M. Megnin gives an account of the form found in the air-cavities; this specimen does not appear to belong to the *Sarcoptidæ*, but to be the representative of a new group, of which it is at present the only known genus; M. Megnin finds that it is provided with a conical rostrum, which is perforated anteriorly, and which is formed by the fusion of the maxillæ, the labial palps, and the mandibles; he names it, on account of its mode of life, *Cytoleichus* (κυτός = cavity, and λείχω = lick up); living as it does on the walls of the cavities which it inhabits, it does not seem capable of producing any inflammation of these parts. The species has, on account of its form, the name *Sarcoptoides*; it is described as ovoviparous, and an account is given of its male, young female, nymphs, octopod and hexapod larvæ. The form is found in the air-sacs of the *Gallinæ*, and especially of the *Phasianidæ*, where it lives in colonies; the individuals are of a relatively large size, and of a white colour. It is only dangerous in excess, when it may produce cough, and, perhaps, asphyxia.

On some Genera of Acarina.—Haller's two papers on this subject [*] are reviewed by Megnin; [†] the first is a revision of the genus *Analges* (*Dermaleichus*). It may be interesting to note the earliest observations

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[*] 'Zeitsch. f. wiss. Zool.' (1877).
[†] 'Journ. Anat. et Phys.' (Robin), xiv. (1878) 107.

on these forms, which were made by Redi (1728), C. C. Cuno (1734), de Geer (1783), and Hermann (1809); as at present regarded, there are two (subgeneric) sets of forms in the genus *Analges*; in one (*Chelopii*) the third pair of limbs are of great size, and provided with a tubercular process to the second joint, which takes part in the formation of a strong pincer; in the second group (*Pachycnemici*) this tubercle is absent, although the appendages in question are of an enormous size. Haller recognizes four species in the former, and nine in the latter group; but Megnin looks upon three of these latter, one of which is a new species (*Certhiæ*), as all belonging to one species, while the two new species of Haller (*affinis* and *coleopteroides*) are regarded as belonging to the *A. corvinus* of Robin and Megnin.

In his second paper Haller describes two new genera of avicolous mites—*Freyana* (dedicated to Professor Frey) and *Picobia*; the former Megnin is inclined to regard as a sub-genus of *Pterolichus*; the second, which was found under the integument of *Picus canus*, appears to be allied to *Myobia*, although it has, according to Megnin, affinities to the parasitic *Chyletidæ*.

Parasitic Chyletidæ.—M. Megnin makes * some very interesting remarks on parasitism, in which he founds a new division of these forms; as is well known, Van Beneden has pointed out the differences between their habits of life, and has grouped them as (1) Commensal, (2) Mutual, (3) Parasitic; on these there is no need to insist, but the new class to which the name of *auxiliary parasites* is given must be briefly described. The author one day chanced to enclose with some *Listrophora*, which belong to the second group, two *Chyletidæ*, which, although of about the same size, are very much more active; these he observed to set on the *Listrophora*, to kill them, and suck their juices. These, then, are truly auxiliary parasites; truly so it should be said, inasmuch as the African "beef-eaters" which extract the larvæ of the *Œstridæ* from the back of oxen, buffaloes, and gazelles, or the falcons of South America, which perform a similar service for the llamas, do not live solely on the parasites of these animals.

A word is said as to the views of Van Beneden on parasites proper. This author states that "the presence of several tæniæ in the human intestines constitutes 'un état de santé enviable,'" but it is pointed out that various Ungulata and even Carnivora can and do fall a prey to these parasites; and it is therefore proposed to divide the forms into an inoffensive and a dangerous (pathogenic) group.

A number of forms are described in detail and figured, and some remarks made on their physiology, of which the following are the more important points :—

Differences in Form.—On a superficial view these are very striking, but the differences exhibited are only to be observed in those structures which come into relation with the host.

Digestive Apparatus.—The mouth is essentially a conical sucker, formed by the fusion of the labrum and maxillæ; the enteric tube is straight, and is but rarely provided with cæca; the anus is very

* ' Journ. Anat. et Phys.' (Robin), xiv. (1878) 416.

small. In *Harpirhynchus* this latter is absent, owing, apparently, to the mode of life of this animal, which feeds itself on the product of the sebaceous glands of its host, and gets rid of the effete gases by means of its tracheal system.

Respiratory Organs.—The tracheæ are very well developed, and are made up of two principal trunks which open near the rostrum. The stigmata have a screw-shaped form, thanks to which the entrance of foreign bodies is very effectually prevented.

Generative Organs.—The male organ is always placed behind the anus, where this is apparent, and the female organs occupy the same position in two species; curious as this fact appears to be, we must remember that in the *Hirudinea* and even *Annelides* the position of the genital orifice may vary very greatly.

Organs of Relation.—The appendages differ in even different species, owing to the different modes by which the possessors are connected with their hosts; in the genus *Chyletus* these variations are confined to the terminal portion of the appendages; in *Harpirhynchus* the hinder ones are greatly reduced, and in *Myobia* they are very delicate.

Intimate Structure of the Central Nervous System of Decapodous Crustacea. — M. E. Yung describes * the nervous system of the Crustacea as composed of fibres and cells. The fibres always present an envelope and contents. Contrary to the opinion of Remak, fibrillar bundles are never found homologous with the cylinder-axis of the nerves of Vertebrates. The fibrillar structure does not appear until after the action of reagents. The contents of the cells are also surrounded with an envelope, and are in all points similar to those of the tubes. There is a nucleus (sometimes two) enclosing one or more nucleoles, which contain in their turn nucleolules. The cells are apolar, monopolar, and bipolar. They are rarely found with three prolongations. With reagents they behave in the same way as the fibres. The latter are, in fact, nothing but cellular prolongations. The elements grouped in the commissures and the ganglia are surrounded with a double envelope of connective tissue. The brain seems to be formed of three pairs of ganglia.

Functions of the Ganglionic Chain in the Decapodous Crustacea. —In a note in a late number of the 'Comptes Rendus,' † M. Yung says that the functions of the ganglionary nervous system of the Arthropoda are still little known. He has studied them in the higher Crustacea (lobsters, crabs, &c.), always making use of living animals, and having regard, in the interpretation of the results, to the influence of the operation, and the circumstances under which it has taken place. There are a number of causes of error in these experiments which explain the divergences of opinion amongst previous authors, and which are to be avoided by operating not upon one only but upon many animals.

* 'Comptes Rendus,' lxxxviii. (1879) 240; 'Rev. Internat. Sci.,' iii. 160.
† 'Comptes Rendus,' lxxxviii. (1879) 347.

The following are the results of M. Yung's observations :—

The ganglionic masses and the commissures which unite them are evidently sensitive throughout the chain ; the sensibility is the same on the superior, inferior, and lateral faces.

The roots of the nerves radiating from the chain are both motor and sensitive, contrary to the classical opinion of Newport, Valentin, Longet, &c.

Each ganglion is a centre of sensibility and of motion to the segment of the body to which it belongs; but the sensibility becomes "*inconsciente*" and the movements reflex when the ganglion is separated from those which precede it.

The sub-œsophageal ganglion is the motor and sensitive centre for all the masticatory elements and the foot-jaws.

The brain or supra-œsophageal ganglion is sensitive on all its faces, contrary to what prevails among insects, whose brain, according to M. Faivre, is insensitive.   It plays the part of motor and sensitive centre for the cephalic appendages (eyes, antennæ).

Each right and left side of the brain acts upon the corresponding part of the body, and it is the same with the other ganglia of the chain.   There is no interlacing in the course of the nervous fibres.

The removal of the brain causes the toppling movement forwards, which arises from a want of equilibrium, resulting from the insensibility of the cephalic appendages, and from the predominance of the movements of the posterior members.

The movements which continue after the total removal of the brain, and which in certain cases have a character of spontaneity, are never co-ordinated.

The lesion of one of the lobes of the brain produces "mouvements de manége" from the injured side towards the other.

The brain is the seat of the will and of the co-ordination of movement.   It has no direct action on the movements of the heart.

The movements of the heart are accelerated by electrical excitation directed to the commissures of the œsophageal ring, whence the current travels to the stomato-gastric ganglion and the cardiac nerve (the nerve described by Lemoine).   They are retarded by the electrical excitation of the thoracic ganglia.

Male Organs of the Decapodous Crustacea.—The new Zoological Station at Trieste is already bearing good fruit, an example of which is to be found in the long and elaborate paper on this subject, * illustrated by six plates, by Dr. C. Grobben.   The state of science during a long period is well illustrated by the fact that no one seems to have taken any interest in the subject to which Dr. Grobben directs attention, between the time of Aristotle and 1750, about which time Portius and Von Rosenhof examined the male organs of the crayfish.

A. *Internal Organs.*

I. Position.   In the *Thoracostraca* the testes are always placed superiorly to the intestine, and in all, except the *Paguridæ*, between this organ and the heart ; in the *Stomapoda* they are placed in the

* 'Arb-it. Zool. Inst. Wien-Triest,' i. (1878) 57.

abdomen; in the *Schizopoda* and *Macrura* in the thorax; in the *Galatheidæ* they extend in front of the digestive stomach, and in most *Brachyura* they reach to the very anterior portion of the branchial cavity; the efferent ducts ordinarily open at the coxa of the last pair of thoracic feet.

II. Structure. In all *Decapoda*, with the exception of the *Paguridæ*, the testes consist of paired parts and an unpaired piece; they are generally divided into anterior and posterior lobes, but the unpaired portion varies greatly in position; in *Astacus* it is represented by the unpaired hinder lobes, but as a rule it forms one, and in some cases two, connecting pieces set transversely.

These organs are simplest in structure in *Squilla mantis*, where they form a tube, the walls of which bulge out into inconsiderable cæca, which are invested by a sperm-producing epithelium; in *Athanas*, among the *Decapoda*, the testes are merely elongated sacs, but the spermigenous epithelium invests regions only of their walls. As the sac elongates, the germinal region becomes broken up, and the testicular tubes attain to an acinous character; this is seen e. g. in *Palæmon*, and further stages of complication are observed in *Alpheus*, in *Astacus*, and in *Homarus*. The testes and efferent ducts are always invested by connective tissue, which varies a good deal in character: in *Homarus* it is very well, but in *Astacus* it is very feebly developed. In various forms, striated muscular fibres were observed in the walls of the testes, the presence of which is explained by the fact that one-half or two-thirds of the testicular tubes here form merely efferent ducts.

Two sets of elements are distinguished in the germinal elements; the one set forms large cells with a large rounded nucleus—spermatoblasts; the other forms a protoplasmic mass in which no cells can be made out, but merely a number of nuclei interposed between the bases of the spermatoblasts; these nuclei, which vary greatly in form, stain very readily; these are the reparative germs, so called because they appear to take the place of the effete spermatoblasts; the difference in these two sets of elements is not to be observed in the young, in which indeed the reparative germs alone appear to be present in any quantity, and what difference there is finally, is shown to be no greater than what obtains in the case of the ovarian cells and the cells of the ovarian follicles; just as each follicular cell is potentially an ovarian cell, so the reparative germs are potentially spermatoblasts; these latter are formed by the metamorphosis of the reparative germs, just as the ovarian cells are formed from those of the follicle. These considerations support the doctrine of the homology of the testis and ovary, as do also the presence of reserve matters in the spermatoblasts, and the striking similarity of the structure of these two organs in such forms as *Eupagurus* (P. Mayer).

III. Structure and development of the seminal corpuscles. As is well known, these bodies are markedly distinguished by their "radiate form," but it is pointed out that the equally common belief in their motionless character has certain exceptions; the simplest arrangement is found in *Squilla*, in which too their history is most easily followed out; an elaborate examination leads to the conclusion

that in the *Macrura* these bodies are larger than in the *Brachyura*, and within the limits of any group the spermatozoa seem to be proportional in size to the general size of the body; greatly as they vary in size, they vary in form still more, and the dictum of Wagner that the Vertebrate spermatozoa may even vary in various species, may be completely applied to the *Decapoda*, and the influence of this variation on the preservation of species is insisted upon, inasmuch as it is obvious that the more the spermatozoa vary in character, the less will they be able to set up the molecular changes by which fertilization commences, in the females of other species than their own; and further, those species are most likely to be preserved that have highly differentiated spermatozoa.

The sum of the rays appears to be homologous with the flagellum of the Vertebrate spermatozoon, and it is pointed out that immobile spermatozoa are never found in any animal in which chitinous structures are not developed.

IV. Vasa deferentia. The author distinguishes in these three chief regions: (1) An efferent portion, which is delicate; (2) a broader glandular portion, and (3) a *ductus ejaculatorius*, which is ordinarily provided with a very powerful musculature. This duct may give rise to lateral dilatations of various sizes, which seem to provide a menstruum for the sperm. Their presence has been frequently denied.

V. Spermatophores. All the *Decapoda* examined by the author form spermatophores, the envelope for which is ordinarily formed in the vas deferens; in *Astacus*, this envelope is of a dead-white colour, which hardens in the water, while the envelope of *Homarus* swells up under the same conditions. In form these spermatophores vary greatly: they are bluntly conical in *Scyllarus*, stalked in *Eupagurus*, pouch-shaped in *Porcellana*; in other *Brachyura* there is no special form for the different members of the group, and in *Dromia* there can hardly be said to be a spermatophore at all.

B. *External Generative Characters.* — As is well known, there is an easily recognized difference between the male and female; of the accessory generative characters by which this is effected, some are due to the development of other organs, such as the ovary, and may be shown to owe their origin to natural selection; others are due to the development of parts which have for their purpose the safety of the sperm or of the young, and these have a similar origin; others, again, are due to sexual selection, such as the offensive organs formed by the appendages of the males, or their coloration; while the last set of all are dependent on the different modes of life of the two sexes.

C. A few brief observations are made on the vascular supply of the generative organs, in which the antennary and sternal arteries take a large share: a species of *Distomum* was observed in the vas deferens of *Portunus depurator*.

Central Nervous System of the Crayfish.—In a brief communication,[*] consisting of histological and of morphological observations, Krieger states that the *perineurium* consists of a firm membrane, in

* ' Zool. Anzeiger,' i. (1878) 340.

which a number of interlaced bands and elongated connective-tissue nuclei can be made out. The name perineurium is applied to the general investment of the nervous system, while that of *neurilemma* is applied only to the coverings of the separate nerve-fibres. The tissue ordinarily known as the outer neurilemma is stated to belong to the connective tissue of the body cavity. As to the nervous elements, he agrees generally with Dietl, but he finds a number of nucleoli in the nuclei of the large ganglion-cells, and also notes that the "tubular" nerve-fibres do not appear to be formed of primitive fibrillæ, but to be composed of a strong sheath containing a clear viscid fluid.

The dotted substance of Leydig is found to be composed of a number of distinct spheres, which are arranged in pairs, which, again, are ordinarily connected by a transverse commissure, or a bridge of dotted substance. Each sphere gives off a peripheral nerve, or a component part of one. Of these spheres there are eight in the cerebrum. The anterior give off fibres for the optic nerves; of those that succeed them, the outermost provide for the outer antennæ, and the others for the inner antennæ and optic chiasma respectively. In the sub-œsophageal ganglion there are seven pairs, five of which are connected by a bridge and commissure, and two by a bridge only. Each of the thoracic ganglia is provided with a pair; in the abdominal ganglia there are two pairs, one ellipse-shaped and one spheroidal; the caudal (post-abdominal) ganglia are found to have five pairs. The greater part of what follows is only intelligible to those who have Dietl's figures at hand, but it may be noted that the nerves arising from the ganglia are stated to be generally made up of two parts, and that the so-called giant nerve-fibres pass through the whole of the ventral cord.

Heart of the Crayfish and Lobster.—The following results are given by Deszö [*] on this subject:—(1) There are five pairs of clefts on the dorsal surface, of which four are so small as to require careful search. On the ventral surface there are three pairs, two of which are very small. (2) The musculature of the organ is composed of *muscle-cells*, and not, as has been supposed by Weissmann and others, of mere *muscle-fibres;* these cells have the transversely striated substance on one surface only. The nuclei of the muscle-cells are provided with nucleoli, which may often be observed in the act of fission. In the lobster the anatomical elements are much smaller than in the crayfish. In the muscular wall of the heart there are eight hæmal spaces corresponding to the eight clefts, and these spaces unite in a central ventricle. (3) The pericardium is an elastic layer of connective tissue, in which a few small nuclei can be made out; it is not provided with any muscular elements. (4) In the posterior region of the dorsal part of the muscular heart, ganglionic cells, ordinarily bipolar, and invested in connective tissue, may be discovered. These are often united together by threes, or in a larger number; the largest of them were found to measure $\frac{9}{10}$ of a millimetre, their nuclei $\frac{36}{100}$, and their nucleoli $\frac{7}{100}$ of a millimetre.

The same author gives [†] a very brief account of the connection

between the circulatory and the respiratory organs in the Arthropoda. He finds that in Insecta, Myriapoda, and Arachnida there are as many pairs of clefts in the dorsal vessel as there are pairs of stigmata; that in the Crustacea there are, likewise, as many clefts as there are pairs of branchiæ; this obtains when the gills are set on the abdomen and post-abdomen; when, however, the gills are gathered under the cephalo-thorax, then there are in the heart as many pairs of clefts as there are pairs of gills under the shelter of this investment.

New Branchiopoda off the French Coasts.—M. Hesse describes* some new Crustacea, for which he forms a new genus—*Copechætes* (κώπη, oar, χαίτη, hair); as their relation to other forms will probably be of interest to naturalists, we append his table of classification, which, as he says, is based on that of Norman and Brady :—

> Legion: *Branchiopoda.*
> Sub-order: *Cladocera.*
> Division: *Calyptomera.*
> Tribe: *Anomopoda.*

Family—*Copechætidæ*	..	..	*Copechæte*, Hesse.
„ *Bosminidæ*	..	..	*Bosmina*, Baird.
„ *Macrotrichidæ*	..	..	*Macrothrix*, Baird, &c. &c.
„ *Lynceidæ*	..	..	*Lynceus*, Müller, &c. &c.

Four new species, to which the names *elongata, affinis, fissa,* and *armoricana* are given, are described and figured; they are all of extremely small size, and are marine in habitat. No details can be given as to the history of their development, but eggs were found, which in some cases were strong and greatly elongated, and in others spherical; in the former case the enveloping membrane was thick, and the thinness of this investment in the latter case appeared to be due to its earlier condition of development. The detailed description which is given indicates the affinities of these forms to the *Bosminidæ*.

As single specimens—which, by the way, all belonged to females—were alone found, M. Hesse is unable to give any anatomical details; he states, however, that the antennæ were long and delicate, but that of these appendages only one pair was to be observed; as to the other, no definite statement is possible; the abdominal is much shorter than the post-abdominal region; this latter, or tail, has a truncated termination, which is very large and surrounded by a horseshoe-shaped pad; it is provided with two powerful muscles, which must evidently be of great assistance in locomotion. The branchiæ, which are elongated, are set towards the centre of the body; the enteric tube takes a direct course from before backwards. The eyes are seated on short broad peduncles, and can be moved laterally or in a line parallel to the long axis of the body.

They were observed to live 283 millimetres below the surface of the water, at which level they were probably supported by the air entangled in the valves of their shells; as in the *Bosminidæ*, the shells of the *Copechætidæ* form a hood-like protection for the anterior portion of the head, but they are at once distinguished by the different

* 'Ann. Sci. Nat. (Zool.),' vii. (1878), Nos. 5–6.

characters of the abdominal termination of the body, and by the presence on the thoracic appendages of hair-like setæ.

They have been obtained from below stones on the sea-shore, from the stomachs of a fish and of a *Medusa*, and from a mass of *Fucus*. The paper is illustrated by a plate.

On the Crustacea of the Mozambique. — The collection of Dr. Peters is described[*] by Hilgendorf in great detail, and illustrated by four plates, but the whole paper is too technical to allow of any brief account. It may be mentioned, however, that the number of known species from this region is multiplied by more than 4,—27 now becoming 128. Of the 101 forms new to this region, only one genus— *Podopisa*, one new sub-genus—*Myomenippe*, and seventeen new species are recorded. The only other collector in this region appears to have been Bianconi, and the importance of it to carcinology cannot be overestimated. The new genus appears to be intermediate between the *Macropodidæ* and the *Maiadæ*.

Vermes.

Pneumonia produced by a Filarian Worm. — M. Megnin has discovered[†] a new worm, which he proposes to call *Strongylus minutissimus;* this creature was observed by him in some African sheep which were brought over to Vincennes, and which suffered from purulent abscesses on the lung, although the bronchi were completely healthy. Clearly allied to *Strongylus filaria*, it differs from it by its much smaller size—1 (male) to $1\frac{1}{2}$ (female) centimetre, while the tail is very short, and the embryo is provided with a short caudal prolongation; the habits also are different; the fecundated females become encysted in the pulmonary tissue, where they die after giving birth to the embryos, which escape by the bronchi ; the dead give rise to inflammatory processes in the lung. Development appears to obtain externally to the host, just as in *Strongylus filaria*, and other pests of the fowl, and *Oxyuris incurvata* and *Strongylus armatus* of the horse. Ova and embryos placed in damp earth were found living after fifteen days, but no other changes have yet been observed ; further investigations on the subject are, however, promised.[‡]

On Sagitella (Wagner).—Although M. Uljanin states that what observations he has to offer [§] on this interesting annelid are merely rough notes, they are of sufficient value to demand very careful attention.

Tegumentary System.—The cuticle is a fine, transparent, strong membrane, which may or may not be striated; it does not appear to cover the anterior part of the buccal segment or the elytra; the greater part of the hypodermis is made up of a very fine protoplasmic layer,

* 'MB. Preuss. Akad. Wiss.' (Nov. 1878), 782.
† 'Bull. Soc. Centrale Vétérinaire ' (1877), 646.
‡ 'Journ. Anat. et Phys.' (Robin), xiv. (1878) 548.
§ 'Arch. Zool. Expér. et Gén.,' vii. (1878) 1.

in which are set a large number of nuclei, each provided with two or three highly refractive nucleoli; the apparent absence of this layer in sections of the worm, which have been treated with acetic, osmic, or chromic acid, is explained by an account of what happens in the fresh creature when it is submitted to these reagents; the protoplasm contracts, and forms more or less oblong masses of varying size, which are separated from one another, and contain two or even three nuclei. In the anterior part of the buccal segment this layer is thick, but Uljanin was unable to make out the separate cells. The elytra are each formed of a somewhat opaque nucleated mass, which is made up of a number of small, distinct cells, each provided with a large nucleus, and of larger bodies, which appear to form unicellular cutaneous glands, such as are so common in the integument of all *Chætopoda*. True cilia seem to be almost completely absent; the buccal segment of two species is, however, provided with a ventral and a dorsal hood, the edges of which are provided with a row of long lamellæ, which on close examination are seen to be made up of a number of united cilia, which so far seem to be just the same as the lamellæ of the *Ctenophora*.

The subjacent muscular layer is arranged in two sets; the outer, in which the bands seem to be circular, is really composed of large bands, separated from one another by spaces almost as large; the elements of these bands are cylindrical, and are altogether similar to those so commonly found in the *Annelides*. The lower layer consists of longitudinal muscles, the elements of which are greatly elongated, narrow at either end, and provided at one edge with small outgrowths containing a finely granular substance (cf. the "nematoid fibres" of Ratzel).

Nervous System.—Uljanin contradicts N. Wagner's description in almost every point; he asserts that what this author took for the cerebral ganglionic mass, is merely the glandular portion of a retort-shaped organ which lies above the œsophagus; while he further states that there is a true ganglionic chain, and not merely two flattened nerve-trunks. At the end of the body of the worm there appears to be a tactile organ, but the most curious portion of the sensory apparatus is represented by the small rod-like bodies which are connected with the elytra; when highly magnified, an elytron is seen to contain in its tissue a number of curved filaments, the two ends of which are set towards its surface; some of these spread out into a fan-like termination, and others remain more compact: the filaments are very fine and highly refractive, and are connected at their ends with spherical and likewise highly refractive corpuscles, of two distinct sizes, and with elliptical bodies of a similar character. Our author is merely content with drawing attention to this apparatus, which he cannot believe to be made up of spermatozoids, much as they resemble them at first sight.

Digestive Organs.—The mouth is situated at the middle of the ventral surface of the buccal segment and above the ventral hood; the œsophagus is short and thick-walled; the intestine largest more anteriorly, and the anus is placed on the dorsal surface of the posterior segment; above the œsophagus there is an elongated organ, which

the animal can be induced to protrude on irritation with acetic acid, and which it moves at short intervals in a longitudinal direction; examination by the aid of sections of the buccal region shows that this organ belongs to the enteric tract, inasmuch as it is lodged in a saccular fold of the œsophagus; no very definite account can be given of its function, but it is presumed to secrete an offensive liquid; the walls of the intestine are remarkable for the presence of enormous cells in the epithelium, very similar to those which are found in the same region of some larval annelids.

The perivisceral cavity is largely occupied by connective tissue, at the expense of which it is probable that the generative elements are produced.

Segmental Organs.—All but the buccal segments are provided with a pair of segmental organs; those of the fifth segment are not, as are the others, long and sinuous, but are shorter and broader, and are evidently efferent ducts for the sexual products.

Reproductive Organs. — The *Sagitellidæ* are hermaphrodite; in mature specimens the whole of the cœlom was observed to be filled with ova and spermatozoa; the former oblong, the latter with a spherical head and a short tail. Passed out by the ducts of the fifth segment, the ova appear to remain for a time in connection with their parent, and under the protection of the elytra of the fourth and fifth segments. They do not appear to undergo any metamorphosis, but in the young the elytra form soft pads, and the lamellæ of the hoods are formed of separate cilia.

Zoological Position.—Satisfied as to their belonging to the *Annelida-Chætopoda*, M. Uljanin proceeds to inquire whether they should be placed with the *Oligochæta* or *Polychæta;* the covering of the segments, the absence of muscular bands in the cœlom, the characters of the segmental organs, are all points which distinguish them from the latter; the tentaculiform appendage of their buccal segment is not found among the *Oligochæta*, while the presence of one or two pairs of elytra on all the segments distinguishes them from both these groups; but these elytra are merely modified parapodia, and the characters of the tentacular appendage are not sufficient to justify their separation from the *Oligochæta;* they must, nevertheless, form a distinct group, for which a name is taken from the small annelid described by Busch, which seems to be a close ally of *Sagitella—Typhloscolex;* the chief characters of the *Typhloscolecidæ*, then, are these:—

Body oblong, and consisting of a varying number of segments; the anterior or buccal segment is provided with one or more tentaculiform appendages, and with cilia, or with lamellæ formed of cilia; all the segments of the body carry one or more pairs of elytra. Some or all (with the exception of the buccal segment) are armed on either side with a few short spine-like setæ. Pelagic.

The two genera — *Typhloscolex* Busch (1851), and *Sagitella* N. Wagner (1872)—are then defined, and of the three species of the latter, *S. Kowalewskii* Wagner, and *S. barbata* and *S. præcox*, which are new species, there follow short diagnoses: the animals have been found at Trieste, in the Red Sea, and in the Mediterranean.

Echinodermata.

Embryogeny of Asteriscus verruculatus.—Barrois has extended his embryological investigations to the *Asteroidea*, of which group the development of *Asteriscus verruculatus* is described.* He finds that the gastrula is of the primitive type, that it grows into a large, ciliated, and completely closed sac, and then becomes trilobed; the two side lobes fall away and the young asterid is developed from the median portion. By invagination of the endoderm the enteric canal becomes divided into three parts, the two lateral sacs being peritoneal, and completely surrounding the middle one. The mouth, as in most, is formed by the invagination of the ectoderm, which pushes its way in between the two peritoneal sacs. The enteric cavity likewise gives rise to the water-vascular system.

The star-shaped form of body is due (1) to the flattening of the rounded large (median) lobe of the embryo; this is effected from behind forwards, and affects the intestine and the parts annexed thereto; (2), between the anterior and posterior surfaces thus formed there arise ectodermal thickenings which grow into the arms; of these, one arises at the most anterior point, and the two others on either side; (3), the development of the water-vascular system into a ring round the mouth. The peculiar point in the structure of this asterid at this moment is the great degree of asymmetry which it exhibits, owing to the much greater development of the superior as compared with the inferior surface, and the excentric position of the mouth; this want of symmetry gradually disappears, owing to the mode of growth now followed; as this goes on, the ambulacral lobes are seen to divide into five branches; at first three lobes are seen, and then five are formed by the trifurcation of the median lobe.

As time goes on, the intestine gives off five cæca, and becomes provided with an anus; and the calcareous plates take on a definite arrangement.

The most important points are henceforward associated with the elongation of the arms and the increase in the number of the ambulacral joints, which is effected in just the same way as is the multiplication of the " zonites " of annelids.

Comparing this form with those in which there are intermediate larval stages, we may note that, in *Asteriscus*, the endoderm grows out into a large sac, from which the intestine, peritoneal sac, and water-vessels are directly differentiated, whereas in the others the endoderm forms the intestine, and it is this intestine which gives rise to the other organs; in the young starfish three regions, dorsal, ventral, and lateral, can be made out; the observation that the ambulacra exhibit the same mode of increase as the *Annelides* may be applied to the *Echinoidea*, as well as to the *Asteroidea*.

On the Skeleton of the Asteriadæ.—An article † on this subject, by M. L. Viguier, consists of an historical introduction, a careful and detailed description of the composing parts, and an account of a number of genera. His chief conclusions are :—

* ‘Journ. Anat. et Phys.’ (Robin), xv. (1879) 1.
† ‘Arch. Zool. Expér. et Gén.,’ vii. (1878) 33.

1. The study of the skeleton, which has hitherto been neglected, and which is by many naturalists regarded as incapable of furnishing any characters useful in classification, is shown to be "the only means by which the different genera of this class can be rationally distributed in natural groups."

2. The mouth, whatever be its type, is made up of a number of ossicles, of which there are five times as many as there are arms.

3. The mouth is limited by a number of pieces, of which there are four times as many as there are arms; these pieces are set in pairs, one of which—*ambulacral*—forms the extremity of the ambulacral grooves, while the others—adambulacral pairs—are set between these; above the adambulacral pairs, and exactly interambulacral in position, is an azygos piece, to which the name of *odontophore* is given.

4. This mouth is formed on one of two types:

    (a) In one the ambulacral pairs extend into the interior of the mouth, and limit its contour—*ambulacral* type.

    (β) In the other the adambulacral pairs extend into the interior of the mouth—*adambulacral* type.

5. These two groups characterize the two sub-classes into which M. Viguier divides the Asteroidea; one, containing the *Asteriadæ*, *Heliasteridæ*, and *Brisingidæ*, has the ambulacral pairs horizontal, the adambulacral pairs truncated, and an "odontophore" which is not provided with apophyses, and which forms a massive body, capable of but a slight amount of movement; in the other group, of which the *Echinasteridæ*, *Linckiadæ*, *Goniasteridæ*, *Pterasteridæ*, and *Astropectinidæ*, are the more important forms, the "odontophore" is ordinarily provided with apophyses, and the adambulacral ossicles are not so completely truncated.

6. This classification accords with the results which M. Edmond Perrier has gained from the study of the characters of the pedicellariæ, so far as they are present to afford assistance in this difficult operation of arrangement.

7. The teeth and the "odontophore" vary in form in the various genera, and in many cases even in the various species.

8. The so-called "odontophore" seems to be homologous with what Müller called the osseous peristomial plates of *Euryalus*, and with the corresponding parts in *Ophiura* and *Ophiocoma*; in extending his survey to the *Echinoidea*, the author finds, as is natural, greater difficulties in his way, and he is content to insist on the morphological resemblances presented by the "tooth" of the dentate forms (*Desmosticha; Cassidulidæ*) when compared with the "odontophore" of the starfish.

No examination of any morphological characters in the *Echinoderma* seems to be complete in these days which does not take into account the corm theory of Haeckel, which, as we are informed by its author, is "as yet the sole theory attempting the genetic explanation of this remarkable group of animals;" [*] and, indeed, the position and the great value of the speculations of the German zoologist do demand

    [*] 'Evolution of Man,' Engl. transl., ii. 480.

a most respectful attention ; facts, however, seem to be against him here, and M. Viguier brings some new considerations to our notice ; the fact that Duvernoy in 1837 spoke of " cinq colonnes vertebrales " in *Asterias*, and that he called the starfishes " serpents à plusieurs corps, et à une seule bouche," is worthy of notice ; much more so are the following points : the general skeleton of no asterid ever presents a regular segmentation, corresponding to that of the ambulacral and adambulacral series, nor are the radial cæca divided in correspondence with the segments of the body as they are in all annelids. As we are on debatable ground we may, as a matter of criticism on the arguments of, and without any desire to object to the final conclusions of M. Viguier, point out that the segmentation of the vertebral column of the adult bird and mammal does not correspond to that exhibited by the episkeletal muscles or spinal nerves, and yet the metamerism of the Vertebrata is as certain as any fact in morphology.

Cœlenterata.

Researches into the Hydrozoa.—Professor Claus has communicated * to the Vienna Academy a long and elaborate paper on such forms as he has observed in the Adriatic.

In the hermaphrodite *Chrysaora* the development of the embryo is effected within the ovary ; the ovarian cells are formed in the lower cell-layer of the ovarian region, the upper layers of which form part of the gastric epithelium and are richly provided with urticating capsules ; as the cells increase in size, they project into the homogeneous layer which separates the upper from the lower (germinal) portion, and gradually become provided with a stalk, which is formed at the expense of the neighbouring cells, and, later on, with a follicular investment of flattened cells ; fertilization is followed by cleavage into two cells of unequal size, and in the succeeding stages of segmentation the spheres produced are also unequal ; at the point where the larger cells are found an ingrowth commences, and the endodermal tube, which rapidly extends to the opposite pole, begins to be formed ; in the primary cœlom of the resulting elongated *Gastrula*-larva a clear fluid is developed ; the next succeeding stages could not be observed.

A point of much interest in the history of this form is that embryonic development goes hand in hand with growth ; in most *Acalephæ* cleavage does not commence until the ovum has attained its full size, but in *Chrysaora*, just as in the viviparous *Aphides* and in the *Polyphemida (Cladocera)*, development commences while the ovum is still very small, and long before it has obtained its full amount of nutrient material, which in the animal under description is obtained from the already mentioned follicular cells. When the blastopore is closed we get a larva of which the two cell-layers are very different in character ; the ectoderm is formed of cylindrical cells, richly provided with urticating capsules of three different forms ; the anterior end of the free-swimming larva is much broader than the hinder end, and the cilia form a broader fan.

* 'Denkschr. Acad. Wien,' xxxviii. (1878) 1.

After tracing the history of the *Scyphistoma* and *Ephyra* stages, Claus concludes with observing that there is no fundamental difference between the *Medusæ* and the *Polyps ;* the *Scyphistoma* is a polypoid *Medusa,* and the *Medusa* a broad, discoid, flattened Polyp, which has ceased to be fixed, and has become adapted to locomotive habits by the aid of its swimming bladder ; the " grappling lines " are the marginal tentacles ; the radial pouches of the gastro-vascular system are represented by the radial vessels, while the gelatinous disk forms a very strong mesodermal layer, which develops into a supporting lamella in the *Hydroida,* and a skeleton in the *Anthozoa.*

The rays along which are set the genital pouches (and marginal bodies) are regarded as rays of the second order, which are developed at an angle of 45° to the four primary tentacles, or rays of the first order ; while the name of intermediate rays is given to the eight rays of the *Ephyra* form in which the tentacular vessels are developed.

Acalephæ and Hydro-medusæ.—In the opinion of Professor Claus, the differences between these forms have never been satisfactorily stated ; the names *Cryptocarpæ* and *Phanerocarpæ,* or *Gymnophthalmata* and *Steganophthalmata,* or *Craspedota* and *Acraspeda,* which we owe to Eschholtz, Forbes, and Gegenbaur, are insufficient, for the large and complicated marginal bodies of the *Acalephæ* correspond, from a morphological point of view, to tentacles ; the cavities in the substance of the umbrella in which the generative organs of the *Cryptocarpæ* are placed, are found to be present in a number of the *Phanerocarpæ ;* neither in structure nor in position is there any fundamental difference between them. A more valuable point of difference is to be seen in the presence or absence of the filaments which appear to form tentacular appendages to the generative organs ; the *Steganophthalmata* (*Discomedusæ*) are stated to be *Scyphistoma Medusæ* with filaments, while the *Gymnophthalmata* are *Hydroid Medusæ* without filaments. With these considerations in mind, Claus has lately addressed himself to the examination of the characters of the *Charybdeidæ* and *Æginidæ,* which had been placed by Fritz Müller with the *Hydro-medusæ,* and by Agassiz among the *Acalephæ* (*Discophora*). The great similarity in the external form of the bell and of the manubrium in *Charybdea* and *Oceania,* as well as the presence in both of four primary rays, have been used as arguments for uniting these forms ; but the number of the radial canals, marginal bodies, and tentacles vary very greatly in the latter, and it appears to be allied to the *Hydro-medusæ,* while *Charybdea* presents distinct points of resemblance to the *Acalephæ ;* judged by the point on which Claus insists, the *Oceanidæ* are found to want the gastric filaments.

Spongicola fistularis, a Hydroid inhabiting Sponges. — A *résumé* is given in M. Lacaze-Duthiers' ' Archives,'* of the observations of F. E. Schulze on the above-mentioned form, the chief interest of which is that it bears on the assertions of Eimer that the *Spongiæ* are provided with nematocysts ; bearing in mind the changes in the zoological scale which the researches, chiefly of Professor Haeckel,

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* ' Arch. Zool. Expér. et Gén.,' vii. (1878), Notes, ix.

have shown to be necessary for the *Spongiæ*, any further information is obviously important. In two siliceous sponges and in a horny sponge Eimer observed a number of canals, which enclosed a whitish body, which contracted on irritation ; believing this to be part of the sponge, and rejecting the idea of its being hydroid in character, Eimer proposed to call it the *prehensile animal* (Fangs-thier). Two English observers, Mr. Carter and Professor Allman, have since 1872 observed similar cases, and they have both regarded the " Fangs-thier " as a hydroid ; to this conclusion Schulze is also led. He says that in no case that he has examined can he regard the nematocysts as forming an integral part of the sponge-body ; in all cases they have been observed on the surface or in the canals which are so characteristic of these lowly forms, and in all cases it has been easy to demonstrate that they are intruders. The four sponges examined belonged to the genera *Reniera*, *Suberites*, *Esperia*, and *Myxilla*. As the characters of this form are found by Schulze to correspond to the description given by Eimer, with the sole exception of their structural continuity with the sponge, it does not seem necessary to enter into further details ; the accounts of Carter and Allman are stated to be too short to allow of any satisfactory comparison.

As to the development of this *Spongicola*, no information was obtained ; but the author is of opinion that it belongs to the Hydroida or Hydro-medusæ, although there are indications of a *Scyphistoma* stage, such as is seen in the common *Aurelia aurita*, with which there are certain other points of agreement in the histological and morphological details.

Deep-sea Siphonophora. — Professor Studer's observations * are reviewed in M. Lacaze-Duthiers' ' Archives.'† The author points out that there are indications of a fauna intermediate between that of the surface and that of " abyssal " depths : during the voyage of the ' Gazelle,' *Siphonophora* were obtained, which can be satisfactorily shown to have come from depths varying from 500 to 2000 fathoms and from a region in which the temperature was from 2° to 6°. Two new species of *Rhizophysa* —*R. conifera* and *R. inermis*—are described, as is also a new genus, *Bathyphysa abyssorum* (1880 fathoms). The author calculates that the air-sac acts in just the same way as in those species that live near or on the surface.

Histological Characters and Development of Myriothela.— Herr Korotneff, of Moscow, makes some brief observations ‡ on this subject, the interest of which has been increased of late years by the work of Professor Allman. Dividing the body into the three regions of foot, median region, and upper region, he proceeds to point out how they differ ; the walls of the body everywhere consist of ectoderm, supporting lamella, and endoderm. The ectoderm consists of several layers, in which three distinct sets of cells may be made out. Below the *superficial* layer there is a layer of subepithelial embryonic cells, in which the

* ' Zeitschr. f. wiss. Zool.,' xxxi. (1878) 1–24.
† ' Arch. Zool. Expér. et Gén.,' vii. (1878), Notes, xiii.
‡ ' Zool. Anzeiger,' i. (1878) 363.

nematocysts are developed, and a fairly well differentiated layer of muscular fibres which run parallel to the long axis of the body. The supporting lamella, in addition to the cells on its outer surface, which Professor Allman regarded as *neuro-muscular*, has also cells on the inner aspect which, as the Russian observer points out, are *flagellate endodermal muscle-cells*; in addition to these there are in the endoderm outgrowths (blastostyles), which are conical in form and centripetal in direction, and which consist of large cells containing brown pigment granules and giving off amœboid processes and flagella; by the aid of these plasmatic processes the cell is enabled to feed itself directly, while the flagella serve as tactile organs.

The blastostyles, which carry the gonophores, differ in structure from the "body" in the feeble development of the subepithelial and muscular layers, the latter indeed being altogether absent in young blastostyles; the supporting lamella has no projecting processes, and the ectoderm varies in character with the age of the blastostyle; just below the supporting lamella there are large dark-coloured cells, whence are developed the generative elements.

In the foot the ectodermal cells are five or six times as long as the ordinary cells, are coarsely granulated, and may be converted into gland-cells, which secrete a strong chitinous outer layer by which the whole of the foot is covered. The cells for the nematocysts are also present in somewhat large numbers, while the muscular layer is absent. The supporting lamella is without any outgrowths, and the endoderm is of the ordinary type.

The tentacles consist of muscular epithelial cells, such as were first observed by the author in *Hydra fusca*, and have since been seen by the brothers Hertwig in the *Medusæ*, together with a supporting lamella and a simple endodermal layer. In the capitular portion of the tentacle four kinds of nematocysts may be observed, three of which are supplied with tactile hairs. Between the nematocysts there are elongated pigmented cells, while the supporting lamella is highly developed, and broken up into fibrillæ which take a centripetal direction.

Tentacular structures (claspers) are found between the blastostyles; these serve for the attachment of the developing ova, and, though structurally similar to the tentacles, differ from them in having the ectodermal layer differentiated into glandular cells, which serve to attach the ova. The statement of Allman that these structures function in fertilization is not supported by M. Korotneff.

In continuation of his researches, Korotneff[*] describes the development of the gonophores; the large embryonic cells at the base of the endoderm of the blastostyle become collected together at various points; this "agglomeration" passes through the ectoderm, and forms an elevation on the surface; the peripheral cells of this "gonogenetic chamber" (Allman) become provided with refractive granules, which form a covering for the egg. One of the cells of the collection increases greatly in size and absorbs its neighbours; impregnation

* 'Zool. Anzeiger,' ii. (1879) 187.

takes place, and the egg escapes, to be seized on by the "claspers." The plan of development of the sperm-cells is of the same character ; after impregnation the endoplasm of the egg is seen to become possessed of a number of cells which move towards the periphery and pass into the ectoplasm, where they form the blastoderm ; between the cells of these two regions a differentiated lamella soon appears, which will go to form the future supporting lamella : the endodermal mass becomes fissured in anticipation of the gastric cavity, while the ectoderm gives rise to ingrowths, which are soon converted into the larval tentacles of *Myriothela*. The free actinula-embryo has no mouth, and nutrition is effected by the remnants of yolk-spheres in the gastric cavity. As soon as the mouth is developed, the embryo becomes fixed, the primitive tentacles are absorbed, and the blastostyles developed. Compared with the calcareous sponges, *Myriothela* differs in the characters of its *gastrula ;* but as is pointed out, these animals have a simple ovum without any nutrient material, while the siliceous sponges which have an ovum provided with nutrient material, do also form a " planula."

The mesoderm is stated to be incompletely differentiated, and to consist of two muscular layers, the upper of which is distinctly separated from the ectoderm, while the lower is intimately connected with the endoderm ; these two layers are separated by the supporting lamella which is likewise mesodermal in origin.

Porifera.

Structure of the Aplysinidæ.—This family of horny sponges is treated of by Professor Eilhard Schulze in one of his important series of " Researches on the Structure and Development of Sponges." [*] The first part of the paper consists of an historical *résumé* of former work on the family, and enumerates the genera belonging to it, namely, *Aplysina, Verongia, Dendrospongia, Darwinella, Janthella,* and the author's new genus *Aplysilla.* To this follows an anatomical and histological description of *Aplysina* and of *Aplysilla.*

1. *Aplysina aërophoba.*—Of the account of this already well-known species, our space will only allow of our noticing the histological portion.

The ectoderm consists of a single layer of flat polygonal cells with distinct nucleus and nucleolus. The boundaries between these cells are often seen only on treatment with silver nitrate, and in some cases even this treatment failed to reveal cell contour, owing to the presence of a structureless cuticula, probably formed under abnormal conditions for protective purposes.

The mesoderm consists of a sort of connective tissue made up of cells imbedded in a matrix, which is partly granular, partly (in the neighbourhood of the external surface and of the canals) hyaline. The cells themselves are mostly stellate, being provided with long, sometimes branching processes. But where the mesoderm surrounds the water canals, these cells become spindle-shaped, and surround

* ' Zeitsch. f. wiss. Zool.,' xxx. (1878) 379.

the canal like a layer of circular muscle-fibres: these have indeed been described as muscular elements, but Schulze prefers to call them "contractile fibre-cells."

Amongst the ordinary mesoderm cells, rounded cells are found without definite processes, and probably to be considered as amœboid wandering cells. There also occur remarkable structures of an irregularly rounded or knobbed form, about 10 μ in diameter, of a bright yellow colour and strongly refractile. Each of these consists of a number of small, globular, hyaline bodies, in close contact with one another: to their presence the yellow hue of the entire sponge is due. When exposed to the air, these yellow granules undergo a remarkable change of colour, becoming first pale bluish grey, then pure blue, and finally dark prussian blue: by this change the coloured bodies become at first more transparent, but finally quite opaque. The yellow colouring matter is turned brown by ammonia, and is slowly dissolved by ether and absolute alcohol, readily by acetic acid. Schulze considers these bodies to be accumulations of reserve material, analogous to the fat-cells of other animals, and to the starch of plants.

In the hyaline portions of the mesoderm occur very fine fibres, probably comparable to the connective-tissue fibrils of Vertebrates. In the neighbourhood of the ciliated chambers occur, scattered through the mesoderm, numerous small rounded granules, of a whitish colour by reflected light. There is no discernible bounding membrane (*membrana limitans*) either between mesoderm and ectoderm, or between mesoderm and endoderm.

The endoderm consists of collar-bearing flagellate cells in the hemispherical portion of the ciliated chambers, into which the afferent canal opens; while the funnel-like portion, leading into the efferent canal, is covered by the same tesselated epithelium as the rest of the internal cavities.

The fibres forming the skeleton of *Aplysina* are circular in section, and consist of a laminated horny cortex, enclosing a soft medulla which exhibits a delicate fibrillar structure. At the apex of the fibre, the lamellæ of the cortex are at a considerable distance from one another, and have the appearance of a series of superposed glove-fingers, the innermost of which exhibits perfect continuity of structure with the medulla, which is thus seen to be in no way essentially different from the cortex.

In autumn and winter, rounded masses consisting of cells with vesicular nuclei were found in the mesoderm of adult individuals: the further fate of these is unknown, but the author considers that they are probably spore-like reproductive bodies.

2. *Aplysilla sulfurea*, nov. gen. et sp.—A full description is given of this genus, which differs markedly from *Aplysina* in the fact that the horny skeleton does not consist of a regular network of fibres, but of isolated, simple or branched, terete fibres, each attached to a basal plate. With regard to the migratory cells occurring in the mesoderm, the author remarks that their presence proves the tisues in which they occur to be a true mesoderm, consisting of actual cells imbedded in a matrix or ground-substance, and answering to the connective tissue

of the higher animals; and not a syncytium, that is, composed of fused cell-bodies with imbedded nuclei.

Both the migratory cells and the collar-bearing cells lining the ciliated chambers contain in their protoplasm yellow pigment granules.

The sexes are distinct. The spermatozoa have an ovoidal head and a long delicate tail, and occur in definite aggregations, each enclosed in a special cavity of the mesoderm lined by a single layer of flat polygonal cells. Probably, as in *Halisarca*, each aggregation is formed by the repeated division of a single cell. The ova are contained each in a similar cavity of mesoderm: the vitellus is opaque, owing to the large number of yolk-granules: there is an excentric germinal vesicle and refractive germinal spot. Probably the eggs, like the aggregations of spermatozoa, result from mesodermal leucocytes.

Only one developmental stage of *Aplysilla* was observed — the blastula phase. This consists of an oval body, covered with a single layer of cylinder cells, each provided with a long cilium, and enclosing not, as usual, a clear fluid, but a definite tissue, consisting of stellate cells with anastomosing processes. From this it seems probable that the mesoderm in *Aplysilla* is formed actually before the gastrula stage.

The other species of this genus, *A. rosea*, is remarkable from the fact that it is hermaphrodite, young eggs and sperm-aggregations being found in one and the same section.

Structure of Spongelia.—In a memoir on this genus of horny sponges, F. E. Schulze * gives, besides an historical summary and enumeration of the species, a full description of *Spongelia avara* and of *S. pallescens*, and short accounts of *S. elegans* and *S. spinifera*. The genus itself is distinguished, according to Schulze's observations, by the following characters.

1. The possession of large, simple, saccular, ciliated chambers, which are provided with numerous inhalent pores, and possess a wide, round, exhalent aperture, opening directly into one of the efferent canals.

2. The complete absence of highly refracting granules in the matrix of the connective tissue surrounding the ciliated chambers.

3. The extensive enclosure of foreign matters by all the chief fibres of the skeleton; the thin connecting fibres may or may not contain foreign particles.

4. The more or less uniform development of conical elevations (conuli), $\frac{1}{2}$–8 mm. high, and the same distance from one another, over the whole surface of the sponge, with the exception of the area surrounding the osculum.

S. avara.—The skeleton in this species consists of a network of fibres of spongiolin, in which are imbedded great numbers of foreign bodies, the chief of which are broken spicules of other sponges, both siliceous and calcareous, fragments of plates and spines of Echinoderms, shells of *Foraminifera* and sometimes of *Radiolaria*, as well as fragments of the hard parts of worms, molluscs, &c., and sand-grains.

* 'Zeitsch. f. wiss. Zool.,' xxxii. (1878) 117.

The arrangement of these foreign bodies is very irregular; they are always, however, situated in the axis of the horny fibre, and those of an elongated shape have their long axis set as nearly as possible in the direction of length of the fibre. It looks, at first sight—so completely is the true skeleton of the sponge interpenetrated with these extraneous matters—as if they were the exciting cause of the formation of the skeleton; but this is shown not to be the case, from the fact that spongiolin fibres were found, exhibiting a concentrically laminated structure, and quite free from foreign bodies. These latter, therefore, are not essential to the formation of the horny skeleton, but are probably adjuvant to it.

The disposition of the fibres is very irregular: they exhibit no distinction into vertical and horizontal fibres, but in each of the column-like elevations of the sponge is seen, in a longitudinal section, that there are eight or ten more or less longitudinal main fibres, between which is an irregular network of fine connecting fibres.

The roundish pores in the ectoderm lead into irregular lacunæ or "subdermal spaces," from which afferent canals branch out into the interior of the sponge, and finally open by minute pores into one of the ciliated chambers, each of which has from twenty to thirty pores. The ciliated chambers are disposed radially round the efferent canals into which they open directly by a wide aperture, there being no intermediate passage or efferent duct between the two. The efferent canals finally debouch into one of the wide cloacal cavities, at the extremity of which is an iris-like contractile membrane serving to regulate the width of the osculum.

All those parts of the sponge which are bathed with water, except the ciliated chambers, namely the external surface and the afferent and efferent canals, are lined with a single layer of flat polygonal cells, constituting the outer cell-layer or ectoderm.

The mesoderm, or connective-tissue layer, consists of a hyaline gelatinous matrix, with imbedded star- or spindle-shaped cells, the processes of which often anastomose. The refracting granules which, in most horny sponges, occur in the mesoderm surrounding the ciliated chambers, are wholly absent. Contractile fibre-cells occur, as in *Aplysina*.

The endoderm consists of the flagellate cells lining the ciliated chambers: in these are contained lilac or rose-coloured granules, to which the tint of the entire sponge is due.

The morula stage was the only phase of development which the author was enabled to observe.

In *Spongelia pallescens* aggregations of spermatic cells were found in definite cavities of the mesoderm, lined with a single layer of flat cells. The ciliated embryos of this species were also examined. They have the form of a cylinder, with one end slightly convex, the other slightly excavated: the latter has a strong brown-red colour. The body is covered by a single layer of columnar ciliated cells, surrounding a central mass having much the same characters as the mesoderm of the adult.

This species is remarkable for being infested by two species of

parasitic alga, *Callithamnion membranaceum* and *Oscillaria spongeliæ* (n. sp.).

Protozoa.

Evolution of the Infusoria from the Lower Protozoa.—In some speculative observations on the probable steps in and causes of the evolution of the *Infusoria* from the lower *Protozoa*,[*] Mereschkowsky remarks upon the (as a general rule) total absence of symmetry in the *Infusoria*, and considers that this is explained by the close genetic connection between that group and *Amœbæ*. The first step in the differentiation of the latter was probably a hardening of the superficial layer of protoplasm, and with this was connected a proportional thinning and lengthening of the pseudopodia, and a slowing of the animal's movements. With the gradual induration of the superficial layer of protoplasm, there seems to have come about a greater and greater restriction of the area suitable for the inception of nutriment; in this way the infusorial mouth was produced. But as the ingestive area became less, it became more and more necessary that the animal should have the means of rapid locomotion, and so be able to make up, by active foraging, for the lost power of taking in any suitable food-particle which might happen to come in contact with any part of its surface. In response to this want, it would seem that the variously disposed cilia and flagella of the *Infusoria* came into existence by the action of natural selection.

Acinetæ and Vorticellæ.—Biologists, as is well known, have never yet accepted the views of Stein as to the *Acinetæ* being stages of development of *Vorticellæ*, &c., mainly from the fact that his observations have not been confirmed by other observers. Mr. H. E. Forrest, one of the secretaries of the Birmingham Natural History and Microscopical Society, in describing what he terms " Acinetation " in the *Vorticellæ*,[†] states that " last October, while examining some *Acinetæ*, he saw a small *Vorticella* burst from the body of one of them and swim away."

Researches on the Acinetæ.—M. Fraipont, in continuation of the results of his investigations on the *Acinetæ* found on the Ostend coast, publishes three parts of his memoirs,[‡] in which he deals with the structure of some well-known and of some new species, and also with the general characters of the group; to this last we will first address ourselves.

Skeletal membrane (Hertwig).—The presence of this structure and its morphological characters have been the subject of considerable doubt and dispute; Claparède and Lachmann regarded it as a calyciform covering of resistant character; Stein asserted that in addition to this there was an internal membrane, while Hertwig has drawn attention to the differences presented by *Acinetæ* as compared with *Podophrya*; in *Acineta* Fraipont always found an internal membrane covering the surface of the protoplasm, at all points where this was

[*] ' Arch. f. Mikr. Anat.,' xvi. (1879) 153.
[†] ' Midland Naturalist.' ii. (1879) 88.
[‡] ' Bull. Ac. Roy. Belg.,' xlv. (1878) 217, 287, 475.

separated from the outer covering; the cavity between the two invest-ments may be single or divided into different parts, according to the extent to which the protoplasm is separated from the outer coat, and it is on the separated parts, and these only, that the second or inner covering is developed, and it is to be regarded as nothing more than a newly formed cuticle.

The stalk is not always developed, and, where it is, it may be merely a continuation of the wall of the body, or it may also have proto-plasmic contents; in either case it varies greatly in character.

The tentacles.—While Lachmann was the first to point out the suc-torial nature of these appendages, it is to R. Hertwig that we owe our knowledge of the fact that they are not always suckers, but that they may remain of a lower grade of differentiation and be simply prehen-sile filaments; and again, the same organism may present tentacles of the two types. Varying as they may in position and in arrangement, it is clear that, from a morphological stand-point, we have to do with a single type of structure. Looked at thus broadly, a tentacle is formed of a wall, and of the contained protoplasm; but it is something more than the pseudopodia, with which Stein, Haeckel, and Gegenbaur would compare it; it is covered by the cuticle of the skeletal mem-brane, and there is evidence of a differentiation of the protoplasm along the axis of the tentacle, and in the higher forms there is a spiral fila-ment differentiated in this part.

As to the *symmetry of the body*, we find all kinds of modifications; bilateral, quadrilateral, pyramidal, radiate, or none at all.

Protoplasmic contents.—The protoplasm is of very nearly the same character in all *Acinetæ*; there is a delicate outer layer, which is finely granular, and a more opaque medullary mass, which is often pigmented; the endosarc is more fluid than the ectosarc, and may contain small shining bodies, which are spherical or navicellar in form, and closely resemble the trichocysts of the ciliate Infusoria. In this substance two kinds of vacuoles may be distinguished; one, set irregularly and varying in form, while the others are pulsatile, and vary in number in different species; they appear to be always found near the surface of the ectosarc, and though undergoing a systole and diastole do not vary in position; with regard to these structures it is of great interest to observe that in some cases the presence of an excretory canal has been noted by some observers. The nucleus appears to vary in character, from a spherical or ovoid form to arborescent structures of great complexity, and the study of one of these latter shows that it passes through all the possible intermediate stages.

Reproduction may be effected in one of three ways; the first and simplest is by fission, but this is rarely observed; the second is by gemmation, and the third by the formation of embryos within the body of the parent; but with regard to these modes, the author has but little to say from his own observations.

With regard to the *classification* proposed by M. Fraipont, we could only deal with it satisfactorily by giving it in detail, and we must therefore be content to make two observations, and to refer those who

are specially interested in the subject to the paper itself. Basing his views on the classification of Claparède and Lachmann, he elevates their eight genera—*Podophrya*, *Sphærophrya*, *Trichophrya*, *Acineta*, *Solenophrya*, *Dendrosoma*, *Dendrocometes*, and *Ophryodendron*—into eight families, to which he adds the *Urnulida*; of these the *Trichophrida* are regarded as the lowest, and the relations of these to the rest, and of the rest to one another, are indicated in a phylogenetic table.

As to the affinities of the group, the formation of internal embryos, the ciliation, and migratory habits of these embryos, are, with certain other points, indications of their affinities to the *Ciliata*, from which they seem to have been derived.

With regard to the more detailed observations, of which only a brief mention can be made; *Acineta tuberosa* does not possess differentiated prehensile processes or suckers; all the tentacular organs, to which M. Fraipont gives the name of prehensile suckers, are similar in character; they are arranged in tufts on ten points of the body, and are only not rigid when they are seizing their prey, at which time they exhibit a high power of rapid movement. As a rule, it never possesses more than one contractile vacuole; the only mode of reproduction observed is that by internal gemmation. The new species *Podophrya Benedeni* is described as a magnificent form, in which four contractile vacuoles can be made out, and in which the two kinds of tentacular processes already described may be observed: reproduction is effected by external gemmation. The other new species described are *Acineta crenata*, *Acineta vorticelloides*, and *Podophrya truncata*. The first is of a dirty yellow colour, and has, as a rule, only one contractile vacuole, and there may be as many as twenty-six prehensile suckers: reproduction appears to be effected by external gemmation.

A few notes are also offered on *Podophrya Lyngbyi* Ehrenberg, in which the pedicle is about five times as long as the body, the prehensile suckers stout and numerous, and the protoplasm, as in so many of this group, coloured dirty yellow; one or two vacuoles are to be observed, and the nucleus has the form of a short rod, bent on itself. No observations are made as to the reproduction or development of this species.

The Noctilucæ.—In addition to the observations of M. Robin, to which we have referred at p. 331 of vol. i. and p. 195 of this volume, the *Noctilucæ* have been studied by M. W. Vignal.[*]

There is an entire disagreement between the results of Robin and Vignal on the subject of their contractility. According to Robin, there is nothing analogous to *muscular* contractility. He says that he has proved with Cadiat, that "induction currents have no influence whatever on the contractions of the tentacle, notwithstanding its striated condition, nor on the contraction of the flagellum or that of the sarcodic contents."

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[*] " Recherches Histologiques et Physiologiques sur les Noctiluques," 'Archives de Physiologie,' 10th Nov., 1878.

Vignal is, on the contrary, convinced of the muscular nature of the tentacle. "On the establishment and breaking of the current," he says, "the flagellum (the tentacle of Robin) contracts in its usual manner; the contraction is more rapid and energetic at the breaking of the current. When I applied an induced current with rapid interruptions, the flagellum became tetanically contracted, and continued in this state for three or four minutes, then it gradually relaxed under the influence of fatigue." There would therefore be, according to Vignal, "analogy between the contractions of the tentacle, and those presented by the muscles of animal life." However that may be, the movements of the tentacle never lead the *Noctiluca* to change its place; they merely cause it, as Suriray has already shown, to oscillate in its place.

As for the phenomenon of phosphorescence, it is due, according to Vignal, to a property of the protoplasmic mass, to the exclusion of the other parts of the body. We know that the phosphorescence attains its maximum by the agitation of the water; according to Vignal, this is an effect of which the cause is merely the mechanical irritation of the *Noctilucæ*: experiment has shown him that if oxygen intervenes in the phenomenon, it is as a necessary agent to life, and not as an oxidizer. Whilst studying the influence of heat on photogeny, he observed that a temperature of 37° (C.) augments the phosphorescence and, above all, renders it more persistent, whilst a temperature of 39° kills the *Noctilucæ* almost immediately. Finally, Vignal maintains that electricity supplied by a Grenet pile, or by an induction apparatus, neither increases nor lessens the brilliancy of the light emitted, a result contradictory to those formerly obtained by De Quatrefages, Robin, and Legros.

In an analysis of the two papers by M. G. Carlet, from which we take the above, he remarks that neither Robin nor Vignal have observed the existence of the anus admitted by Professor Huxley, and it would seem, therefore, to be clear that the alimentary residues are rejected by the oral aperture, the sole orifice of the body. Professor Huxley also described in the *Noctilucæ* permanent stomachs, which it must be considered do not really exist—these are vacuoles in the interior of the body, of variable number and volume, which are displaced by the movements of the protoplasm; they contain diatoms and other alimentary corpuscles, and represent only temporary stomachs.[*]

The dead bodies of *Noctiluca miliaris* left upon a beach in Beaumaris Bay by the receding tide, are said to have been of an orange-red colour. [†]

Flagellum of Euglena viridis.—In a "Notice to Correspondents," in 'Science-Gossip,'[‡] the editor mentions that the flagellum of a specimen of *Euglena viridis* sent to him terminated in a bulb. The bulb was used occasionally as a kind of sucker against the glass sides of the zoophyte trough.

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[*] 'Rev. Internat. Sci.,' iii. (1879) 47.
[†] 'Sci.-Gossip,' No. 173, p. 113.   [‡] Ibid., p. 119.

BOTANY.

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

Chemical Composition and Function of Leaves. — A paper on this subject, by M. Corenwinder, appears in the 'Annales des Sciences Naturelles,' * of which the following is a summary:—

The leaves of plants, in their relation to the external air, are the seat of two distinct functions.

1. By their protoplasm they absorb oxygen, and are perpetually producing carbonic acid.

2. By their chlorophyll they inhale carbonic acid during the day only, and exhale oxygen.

When young the protoplasm predominates in the cells, the quantity of chlorophyll being small; during this period therefore the function of respiration overbalances that of assimilation, and leaves consequently exhale carbonic acid without interruption.

In proportion as the leaves increase in size, the protoplasm diminishes and the chlorophyll increases; the power of exhaling carbonic acid then rapidly decreases, and they begin to give off more oxygen. After this the process of respiration can be detected only by placing the plants in the dark, or at least in diffused light, i. e. by suspending more or less the action of the chlorophyll.

These observations, therefore, completely confirm the doctrine now taught by nearly all vegetable physiologists; that there is in plants only one kind of respiration, and that this is identical with the process of respiration in animals, viz. an absorption of oxygen and disengagement of carbonic acid; and that the function of chlorophyll is one of assimilation.

Fermentation in the Tissues of Plants. — Professor de Luca, of Naples, publishes † the results of a series of experiments on the production of alcohol in the leaves, flowers, and fruits of certain plants. They may be summed up as follows:—

1. Fruits in closed vessels remain unchanged for a longer or shorter time, whether in carbonic acid or hydrogen, in a vacuum or in a limited supply of air.

2. Under these conditions fruits undergo a slow fermentation, with disengagement of carbonic acid gas, nitrogen, and, in certain cases, of hydrogen, and with formation of alcohol and acetic acid, but without the intervention of any ferment. In closed vessels these changes are only incompletely effected, in consequence of the strong pressure of the gases developed and compressed into a small volume.

3. In a limited supply of air and in closed vessels the final results are identical with the preceding; but the oxygen of the air is absorbed by the organic substance of the fruits.

4. Leaves and flowers present the same phenomena as fruits in a

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* (Botanique), vi. (1878) 303.

† 'Ann. des Sci. Nat. (Bot.),' vi. (1878) 286.

limited supply of carbonic acid, hydrogen, or air, or in a vacuum and in perfectly closed vessels. The gases developed exercise a strong pressure, under which an incomplete decomposition of the carbohydrates takes place, resulting in the formation of alcohol and acetic acid, but without the assistance of any ferment.

5. The same results ensue with fruits, flowers, and leaves, under the ordinary pressure, with a limited supply of carbonic acid, hydrogen, or air; but the decomposition is carried out so completely that, when the disengagement of gas ceases, neither sugar nor starch remains, but, in their place, abundance of alcohol and acetic acid.

6. Fruits, flowers, and leaves placed, under the ordinary pressure, in a limited supply of air, carbonic acid, or hydrogen, do not remain unchanged for any considerable time, but deteriorate, and the fruits in particular become reduced to a brown and gelatinous mass.

7. When the leaves, flowers, and fruits of certain plants disengage hydrogen during fermentation, and under the conditions specified, this gas probably arises from the decomposition of mannite, which is a sugar with excess of hydrogen. In fact, fruits, flowers, and leaves which contain mannite, when fermenting, disengage hydrogen in addition to carbonic acid and nitrogen.

8. When the receivers resist very strong pressure, and the substances are introduced in very small quantity, the sugar is almost completely decomposed.

Assimilation of Soda by Plants.—M. Déhérain, continuing his researches on the assimilation of mineral substances by plants, has now turned his special attention to soda.[*] The following are the chief results arrived at :—

1. That sodium chloride may be absorbed by plants that do not ordinarily contain any soda.

2. That when the roots come into contact with a complex solution, this absorption takes place only when sodium chloride occurs in considerable proportion in this solution, a condition not presented by ordinary arable lands. Hence the occasional absence of sodium from the ashes of terrestrial plants.

3. That the absorption takes place much more readily when the sodium chloride is presented only to the roots; but in this case it ceases to be indifferent; it is, on the contrary, utilized by the plant, as may be demonstrated by the following considerations :—

a. Haricots (on which the experiments were chiefly made) exhaust their cotyledons when their roots are plunged in a solution containing sodium chloride.

b. Haricots plunged in a very dilute solution take up the salt in much larger proportion than the water. The combination effected in this case between the salt and the tissues explains its more ready absorption.

These facts are readily explicable on the ordinary theory of diffusion (osmose). M. Déhérain completely confirms the previous observations of Peligot as to the feebleness of the tendency of plants to absorb soda.

* 'Ann. des. Sci. Nat. (Bot.),' vi. (1878) 340.

Nutrition of Phanerogamic Parasites.—M. Chatin forwards to the French Academy* the result of some investigations on the mode in which parasitic flowering plants derive their nutriment from the host. This is effected by means of a kind of conical pivot or peg, performing the double functions of an ordinary root, viz. to fix the plant, and to absorb nutriment. The extremity of this cone, although consisting entirely of parenchymatous tissue, has a remarkable power of forcing itself through the tissue of the host, even when this is of very great hardness. In certain cases, and especially in the mistletoe, lateral suckers are formed, in addition to the terminal one. The structure is the same in all important points whether the parasite obtains its nourishment from the root of the host, as in the case of *Thesium* and *Pedicularis*, or from the stem, as in *Cuscuta*, *Cassytha*, and *Viscum*.

Polyembryony, true and false, and its relation to Parthenogenesis.—Professor Strasburger's researches † upon the fecundation of the angiospermous Phanerogams show that the embryo-sac very seldom produces more than one embryonal vesicle which is fecundated or capable of being fecundated. The single constant exception to this rule known to him is that of *Santalum album*, which produces two, besides one or two orchids in which the embryonal vesicle occasionally divides into two. True polyembryony must therefore be very rare in Angiosperms. But seeds containing more than one embryo are of common occurrence in the orange, *Funkia*, *Allium*, *Nothoscordum*, &c. According to Strasburger, all supernumerary embryos in such cases are adventitious, originate outside the embryo-sac, by a kind of prolification in the nucleus, and are not fecundated at all. They appear in the form of minute cellular protuberances, which lengthen by degrees and push into the embryo-sac by a sort of hernia, or pierce their way into it, becoming in the ripe seed veritable embryos, which it is not easy to distinguish from the one resulting from the fecundation of the embryonal vesicle itself. Independent as these adventitious embryos are of fecundation, yet Strasburger could not obtain them in *Nothoscordum* when he had removed the stamens before flowering, and prevented access of pollen. But it appears that *Cælebogyne* is a case of this kind, namely, one in which an adventitious embryo is habitually produced, instead of the normal embryo, which fails from the want of fecundation, the male plant not being in cultivation. It is stated that this is not a mere inference, but that Strasburger has traced the development of the embryonal vesicle in the ovule of *Cælebogyne*, followed by its disappearance and resorption, and by the independent production of adventitious embryos in the manner above described.

This, then, gives an explanation of the long-disputed parthenogenesis of *Cælebogyne*, and therefore of the less notable instances.

Parthenogenesis, it is then concluded, is only so in appearance; it is sometimes, and perhaps in all cases, "a prolification of the nucleus."

* 'Comptes Rendus,' lxxxviii. (1879) 108.
† 'Jen. Zeitschr. f. Nat.,' v. (1878) 647.

Now we should insist that since the result is "a true embryo" (equivalent in structure, position of radicle, and ultimate growth to the normal embryo), and not a bud, parthenogenesis is the correct term; and the very interesting and important conclusion attained is, that parthenogenesis results, not from the development of an unfecundated embryonal vesicle, as was supposed, but from the development of other and extraneous cells into an embryo ; also that it is not very rare, since the adventitious or supernumerary embryos of various seeds are cases of this parthenogenesis.

Not the least interesting consideration is, that we have here a counterpart of what De Bary terms apogamy, instead of an analogue of it. Apogamy is a vegetative prolification from what should normally result in the product of sexual reproduction. Parthenogenesis proves to be the inverse of this, a vegetative production in the ovule of the normal result of sexual reproduction, viz. the embryo. And, finally, we have in these two modes, taken together, what was quite to be expected — a manifest and significant rendering of the hiatus between vegetative and sexual reproduction which Mr. Darwin may turn to account.

Some applications of this new knowledge may be made. It is quite possible that more embryos than we are aware of may be adventitious. Rather more than a year ago an abstract was given in the 'American Journal of Science and Arts,' of Mr. Francis Parkman's interesting paper on the hybridization of lilies. It may be remembered that the greater part of his hybrids exactly reproduced the female parent. The explanation suggested by him, and which he refers to in his paper, was that those plants were not really hybrids at all, but were from embryos originated without male influence. What then seemed the least improbable explanation, would now appear to be the one altogether probable.*

B. CRYPTOGAMIA.

Luerssen's Handbook of Cryptogamic Botany.† — The crying want so long felt by all botanists of a good handbook of cryptogamic botany, brought down to our present state of knowledge, is at length supplied, as far as German readers are concerned, by the excellent book before us. Though the work is designed in the first place for pharmaceutists, and is intended to deal especially with pharmaceutical products and their sources, this programme is far exceeded in the present volume. Starting from the classification of Sachs in the fourth (German) edition of his 'Lehrbuch,' the author takes every class and order of Cryptogams in succession, and supplies the reader with an accurate, succinct, and at the same time sufficiently full account of the morphology, physiology, and life-history of each. The result is a thick volume of 657 pages, with 181 admirable woodcuts, many of them new. It is easy to criticize Sachs's classification in many of its

* 'Am. Journ. Sci. and Arts,' xvii. (1879) 334.
† 'Medicinisch-pharmaceutische Botanik : zugleich als Handbuch der systematischen Botanik, für Botaniker, Aerzte u. Apotheker.' Bearbeitet von Dr. Chr. Luerssen. 1 Band, Kryptogamen. Leipzig, 1879.

details, and in some points it will certainly not be followed by future systematists; but it is far in advance of its predecessors, and the author of the present work was probably wise in following to so large an extent a system that has so many recommendations. In some minor points he has adopted evident improvements, as in the removal of *Volvox* from the Zygosporeæ to the Oosporeæ, in accordance with the recent observations of Cohn. He also removes Characeæ from Carposporeæ to Oosporeæ, which is perhaps better, if they are to be retained among Thallophytes. But will it be possible to do this? If a single criticism is admissible, we may append one which so often occurs in reading German books:—Why is there no index?

Anomalies in the Development of the Lowest Organisms.—Some researches lately made by W. Schmankewitsch, of Odessa,[*] on the development of fungus spores under changed external conditions, show the relation of certain colourless *Flagellata* on the one hand to *Fungi*, on the other to *Algæ*. The author's observations, if confirmed, will certainly tend to break down the distinction between these groups.

1. Spores of *Penicillium* were sown in a drop of filtered and boiled sea-water, the drop being placed on the under side of a cover slip serving as the roof of a small moist chamber. The chamber was exposed to sunlight, and the air in it was occasionally renewed, and was kept moist. The spores swelled up in the usual way prior to germination, but did not send out hyphæ. Their contents became sharply differentiated from the cell-wall, acquired a granular appearance and a distinct green colour, and developed a nucleus. The spores then divided like unicellular algæ, each into two daughter-cells.

2. Spores of *Aspergillus* were sown in the same way, in a drop of fresh water. A little distilled water was placed on the floor of the chamber, in a place darkened by a diaphragm, and in it was sown other spores of the fungus as generators of carbonic acid. The first drop of water was exposed to light from the concave mirror of the Microscope, and the air in the chamber was renewed weekly. After five weeks such spores as had not germinated, as well as the swollen cells of the hyphæ which others had sent out, had altered their appearance, their contents becoming green and granular, and sharply separated from the cell-wall, and afterwards dividing into four segments. The protoplasm also contained granules, which the author hints may be starch granules.

3. Some examples of a flagellate infusor (probably Bütschli's *Anisonema acinus*) were placed in a similarly disposed drop of fresh water. They soon ceased moving, and the secreted granules in their protoplasm (Secretkörnchen, Bütschli) began gradually to turn green, and many of them to increase in size, while some slowly made their way out of the body of the *Anisonema*. The latter, when full of these green granules, closely resembled the unicellular alga *Chlorococcum* during its multiplication by still gonidia. In the largest green granules a cell-wall could be distinguished. The author states that he has observed the converse of this case, namely, the trans-

formation of the gonidia of *Chlorococcum* into colourless monads, and he considers that the "Secretkörnchen" of such flagellates as *Anisonema* are the homologues of the still gonidia of *Chlorococcum*. When the *Anisonemæ* were placed in the dark, the green granules became colourless, and then resembled ordinary fungus spores.

4. In a similar chamber colourless monads, probably undeveloped *Anisonemæ*, were observed to send out mycelial filaments, which afterwards broke up into short pieces; these subsequently assumed an oval form.

5. *Aspergillus* spores were sown, in water, on the bottom of a shallow chamber, and exposed to light. These spores became brighter and quite colourless; then, after three or four weeks their contents became granular, and a nucleus-like body appeared: the cell-wall at the same time became mucilaginous and the spores assumed an oval form. They then divided in the direction of their length into two parts. If the water evaporated somewhat, the spores elongated still more, becoming spindle-shaped; the division planes became more oblique, and, in each spore, a second division-plane appeared, intersecting the first, so that the two planes, as seen under the Microscope, crossed one another like the two arms of an X. The spores thus became divided into four elongated bodies, and thus closely resembled the alga *Scenedesmus*. Other spores became dark green in colour, and divided into four, like *Pandorina*.

6. *Aspergillus* spores, sown in water, became colourless, their cell-wall dissolved, and they became transformed into amœbiform masses, and then into true *Amœbæ* of light greenish colour. These *Amœbæ*, later, contracted into darker green spheres which divided, forming motile green bodies quite like the unicellular alga *Chlamydomonas*. In other cases the contents of the spores divided into colourless granules, the spores then resembling the cysts of certain monads.

The author concludes with some general observations on these very startling results.

Influence of Light on the Movements of Mobile Spores.—Along with the movements of mobile spores, caused by currents of water, which Sachs has succeeded in imitating by emulsions ('Flora,' 1876, Nos. 16–18), by which spores placed in water congregate near the edges of the vessel, and form the figures which Nägeli has shown, zoospores also possess, through their own innate force, a movement at once progressive and rotatory. Researches recently made by E. Stahl [*] have convinced him that the direction of the forward movement is determined by light, and is absolutely independent of the passive currents of water above mentioned.

The following are given by Stahl as the principal results of his researches, which he intends to amplify later.

Light exercises an influence on the forward movement of many mobile spores which have been called *heliotropic spores*. Other zoospores are absolutely indifferent to light.

The movement of heliotropic zoospores changes periodically in

[*] 'Bot. Zeit.,' xxxvi. (1878) 715.

direction, since the same individual sometimes directs itself towards the light, and sometimes away from it. In the movements here spoken of, the colourless portion which bears the cilia is always directed forwards. It depends on the power of the light whether the forward or the backward movement is the more rapid; if the light is feeble, the forward movement is almost always the most marked, and the contrary when the light is strong.

The final result will therefore be, that after some time, in the one case, the zoospore will approach the light, and in the other it will go away from it. The intensity of the light has moreover an influence on the ulterior movements, since mobile spores of the same species, which have attained the same phase of development, will behave differently under the same conditions of light, depending on whether they have been previously kept for some time in darkness, or on the contrary exposed to a strong light.

The sudden removal of the source of light which determines the direction of the movement of mobile spores is immediately shown by the abandonment of the direction previously followed; in many cases the forward movement ceases suddenly. This phenomenon is produced in both phases of the periodic movement, that is to say, in the individuals which are at the moment directed towards the light, and in those which are moving in the opposite direction.*

Entophytic and Entozoic (parasitic) Species of Cryptogams.— P. F. Reinsch contributes to the 'Botanische Zeitung,'† an account of the parasitic Algæ and Fungi which he has himself detected as growing within the tissues of animals and plants. Those hitherto observed as entozoic within the bodies of living animals belong to the lowest classes of Algæ and Fungi, viz. Phycochromaceæ, Oscillatoriceæ, Leptothricheæ, Schizomycetes, and Hyphomycetes, and especially to the genera *Protococcus*, *Pleurococcus*, *Chroococcus*, *Sarcina*, *Vibrio*, *Spirillum*, and *Bacterium*. In addition to these he records the following:—

1. *A Floridea parasitic on Sponges and Bryozoa.*—This has been detected by M. Reinsch in the form of red threads, growing within the tubes of sponges and of *Sertularia pluma*, the latter itself growing on some of the large Fucaceæ of the Atlantic coast. The parasite enclosed within the thallus of the sponge forms elongated, usually but slightly branched threads, isolated or collected into bundles, penetrating the medullary and cortical substance of the sponge, never breaking through to the outside. No reproductive organs were detected. The parasite found within the tubes of Sertularia and Tubularia was different in form. It occurs as a weft of branching filaments covering the interior of the tubes, some of the filaments penetrating through the tissue of the tubes themselves. The reproductive organs occur in the form of tetrasporangia placed on short unicellular or bicellular pedicels, which were found only in the Sertularia and not in the Tubularia. These indicated a close affinity on the part of the parasite to Callithamnion.

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* 'Rev. Internat. Sci.,' iii. (1879) 66.　　　† xxxvii. (1879) 17 and 33.

2. *A Chytridiacea parasitic on Florideæ.*—In the tissue of *Eucheuma isiformis* (from Key West) were observed cells of a different character from those of the tissue of the seaweed, and presenting the nearest resemblance to those of a Chytridium already known as a parasite on Desmidieæ.*

3. *Asterosphæriæ parasitic on Mesocarpus scalaris.*—These occur in the form of minute globular cells found in pairs within the cells of the Mesocarpus, one of each pair being usually smooth, and the other covered with spines. When the parasite is fully developed, the infected cell of the Mesocarpus is swollen into the form of a bladder, and all its protoplasmic contents have disappeared. The parasite probably enters in the form of a zoospore which pierces the cell-wall of the host, the orifice subsequently again closing up. The green colour of the infected cell gradually disappears as its protoplasm is absorbed by the parasite. Ultimately a kind of conjugation takes place between the smooth and spiny parasitic cells, the contents of the former passing into the latter. The ultimate fate of these latter is uncertain, and it is possible they may be merely stages in the development of some higher organism.

4. *Nostochaceæ and Oscillatorieæ in Gromia and in the Ova of Fresh-water Snails.*—An Oscillatoria is not uncommon within the siliceous carapace of Gromia, consisting of a coiled filament with a diameter of about 0·0084 mm. The two ends grow slowly, it is not enclosed in a gelatinous sheath, and is probably a Hypheothrix. In another species of Gromia a much coiled filament was observed completely filling its cavity, apparently a Cylindrospermum; it had abundance of chronospores. The ova of a small fresh-water snail found on the leaves of a Potanogeton, enclosed in a thin transparent calcareous shell, and about 0·13 mm. in diameter, were found to contain well-developed sporiferous filaments of a Spermosira; the spherical or elliptical spores, ·0056 mm. in diameter, were double that of the filament. The parasite had apparently developed after the escape of the young mollusc from the shell.

5. *Anabæna and Chlorococcum in the perforated Cells of Sphagnum.*—The green spherical cells of these two algæ were found in the large colourless empty cells of *Sphagnum latifolium* from Cape Cod. As the diameter of the smallest of them was double that of the perforations of the Sphagnum cells, they must have developed in that situation.

6. *Anabæna in the Leaf of Azolla canariensis.*—The hollow of the leaf of Azolla is, in at least one case out of three, filled with filaments of an Anabæna, which can only have penetrated from without through the open channel into the cavity.

7. *Oscillatoria parasitic in the Oogonium of Œdogonium.*—This is one of the most singular cases of parasitism. The specimen, apparently one of *Œdogonium Rothii*, had a well-developed, perfectly closed oogonium of normal structure, into which had penetrated a twice-coiled Oscillatoria-filament, probably a Hypheothrix. As the oogonium was perfectly closed, the parasite must apparently have

* Reinsch, in Pringsheim's ' Jahrb. f. wiss. Bot.,' xi. 18.

been nourished by its contents, which had completely disappeared, with the exception of a few mucilaginous particles.

8. *An intracellular Floridea parasitic on the Thallus of a Porphyra.*— On the margin of the thallus of *Porphyra vulgaris* (from Marblehead, Massachusetts Bay) were seen minute reddish specks formed by a peculiar parasite.   Under a high power they were found to consist of a single cell of singular form with a number of branches radiating from its centre. The parasite had in these spots completely consumed the tissue of the host. Most of the radiating branches of the parasite were united in their growth with segmented bundles of cells running through the thallus of the host, which are metamorphosed cells of the Porphyra itself. The phenomenon presents the peculiarity that the parasitic cell has taken up in its growth, not the contents only but the cell-wall also of the infected cell. From this the author concludes, on physiological grounds, that the parasite cannot be a fungus, but must be a Floridea nearly related to Porphyra itself.

9. *Fungus-mycelium parasitic within the Hen's Egg.**—A hen's egg of ordinary size, and presenting nothing abnormal in the structure of the shell, skin, albumen, or yolk, showed, when held up to the light, small bright dots on the shell; the albumen and yolk were quite free from foreign bodies, and the shell was without any fungus-filaments, and showed no perforations under the Microscope. The parasite consisted of four hemispherical bodies with a diameter of from 4 to 4·5 mm., three of them of a greyish-brown colour, the other clear and nearly transparent. They were composed of a densely interwoven tissue of much-branched nearly transparent filaments, indistinguishable from the mycelium which is ordinarily formed after a time in an albuminous solution. The contents of the cell were quite clear, with a few large colourless granules. The author suggests that the spores must have entered the egg during its formation within the body of the bird.

10. *Dactylococcus De Baryanus and Hookeri.*—These parasitic algæ were first observed on small species of Copepoda (Cyclops and Lepidurus), where they occur in enormous quantities, appearing and again disappearing with great rapidity, and giving them a distinct green colour to the naked eye. The earliest condition of the parasite is that of a tolerably large motile cell, with amœba-like power of extension and contraction, between 0·02 and 0·03 mm. in diameter. The contents consist of green granules, among which is always one red one. When stretched to its full length, one end of the cell is free from granules, and at that end is a single rapidly vibratile cilium with club-shaped apex. After a short time the cells lose their motility, and then fix themselves to some part of one of the Entomostraca which are moving about among them. The point of attachment of the parasitic cell develops into a short clear pedicel, and the union with the body of the host becomes very close, and is effected with great rapidity. It does not appear, however, to have any injurious effect upon the host. In the female *Cyclops bicaudatus* the ovary in the last segment of the

* See also this Journal, ii. (1879) 315.

abdomen is always free from the parasite. The further development has been observed in both German and American examples, and consists of a separation of the contents in the largest diameter of the cell, and the formation of three or more daughter-cells; but the origin of the amœba-like cells has not yet been observed.

Cryptogamia Vascularia.

Germination of the Schizæaceæ.—This interesting and singular family of Ferns has been made a subject of careful investigation by Bauke,[*] as far as concerns the structure of the prothallium and its development from the spore; his observations having been made chiefly on *Aneimia Phyllitidis, collina,* and *cheilanthoïdes,* and *Mohria caffrorum.* The following is a summary of his conclusions:—

1. In all the genera examined, Schizæa, Lygodium, Aneimia, and Mohria, the spores are of a tetrahedral form.

2. In Aneimia and Mohria, the exospore is invariably furnished with characteristic ridges, which are either smooth or covered with conical protuberances.

3. The germination of the spore of Aneimia and Mohria does not differ essentially from that of the Polypodiaceæ and Cyatheaceæ, except that the filament which is the first result of germination develops into the plate of cells which constitutes the prothallium, by the formation of longitudinal walls by the other cells of the filament, at the same time that this takes place in the apical cell, or even earlier.

4. The apical cell of the filament divides longitudinally into two more or less unequal segments. One of these becomes a plate of cells increasing by marginal growth. The other, usually the larger one, is either distinctly marked as a wedge-shaped apical cell (Mohria), in which septa arise inclined alternately to the right and left; or (Aneimia) several parallel septa are formed at right angles to the first division-wall, commencing from below upwards. Even where there was a distinct apical cell, it was not observed to become segmented more than three times.

5. In the first segment-cell of the apical cell formed in the last-named manner, there is usually produced, after a time, a marginal cell of characteristic form, which grows in the direction parallel to the margin of the prothallium, and becomes divided by transverse septa. This is the origin of the "cushion" of the prothallium.

6. Independently of this lateral row of cells, which ultimately becomes the cushion, the plate of cells increases by ordinary marginal growth, advancing in a direction at right angles to the margin. This proceeds actively, so that ultimately the lateral row of cells is removed to a considerable distance from the base of the prothallium.

7. At the time of the formation of the cushion, the form of the prothallium is, in Aneimia, more or less distinctly reniform, the lateral row of cells lying always on the concave side; in Mohria it is at first broadly spathulate, ultimately roundish.

8. In Mohria, and sometimes in Aneimia, the cells of the lateral

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[*] Pringsheim's 'Jahrb. f. wiss. Bot.,' xi. (1878) 603.

row also divide. The innermost of the cells thus formed, together with the adjoining cells of the flat portion, then further divide by walls parallel to the plane of the latter, and thus form the cushion. The marginal cells of the original row become, in Aneimia, the " apical edge " of the cushion, growing in a direction at right angles to the margin, but maintaining their narrow form. In Mohria no such apical edge is formed.

9. Both in Aneimia and Mohria the cushion is formed at the side of the prothallium, rarely, in the former genus, at its apex.

10. A common characteristic of the prothallium of both genera is the occurrence of papillæ; in Aneimia only on the margin, and curved towards the apical edge of the cushion; in *Mohria caffrorum*, on the contrary, almost exclusively on the surface of the prothallium. The first papilla is always formed in close proximity to the lateral row of cells.

11. The rhizoids make their appearance on the oldest cells of the germinal filament, and next most abundantly on the lower margin of the prothallium, and especially on the same side as the row of cells already mentioned. Subsequently, as in other cases, they spread over the lower surface of the cushion.

12. The antheridia are distinguished, in both genera, by the formation of a bell-shaped membrane when the central cell is separated from the wall. The " stigmatic " or covering cell appears to be always thrown off in *Mohria caffrorum*, while in Aneimia it is ruptured in the form of a star. The first antheridia are produced in both genera, like the rhizoids, on the margin below the lateral row of cells, spreading thence to the surface of the cushion.

13. The construction of the archegonia offers no striking peculiarity. In Aneimia the neck was usually found straight; in Mohria, curved towards the base of the prothallium.

14. From the time when the cushion is formed, the divisions parallel to the surface of the prothallium continue in a backward direction; while the part which takes no share in the formation of the cushion continues its marginal growth, and in Aneimia becomes more and more arched upwards.

15. In those prothallia of Aneimia where, from deficiency of antherozoids or any other cause, fertilization is not effected, the cushion always projects laterally in the form of an outgrowth of usually nearly uniform breadth, and continues to grow at the apical edge until either fertilization takes place or the prothallium perishes.

16. Under certain unfavourable conditions the production of archegonia on the cushion ceases, the cushion continuing its growth; and its lower side then becomes covered instead with antheridia; thus showing that the continued growth of the cushion need not necessarily result in the formation of archegonia.

17. While in the Polypodiaceæ and Cyatheaceæ there are not usually any adventitious shoots on the normally cordate prothallium, such shoots are almost invariably formed, in both Aneimia and Mohria, on the cushion of older prothallia, originating in cells belonging to the flat portion.

Fungi.

Relationship of Oidium albicans and Mycoderma vini. — The relationship to one another of the various forms of the fungi known as Schizomycetes which cause or accompany the phenomenon of fermentation has been much debated. In an article in Virchow's 'Archiv' [*] Grawitz concluded, from Cienkowski's descriptions and figures, the identity of the " Soor-pilz," *Oidium albicans*, or *Saccharomyces albicans*, with the " Kahmpilz," variously known as *Mycoderma vini*, *Mycoderma cerevisiæ*, *Saccharomyces Mycoderma*, *Hormiscium vini*, and *Hormiscium cerevisiæ*. In the 'Sitzungsbericht der phys.-med. Soc. zu Erlangen,' 1878, Reess now contests this view, and maintains the complete distinctness of the species. The two ferments can, he states, be cultivated side by side under precisely similar conditions of nutrition, supply of air, temperature, &c., without one of them passing over into the other. The Mycoderma can be cultivated in cherry-juice or in a strongly acid aqueous solution of ammonium acetate with a little yeast and solution of cigar-ash; even when agitated daily, the cells and groups of cells never assume the forms which Oidium would take under similar conditions. In the same manner cultures of Oidium in solution, well supplied with nutriment and with air, can be kept for as much as six weeks without any development of Mycoderma taking place; the surface of the fluid remains clear. The masses of Oidium consist mostly of roundish cells formed in much-branched groups, mixed with which are less often to be found short filaments which bud at the septa. These are not to be confounded with the filaments of Mycoderma produced in similar circumstances. Reess gives a detailed account of the series of experiments on which he relies for the establishment of the position laid down above.[†]

Alcoholic Fermentation. — M. P. Miguel [‡] has made some experiments which confirm M. Pasteur's views on fermentation. When the must of grapes, which has been sterilized, is exposed to the air in September, in vineyards in the south of France, and put in vessels free from germs, it generally begins to ferment after a few days. This is due, he considers, to gnats, who carry through the air the yeast of the vine, attached to their proboscis and to different parts of their bodies. If the must is preserved, boiled and clean, from the insects, at the same time permitting the air to circulate freely with its numerous microbia, the must most often becomes mouldy and does not ferment.

This fact shows therefore that *all* the cases of spontaneous alcoholic fermentation cannot be attributed to the organized " dust " of the air ; on the other hand, experiments prove that air in motion does carry the alcoholic yeast. It was found to abound in the vineyards, whilst at Paris not a single case of spontaneous alcoholic fermentation could be obtained. In Paris also it is not difficult to obtain microbia exactly resembling the alcoholic yeasts. In some attempts at sowing these organisms, introduced into the sterilized

[*] lxx. (1877) Part 4.   [†] 'Hedwigia,' xvii. (1878) 56.
[‡] 'Comptes Rendus,' lxxxvii. (1878) 759.

must with the spores of mould which accompanied them, fermentation did not result, and we may therefore suppose either that they belong to Cryptogams whose physiological functions differ from those of the alcoholic yeasts, or that their germination may be hindered by the rapid development of the moulds. In the course of the experiments several cases were observed of fermentation suspended by the excessive growth of microphytes.

Experimental Researches on a Leptothrix found during life in the blood of a woman suffering from a severe (and mortal) attack of puerperal fever.—A note on this subject by M. V. Feltz, is to be found in the ' Comptes Rendus.' * Two days before death a number of transparent, immobile filaments, which were simple or jointed, straight or curved, were found in the blood of the patient; they were ·003 to ·006 mm. long, and ·0005 to ·0003 mm. broad; they differed from the Leptothrix found in the mouth in the absence of the mobile spores from which the latter are developed. While they are destroyed by putrefaction, they increase in great quantities when introduced into the blood of the living animal. The state thus induced is marked by an incubation period of varying length, and a diseased stage, in which there is a slight rise in temperature, and an affection of the mucous membranes, and difficulty of respiration, terminating in death by asphyxia. Post-mortem examination reveals the presence of an enormous quantity of immobile rods, by which the small vessels may be obliterated. Multiplication is most rapid in the rabbit. Small, and even infinitesimal doses produce the same effects, but successive inoculations do not, as in septicæmia, increase the virulence of the attack. The poisonous matter does not dialyse, and neither desiccation nor cooling has any effect on it. Solutions containing the poisonous body may be rendered innocuous by filtration in vacuo through thick layers of charcoal. When cultivated in alkaline urine, the development of the rods from ovoid spores may be followed out; the rods become granular and break up under the action of alcohol or the prolonged action of carbonic acid, as well as by heating to 130° or 140°.

The Leptothrix of the gums does not produce any toxic effect on the blood of the rabbit, and the form now under description appears to be inoffensive to the dog.

Sexuality of the Ascomycetes.—The Italian cryptogamist Borzi, in accordance with the views of De Bary, Woronin, Janczewski, and others, but in opposition to those of Tulasne, maintains † the existence of a sexual mode of reproduction in these fungi. He confirms the view of previous observers that the sexual organs are to be found on the scolecite, a mycelial branch so called in consequence of its vermiform shape, at present known only in the Discomycetes. Janczewski has already described this organ in five species, *Ascobolus pulcherrimus, A. furfuraceus, A. carneus, A. saccharinus,* and *A. pilosus;* to which Borzi now adds five more, viz. *A. immersus, A. æruginous, Saccobolus violascens, Ascophanus granuliformis,*

* lxxxviii. (1879) 610.   † ' Giorn. Bot. Ital.,' x. (1878) 43.

and *Ryparobius*, sp. n. Borzi describes the scolecite of *Ascobolus pilosus* as composed of three parts. The first consists of the apical cell only, which is hemispherical, and contains a transparent protoplasm. The second part also consists of a single cell, termed the ascogenous cell or ascogonium, which is of about double the diameter, and nearly spherical; its protoplasmic contents are much more granular. The third and lowest part of the scolecite is composed of a row of from four to seven much smaller cells, gradually decreasing in size towards the base; they also contain a finely granular protoplasm. From the hyphæ which surround the base of the scolecite springs a single branch which runs obliquely up the scolecite, and, at about two-thirds of its height, i. e. near the base of the ascogonium, branches. To this body, which does not differ morphologically from the other cells of the hymenium, but to which a fertilizing agency has been attributed by De Bary, the term pollinodium has been applied. Borzi, however, disputes this interpretation, and considers that the organ in question has no function but one of protection to the scolecite. The ascus ultimately develops from the ascogonium, the first indication being presented by the appearance on its surface of a number of minute papillæ. These gradually elongate and divide transversely into short filaments; the terminal cells of some of these filaments acquire a club-like form, and are the young asci. The ascogonium, and indeed the whole scolecite, then disappears. That the ascus and ascospores are the result of a process of fecundation, Borzi was unable actually to determine, though he has little doubt that this is the case. His own view is that the male organs of fecundation are the spermatic cells of minute size produced on special hyphal branches in the neighbourhood of the scolecite, and this last organ he looks on as a carpogonium, the terminal cell being a trichogyne, through which the fecundating particles are conveyed to the ascogonium; the lower multicellular portion of the scolecite being simply a support for the female sexual organ. The apothecium of Ascobolus Borzi considers to consist of three parts:—the cortical layer, which involves the whole apothecium except the upper part; the excipulum, the cells of which, uniform in size, compose a pseudo-parenchymatous tissue; and the hymenium, consisting of the asci, and of paraphyses, elongated barren filaments, ramifying at the base. The asci spring from the lower or sub-hymenial portion of the hymenium. They have at first the form of club-shaped cells containing abundance of protoplasm; the ascospores are formed in them by free cell-formation. The ejection of the spores is the result of the constantly increasing pressure of the hymenium on the mature asci. In addition to the ascospores, *Ascobolus pulcherrimus* produces another kind of germinating cell, the chlamydospores, produced probably non-sexually, at the apex of short mycelial filaments. In several species of Peziza, Borzi claims to have observed phenomena altogether similar to those of Ascobolus.

Polymorphism of Agaricus melleus.—In his researches on the chestnut-tree disease,[*] J. E. Planchon was struck with the difficulty

[*] This Journal, ii. (1879) 167.

of determining the species of Agaricus, the mycelium of which is the cause of the disease. In a note read before the French Academy,[*] he now identifies it as *Agaricus melleus* Vahl, of which he considers *A. griseofuscus* DC., and *A. Mori* Fr., to be mere varieties. The mycelium of this fungus, known to older authors as *Rhizomorpha fragilis*, attacks the roots of a variety of trees, as the mulberry, chestnut, horse-chestnut, lilac, apple, and vine. This mycelium occurs in three different forms—(1) filamentous or byssoid, which has been seen to proceed directly from the spore, and which attacks especially the root of the vine; (2) radiciform or rhizomorphic (*Rhizomorpha fragilis subterranea* of authors), smooth and brown, with tufts of red filaments, comparable to the sclerotia of other fungi; and (3) membranaceous or hymenoid (*Rhizomorpha fragilis corticalis*), which penetrates in the form of flat expansions, between the layers of the bark, into the cambium zone, and even into the wood itself.

Conidia of Fistulina hepatica.—As long ago as 1864, Seynes described certain spore-like bodies which he found on the upper surface of the receptacle of this fungus; and the observation was confirmed by Léveillé, Thuret, and Bornet. G. Arcangeli has submitted these bodies to a fresh examination,[†] and confirms in all important points the observations of Seynes. The conidial region of the receptacle is easily recognized by its more intensely red colour. The conidia are oval or ellipsoidal, varying in length from 0·006 to 0·01 mm., and in breadth from 0·004 to ·005 mm.; and they are borne, in larger or smaller numbers, on delicate conidiophores, the whole being of a tawny colour. Arcangeli has no doubt that these conidia belong to the Fistulina itself, and not to another fungus parasitic upon it. He considers that the presence of these organs indicates a transition from the Polyporei to the Gasteromycetes which are furnished with more than one kind of reproductive organs.

Algæ.

Morphology and Biology of the Phycochromaceæ. — Professor Borzi,[‡] of Vallombrosa, has worked out a classification of one of the lowest and least studied groups of chlorophyll-containing Thallophytes, the Phycochromaceæ (known to some writers as Phycochromophyceæ), called by Cohn Schizophyta, to correspond with the analogous Schizomycetes of the non-chlorophyll-containing Thallophytes. This group he classifies as follows:—

Ord. I. NEMATOGENÆ Rabh. Cells united into linear filaments.

Sub-ord. 1. **Hormogeneæ** Thr. (*Nostochineæ* pl. auct.). Multiplication by means of hormogonia (mobile fragments of filaments).

Fam. 1. *Nostochaceæ* Rabh. Filaments of cells vermiform, simple, usually interrupted by heterocysts; increase indeterminate; spores.

* 'Comptes Rendus,' lxxxviii. (1879) 65.
† 'Nuov. Giorn. Bot. Ital.,' x. (1878) 369.   ‡ Ibid., 236.

Fam. 2. *Scytonemaceæ* Borz. (*Scytonemeæ* Thr., *Scytone-maceæ* and *Sirosiphonaceæ* Rabh.). Filaments filiform, simple, or more often branched, interrupted by hetero-cysts; increase apical and indefinite: spores.

Fam. 3. *Rivulariaceæ* Rabh. (*Calotricheæ* Thr.). Fila-ments filiform, simple or branched, often with heterocysts; increase apical and limited: spores.

Fam. 4. *Oscillariaceæ* Rabh. ex part. (*Lyngbyæ* Thr.). Filaments filiform, simple, without heterocysts; in-crease indefinite; no spores.

Sub-ord. 2. **Cystogoneæ** Borz. Multiplication by means of isolated, immobile, vegetative cells.

Fam. 5. *Chamæsiphonaceæ* Borz. Filaments filiform, simple; increase apical, indefinite; no heterocysts; spores (?).

Ord. II. **Glæogenæ** Cohn. Cells distinct, either isolated or collected into larger or smaller families.

Fam. 6. *Chroococcaceæ* Rabh. ex part. Cells multiplying by indefinite bipartition in three directions, at all events at the moment when the colonies are first formed; spores.

The paper referred to contains an exhaustive account of the biology and morphology of the first of these families, the *Nostochaceæ*, under which Borzi includes the following genera :—*Nostoc* Vauch., *Anabæna* Kütz., *Isocystis* Borz., *Sphærozyga* Rlfs., *Cylindrospermum* Rlfs., *Nodularia* Mart., and *Aphanizomenon* Morr.

In a subsequent paper in ' Flora,'* Sig. Borzi makes some further remarks on his proposed new genus Isocystis, of which he gives the following character :—Filaments solitary, a larger or smaller number irregularly and more or less densely interwoven into an indefinitely extended layer, never united in parallel growth, often very delicate and perceptibly narrowed at the apices; cells elliptical or spherical, some-times oblong-quadrate from mutual compression, sometimes angular or disk-shaped, closely connected or distinct; spores, where known, glo-bose, sub-globose, or oval, of a bluish-olive or dusky golden colour; exospore thin or moderately thick, very smooth or scabrous. The typical species is very similar in external appearance to an Anabæna, but is distinguished by the invariable absence of heterocysts, and by the tendency of the filaments to unite into small bundles, like those of Aphanizomenon. The genus includes four species, three of them now described for the first time, the fourth previously regarded as an Anabæna (*A. infusionum*). They represent the simplest and lowest type of the Nostochaceæ, scarcely ever forming colonies of any considerable size. The very delicate moniliform filaments are found floating on the surface of the water, either solitary or in interwoven masses; the mucilage which envelops them is very small in quantity, and disappears completely at a very early period. Borzi considers

* ' Flora,' xxxvi. (1878) 465.

the genus of considerable importance from a systematic point of view, as exhibiting a clear affinity with the lower forms of the Schizomycetes, especially the Bacteria.

Halosphæra, a new Genus of Unicellular Algæ (Plate XVI.).—Dr. F. Schmitz gives an extremely interesting description of a new form of unicellular marine algæ, under the name *Halosphæra viridis.**

It presents the appearance of minute green points just visible to the naked eye, the largest being a little more than half a millimetre in diameter, floating on the surface of the water in the Bay of Naples, and long known under the designation "punti verdi." It is to be found regularly in the spring from the middle of January to the middle of April, when it disappears. The light green globule, which has no independent power of motion, is enclosed in a tolerably thick, smooth, and perfectly colourless membrane; the inside of this membrane is clothed with a thin layer of protoplasm, enclosing a single very large central vacuole with colourless cell-sap. Imbedded in the protoplasmic layer are a small number of minute chlorophyll-grains, and a single globular nucleus with a somewhat darker nucleolus.

The process of cell-division which takes place during the development of this alga is very interesting, and altogether in accordance, in all essential points, with that described by Strasburger in his 'Zellbildung und Zelltheilung' as occurring in the tissue of more highly organized plants. As the cell increases in size, the nucleus divides into two, which gradually separate from one another, and again undergo division (Fig. 1); and, as this process is repeated many times, a very large number of nuclei, from 200 to 300, come to be tolerably regularly dispersed throughout the protoplasm of the mother-cell. The mother-cell has now attained its full size, and the division of its contents into daughter-cells commences, the protoplasmic layer gradually collecting around the nuclei, so that each becomes the centre of a new primordial cell (Fig. 2). This process takes place slowly, so that its various stages can be closely followed. The space between the daughter-cells appears to be occupied only by a colourless cell-fluid; the cells having the form of hemispherical balls in close contact with the inner membrane. They are of a bright green colour, but no separate chlorophyll-grains are to be detected in them. These become the mother-cells of the zoospores. The outer membrane of the entire cell has in the meantime become differentiated into two distinct layers, of which the outer one now bursts by a nearly circular slit, and slips off the inner membrane, which now itself clearly consists of two layers. This layer next begins to swell up and deliquesce, and at length becomes resolved into mucilage. As soon as this change commences, the hemispherical green daughter-cells begin gradually to detach themselves from the outer membrane, and to distribute themselves over the interior of the cell (Figs. 3, 4, 6). Each of them usually divides into two zoospores, though sometimes a larger number, and sometimes only one, are developed from each daughter-cell (Figs. 7–15). In the ordinary case the green primordial cell first of all contracts in the

* 'Mittheil. Zool. Station Neapel,' i. (1878) 67.

Halosphæra, a new Genus of Unicellular Algæ.
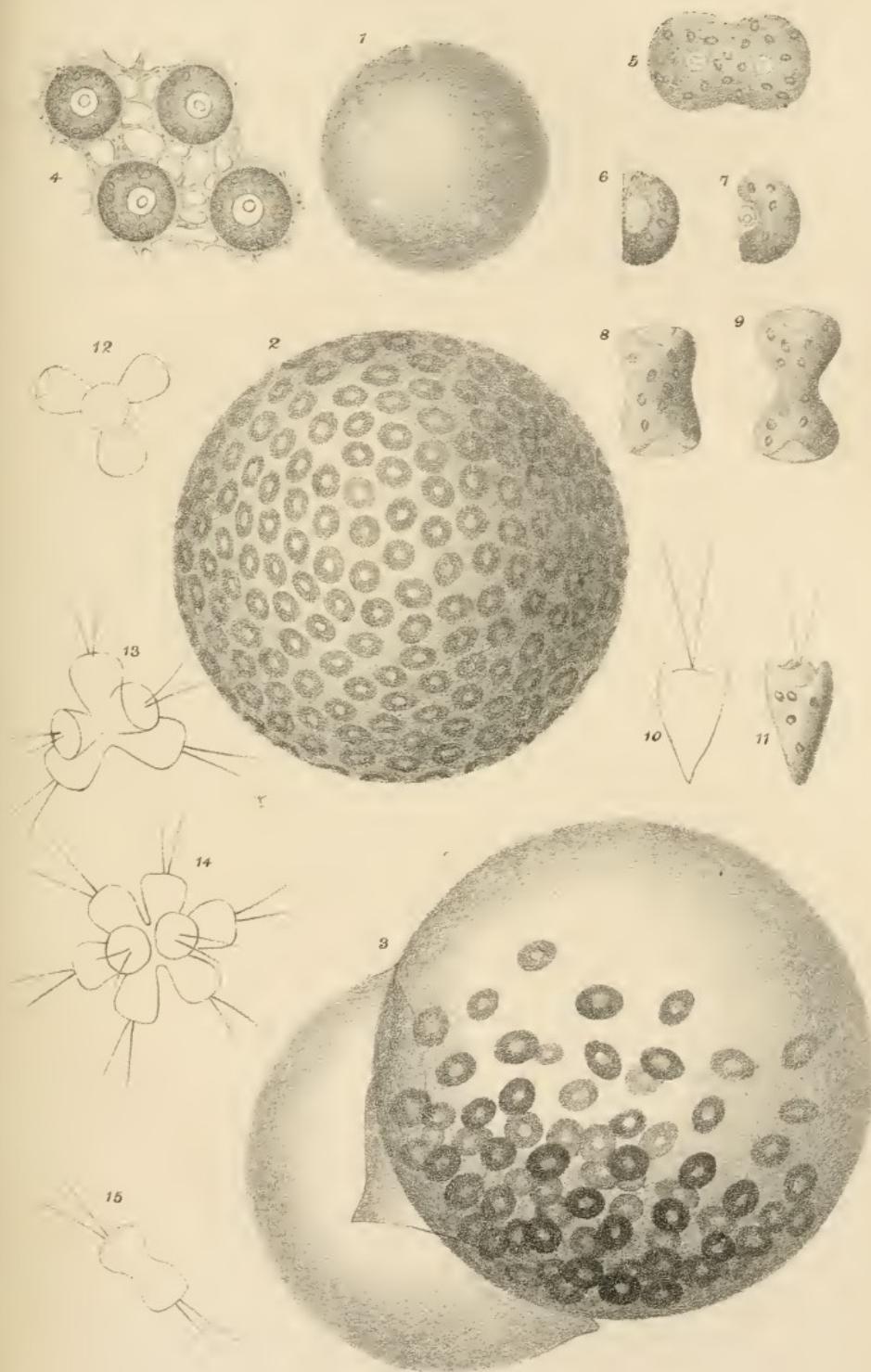
middle into an hour-glass shape, and then divides in the centre into two bodies of conical shape, each with a nearly flat but toothed base and a pointed apex. To a colourless elevation in the centre of the nearly flat base are attached two long vibratile cilia; the zoospores thus differing considerably in form from any known elsewhere. Various stages of this process are to be observed at one time within the external membrane of the same mother-cell, which is now gradually deliquescing, so that the zoospores are set free into the surrounding water, where they move about for a time with a comparatively slow motion, and then fall to the bottom. Their further development Dr. Schmitz has been unable to follow.

With regard to the systematic position of *Halosphæra*, notwithstanding its external resemblance to *Volvox*, its internal structure forbids its location among Volvocineæ. It bears more resemblance to De Bary's genus of Conjugatæ *Eremosphæra*; but until its life-history is more completely known, its genetic affinities must remain in obscurity.

Plate XVI. Fig. 1.—Single cell of *Halosphæra viridis*; the nucleus has formed a great number of nuclei by repeated bipartition.

Fig. 2.—The same. The parietal layer of protoplasm has collected round the very numerous nuclei into flatly hemispherical masses.

Fig. 3.—The same. The outer cell-wall layer has burst after the daughter-cells have been completely formed; the inner layer has stretched considerably; within it the daughter-cells have become separated from the cell-wall.

Fig. 4.—Formation of the daughter-cells. The thin parietal layer of protoplasm between the separate hemispherical masses of protoplasm is beginning to separate; a number of cavities have already made their appearance in it.

Fig. 5.—Abnormal formation of two daughter-cells, whose nuclei have nearly coalesced.

Fig. 6.—Daughter-cells immediately after the division of the mother-cell, still in close contact with the cell-wall.

Figs. 7–9.—Division of the daughter-cells in the formation of zoospores.

Figs. 10, 11.—Zoospores. Fig. 10 in optical longitudinal section.

Fig. 12.—Division of a daughter-cell into four zoospores.

Figs. 13–15.—Abnormal formations. Two (Fig. 15), five (Fig. 13), and twelve (Fig. 14) zoospores are formed by incomplete division from a single daughter-cell; they have become completely separated from one another.

(Figs. 1–3 × 100; Figs. 4–11 × 300; Figs. 12–15 × cir. 150.)

Black Mildew of Walls.—Professor Leidy, at a meeting of the Philadelphia Academy of Natural Science, referred to an article in 'Hardwicke's Science-Gossip' for August by Professor Paley, entitled " Is the Blackness on St. Paul's merely the effect of Smoke? " According to the author, the blackness is mainly due to the growth of a hitherto undescribed lichen which appears to flourish on limestone, and in situations unaffected by the direct rays of the sun. Professor Leidy

said that his attention had been called a number of years ago to a similar black appearance on the brick walls and granite work of houses in narrow shaded streets, especially in the vicinity of the Delaware river. Noticing a similar blackness on the bricks above the windows of a brewery, from which there was a constant escape of watery vapour, in a more central portion of the city, he was led to expect that it was of a vegetable nature. On examination, the black mildew proved to be an alga closely allied to what he supposed to be the *Protococcus viridis*, which gives the bright green colour to the trunks of trees, fences, and walls, mostly on the more shady and northern side. It probably may be the same plant in a different state, but, until proved to be so, may be distinguished by the name of *Protococcus lugubris*. It consists of minute round or oval cells, from 0·006 to 0·009 mm. in diameter, isolated or in pairs, or in groups of four, the result of division; or it occurs in short irregular chains of four or more cells up to a dozen, occasionally with a lateral offset of two or more cells. By transmitted light the cells appear of a brownish or olive-brownish hue. In mass, to the naked eye, the alga appears as an intensely black powder.[*]

MICROSCOPY.

Employment of Wet Collodion for Microscopic Sections. — M. Mathias Duval points out [†] the difficulty of finding any body which would firmly hold delicate objects, in which there are a large amount of hollows and cavities, such, for example, as embryonic tissues; it is obvious that the best substance would be one, which though solid is not friable, and which at the same time is homogeneous; these conditions are not satisfied by the ordinary imbedding mixtures, such as gelatine, wax and oil, or soapy bodies; one that has been largely used is gum solidified by the action of alcohol, and this has been recommended by Dr. Klein; in the directions appended to their 'Treatise on Embryology' (of the Chick), Foster and Balfour expressly state that they do not recommend it for the study with which they are there particularly engaged, nor does the experience of other embryologists seem to do otherwise than confirm their opinion. Nor, again, do the methods ordinarily in use allow of the advantages which would be gained by the use of a transparent imbedding substance.

Already used in its *dry* state for certain observations, collodion has been found to have much to recommend it, but it is too hard for delicate bodies; when, however, a small quantity is treated with alcohol at 36°, it is found to retain its volume, while presenting a large amount of consistency, elasticity, or transparency. Having used the substance for six months, M. Duval now feels justified in recommending it to the attention of students; the embryos to be examined are first hardened by osmic acid, alcohol, or some other method, are stained with carmine, and then placed in alcohol; they are placed for a few minutes in ether, and are then removed to the liquid collodion, in which they remain for a period varying from

* 'Proc. Acad. Nat. Sci. Phila.' (1878) p. 331.
† 'Journ. Anat. et Phys.' (Robin), xv. (1879) 183.

ten minutes to twenty-four hours. When withdrawn from this, they have attached to them a piece of elder-pith, or are, if their size and state permit of their being cut without any such aid, thrown at once into alcohol; the body now becomes surrounded with an elastic mass of collodion, which solidifies without alteration of volume, and encloses the pith if this has been already added. Thus treated, the tissue is ready for immediate section, or may be kept in alcohol for an indefinite period without danger.

As the sections are made in the ordinary way, that is, the body itself and the razor being both wetted with alcohol, it is obvious that the collodion will be prevented from becoming dry; there is no need to remove the imbedding substance, and the section may be immediately placed on a slide; a drop of glycerine and a cover-glass are then all that is necessary for the observer to find himself delighted with an object, the optical properties of whose imbedding substance are exactly the same as those of glass. Another advantage remains to be noted, the collodion has not in M. Duval's sections lost its transparency after a period of six months.

A similar method may be used for fœtal cerebral structures, and in the study of the eye or of the cochlea and similar delicate parts.

Method of Preserving the more delicate and perishable Animal Tissues.—In a valuable article [*] on the development of the earthworm, *Lumbricus trapezoides* Dugès, M. Kleinenberg says that whilst a great part of the earliest formations of the egg can be made out in the living state, the protoplasm being sufficiently transparent to allow the internal parts to be seen, yet afterwards the precise outlines of the cells disappear, and nothing can be seen but the grosser structure. To make out the more delicate structure it is necessary to employ reagents.

Osmic acid applied in the state of vapour gives good results; but the preparations obtained by the use of a mixture of picric with sulphuric acid are more satisfactory. It has, however, the same drawback as osmic acid, of occasionally producing swellings in the primitive blastomeres, which, if it only slightly alters the normal conditions, renders the preparations less sightly. This difficulty is overcome by the addition of a little kreosote.

M. Kleinenberg, however, after many experiments, recommends strongly the following method of preservation, which he used for the particular researches treated of, and for the majority of other animal tissues, especially for the more delicate and perishable.

Prepare a saturated solution of picric acid in distilled water, and to a hundred volumes of this add two volumes of concentrated sulphuric acid; all the picric acid which is precipitated must be removed by filtration. One volume of the liquid obtained in this manner is to be diluted with three volumes of water, and, finally, as much pure kreosote must be added as will mix.

The object to be preserved should remain in this liquid for three, four, or more hours; then transferred, in order to harden it and

remove the acid, into 70 per cent. alcohol, where it is to remain five or six hours. From this it is to be removed into 90 per cent. alcohol, which is to be changed until the yellow tint has either disappeared or greatly diminished. Alcohol of 90 per cent. is better than absolute for preserving the more delicate structures for a long time uninjured, and for keeping the preparation at the proper degree of hardness.

For colouring, crystallized hæmatoxylin is to be used, dissolved in the following mixture:—Prepare a saturated solution of calcium chloride in 70 per cent. alcohol, with the addition of a little alum; after having filtered, mix a volume of this with from six to eight volumes of 70 per cent. alcohol. At the time of using the liquid pour into it as many drops of a concentrated solution of hæmatoxylin in absolute alcohol as are sufficient to give the required colour to the preparation of greater or less intensity, according to desire.

This mixture, notwithstanding its chemical irrationality, gives good results. Aqueous solutions, especially when they contain traces of ammonia, are to be avoided, since they are very hurtful to many delicate tissues. The object must remain in the dye for a period varying from a few minutes to six hours, according to its size and to the nature of the tissues composing it. It is a good rule, when intending to make sections, to stain deeply and to cut them *very thin*.

When removed from the dye the preparation is to be washed in 90 per cent. alcohol, in which it may remain from six to twelve hours. Finally, to remove every trace of water, it should remain for half or a whole day in absolute alcohol.

If the preparation is to be cut it must be removed from absolute alcohol to essential oil of bergamot, in which it should remain for some hours, in order to fit it for being imbedded in paraffin, which is removed from the sections when cut by means of a mixture of four parts of essence of turpentine with one part of kreosote. Finally, the sections are mounted in resin dissolved in essence of turpentine.

Histologists are warned not to use a solution of resin in alcohol. The preparations mounted in this are at first beautiful but soon become spoiled, in consequence of the precipitation of crystals or of an amorphous substance. He lost in this manner many hundreds of preparations, and the same results have occurred in the Zoological Station at Naples.

Preparation and Preservation of the Lower Organisms.—M. Raphaël Blanchard, of Paris, referring to the process employed by Koch to preserve and photograph Bacteria,[*] says [†] that more than two years ago, he preserved Bacteria in lasting preparations by using with excellent results osmic acid instead of the process of desiccation employed by Koch, which he considers a very bad one.

In a few hours, or two days at the longest, the surface of water in which an organized substance (vegetable or animal tissue, &c.), has been macerated, becomes, as is well known, covered with a slight

[*] See this Journal, i. 195.   [†] 'Rev. Internat. Sci.,' iii. (1879) 245.

pellicle composed of a more or less compact mass of Bacteria, enveloped in a hyaline, transparent substance of slight consistence. This membrane is so fragile that the slightest movement or breath which ripples the surface of the water tears it. A tolerably large piece of this membrane can be obtained by carefully introducing into the liquid beneath it a glass slide, and raising it with caution.

If we then add, with a pipette, one or two drops of a concentrated solution of osmic acid (or even a solution of 1 in 100) to the membrane on the slide, it immediately acquires a much greater consistency and can be covered without fear of tearing it. A drop of a solution of violet of methylaniline should be placed at the side of the coverglass, drawing away the osmic acid by a cigarette paper on the opposite side. In about half an hour the Bacteria assume a fine violet tint, the fundamental substance remaining colourless; if the impregnation lasts longer the Bacteria assume a deeper hue, and the fundamental substance becomes tinted. We can then replace the violet of methylaniline by glycerine, which does not render the preparation colourless, as Koch says, if we add a small quantity of the violet. A concentrated solution of sulphate of calcium can also be used with advantage to preserve the preparations. M. Blanchard's collection contains preparations made thus in 1876, which are as bright in colour as at first.

The violet is not the only aniline colour which can be used, but it seems to be more durable than others.

A solution of hæmatoxylin can also be used with advantage. When a "proliferous membrane" (F. A. Pouchet) has been treated with osmic acid, it is left for twenty-four hours under a damp bellglass, in a watch-glass containing a few drops of hæmatoxylin. There is then formed an iridescence which spoils the clearness of the preparation, but which can be easily removed by repeated washings. The membrane is then mounted in glycerine (with or without the addition of hæmatoxylin), or in a solution of chloride of calcium, and preserves indefinitely a fine violet tint.

If the Bacteria are free in the liquid, the process of mounting them would be exactly the same.

To prepare Infusoria, or any of the lower organisms, osmic acid should be used, but in a strong or even concentrated solution which instantly kills the animalculæ. A group of Vorticella thus fixed will retain their natural form, some of them being completely extended and others more or less retracted. Amœbæ, Rhizopoda, &c., have no time to retract their protoplasmic filaments, and die spread out on the glass in their living aspect.

Ciliated Infusoria do not lose their cilia, and except a slight blackish hue they are in no way modified by the reagent. Some Opalinæ found more than a year ago in the intestine of a Triton have preserved to this day the delicate cilia with which their body is covered.

The contact of the osmic acid must not be prolonged, or the objects will blacken with age. After the animalculæ are covered with the thin glass, a few drops of picro-carmine or hæmatoxylin can be added.

The picro-carmine does not sensibly colour Bacteria, but it colours very clearly the nuclear formations contained in the bodies of the Infusoria. After the colouring glycerine can be added, and the preparation is complete.

In the study of the lower vegetable forms with naked protoplasm, Myxomycetes, for instance, osmic acid and picro-carmine and hæmatoxylin can be equally well used. By the action of osmic acid the currents in the protoplasm of the Myxomycetes are instantly suspended, and in a few instants the protoplasm is sufficiently hardened to make sections possible.

There are certain exceptional cases in which osmic acid has no direct action. A Nematode, for instance, *Anguillula aceti*, can live a long time in a liquid containing osmic acid. In the case of a female the eggs develop and hatch, and the embryos grow at the expense of the mother, until nothing remains of her body but the outer cuticle, which resists all attacks of the acid. When the young Anguillulæ have pierced the cuticle and are free, they swim apparently unharmed by the acid, though they generally die in a few days.

A similar example is furnished by the larvæ of the Diptera, *Chironomus plumosus* Linn., which lives in water strongly mixed with osmic acid, owing to its cuticle resisting the acid.

Another Method of Preserving Bacteria, &c.— " T. C.," in 'Science-Gossip,'[*] says that he has experimented upon a method for obtaining permanent preparations of Bacteria, Vibriones, &c., and after some years of patient research has found the following excellent method:—The requisites are a bottle of thin Canada balsam diluted with chloroform, a hot-water plate, and the fixing solution, which consists of 25 cc. of chromic oxidichloride acid to which is added 50 cc. of water with 50 cc. permanganate of potash. A ring of white wax, much larger than the cover-glass, is drawn on the slide, within which the organisms are placed with some water. When they have attached themselves to the slide, some of the solution is added, which will instantly fix the specimen. After three minutes the water may be poured out, and a few drops of chloroform added and poured off, the cover-glass placed carefully on, and a few drops of dilute Canada balsam added, so as to flow under the cover, and the preparations placed on the hot-water plate to dry. Thus prepared they retain all the features of the living animal.

Mounting Noctiluca miliaris.—Some *Noctilucæ* having been collected last summer in Beaumaris Bay, Mr. J. E. Lord says † that he and Dr. Worrall tried mounting them in shallow cells, with various preservative media to compare the results. Balsam, glycerine, fresh and sea-water, glycerine jelly, Dean's medium, and several others were tried. One or two of the slides rapidly deteriorated, others held out for a longer period, but the specimens mounted in sea-water retained all their features to this date (not specified). As the animals retain their shape, it would appear that there has been no endosmose or exosmose action going on.

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[*] 'Sci.-Gossip,' 1879, No. 173, p. 111. † Ibid., p. 113.

Searching for Trichinæ.—Mr. George W. Morehouse, of Wayland, N.Y., says * that it is undeniable that microscopists waste a good deal of valuable time by the use of higher powers than are necessary, and by imperfect preparation of objects for examination. In nothing is this more forcibly illustrated than in the examination of pork for trichinæ. For this purpose it is customary to use powers of 75 diameters and upwards (seldom as low as 50), and the meat is not always made sufficiently transparent for ready detection of the parasites. A power of 25 diameters, obtained with a good 2-inch objective, and 2-inch ocular, is amply sufficient. With the 2-inch we have greater depth of focus, the object is still shown with great clearness, and, most important of all, we are able to do as much searching in one hour as it would take about nine hours to accomplish with a $\frac{2}{3}$-inch objective.

As to preparing pork for present, rapid, and accurate observation, he has found the following method to work well :—Cut thin longitudinal sections from the extremities of muscles, and from other favourite localities where the worms, in migrating, stop in greatest abundance, and place the sections in a watch-glass, covering them with acetic acid. In a few minutes the tissues will be transparent enough to enable one to see the letters through the specimens when the watch-glass is placed on a printed page. Drain off the acid, add water and examine, or wash and transfer to a glass slip (large, with large cover, for a number of sections at once), either in water or glycerine, and cover. For permanent preservation, while the sections are still in glycerine, press them for several days between plates of glass, and mount at leisure in pure glycerine. When thus prepared, the parasites remain coloured more highly than the surrounding muscular fibres, and readily attract the eye. They are so plain, that none, when brought into the field of view, can escape instant detection. The process is simple, takes but little time, and is inexpensive.

Method of Studying the Structure of Vegetable Matter.—M. Merget, of Bordeaux, finding that mercurial vapour easily permeates disks of wood, recommends it as a means for studying the structure of vegetable matter. If wood, after exposure to the vapours of mercury, is brought in contact with a sensitive paper (obtained by saturating paper with an ammoniacal solution of nitrate of silver) a distinct design of the fibro-vascular bundles and of the medullary rays will be obtained. We may thus design the stomata of a leaf, and show that in the case of those possessing stomata on both surfaces the air circulates from one epidermis to the other.†

Thin Stages.—It is, we think, a matter for surprise that with all the attempts that have been made to produce stages of excessive thinness, to allow of the use of light of extreme obliquity, opticians have never provided their Microscopes with any contrivance for allowing the slide to be attached to the under side of the stage. Such a contrivance would cost a very trifling sum, and by its adoption the

utmost possible limits of obliquity would be attained. This is the more important at the present time, when the apertures of object-glasses are being so largely increased.

Contrivance for holding Objects beneath the Stage.—Since the preceding note was in type the 'Monthly Journal of Science' has published * a note on a simple contrivance for holding the object beneath the stage of the Microscope when extreme obliquity of illumination is required. It is the device of Mr. John Phin, of New York,
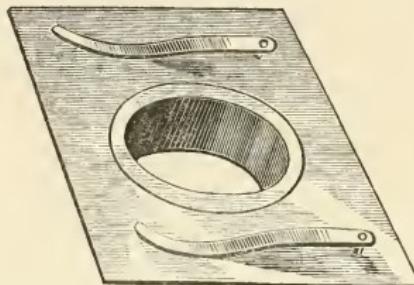
and has the advantage of being easily adapted to any Microscope. The little "sub-stage" (shown in the annexed woodcut) with clips attached slides into the aperture in the stage, and the mode of use is obvious. Mr. Phin states that the plan of holding the object beneath the stage is not new, having been invented by Mr. C. S. Spencer about twenty years ago.

New Microtome.—Several years ago, wishing to make some thin sections of animal tissue, and not having the educated hand, Dr. S. W. Fletcher, of Pepperell, Mass.,† set about devising an instrument for doing such work. The conditions to be fulfilled appeared to him to be: to attach the cutting blade to a carrier so arranged as to draw repeatedly the edge of the blade over the specimen with any desired inclination and in exactly the same course; to prevent every part of the blade, except the edge actually cutting, from touching the preparation; to immerse the object in alcohol or other preservative fluid whilst being cut; and to approach the specimen to the blade to any desired extent, the whole instrument being made heavy and firm enough to prevent any considerable trembling under ordinary use. These conditions he has endeavoured to fulfil in the following manner:—

X X, Fig. 1, is a wooden frame 16 inches in length, 8 inches in width, and $5\frac{1}{2}$ in height; to the top of this is clamped the wooden bar R R by means of the bolts 6 and 7, which pass through the slots cut in the arms which project from each end of it. B is a piece of thick plate-glass cemented to the side of the bar R R, and C and D are similar pieces of glass cemented to the top of the frame X X. In the centre of

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* 'M. Journ. Sci.,' i. (1879) 392.
† 'English Mechanic,' xxix. (1879) 108 (from 'Boston Medical and Surgical Journal').

the frame is the brass pan E. Near the centre of this pan is a well, 1 inch in diameter and 2 inches deep. At one side of the well is a clamp, 4, which by the screw 1 is pressed tightly against the specimen to be cut. Over this pan is the iron tripod T T (see Fig. 2), beneath which is suspended a brass plate A by means of the bolts 8 and 9.

FIG. 1.
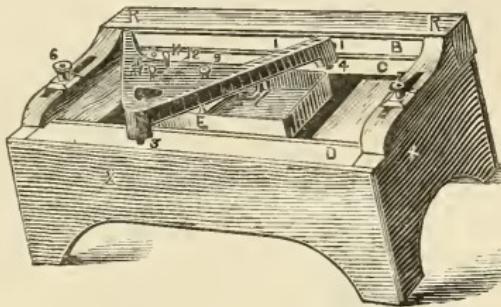
This plate is made to incline more or less towards the glass plate C, and is fastened firmly in position by the set screws 11 and 12. By these any desired inclination can be given to the cutting blade, which is clamped to the under surface of the plate A. He commonly used a wide Le Coulter razor blade for cutting. The legs of the tripod have ivory pins driven firmly into holes drilled deep in their ends; these

FIG 2.
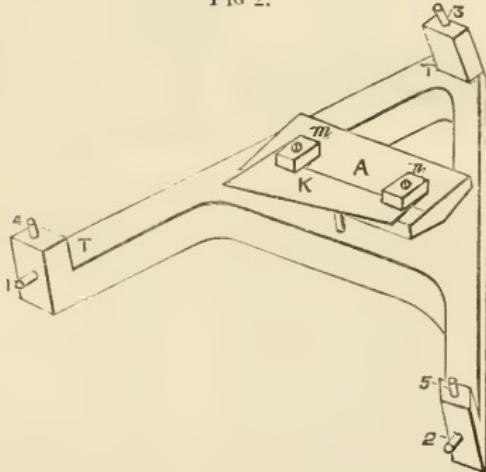
pins project one-fourth of an inch, and their points, 3, 4, 5, rest on the glass plates C and D. From the sides of two of the legs ivory pins project in the same way, and their points, 1 and 2, rest against the glass B. The opposite sides of the well are grooved on their outer surfaces, and in these grooves rest brass guide-pieces, which are firmly bolted to the frame X X, and connected with these guide-pieces is a screw, the point of which presses against the lower part

of the bottom of the well. The threads of this screw are forty-eight to the inch, and the circumference of its head is divided into fifty equal parts.

Fig. 2 represents the tripod seen from below, showing the ivory points 1, 2, 3, 4, 5, the brass plate A, and the blade K fastened by the clamps m and n.

Fig. 3 shows the shape of the heads of the bolts 8 and 9, Fig. 1, and the manner in which they are let into the plate A.

FIG. 4.
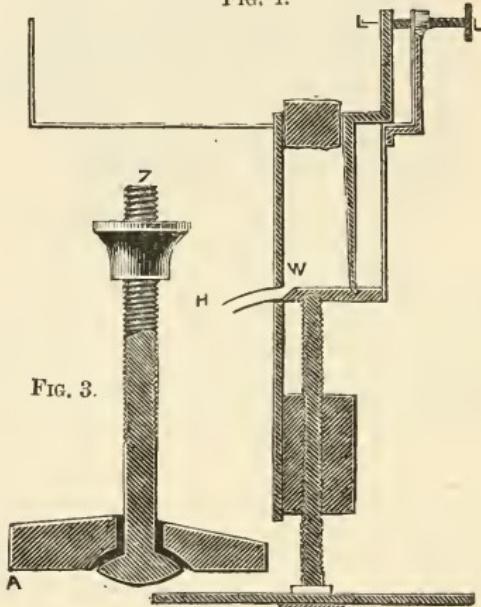
FIG. 3.
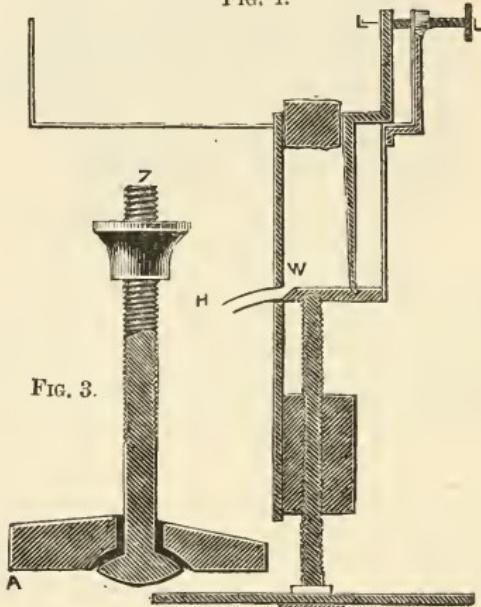
Fig. 4 represents a section through the pan, showing the arrangement of the well W, clamp L, and screw for raising the pan. H is a rubber tube, leading from the bottom of the well, for drawing off the alcohol in the pan after using the instrument.

FIG. 5.
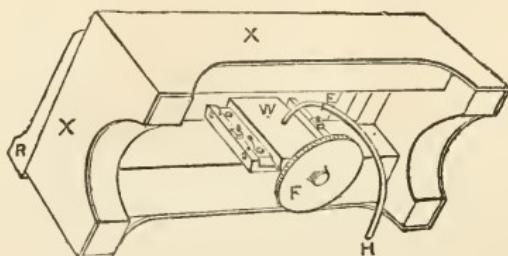
Fig. 5 represents the frame X X seen from below, showing the pan, well W, screw F, rubber tube H, and brass guide-pieces, and the manner in which they are attached to the frame.

The ivory points being well oiled, fill the pan with alcohol, so as to cover the top of the specimen O ; place the tripod over the pan, and as far to the left as possible; turn up the screw F until the top of the object to be cut reaches the blade ; push the tripod forward from left to right, and the blade will shave the top of the preparation ; draw the tripod from the glass B for half an inch, or raise the leg of the tripod resting on D half an inch ; it can then be pushed to the end of the glass plates from which it started without the knife touching at any point. Now let the tripod approach the glass B until the points 1 and 2 touch the glass ; turn the screw F so as to elevate the pan more or less, according to the desired thickness of the section ; again repeat the moving of the tripod as already described, and a section is obtained of uniform thickness and any desired thinness the blade is capable of cutting. With a well hardened specimen and a very thin, sharp blade, sections three-fourths of an inch wide, 1 inch long, and 1-2400th part of an inch thick can readily be made. Very delicate objects need to be imbedded in wax or paraffin ; ordinary ones are held by the clamp L without any such preparation.

The whole instrument weighs about 16 lbs., and costs about twenty-five dollars, not including the blades. The cost of four or five blades is not far from five dollars, or one dollar each.

Electrical Mounting Table.—Mr. F. M. Rogers, of Moorgate Station Buildings, E.C., communicates the following :—Microscopists who mount their own objects must have felt the want of a mounting table that would automatically run at any desired rate of speed, while allowing the mounter free use of both his hands. The instrument represented in the woodcuts, which has been devised by him, supplies these requirements, the motive power being electricity, derived preferably from a small and very inexpensive bichromate battery.

Fig. 6.
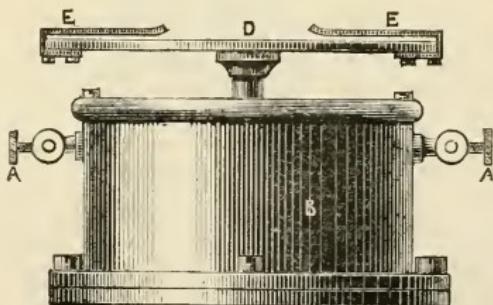
Upon joining up the two connecting wires from the battery to the terminals marked A, Figs. 6 and 7, a current flows through the insulated wire A^2 surrounding the bar of soft iron B, which is pivoted to the spindle D, and carries the table E. The bar is thus rendered powerfully magnetic, and instantly turns towards the top of the nearest inclined armature, of which there are six, C^2 (Fig. 8), cast

in the case C. By means of a circular contact-breaker F, Fig. 7, fixed to the spindle D, but insulated from it, the current is only allowed to excite the magnet when its poles are at the foot of any of

FIG. 7.
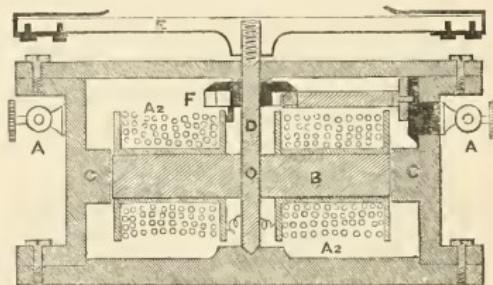
the inclined armatures; as it turns towards the top, or point nearest its poles, the current ceases, and with it any retarding action upon the magnet. Acquired momentum carries it to the foot of the next

FIG. 8.
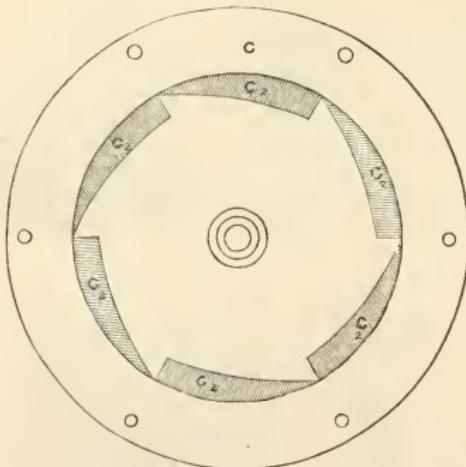
incline, and the process is repeated, a steady rotary motion resulting, which can be regulated by exposing more or less of the zinc in the battery to chemical action.

English Microscope for Students of Mineralogy and Petrology. —Mr. Frank Rutley describes * a new Microscope, specially suited for mineralogical and petrological research, constructed for him by Mr. T. W. Watson, of Pall Mall.

An examination of one of the Microscopes devised by Professor Rosenbusch and manufactured by Fuess, of Berlin, showed that, although that instrument possessed many features of great merit, it

* 'Nature,' xx. (1879) 13.

also had certain defects which could be best overcome by adopting and modifying a good English model.

The great defects in most of the Microscopes built on the continental patterns consist in their fixed vertical position, the smallness of their stages, and, very commonly, in the absence of any means of coarse adjustment, except by a sliding movement of the body or tube, which, if working stiffly, is very inconvenient, while, if sliding easily, it is apt to be shifted by a very slight touch.
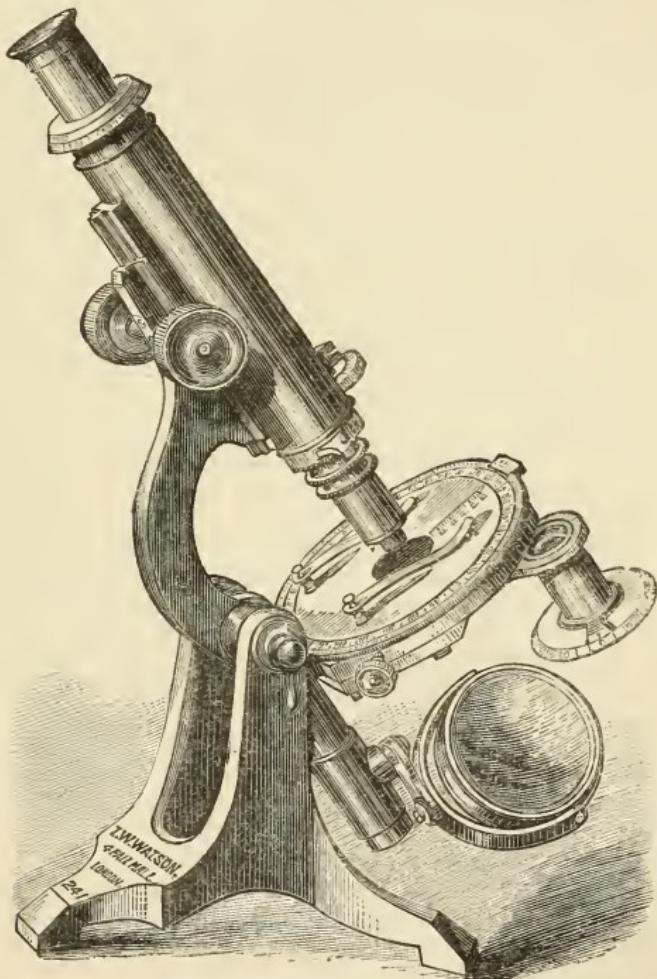
The instrument now manufactured by Mr. Watson is in most respects quite equal in performance to Rosenbusch's, so far as the mechanical appliances and adjustments are concerned, and is, in point of convenience, decidedly superior to the latter instrument.

The general form of the instrument is sufficiently shown in the accompanying woodcut. In the stand first made the milled head of

the fine adjustment was divided for the measurement of the thickness of sections, but in future it is proposed to effect this object in a different manner by divisions engraved upon the limb and the sliding portion of the coarse adjustment (a vernier). The right trunnion carries a clamp to fix the instrument at any angle. The head of the tube or body carries a bevelled disk which is divided to 10° spaces. A corresponding disk with an index is attached to the bottom of the analyzer-fitting, and rests directly upon the fixed divided disk; so that the analyzer can be set in any required position, and any amount of revolution imparted to it can also be registered. The eye-piece, when inserted, is kept in a fixed position by a stud, which falls into a small slot. Crossed cobwebs are fixed within the eye-piece for the purpose of centering the instrument. A small plate of calc-spar, cut at right angles to the optical axis, is mounted in a little metal ring, which can be placed between the eye-glass and the analyzer for stauroscopic examinations.

At the lower end of the Microscope-tube a slot is cut to receive a Klein's quartz plate or a quarter-undulation plate, both of which are set in small brass mounts. When these are not in use the aperture can be closed by means of a revolving collar.

The stage is circular, and capable of concentric rotation, and it is divided on the margin to 360°. A vernier is attached to the front of the stage, giving readings to one minute. The edge of the stage is milled, and rotation is imparted by hand.

The polarizer slides into a fitting which is fixed to an arm pivoted on the lower, movable surface of the stage, so that it can readily be displaced when ordinary transmitted illumination is required, and replaced with equal facility.

Two little lenses, affording a strongly-convergent pencil of light, are set in metal rings which drop into the top of the fitting which surrounds the polarizing prism. When these are employed and the analyzer is used, without lenses in the eye-piece (a separate fitting is supplied for this purpose), examinations of the rings and brushes presented by sections of certain crystals, can be advantageously carried on, and a quarter-undulation plate can also be employed when needful. The lower end of the fitting which carries the polarizer is surrounded by a divided disk, turning beneath a fixed index, so that any position of the prism can be recorded, and the rotation imparted to it can be measured.

From the foregoing description it will be seen that this instrument is capable of performing the functions of an ordinary Microscope, a polariscope, a stauroscope, and, to some extent, a goniometer. A spectroscope could be fitted to it if needful, as well as an apparatus for heating sections of crystals.

Female Microscopical Society.—We gather from a report of a " regular meeting " of the Microscopical Society of Wellesley College, U.S., on March 15, reported in the ' American Journal of Microscopy,'* that it consists exclusively of lady members. The

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* ' Am. Journ. Micr.,' iv. (1879) 71.

President, Miss Cook, was in the chair. Miss Dickinson read a paper upon animal and vegetable hairs, which was illustrated by slides of horizontal sections of the scalp prepared by Miss Nunn, Professor of Biology; Miss Beattie presented a paper on Bacteria; Miss Whipple gave a demonstration of the method of cutting and double staining vegetable sections, beginning by describing the proper method of honing a razor; slides mounted by Misses Cummings and Whipple were exhibited; Miss Whiting called attention to the receipt of fifty of Smith's slides of Diatomaceæ; and, finally, the report is attested by " Marion Metcalf, Corresponding Secretary."

Oblique Illumination.—Mr. C. Hue says that he has obtained highly successful results where extreme obliquity of illumination is required, by the use of the parabolic illuminator, in conjunction with a small super-stage, similar to that of Dr. Matthews.

Limits of Accuracy in Measurements with the Microscope.— Professor Rogers calls attention to the note on p. 345 of vol. i., and says that the error referred to consists in the report from which we quoted having given 32 millionths instead of 32 ten-millionths.

Royal Society Conversazione.—On April 30th, at the above Conversazione, the following were the exhibits relating to microscopy :—

Messrs. Powell and Lealand :—Their new $\frac{1}{8}$ oil-immersion lens, with *P. angulatum.*

Mr. F. Ward :—New micro-spectroscope, in which a rectangular quartz prism is substituted for the usual metallic slit. (This Journal, vol. i. p. 326.)

Mr. J. Mayall, jun. :—Zeiss's new $\frac{1}{18}$ oil-immersion lens, with *Amphipleura pellucida* (in balsam); and the improved immersion illuminator designed by the exhibitor with special reference to the Ross-Zentmayer stand.

Mr. Crisp :—Powell and Lealand's new $\frac{1}{8}$ oil-immersion lens, with *Frustulia Saxonica* (dry), and a similar illuminator.

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PROCEEDINGS OF THE SOCIETY.

MEETING OF 14TH MAY, 1879, AT KING'S COLLEGE, STRAND, W.C.
THE PRESIDENT (DR. BEALE, F.R.S.) IN THE CHAIR.

The President on taking the Chair congratulated the Fellows upon having obtained possession of their new room and upon the appearance it presented. They were very much indebted to the Library Committee for the successful manner in which they had arranged the room, and it was also satisfactory to know that this had been effected out of revenue, and without diminishing the capital account of the Society.

The thanks of the Society were, on the motion of the President, voted to the Library Committee.

The Minutes of the meeting of 9th April were read.

Mr. Michael said that though Mr. Stephenson's motion included a declaration that the $\frac{1}{100}$ of a millimetre was too large a standard, he and others who voted upon it understood that a suggestion of Dr. Edmunds had been adopted, and that the latter part of the motion only was intended to be put to the Meeting.

Mr. Ingpen confirmed this, and

The President, with the assent of the Meeting, erased the first part of the motion (leaving it to stand, "That in the opinion of this Society it is not expedient at present to prescribe by any formal resolution the adoption of a fixed standard for micrometry"), and the minutes were so confirmed and signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted and the thanks of the Society given to the donors, viz.:—

From

Burgess, E.—The Anatomy of the Head and the Structure of the Maxilla in the Psocidæ. (Reprinted from the 'Proceedings of the Boston Society of Natural History.' Vol. xix. 1878) .. ..   *The Author.*

'Index Medicus: a Monthly Classified Record of the Current Medical Literature of the World.' Compiled under the supervision of Dr. J. S. Billings and Dr. R. Fletcher. Vol. i. Nos. 1, 2, and 3 (January, February, and March.) 4to. New York, 1879 .. ..   *The Editor.*

Trübner, N.—'Bibliographical Guide to American Literature.' 8vo. London, 1859 .. ..   *Mr. Crisp.*

12 Slides of Insects from Nevis, West Indies .. .. ..   *Dr. J. Borell.*

2 Slides of Lung of Sheffield Saw-grinder .. .. ..   *Mr. A. C. Cole.*

15 Photographs of Blood-corpuscles of Man and Animals ..   *Dr. J. B. Treadwell.*

3 Carved Wood Chairs for the President and Secretaries ..   *Mr. Crisp.*

The President, in reading the names of further Societies recommended by the Council under the bye-law as to Ex-officio Fellows, said

that the Council had been much gratified at the extremely cordial manner in which the Societies previously nominated had received the nominations.   Two of them had done him the honour to elect him an Honorary Fellow.

Photographs (15) of blood, sent by Dr. J. B. Treadwell, of Boston, U.S. (through Mr. C. Stodder), were shown, and the following letter from Mr. Stodder read :—

" Dr. Treadwell's object is the measurement of the blood-disks and comparison of size of human blood with that of other animals, and the focussing is so done as to show the sharpest outline of the diameter. I will call the especial attention of the Society to those photographs on which there are two kinds of blood—blood from two animals. Several devices have been used by others to accomplish this object, one of much importance for obtaining in a picture the exact amplification for both kinds of blood, and which, I believe, has not been so successfully before accomplished.   I trust that these will be acceptable to the Society.   The mounting of the slides and the photographing is all done by Dr. Treadwell."

Mr. A. W. Waters' paper " On the occurrence of recent Heteropora " (see p. 390), was read by Mr. Stewart, who also described by drawings on the black-board the slide of *Membranipora membranacea* brought by Mr. Dreyfus.

Mr. John Davis's paper on " A new species of Cothurnia " was read by Mr. Stewart, and the drawings enlarged on the board.

Mr. Wenham's " Note on Homogeneous Immersion Object-Glasses " was read by Mr. Crisp (see p. 394) :—

" From a paper contributed by me to the ' Monthly Microscopical Journal,' June 1st, 1870, I quote the following comments in favour of ' Homogeneous Immersion.' ' One advantage in the immersion objective is that it almost prevents the loss of light from the reflection of the upper surface of the cover and front of lens, and in part neutralizes any error of figure and polish that may exist between them.   There is another condition annexed, it has the singular property of a *front lens of adjustable thickness*, and therefore can be set to the utmost nicety to balance the observations.   Of course there is no optical advantage attendant upon the use of *water*.   If a medium of the same refractive power as the glass were to be employed, the result would be better.   Water having a low refractive index, an adjustment is required for each thickness of cover, and a difference of adjustment is not so marked and sensitive as in the ordinary dry objectives ; but if a medium of similar refraction to the glass were to be used, no adjustment would be required for any thickness of cover, supposing the test objects to be mounted thereon (which they generally are), for in fact we should then view them all with a front of the same

thickness—considering the cover, the front lens, and the interposing medium as one.'"

Mr. Stephenson being absent from town the following note from him was read by Mr. Crisp.

"I have read Mr. Wenham's note containing a reference to his paper of 1870, of which, however, I was not aware when I brought the subject of Homogeneous Immersion before the Society in 1878.

"I do not understand what it is that Mr. Wenham claims.

"The use of oil instead of water was suggested by Amici prior to 1850; and it is equally clear that it was not until 1878 that any homogeneous immersion objectives were produced in a practical form, and then it was by Professor Abbe and Mr. Zeiss, and more recently by Messrs. Powell and Lealand.

"As, during a great part of the period between 1870 and 1878, Mr. Wenham has been actively engaged in the construction of immersion object-glasses, it is evident that he did not appreciate the practical advantages likely to follow from the introduction of oil-immersion glasses any more than Amici and other previous experimenters on the subject did.

"This is not surprising when it is remembered that the *very essence* of the homogeneous system depends under Professor Abbe's able development on an optical principle which Mr. Wenham has for many years contended, and still contends, to be a physical impossibility, viz. it gives an angle greatly in excess of even the ideal maximum of a dry lens (180°).*

"Moreover, if Mr. Wenham had attempted to give practical effect to his suggestion of 1870 he would have found that identity of refractive index between the cover-glass and immersion fluid was by no means consistent with optical homogeneity, one of the most essential conditions of which is identity of dispersion."

Mr. Wenham said that it had not been his intention to raise any controversy, but simply to record what he had done. If Amici had given a distinct description of it he did not, of course, want to claim it.

Mr. Crisp said, that he thought it must be considered beyond dispute that Amici was the first to suggest and to use oil as an immersion fluid for objectives, in which he was followed by Oberhäuser, Harting, and others. They all apparently thought, however, that oil-immersion objectives, were not capable of practical application. He read the following extract from M. Robin's book :—

"We have seen that the principal obstacle to good resolution arises from the violent refraction which the rays undergo on leaving the cover-glass and passing into air, and again on their second refraction by the front lens. Amici thought that to correct this defect the front lens should form part of the cover-glass, but how could the distance of the object from the lens be made variable ? Simply by interposing between them an elastic medium having nearly the same refractive index as the glass. He suggested that the lens

* See 'M. M. J.,' v. pp. 16–17 and 118 ; vi. pp. 84–86 and 292 ; vii. p. 272 ; xi. p. 113 ; xii. p. 222 ; xiii. p. 35, &c.

should be plunged in a liquid of the same index as the cover-glass, glycerine mixed with oil of aniseed, for instance, or even the latter alone; later he recognized that distilled water corrected very well the feeble aberrations produced by the differences in the relative thickness of the media, glass and water. . . . The experiments of Amici on immersion objectives date from 1844. I saw in that year, or the following one, at Oberhäuser's, an objective with which he showed the advantages [of the immersion system] by interposing between it and a preparation of *Lepisma* scales either a drop of neats' foot oil or a drop of essential oil. He considered them to be preferable to water, the employment of which he had already recommended as giving good results with all kinds of objectives of short focus." *

Mr. Woodall called attention to the passage in Professor Abbe's paper (see p. 256), in which he referred to Mr. Stephenson's suggestion, that homogeneous immersion objectives would allow of increased angular aperture, which suggestion led to the making of the objectives.

. Mr. Ingpen thought they must all regret that Mr. Wenham had not followed up his experiments in homogeneous immersion. Had he done so, we probably should have long since had the oil-immersion objective as an English instead of a foreign production. The refractive index of the immersion fluid employed was not the only consideration—the selection of an oil of suitable *dispersive* power had been made by Professor Abbe, after many experiments. Moreover, it must be remembered that the great advantage of the oil lens was its increased angle and consequent augmented resolving power, which was not originally contemplated as a result of homogeneous immersion. In the case of the new lenses they had not merely the results of a series of experiments, but also their successful practical application in the construction of improved objectives.

Mr. Wenham wished to say one word as to the medium. At the time referred to he had used oil of cloves. He did not care to make any oil lenses then because he had a wholesome fear of it. If the fingers were smeared with it and the instrument then touched, it took off the lacquer, besides unsetting the cement and destroying the objects.

Mr. Hue's suggestion for the more convenient use of oil with homogeneous immersion objectives was explained by Mr. Crisp, viz. to screw over the front of the objective a small receptacle contain-

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* Prof. Ch. Robin, 'Traité du Microscope.' Paris, 1871. Pp. 191–192.

Prof. Harting, in his work on the Microscope, thus referred to the use of oil:—
"If we could replace the layer of water by a fluid of still greater refractive power, such as oil, further advantages must obviously be obtained. This has been successfully tried. It seems to me, however, a great risk to bring costly objectives in contact with an oily fluid which would have to be again removed by alcohol and ether. This would be hazardous with double lenses cemented with Canada balsam. The immersion system has, it is true, been so arranged that the front lens is not a double, but a single one of crown glass, and for these immersion in oil would certainly be much less objectionable. Nevertheless, I must doubt whether the oil-immersion system can ever come into more general use."—P. Harting, 'Das Mikroskop' (2nd German edition). Brunswick, 1866.

ing the oil, having capillary holes in a ring round the front lens, so that by screwing it up or down the oil would be forced out or drawn back again.

Mr. **Crisp** said that he should have stated at the meeting of 12th March last that the immersion illuminator, consisting of a hemispherical lens with movable setting (see p. 223), was the design of Mr. J. Mayall, jun., and was specially applicable to the Ross-Zentmayer stand.

Mr. **Watson** exhibited Mr. Frank Rutley's petrological Microscope (see p. 471), and the exhibition of Mr. J. M. Rogers' electrical mounting-table was, at his request, postponed until the next meeting, in consequence of his absence from England (see p. 469).

The **President** reminded the Meeting of the Scientific Evening on the 21st inst., and said that if any Fellows wished to measure the aperture of their objectives by Abbe's apertometer, Mr. Mayall would have the apparatus at the meeting, and be prepared to do so.

The following were exhibited:—

Mr. A. C. Cole :—2 sections of lung of a Sheffield saw-grinder who died from the effects of his work, the lung being the typical specimen on which the late Dr. J. C. Hall founded his successful agitation for improved workshops.

Mr. Dreyfus :—*Membranipora membranacea* (Polyzoon).

Mr. C. Hue :—Parabolic illuminator and super-stage (see p. 473).

Dr. J. B. Treadwell :—15 photographs of blood-corpuscles.

Mr. F. H. Ward :—Section of leaf of misteltoe, stained.

Mr. Watson :—Rutley's Petrological Microscope (see p. 471).

Mr. Crisp :—(1) Various microtomes: (*a*) the Rivet microtome (in wood); (*b*) Schiefferdecker's microtome ('Q. Journ. Micr. Sci.,' vol. xvii. 1877, p. 35); (*c*) Walmsley's adaptation of Bevan Lewis's ether-spray microtome; (*d*) Army Medical Museum (U.S.) pattern microtome. (2) Spawn of perch, showing embryo and peculiar radial pin-shaped striæ in the albumen (from Mr. Bolton). (3) *Melicerta tubicolaria* (Hudson) (*M. Troy*), described by Dr. Hudson in 'M. M. J.,' November, 1875, which Mr. Bolton had now found again in another locality.

New Fellows:—The following were elected *Fellows*:—Messrs. J. F. Hepburn, A. R. Kirby, W. R. Makins, F. Oxley, and J. H. Puleston, M.P.

WALTER W. REEVES,
Assist.-Secretary.

JOURNAL

OF THE

ROYAL

MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

INCLUDING EMBRYOLOGY AND HISTOLOGY GENERALLY.

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.

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Alectona Millari. n. sp.

TRANSACTIONS OF THE SOCIETY.

XXVI.—*On a New Species of Excavating Sponge* (*Alectona Millari*)*; and on a New Species of Rhaphidotheca* (*R. affinis*).

By H. J. Carter, F.R.S., &c.

(Read 11th June, 1879.)

Plates XVII. and XVIIa, Figs. 1–4.

At the request of Dr. Millar I undertake the description of these sponges respectively, prefacing the former with his own observations, which are as follows :—

"In the month of May last, while looking for sponges on a piece of *Amphihelia oculata* given to me by Dr. Duncan, I noticed on it numerous small, cribrate, flattish papillæ, of a pale pinkish colour, slightly raised above the surface, which, when detached and examined microscopically, were found to be almost entirely composed of spicules so like those of a *Gorgonia* that, until tried with acid, I could not be convinced of their siliceous composition. Seeking for the form of the largest ones in the late Dr. Bowerbank's 'Monograph of the British Spongiadæ,' I found them to correspond with the spicule figured in No. 245,* which Dr. Bowerbank believed 'to belong to a sponge not yet identified.'

"Having in vain attempted to extricate one of these papillæ

EXPLANATION OF PLATE XVII.

Fig. 1.—*Alectona Millari*, n. sp. Longitudinal section of branch of coral of *Amphihelia oculata*, Dune, showing :—*a a*, excavated portion occupied by the Sponge ; *b*, cribriform papilla ; *c c*, minute processes.

Fig. 2.—The same. Cribriform papilla, more magnified.
,, 3.— ,, Skeleton-spicules.
,, 4.— ,, Subskeleton-spicules.
,, 5.— ,, Varieties of subskeleton-spicules.
,, 6.— ,, Flesh-spicules.
,, 7.— ,, Larger variety of flesh-spicules.

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* Vol. i. pl. x¹.

by mechanical means, I subjected a portion of the coral bearing one to the influence of acid, when the papilla above mentioned was not only eliminated in a perfect state, but numerous brown points made their appearance at various depths from the surface of the coral, which, as the latter became entirely dissolved by the acid, were, together with the cribrate papilla, found to be processes of membranous, cellular sarcode, presenting a brown colour (in its dried state), which lined the centre of the coral, now reduced by excavation from solidity to a mere shell in many parts. These ' processes' which were conical and thus engaged in excavating the coral, might also, on reaching the surface, grow into the form of cribriform papillæ if necessary.

" As the sponge appears to be nearly allied to *Gummina Wallichii** recently described and illustrated by Mr. Carter, which he informs me has therein by mistake been called ' *Corticium*,' I do not think I can do better than hand it over to him for technical record."

Having thus premised Dr. Millar's remarks on his discovery, I now proceed to comply with his request.

Alectona † *Millari*, Crtr. n. sp.

Amorphous, excavating, membranous, cellular, consisting of simple, fibreless sarcode (now, i. e. in its dried state, brown and gum-like), charged with the spicules of the species and projecting outwardly, in processes of different forms and different degrees of length, until some reach the surface, where they appear like flattened papillæ. " Processes " of two kinds, viz. those which form papillæ on the surface, which are comparatively large, and those which extend more or less into the substance of the coral, which are minute. Papillary processes of two forms, viz. one with an irregularly circular, more or less flattened, cribrate head, in which the spicules of the species, imbedded in sarcode, produce a cribriform structure dividing the area of the head into a variable number of minute apertures, each of which in all probability, when fresh, is provided with a delicate sphinctral diaphragm of sarcode (Pl. XVII*a*, Figs. 1 and 2); and the other, with a conical head in which the spicules are arranged radiatingly, so that when retracted in the living state, a *single* large aperture only would be presented. Each form of the papilla when largest, about $\frac{1}{24}$ inch in diameter, but variable, down to $\frac{1}{225}$ inch with holes in the latter correspondingly small, viz. $\frac{1}{1800}$ to $\frac{2}{1800}$ inch in diameter. Minute conical processes or points engaged in excavating the coral, but all charged to the extremity with spicules of the species,

* 'Ann. and Mag. Nat. Hist.,' vol. iii. 1879, p. 353.
† *Alecto*, one of the Furies.

especially the largest, which will be described presently, Fig. 1, *c c*. Pore-areæ represented by the cribriform, and vents by the conical papillæ respectively. Spicules of four forms, viz. 1, the largest or skeleton-spicule, acerate, abruptly curved or rather bent in the middle, covered with tubercles arranged linearly and longitudinally in twelve rows; tubercle simply conical, or divided into two or more portions at the extremity, arranged alternately in adjoining rows extending over the ends of the shaft, so as to render the latter obtuse and irregular; medullary canal angular in the centre and more or less undulating throughout; skeleton-spicule about $\frac{1}{72}$ by $\frac{1}{500}$ inch in its greatest dimensions (Fig. 3); 2, sub-skeleton-spicule, acerate, also abruptly curved or bent in the centre, more or less obtusely pointed at the ends, sparsely covered with tubercles irregular in number and situation, sometimes absent altogether, about $\frac{1}{200}$ by $\frac{1}{4000}$ inch in its greatest dimensions, but very variable in all respects (Figs. 4 and 5); 3, acerate undulating, almost immeasurably fine, hair-like, with an enlargement in the centre barrel-shaped, inflated in the middle and at the ends respectively, about $\frac{1}{500}$ inch long; 4, flesh-spicule, consisting of a straight microspined shaft, interrupted in its course by two circles of tubercles equidistant from the extremities and from each other, about $\frac{1}{1000}$ inch long, but very variable in size, and in number and disposition of the tubercles (Figs. 6 and 7). Spicules scattered more or less generally throughout the sarcode of the sponge, where they appear to be chiefly congregated, especially the larger ones, in the projecting processes. Size indefinite, extending in this instance throughout the main stem and branches of the specimen of *Amphihelia oculata* which is about $5\frac{1}{2}$ inches long and 2 inches in transverse diameter, the thickest branch being $\frac{3}{4}$ inch in diameter.

Hab. Marine, in the coral of *Amphihelia oculata*, Duncan.

Loc. North Atlantic Ocean, between N. of Scotland and Faroe Islands ('Porcupine,' 1869, Sta. 54); lat. N. 59° 56'; long. W. 6° 27'; depth, 363 fathoms; bottom temp. 31° 4'.

Obs. Examined in the dried state. This evidently is a variety of, if not the same species as *Gummina Wallichii* (*mendose scrip.* "*Corticium*" *l. c.*) under a slightly different form of spiculation, of which species it is stated * that "further observation" could only determine its real nature, as so little of it had been obtained, that this could not then be even satisfactorily inferred. Curious enough, this had hardly been published before Dr. J. Millar found the specimen above described in *Amphihelia oculata*, which is so like *Gummina Wallichii* that no doubt can be entertained of the latter belonging to the "excavating sponges," and that, too, to one of the most devastating kinds that I have met

* Page 354 *op. et l. c.*

with. Were we only to see a fragment of the brown substance from the interior of the coral in its *dried* state, the homogeneous, fibreless character of the then gum-like sarcode, although charged with spicules, might induce one to think that it belonged to the Gumminida, and so, provisionally, I called the species described in the 'Annals' (*l. c.*) *Gummina* (*mendose, Corticium*) *Wallichii*; but Dr. Millar's discovery undoubtedly proves it to be an "excavating sponge," so the generic name "*Gummina*" will still have to be changed to meet this in the way that will presently be mentioned.

The spiculation in *Alectona Millari* (it is the only form that I can give to "Alecto," which has been so often used, and as often transformed, for other things), is somewhat different from what I have figured of *Gummina Wallichii* (*l. c.*), and these differences are as follows:—In the skeleton-spicule (No. 1) the tubercles are conical or divided at the extremity, and not smooth, round, inflated, flattened and undivided as in *G. Wallichii*; while the earlier untubercled form of this spicule (pl. xxix. fig. 6, *op. et l. c.*) coming so near in size to the large tubercled form, I have not seen in *A. Millari*; but there are much smaller ones, viz. No. 2, that might stand for this, and amongst these every grade in form between the large skeleton-spicule No. 1 and the minute flesh-spicule No. 4. So that when compared with the spiculation of *Gummina Wallichii* as a standard, the whole of the former, characterized by their extreme variability, can only be considered as derivative from the latter, and hence my opinion that *Alectona Millari* is only a variety of *Gummina Wallichii*.

At last, then, the nature of this sponge has been discovered, whose singularly beautiful skeleton-spicules created such a desire to know their origin; and thus, as just stated, it becomes necessary to change the name "Gummina" to the generic one of "Alectona." With this, too, it seems desirable, now that three distinct genera of "excavating sponges" are known, the whole should, from this distinguishing peculiarity, be placed under one family, to which hereafter it is very possible that more may be added. To effect this I would propose the following classification, viz.:—

Order VI. Holorhaphidota.

Family. *Eccœlonida.*[*]

Char. Sponges burrowing in hard calcareous objects, organic and inorganic, communicating with the exterior through small fenestral openings; sarcode fibreless, but spiculiferous.

Gen. 1. *Cliona*, Grant, 1826.

Possessing a pin-like spicule, with or without subskeleton and flesh-spicules. Flesh-spicule sinuous, smooth, or microspined.

* ἐκκοιλαίνω, to hollow out.

'Gen. 2. *Thoosa*, Hancock, 1849.

Form of skeleton-spicule undetermined (? "multifid"). Flesh-spicule nodular, consisting of a stout shaft, terminated at each extremity by a globular inflation, and encircled by two rings of similar inflations equidistant from the extremities respectively and from each other.*

Gen. 3. *Alectona*, Crtr., 1879.

Skeleton-spicule acerate, abruptly curved or bent in the centre, tubercled throughout. Flesh-spicule spindle-like, consisting of a straight shaft, pointed at the extremities and encircled by two rings of tubercles equidistant from each other and from the ends of the shaft respectively.†

It is not improbable that *Samus anonyma* ‡ may have to come in as a fourth genus.

Lastly, I would observe, with reference to *Alectona Millari*, that on one part of the specimen of *Amphihelia* was an irregular mass about two lines in diameter horizontally, and $\frac{1}{24}$ inch high, opaque and cream-coloured, looking very much like a bit of *Alcyonium*, especially from the form of its spicules when viewed under the Microscope, but which, on the application of acid, proved to be entirely siliceous and identical in spiculation with *A. Millari*. Thus, *A. Millari*, like *Cliona celata*, may leave its burrows and grow up externally into a massive form.

The papilla, too, may be represented by a solid mass or plug of spicules, when it appears to have become effete, and the whole mass externally, composed of sarcode charged with spicules of the species mixed with, and finally faced by foreign material, i. e. quartz-sand, with a slight admixture of carbonate of lime, which causes it to effervesce under the influence of acid; thus entirely devoid of pores or passages.

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Rhaphidotheca, Kent, 1870.
('Ann. and Mag. Nat. History,' vol. vi. p. 222, pl. xv.)

Rhaphidotheca affinis, n. sp.

Another sponge found and recognized by Dr. Millar upon this specimen of *Amphihelia oculata* is similar to that described and illustrated by Mr. Saville Kent,§ which came from a specimen of a like kind, viz. *Lophohelia prolifera*; that is, it consists of an

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* See Hancock's figure and description, 'Ann. and Mag. Nat. History,' 1849, vol. iii. p. 346, pl. xii. figs. 2, &c. ; also ibid., 1879, vol. iii. pl. xxix. fig. 21.
† Ibid. ib., p. 353, pl. xxix. figs. 5-9, *Corticium*, now *Alectona Wallichii.*
‡ Ibid. ib., *l. c.* p. 350, pl. xlix. fig. 1, &c. § *Op. et l. c.*

Esperia faced by a crust of pin-like spicules arranged perpendicularly to the surface of the *Esperia*, with their heads outwards and their pointed ends struck into the dermal layer of the latter like pins into a pin-cushion, so that these spicules appear to have been appropriated by the *Esperia* itself, as I have before stated.* But the fragment found by Dr. Millar not being more than one-third of an inch in diameter, and very imperfect, does not afford sufficient character for a description of the general form of the sponge, although the details are quite enough to prove that it is what I have stated. Herein, however, consists the most important part, for the heads of the pin-like spicules and the anchorates respectively are different in form from those of *Rhaphidotheca Marshall-Hallii* Kent.† Thus, the head of the former is flask-shaped elongate (Plate XVII*a*, Fig. 1), while that of *R. Marshall-Hallii* (Fig. 2) is globular oblate;‡ and the small end of the inequianchorate comparatively longer and truncate (Fig. 3), not round and comparatively shorter as in that of *R. Marshall-Hallii* (Fig. 4).§ In every other respect *R. affinis* is almost identical with *R. Marshall-Hallii*, as slight differences in the size of spicules, such as may be found in the larger bihamates of *R. Marshall-Hallii*, go for nothing in specific distinction; while the head of a pin-like spicule and the form of an inequianchorate often vary much, even in the same individual. Still, the differences in the form of the anchorate here seem to me to be sufficient to constitute a variety, if not another species of *Esperia*, and hence I have designated it "*affinis*"; while the difference in the heads of the pin-like spicules respectively, still further strengthens this view. The pin-like spicule and anchorate of *R. Marshall-Hallii* from a fragment of the type-specimen, are figured in the Plate by the side of those of *R. affinis* for comparison.

As, however, the form of the pin-like spicule both of *R. Marshall-Hallii* and *R. affinis*, especially as regards its head, has, with much search, not yet been found in any sponge possessing a pin-like spicule, either as a *Cliona* about the specimen of *Amphihelia*, or elsewhere, it becomes questionable whether the difference has not been produced by the *Esperia* after these spicules had been appropriated; for the sarcode has the power of producing such changes by the addition of more siliceous material in Sponges where the spicules themselves have been produced.

Still the value of Mr. Kent's record now becomes evident, for what he has stated Dr. Millar has found to be repeated in another species, and therefore it may fairly be inferred that other instances of a like nature may follow.

As regards the absence of the sinuous flesh-spicule in *R. affinis*, while it is present in *R. Marshall-Hallii*, this does not militate

* 'Ann. and Mag. Nat. Hist.,' 1878. vol. i. p. 170.
† Ibid., 1870, vol. vi. pl. xv.   ‡ Ibid., *l. c.* fig. 6.   § Ibid., *l. c.* fig. 7.

against the probable *appropriation* of these spicules; while the presence of the *Esperian* rosettes in *R. affinis* (where they are abundant), and their absence in *R. Marshall-Hallii*, is met by the facts—first, that when inequianchorates have attained their full development in the rosettes, the latter break up and they are dispersed; and second, the statement of Dr. Bowerbank that, wherever there are *inequi*-anchorates there may or may not be rosettes.

EXPLANATION OF PLATE XVII*a*. FIGS. 1–4.

FIG. 1.—*Rhaphidotheca affinis*, n. sp. Pin-like spicule. Scale $\frac{1}{24}$ to $\frac{1}{1800}$ inch.

FIG. 2.—*R. Marshall-Hallii*. Pin-like spicule. Same scale.

FIG. 3.—*Rhaphidotheca affinis*. Inequianchorate. *a*, front view; *b*, lateral view. Same scale.

FIG. 4.—*R. Marshall-Hallii*. Inequianchorate. *a*, front view; *b*, lateral view. Same scale.

N.B.—The pin-like spicule and inequianchorate of *Rhaphidotheca Marshall-Hallii*, drawn from a fragment of the type-specimen, are introduced here for comparison.

XXVII.— *On a New Genus of Foraminifera (Aphrosina informis), and Spiculation of an unknown Sponge.*

By H. J. CARTER, F.R.S., &c.

(*Read* 11*th June,* 1879.)

PLATE XVIIa, FIGS. 5–12.

ON the same specimen of the coral of *Amphihelia oculata* wherein Dr. Millar found *Alectona Millari,*[*] I also found a species of Foraminifera which I think must be considered the type of a new genus. It had grown round a hole about three-quarters of an inch in diameter formed by the sudden reunion of a branch which had undergone division (Plate XVIIa, Fig. 5, *d*); and resembling a bit of froth which consists of vesicles of different sizes, irregularly spread abroad and heaped upon each other, I have designated it thereafter, thus giving it the following name and description, viz.:

Aphrosina[†] *informis,* nov. gen. et sp.

Amorphous, flat, spreading; slightly convex and uneven superiorly or on the free surface; smooth and uniform below or on the fixed surface, where it is attached to the object on which it has grown; margin thin and irregular. Composed of a great number of vertically compressed chambers of different shapes and sizes formed successively one after another, and sometimes one upon another with the greatest irregularity, presenting on the surface a number of convexities corresponding with the shapes and sizes of the chambers below respectively (Fig. 6). Surface presenting a

EXPLANATION OF PLATE XVIIa. FIGS. 5–12.

FIG. 5.—*Aphrosina informis,* n. gen. et sp. *a,* portion of the coral of *Amphihelia oculata*; *b,* hole formed by the reunion of the branch *c*; *d, Aphrosina informis* in situ. Natural size.

FIG. 6.—The same. Diagram. Fragment of the surface to show its convexities opposite the subjacent chambers. *a,* puncta representing hemispherical tubercles; *b,* apertures on the margin.

FIG. 7.—The same. Diagram. Vertical section to show—*a,* cavity of chamber; *b,* intercameral aperture; *c,* arch or upper wall; *d,* floor or lower wall; *e e e,* manner in which the chambers are successively added.

FIG. 8.—The same. Diagram. Fragment to show the apertures.

FIG. 9.—The same. Diagram to scale of $\frac{1}{74}$ to $\frac{1}{1800}$ inch showing linearly— *a a a,* the polygonal division and its pore tesselating the surface; and *b b b,* the hemispherical tubercles; all relatively magnified both as to size and position.

FIG. 10.—The same. Diagram of vertical section drawn to same scale, showing —*a a a,* prismatic pillars and their tubes respectively; *b b'b,* hemispherical tubercles; all relatively magnified both as to size and position.

FIG. 11.—The same. Aperture, on same scale.

FIG. 12.—Spiculation of unknown sponge. *a,* skeleton-spicule; *b,* bihamate; *c,* equianchorate. Drawn to the scale of $\frac{1}{24}$ to $\frac{1}{6000}$ inch, and all relatively magnified.

[*] Vide preceding paper. [†] Αφρος, sea-froth.
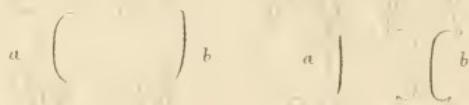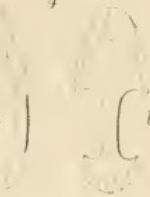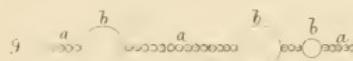
minute tesselation of polygonal areæ in the centre of each of which is a punctum or pore, and irregularly scattered over this again, a great number of hemispherical tubercles (Fig. 9, *a, b*); polygonal areæ about $\frac{1}{1000}$ inch in diameter; pore about $\frac{1}{6000}$ inch; hemispherical tubercle, which is hollow, from $\frac{1}{900}$ inch to $\frac{1}{360}$ inch in diameter, and from $\frac{1}{900}$ inch to $\frac{1}{180}$ inch apart (Figs. 9 and 10, *a, b*). *Internal structure:* largest chamber about $\frac{1}{20}$ inch in horizontal diameter and $\frac{1}{30}$ inch high (inside measurement); more or less filled, with (now) dry apparently homogeneous sarcode, that is, without fragments of sponge-spicules or any other foreign material; arched over superiorly and more or less straight inferiorly, that is, following the surface of the object on which it may be growing (Fig. 7, *a*); upper wall about $\frac{1}{360}$ inch thick, constructed of vertical prismatic pillars in juxtaposition traversed by a central tube whose external end, together with that of the prismatic pillar, forms the minute tesselated surface above mentioned, and its inner end that of the roof of the chamber, through which, communication between the external and internal parts of the test is effected; pillars arranged perpendicularly to the curve of the wall and together with their tubes of the same diameters as the polygonal areæ and pores of the surface respectively (Figs. 7, *a*, and 10, *a*). Chambers communicating with each other by means of one or more apertures (Fig. 7, *b*). Lower wall or floor (Fig. 7, *d*) less thick than the roof, but still traversed more or less by the vertical tubulation, and presenting a larger hole here and there which must have allowed the sarcode of the chamber to come into direct contact with the coral. Aperture in plurality on the margin opposite the chambers respectively supported on a papillary projection about $\frac{1}{360}$ inch in diameter; the hole itself about $\frac{1}{900}$ inch (Figs. 8 and 11). Size of specimen about one inch in diameter, that is, three times that of the circular space in the coral which it surrounds; maximum thickness about $\frac{1}{30}$ inch.

Hab. Marine, on the coral of *Amphihelia oculata*.

Loc. North Atlantic Ocean, between N. of Scotland and Faroe Islands (' Porcupine,' 1869, Sta. 54); lat. N. 59° 56'; long. W. 6° 27'; depth, 363 fathoms; bottom temp. 31° 4'.

Obs. Of this species I have already stated that it appears to be new, and although it is to a certain extent like Carpenteria, it nevertheless differs in the flat, vesicular character of its chambers extended more or less horizontally over the same plane; in the absence of elongated branched apertures; and that of foreign material (fragments of sponge-spicules, &c.) in its sarcode, with which the chambers of Carpenteria are invariably filled. The presence of hemispherical tubercles scattered over the poriferous surface is a common occurrence or feature on the tests of many Foraminifera; while the prismatic structure of the wall in which

each prism is traversed by a tube, represents the so-called " pore tubulation."

The vesication of *Aphrosina informis* forcibly recalls to mind that of *Æthalium septicum*, whose active state is so like *Amœba;* and whose form and appearance sometimes, are almost identical with *Lieberkühnia Wagneri.*[*]

Spiculation of an unknown Sponge.

On the surface of the foregoing species of *Aphrosina informis* are plentifully strewn the spicular remains of an unknown sponge remarkable for the size of the larger bihamates, which almost equal in length the skeleton - spicule, and on this account it seems desirable to record the fact, together with an illustration of each spicule drawn to the same scale, viz. $\frac{1}{24}$ inch to $\frac{1}{6000}$ inch, in order that their relative sizes may be at once realized.

Skeleton - spicule acuate, slightly fusiform, and sometimes spinulate (Plate XVII*a*, Fig. 12, *a*); large flesh-spicule bihamate, simple, smooth, showing plainly the central canal (Fig. 12, *b*); small flesh-spicule equianchorate, navicular, alæ or flukes inflected (Fig. 12, *c*).

Skeleton-spicules in successive bundles, indicating a fibrous arrangement, among which the bihamates of various sizes are plentifully scattered, together with a few equianchorates. The spiculation somewhat resembles that of *Esperia villosa.*[†]

[*] Clap. et Lach., ' Études Infusor.,' vol. i. pl. 23.
[†] ' Annals,' 1874, vol. xiv. pl. xiii. fig. 13, &c. (' Porcupine ' dredgings).

XXVIII.—*On the Theory of Illuminating Apparatus employed with the Microscope.* Part I.

By Dr. H. E. Fripp, Ex.-Off. F.R.M.S.[*]

(*Read* 11*th June*, 1879.)

Whoever tries to explain the diverse practice of microscopists in illuminating difficult objects, will find it equally hard to reconcile the conflicting opinions upon which this practice is based, and the contradictory results obtained by the methods employed. And the question will naturally arise in his mind, whether all microscopists accept in the same sense, and with the same confidence, those optical principles whose validity is beyond question, but whose practical import depends entirely upon their correct application.

For when the performance of the different kinds of illuminators is under discussion, the sincerity of appeal to optical principle often seems so dubious that one cannot but be impressed with the conviction of the expediency of reconsidering the whole theory of the action of the various apparatus now in use.

If there be no common ground of accepted doctrine it is obviously impossible to institute precise comparisons of the several excellencies, defects, or relative fitness for the particular purpose for which each illuminator is used (or designed), until some general rationale of their optical action has been established, and the more or less perfect realization of this optical rationale has been demonstrated for each case. My aim, therefore, in the present paper is to systematize as far as lies in my power those general propositions which, if accepted as rightly representing the optical aspects of the subject, may be used as a basis and standard of such comparisons. But while it is necessary to keep in view the various modes of action of the various apparatus used, in order to draw the particular conclusions upon which general propositions may be founded, I purpose to avoid all side issues involved in the attempt to decide for or against the claims severally advanced by the advocates of one or the other illuminator. It would indeed be impossible to include within prescribed limits a reasoned estimate of the performance of each separate invention, and equally fruitless to enter upon bypaths of theory which only interest those who are studying special objects and employing unusual methods of procedure according to the requirements of the illuminator used or object examined. Any inferences here drawn on general theoretical grounds respecting the real worth and use of the several classes of illuminators, will turn not upon art and skill of construction, but upon the optical intention and actual fulfilment of service in perfecting the definition of the Microscope image. In a word, my

* President of the Bristol Naturalists' Society.

standpoint is *the direct co-ordination of the illuminator and objective considered as parts of the same instrument tending by one combined series of acts to a common result in which the function of each part is a complement of the other.*

But it may be objected that a *theory* of illumination is better replaced by the *practice* which has long been successfully carried out by force of instinct aided by a little empirical manipulation, and that every microscopist can thus gain sufficient insight and mastery of his instrument to become independent alike of the restraints of theory and the methods of science. Or that, if inclined to rest his practice on a firmer foundation, he has only to turn to some "manual" and find therein all needful guidance. Such, indeed, is the general belief; and he who dissents from it in the face of current opinion and "authority" will scarcely escape the imputation of prejudice or presumption. Nevertheless I put in my plea of "not guilty," and proceed to offer reasons for dissent from the popular creed.

1. The microscopic image cannot be interpreted by mere intuition or insight of indisputable self-evident realities, but is the outcome of a prolonged study of optical phenomena occurring under unusual conditions, and presented to the eye in an unusual form. Visual perception may be correct as regards the optical effects presented, but this does not ensure accuracy of inference regarding the objective facts which are their antecedent. Experience teaches us that a perfect optical image requires a critically perfect illumination of the object; but a knowledge of optical effects as complete as exact science can make it is required before this illumination can be effected with certainty and constancy. No amount of practice will confer the power of discriminating between adventitious effects (which are yet true in an optical sense) and those which really characterize some structural detail of the object. The fact that a clearly seen and perfectly defined image is in a large number of cases *not* conformable with the object itself has been demonstrated beyond possibility of dispute.*

2. Yet our handbooks have nothing to say on these matters which can assist even the novice in his theoretical studies. The ordinary schoolboy crib from some elementary treatise on dioptrics transferred with no little parade to the introductory chapters of our handbooks as optical principles of the Microscope (!) is simply an evasion of the obligation (confessed, indeed, in the attempt) to explain the formation and character of the Microscope image. And, so far as the theory of illumination is concerned, catoptric problems of fundamental significance, such as the action of plane

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* For further observations on this subject I beg to refer to various articles in the Bristol Naturalists' Society's 'Proceedings,' and particularly to an essay on the question, "Is there a Science of Microscopy?"

and concave mirror, are either omitted altogether or treated in a manner which is at variance with the first principles of optical science. The same erroneous teaching is even chargeable against some of the diagrams illustrating refraction and reflection of light, while the general poverty of diagrams explanatory of optical problems is scarcely redeemed by figures of lamps and instruments interesting only to the maker and mechanical draughtsman. So again, when practical directions are substituted for theory, inconsistencies which crop up while consulting "authorities" demonstrate the present uncertainty of rule and inconstancy of result. On the part of the general body of microscopists, this leaning towards authority weakens the power of and trust in personal observation, and proportionally lengthens the reign of divided doctrine and opinion. Thus it happens that the first difficulty encountered by the beginner—namely, the fitting illumination of objects viewed through the Microscope—still remains the last difficulty to be overcome by the experienced microscopist.

3. Since then we look in vain for any systematic exposition of the principles of action upon which the performance of the several classes of illuminator (reflecting, refracting, or combined apparatus) depends, it seems expedient to collect such evidence as our micrography may afford of the current doctrine and practice in England, in order that we may form a just estimate of the subject before attempting any alternative theoretical views. The extracts here quoted are chosen solely on account of the optical principles, implied though not always expressed, on which the practical remarks are based. In the present paper the consideration of the theory and practice of illuminating opaque objects is omitted, as this part of the subject is more conveniently treated separately, though not involving any essential difference of principle.

Mr. Ross pertinently remarks, "The manner in which an object is lighted is second in importance only to the excellence of the glass through which it is seen." And again, "The principal question in regard to illumination is the magnitude of the illuminating pencil, particularly in reference to transparent objects. Generally speaking, the illuminating pencil should be as large as can be received by the lens, and no larger. Any light beyond this produces indistinctness and glare. The superfluous light from the mirror can be cut off by a screen having various sized apertures placed below the stage" (diaphragm).

Mr. J. Smith says, "In viewing transparent objects the plane mirror is most suitable for bright daylight; the concave for a lamp or candle, which should have the bull's-eye lens, when that is used, so close to it that the rays may fall nearly parallel on the mirror. If the bull's-eye lens is not used the light-source should not be more than five or six inches from the mirror. This latter is seldom

required to be more than three inches from the object, the details of which are best shown when the rays from the mirror fall upon it before crossing, and the centre (of mirror) should be, especially by lamplight, in the axis of the Microscope. For obscure objects seen by transmitted light and *for outline* a full central illumination is commonly best ; but for seeing delicate lines (e. g. on insect scales) it should be made to fall obliquely and in a direction at right angles to the lines to be viewed. The diaphragm is often of great use in modifying the light and stopping such rays as would confuse the image (especially with low or moderate powers), but many cases occur when the effects desired are best produced by admitting the whole from the mirror. If an achromatic condenser is employed instead of the diaphragm its axis should correspond with that of the body, and its glasses when adjusted to their right place should show the image of the source of artificial light, or by day, that of a cloud or window-bar in the field of the Microscope while the object to be viewed is in focus."

The above directions are quite compatible with a correct theory of illumination, though it cannot be said that they constitute any systematic expression of such a theory. If we now turn to the practical directions given by Sir D. Brewster in his article on the Microscope in the seventh edition of the ' Encyclopædia Britannica,' * we find certain directions relating to the position of the observer, the condition of the conjunctiva of the eye, the proper direction of lined objects in relation to the flow of moisture over the conjunctiva, which may be passed over, and certain rules to be observed in managing the illumination, which I here quote.

Firstly. The eye should be protected from all extraneous light, and should not receive any of the light which proceeds from the illuminating centre except that portion of it which is transmitted through or reflected from the object.

Fifthly. The field of view should be contracted so as to exclude every part of the object excepting that which is under immediate examination.

Sixthly. The light employed for illuminating the object should have as small a diameter as possible. In the daytime it should be a single hole in the window-shutter of a darkened room, and at night it should be an aperture placed before an argand lamp.

Seventhly. In all cases, and particularly when very high powers are requisite, the natural diameter of the light employed should be diminished and its intensity increased by optical contrivances.

The *eighth* direction refers to the use of homogeneous light.

Sir D. Brewster's essay on the Microscope marks an important

* Vol. xv. 1842.

date in the history of English invention of Microscope apparatus, for since this date the claim of construction upon scientific principles has been steadily preferred. It is therefore worth while to look upon the theory and practice of the present day from the standpoint of those who are its earlier founders, and whose mastery of optical science is acknowledged.

Sir D. Brewster states the case as it stood in 1820 with candid accuracy, as follows:—

"But the nature of the light employed, the magnitude of the pencil (thrown on the illuminator), its condition with regard to parallelism, divergency, or convergency, and the diameter of the pencil employed (i.e. thrown on the object), or the direction in which it falls upon the object, and upon which the performance of the finest instrument essentially depends, have never been discussed as matters of science."

The deduction by which Sir D. Brewster arrives at his theory of illumination is based upon the following physical and physiological grounds. If, he says, the object upon which a Microscope is focussed be lit by a surface containing an infinite number of radiant points, the images formed on the retina of the shadows caused by the intervention of opaque parts of the object will not be coincident, because these opaque parts cannot possibly be situate exactly in the focal point of the crossed rays, and also because of the spherical aberration which gives different conjugate foci for images formed by pencils passing through the lens at different distances from its central axis. Hence the indistinctness of the total effect produced by a number of not accurately coincident (that is overlapping) images, and the importance of illuminating the object from *one* point only. And this theory is embodied in the practical directions above quoted.

From what follows it will be seen that this physical and physiological reasoning is untenable. It is sufficient to point out here that the "condenser" which Sir D. Brewster designed with the special object of lighting the object from a point, upsets his own theory; as the source of light is practically the surface of the lens nearest to the object—a relatively large surface from which pencils of considerable angular value are directed at various inclination to the axis! consequently the illumination by daylight from a single hole in a window-shutter has no support from the practice of artificial illumination, while it is self-evident that when a mirror only is employed the illumination is simply enfeebled by exclusion of light.

It is therefore not a little remarkable that in discussing the proper method of illuminating objects for the solar Microscope (by "reflected" light), Sir D. Brewster discards the illumination from a single point, because "in consequence of the light arriving from

one direction only the surface of the illuminated object is covered
with deep shadows, and the intensity of illumination is by no means
sufficient when the power of the instrument is considered." Hence
he proposes " that the sun's light should be reflected by a very large
mirror through four apertures, each of which is furnished with an
illuminating lens. By these means the light would fall upon the
object in four different directions, and by shutting up one or more
of the four lenses (or parts of them) we shall be enabled to find the
particular direction of the light which is best suited for developing
the structure."

In 1829 Dr. Wollaston's observations were made public, and a
drawing of his condenser given in the 'Philosophical Transac-
tions'; and we next quote from Sir D. Brewster's essay * the
following passage :—" The marked difference between the methods
of illumination proposed by Dr. Wollaston and Sir D. Brewster,
induced the latter to publish in 1831 a paper "On the Principle of
Illumination of Microscopic Objects." In this paper the mistake
committed by Dr. Wollaston is clearly pointed out. The rays which
Dr. Wollaston throws upon the object, in place of being *rays
actually converged to a focus*, as they ought to be, are rays which
diverge from a focus situated between the object and the lens.
He makes the focal point of the circular margin of the perforation
(that is, the diaphragm) fall upon the object without considering
that the rays which pass through that perforation do not diverge
from it, and therefore cannot be collected in the conjugate focus
corresponding to the perforation. In Dr. Wollaston's diagram †
the rays which are incident on the mirror are actually drawn as
parallel rays, and it is quite clear that he meant them to be
parallel rays issuing from the bull's-eye lantern which he recom-
mends. But if we suppose that a common flame is used, the error
is just of the same nature. It is a distinct image of the flame that
should be thrown on the object, and hence the perforation (diaphragm
aperture) should be placed close to the flame, the source of light
and the illuminated object forming the conjugate foci of the lens."

It is not for the sake of controversy, but because the sharp
criticism of Dr. Wollaston's invention by Sir D. Brewster offers a
starting-point for a more progressive discussion of the theory of
illumination, that the present writer ventures in a humble way to
re-enact the part of *sartor resartus*.

It is first of all to be noted that the original intention of an
illuminator which should *collect* light on the object was not to
condense it, but to exclude any other rays from the field of vision
except such as came through or from the object. Dr. Wollaston
lays down the following proposition which Sir D. Brewster accepts

* 'Encyclop. Brit.,' vol. xv. p. 49, 7th ed.
† 'Phil. Trans.,' 1829, plate ii. fig. 1.

as the same, "though not so fully developed," as his own propositions enunciated in 1 and 5. "In the illumination of microscopic objects, whatever light is *collected* and brought to the eye beyond that which is fully commanded by the object-glasses tends rather to impede than to assist vision." In the next place, Dr. Wollaston plainly states that the intensity of illumination will depend upon the diameter of the illuminating lens and the proportion of the image of the aperture to its actual size, "which may be regulated according to the wish of the observer." Here we see the "marked difference" between the principles respectively advocated by Dr. Wollaston and Sir D. Brewster. The former advocates the principle of illumination from a large radiant surface, employing at the same time a method of regulating the amount of light derived from the original source by a diaphragm perforation. The latter arranges a circumscribed and small area of light-source, a point of light which is transferred to the object as a point of light of exactly the same size, the two points being conjugate foci. Now it is obvious that in both illuminators the intensity of light is not gained by *condensation*, but by *nearer approach to the object;* the brightness being inversely proportional to the square of the distance from the light-source. It is equally certain that in both illuminators the surface of the lens nearest the object is practically the light-giving source.* In the illuminator of Sir D. Brewster the light spreads first upon the collecting surface of a lens much larger than the diaphragm aperture, and after various changes of direction is again concentrated on the object. Yet in reforming the original point of light the rays previously dispersed until they occupy the whole surface of the lens which focusses them on the object, fall in from this radiant area with converging lines of various inclination to the axis: thus fulfilling the very conditions which Sir D. Brewster considered unsuitable, and which he sought to remove by an apparatus which, after all, acts upon the "mistaken principle" charged upon Dr. Wollaston! Fortunately, however, for microscopy, the modern objective not only enables, but demands, the adoption of this principle, which perhaps in 1829 Sir D. Brewster had some grounds for denouncing as a mistake when single lenses with great spherical aberration were the only objectives in use.

It remains now to examine Sir D. Brewster's criticism, as quoted above, on Dr. Wollaston's optical diagram and its explanation. The rays incident on the mirror are drawn parallel (the same blunder is repeated to-day in our handbooks!), and Sir D. Brewster says truly that the image of the diaphragm aperture could not fall

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* Anyone may satisfy himself of this fact by looking at a light (of any kind) through a lens placed before the eye at the principal focal distance; when the whole surface of the lens will be seen equally radiant, while the primary *source* is not seen.

upon the object unless the rays diverged from the diaphragm towards the " condensing " lens. But by constructing the diagram (as here given) *from the object as the starting-point,* we readily see that a light-source placed in the position indicated (*c f*) would

Fig. 1.   Fig. 2.
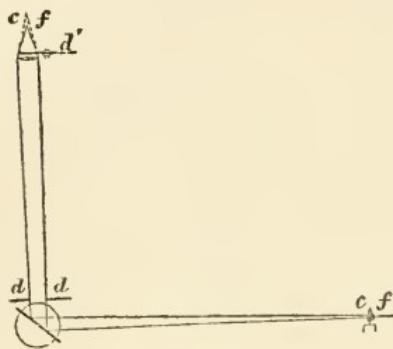
Fig. 1, from Dr. Wollaston's data.

Length of tube	.. ..	6	inches.
Focal distance of object from lens	.. ..	·8	,,
Distance of lens from diaphragm	.. ..	4·1	,,
Aperture in diaphragm	.. ..	·3	,,
Radius of lens to give the focal distance wanted	.. ..	·4	,,
Diameter of front surface of ditto	.. ..	·4	,,

c f, Conjugate foci by construction showing diverging pencil from light-source.

Fig. 2, copied from p. 49, ' Encycl. Brit.,' Sir David Brewster's article on Microscopes.

Focal distance of object from lens	.. ..	1·14	inch.
Distance of lens from diaphragm	.. ..	4·7	,,
Aperture in diaphragm	.. ..	·2	,,
Radius of lens	.. ..	·5	,,
Diameter of front surface	.. ..	·6	,,

Both figures show the effect of the diaphragm aperture in determining conjugate foci and divergence of pencil. Fig. 2 is, however, not drawn to scale accurately in accordance with Dr. Wollaston's data, and therefore exaggerates the supposed error of focus.

Dotted lines show the focus for parallel rays. Continuous lines, conjugate foci.

N.B. By this arrangement the upper surface of the condensing lens becomes virtually the light-source, and the diaphragm aperture just over the mirror acts on the same principle as in the Brewster illuminator. Obviously the best arrangement would be to leave the mirror free and remove the diaphragm, placing a revolving diaphragm with apertures just over the lens at *d'*.

give the necessary outlines of the diverging and converging cones, the apices of which shall be conjugate foci. But Sir D. Brewster's illuminator effects nothing more, and in passing judgment on the position of the diaphragm in Dr. Wollaston's apparatus, he lays himself open to objections of a graver kind against his own arrangement.

For since, theoretically, any plane below the diaphragm (or even its own aperture) may be considered the illuminating surface whether the light reaches such a position directly or by means of reflecting or refracting media, the best position of diaphragm may consequently be affirmed to be *above* the last reflecting or refracting surface, as thus the regulation of light-intensity may always be controlled without any change of apparatus. But it is a matter of daily experience that the position of the diaphragm in Microscopes of various model, and in " condensers " of various construction, is *not* dependent upon the principle contended for by Sir D. Brewster, namely, of immediate proximity to the light-source, since in all later constructions the diaphragm is a constituent part of the condensing apparatus, and situate always at some distance from mirror or lamp. The reason for which may be found in the principles here enunciated.

What is, however, practically valuable in the illuminators of Wollaston and Brewster, is not the application of a single narrow axial pencil of light, but of a comparatively wide illuminating cone whose base is formed by the radiant surface of the collecting lens next the object. And the suggestion therein conveyed covers most of the designs subsequently adopted of combining with an illuminating lens diaphragms pierced with apertures of various size and form giving oblique, central, or full all round illumination. But microscopy is more particularly indebted to Sir D. Brewster for his emphatic advocacy of a scientific study of a too long neglected subject. " The art of illuminating microscopic objects is," he says, " of no less importance than that of preparing them for observation," and he reiterates in the same article his conviction that " the progress of discovery with the Microscope must depend upon the scientific illumination of the objects under examination." And again, " I have no hesitation in saying that the apparatus for illumination requires to be as perfect as the apparatus of vision; and on this account I would recommend that the illuminating lens should be perfectly free from chromatic and spherical aberration, and that the greatest care be taken to exclude all extraneous light, both from the object and from the eye of the observer." *

Dujardin and others taught the same doctrine that Wollaston contended for, namely, that a converging light was best. Pritchard, on the contrary, held that difficult test objects could be best seen with diverging light. Harting, who mentions Pritchard's

* The Jury in a Report on Microscopes exhibited at the first world's fair (1851), mention Sir D. Brewster's method of illumination by achromatic lens combinations placed beneath the stage, and state their belief that it is a great advance on the simple condenser of Dr. Wollaston. But, as above shown by diagrammatic construction, Dr. Wollaston's condenser effects the very same result —a conjugate image and an illuminating pencil of considerable angular convergence.

view of the matter, tries to explain it as an effect produced by the *object* upon the course of the rays passing into the objective, and proposes an eclectic mode of solving the difficulty, by employing parallel, converging or diverging rays, according to the nature of the object, and other circumstances special to each case. He further says, speaking of the means by which, as he supposed, a proper direction could be given to the illuminating rays, that the *shape* of the plane mirror was a matter of indifference, while of course the concave mirror must necessarily be round. Goring, on the contrary, maintained that the mirror should be shaped elliptically, and as large as possible (5×4). Schleiden remarks that where it is possible, light from a plane mirror is to be preferred, because parallel rays are more advantageous for correct observation, although they give a less intense light. "For it appears," he adds, "as though a shifting of the image was occasioned by the convergence of rays reflected from the concave mirror." But though he has often observed this, he confesses that he cannot explain it, and that "our opticians leave us in respect to this matter quite in the dark." *

Dr. Carpenter, in his article on the Microscope,† follows Sir D. Brewster in his explanations and directions respecting illumination. I quote the following extracts:—" The principle of illumination on which Sir D. Brewster lays great, and we think fully deserved stress, is that the focus of the illuminating rays shall be coincident with the object so that there shall not be two sets of rays at different angles, one proceeding from the luminous object (source of light?) and the other from the object to be magnified." Commenting further on the best means of developing this principle, Dr. Carpenter says, "The rays of light proceeding from the radiant point being brought to a focus by the 'condenser' on the object, cross each other there, and should proceed to the object-glass of the microscope as if they came from the object itself. Now unless they are made to converge upon the object at the same angle at which they diverge to enter the objective, we cannot but think that a source of error still remains, and that the most perfect image possible formed by an achromatic object-glass of an object which is artificially illuminated, can only be produced when the rays from the source of light take exactly the same course as if they proceeded from the object itself. That they may have this course they must be made to converge upon the object by a condensing lens whose focus for parallel rays shall be the same as the acting focus of the objective. A different condenser would thus be required for every objective."

But the practical experience of this able microscopist does not

* Quoted from Nägeli and Schwendener, 2nd ed. p. 92.
† Todd's 'Cyclop. Anat.,' vol. iii. 1847.

appear to have agreed with the theory propounded by the authorities of the day, as will be seen from the following extract:—
"We may mention it as a fact for which we cannot very well account, that we have been able to obtain a very beautiful and distinct illumination by the use of an aplanatic doublet condenser, receiving its rays from the ground-glass globe of the common table-lamp, which would not seem to furnish any of the conditions that we have dwelt on as of theoretical importance."

In respect to the opinions expressed in the above quotations, I need at present only remark that although a theory of illumination is partially indicated in the acceptance of Brewster's "achromatic condenser" and the principle of its mode of action, as explained by its inventor (which has already been criticized), the suggestion of optical relation between the size of the illuminating cone and the aperture of the objective, more distinctly asserted by Ross (see *ante*), is based upon the assumption that every objective works best at its fullest aperture, which is rarely the case, and that "definition" and "penetration" are always improved by intense light, which is the case only when the focussing function of the objective is absolutely perfect; and even then definition becomes more critical as the *whole* aperture of the objective is occupied at the same moment. Sir D. Brewster's insistance on the propriety of using a narrow point of light, amounts in practice, when his illuminator is used, to this—that its specific intensity is first equalized by being distributed over a large radiant surface, viz. of the lens next to the object, and then directed from a number of radiant points in lines converging on the object. The true rationale of "definition," so far as brightness of illumination is concerned, is indicated by Helmholtz in his essay "On the Limits of Optical Capacity of the Microscope," written at a much later date. Sufficient delineating shadow, he says, can only be got by narrowing the size of the illuminating pencil, and a comparatively large illuminating cone can be applied beneath the object only when the objective admits a large incident cone. But it must be borne in mind that large angular aperture is associated with high magnifying powers, and as the optical aperture of such objectives diminishes with each increase of magnifying power, diffraction effects begin to affect the delineation. The theory of these diffraction effects was not however studied or followed out to its proper conclusion by any writer of that date. Again, it has been fully demonstrated that the function of large aperture is summed up in the admission and transmission of diffraction pencils, caused by the splitting of such pencils of light as fall upon minute details of the object into diffraction pencils which do not follow the original direction of the pencils thrown by the illuminator. And although fresh detail is thereby introduced into the image by an objective of

large aperture, *when the object contains such detail*, the greater admission of light through such an objective when viewing an object which does *not* contain such detail, severely tests its capacity of definition by flooding out the delineating shadows. Thus the benefit of a wide illuminating cone is confined to particular cases, and is not of general application.

Further, as respects the necessity of a different condenser for every object : everyone is of course aware in our day that a single illuminating lens, if constructed to admit the widest pencils required for any objective, can also be used for objectives of lesser aperture, when the incident light is regulated by a diaphragm properly placed at the plane of its lower focus, and supplied with openings of the required size. But this regulation of the size of incident pencils did not enter into the design of the Brewster illuminator, and it may fairly be inferred that the special function of a diaphragm as now used was not then (as it is not always now) comprehended. The Brewster design has indeed been long superseded by arrangements which leave the mirror free and yet combine refraction and reflection of light in pencils of any desired angular magnitude applicable to central or lateral illumination as well as for showing a positive image on a dark background, so that every desired mode of illumination may be effected without change of apparatus, or of the position of light-source. But for the present improved arrangements we are indebted to the practical optician rather than to any general advance in theoretical knowledge. For we still hear a great deal about "condensing " lenses, which nevertheless only increase the brightness by bringing an image of the original light-source nearer to the eye by optical means, without any actual increase of specific intensity. We are still taught the superiority of achromatic illumination, though it is easy to control by proper use of a diaphragm any excess of colour that may arise from dispersion of rays given off by reflection from mirrors, prisms, &c. And yet we still find the diaphragm, whose special function is to regulate by limiting apertures the size of the illuminating cone, placed in any chance position required by the mere mechanical exigencies of a thick Microscope stage ; the usual consequence of which is that when an objective of even moderate power is used, its angular aperture is far in excess of any illuminating cone which can be brought to bear on the object, so that the full resolving power of the objective cannot be obtained without additional apparatus. And while it is universally accepted that light is shut off by means of the diaphragm, we still find the old diagrams of mirror reflection invariably indicating—in defiance of the fundamental law of incidence and reflection—a *parallel* beam of light traced in towards the object, whereas a moment's consideration must convince everyone that if light is incident with *parallel* rays upon a

microscopic object only an infinitesimally small amount of light can be directed in the axial line upon the object, and that diaphragm openings having a larger diameter than the object could have no effect of excluding light, though we know the contrary to be the case.

And this consideration brings me to remark on the singular absence of any scientific exposition of the respective functions of the plane and concave mirror, and the function of the diaphragm when employed with the mirror; although these illuminators are of fundamental import to the general theory of illumination, while their constant employment renders the science of their effectual application a matter of prime and lasting necessity.* In comparison with this extraordinary omission, the perpetually exercised ingenuity in construction of new " condensers " and reflectors of all kinds, and the much-favoured discussion of exceptional and often useless methods of illumination, fail in real and general interest. Another remarkable omission is the absence of any study of the effect of the object which intervenes at the crossing point of converging illumination and the diverging pencils of light emitted from the object. The fact is too obvious to escape the notice of any practised observer that *mere* incidence of light is not the sole determining condition of perfect definition. A complete theory of illumination requires some special study of the physical effect of the constituent particles of the object on the rays incident upon them, whether from below or above. The intervention of the object *must* break the continuity of these rays (how otherwise would delineating shadows exist ?). Opaque parts interrupt more or less the passage of a large number of rays, while diffraction causes the additional phenomena of points of light which initiate a new series of light pencils whose appearance in the objective image is necessary to its perfect delineation of detail. And even where light passes through transparent parts of the object it is possible, nay probable, that its transmission is not unaffected by differences of homogeneity and specific gravity of the substance of the object (which has some thickness, even in the finest preparations). Such facts radically dispose of the received notion that transmitted light passes without change of direction through the object. The different specific density, for instance, of the fluids in which a preparation is preserved cannot but possess some influence, just as different specific density and thickness of a glass cover produce an effect for which correction of the objective has long been acknowledged to be necessary. In short, the principle of homogeneous immersion applies equally to the operation of the particular preservative menstrua used, which comprise such various fluids as glycerine, spirit, turpentine, saline solutions, &c. It is not,

* The latest editions of our Microscope manuals are as bare of information in this respect as the earliest.

therefore, too much to affirm that a right understanding of optical effects (initiated *before* the specific function of the objective is called into play) would have sufficed to expose the weakness of the strangely inadequate theory of the Microscope indicated in our handbooks by the hypotheses of penetrating and resolving powers; and that the maxim not long since considered unassailable, " No resolution without magnifying power," requires qualification in many important particulars.

The foregoing observations confirm to a large extent a statement made by Mr. Crisp in a communication read last year before the Society,* which I take the liberty of quoting here:—" At the present time," says this gentleman, " there is nothing extant which constitutes a commencement of a systematic theoretical treatment of the subject of illumination; yet, being purely optical, it is obviously capable of being so treated, and great practical advantages would undoubtedly follow from the development of an exact theory on the subject. In nothing has the ingenuity of microscopists been more exercised than in the invention of novel modes of illumination for lined objects; but however clearly these appliances may bring out particular appearances, there is good reason to believe that in the majority of cases they are illusions, originating in the character of the illumination employed, and that all possible methods of illumination may be reduced from the fifty or more kinds now existing to less than half a dozen at the most."

In adding to Mr. Crisp's milder denunciation a charge of erroneous teaching in respect of " the scientific illumination of objects " so strenuously contended for by Sir D. Brewster, I am fully sensible that such a charge requires to be sustained, not merely by the evidence above adduced of contradictory opinion and practice, as well as absence of definite rule, which prevails at the present time, but also by some alternative exposition of facts based on demonstration as well as theory. Such an exposition may be found in the respective essays of Professors Nägeli and Schwendener, Abbe, Helmholtz, and others, but as it seems to be little known or appreciated in English microscopy, an attempt to give some account of what is authoritatively taught abroad as a scientific theory of illumination, may serve at least to remove the reproach of inattention on the part of English microscopists to the *systematic* study of so important a subject. And it may be well also that the student should realize more distinctly how much of the actual performance of his Microscope depends upon the scientific application of his illuminating apparatus, even if he work with such simple illuminators as the plane and concave mirror.

It need scarcely be remarked that if the Microscope could always be turned towards a bright expanse of sky or reflected

* This Journal, i. (1878), p. 126.

sunlight (as from a cloud, whitened wall, &c.), or towards an artificial light-source of sufficient extent of surface and from every point of which an equally diffused light emanated (e. g. lamplight with ground-glass plate in front of it or reflector behind it), no other illuminator would be required for the greater number of observations made. But on account of the mechanical arrangements of the Microscope and for the convenience of the observer a mirror is an indispensable addition, while for greater control over the intensity of the light two accessory instruments are desirable: namely, a diaphragm for exclusion and a lens for collection (not condensation) of light.

In discussing the action of the plane mirror as applied to the Microscope, it must be borne in mind that from every light-source having a greater area of surface than that of the mirror itself there emanates a *converging* beam of light, which, after reflection, must converge further to a given point in the axial line of the reflected cone. If we hold a small mirror in the hand, with its surface turned towards an unlimited expanse of bright sky, and so inclined to the eye looking down upon it that the observer may see the reflected sky, then, as the mirror is held further from or nearer to the eye, a greater or smaller extent of sky is seen: or, if we look at a landscape, or a row of houses, or trees, &c., reflected from the mirror, a greater or less number of objects is included in the field of vision according to the distance of the mirror from the eye. And in every case the field of vision is circumscribed by lines drawn from the pupil to the periphery of the mirror and continued into space in the direction of incidence. A trivial experiment! but serving to demonstrate that daylight illumination with the plane mirror *must always be effected with converging light.* Each point in the surface of the mirror reflects independently in every direction the light it receives, and consequently when (in place of the eye looking upon the mirror) we suppose an object to be placed on the Microscope stage and in the optical axis of the instrument, the whole mirror appears as a self-luminous surface in relation to that object. Moreover, the luminousness of the surface remains equal, whether the surface be curved or not (supposing of course the light-source to be of practically unlimited extent). By reference to Fig. 3 it will be seen that a converging incident beam on the plane mirror is reflected on the same focal point as the parallel beam thrown on the concave mirror; and that a certain inclination of the mirror (supposing it to be centered on the optical axis of the instrument and arranged for direct central illumination) of 45° is necessary in order to reflect this converging beam on the object.

When a parallel beam of light is reflected from the plane mirror set at 45° to the axis of the instrument, the central rays alone fall on the object and the illumination is proportionally

feeble. But if the mirror be inclined forwards, backwards, or sidewards, at a greater angle, the outside rays of the beam fall with a certain obliquity, depending upon the size of the reflected

Fig. 3.*
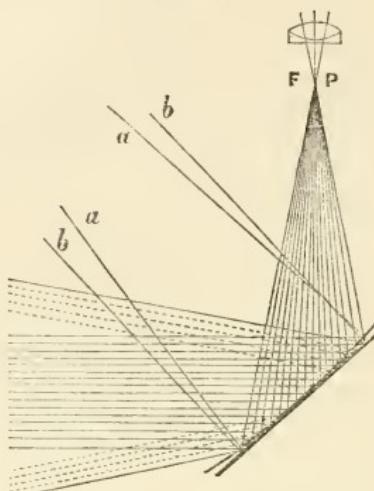
Fig. 3, to show that plane and concave mirrors have an exactly similar converging effect from the mirror upon the object.

The effect of the curve of the concave mirror is, here, to cause parallel rays incident upon it to be converged with an inclination to F P equal to that which is produced by means of the plane mirror when a larger converging cone of rays falls upon it; the area of mirror surface being practically equal in both.

Angle of aperture, 20°.

Distance of mirror from F P, 4 inches.

Radius of curve of concave mirror, 12 inches.

a a, Radii for constructing angles of incidence and reflection on concave mirror.

b b, Verticals to plane mirror.

Dotted lines = direction of incident light upon plane mirror.

Continuous lines = direction of rays incident upon concave mirror.

beam and its freedom from obstruction by the projection of stage or other impediment to free play of the light. In the small model instruments in which a relatively large mirror is centrally fixed at a short distance beneath the stage, the oblique illumination thus obtained has a marked influence upon the delineation of many objects.

When, again, the surface of light-source is reduced less than that of the mirror, the illuminating pencil falls with diverging rays upon the mirror and with corresponding diminution of light intensity, the same divergence and diminution of light effect continuing after reflection.

What now is the function of the diaphragm as ordinarily used with the plane mirror? It is evident from inspection of Figs. 4, 5, 6,†

* The dotted lines, by error of the engraver, are drawn parallel with each other: each line traced backwards from the object has its special angle of divergence from, or convergence towards, the mirror.

† Taken from the Handbook of Nägeli and Schwendener.

where A B represents the plane mirror, C D the concave mirror, a—b, the aperture in a diaphragm below the stage, and p a point in the focal plane of the object on which the Microscope is focussed, that the lines $p\,m$, $p\,n$, form the limiting boundary of a converging cone of light-rays reflected by either mirror. Assuming that the mirror is large enough to occupy the base of this illuminating cone, the intensity of illumination will vary with the size of the aperture in the diaphragm. And it matters not whether the mirror be nearer to or further from the point p, if only it be large enough to subtend the base of the cone: for since the area of reflecting surface increases with its distance from the point p, the number of illuminating points compensates for diminished intensity of light. If the diaphragm were removed, the face of the mirror would form the base of the illuminating cone, and in proportion as the mirror is brought nearer to the point p, will the angular spread of this cone increase.

It follows also, from the demonstration given with Fig. 3, that the cone of light from the concave mirror, circumscribed by the same diaphragm aperture, illuminates the point p as well (but no better) whether its focus falls exactly upon p, or not. As the curve is without influence in this direction, so the position of its focus has no optical significance. When the condition of unlimited expanse of sky light is realized, the converging cone of the plane mirror reflection has as good a claim to be considered "condensed" light as that of the concave mirror, or that of the collecting lens. But when its surface does not afford a sufficiently large base for a cone of light, which might act with real optical effect through a given diaphragm aperture, it is then deficient: and when it is sufficient for all effects the diaphragm has a special function to fulfil in controlling by exclusion or admission the amount of light required for each object according to the magnifying power of the objective used.

But in the next place, if we compare the outward course of the lines (in Figs. 4, 5, 6), which represent the incidence of the respective cones of light falling upon the two mirrors from the respective light-sources, we find differences which suggest reasons for the selection of one or the other according to the particular circumstances of the case.

If the Microscope be set up close to the window, and the mirror towards a clear sky, the condition of an unlimited expanse of light-source is fulfilled, provided the window-frame allows passage to all rays of light included within the outlines of the cone traced by the outermost rays incident upon the mirror to form the illumination. Thus, if $p\,m$ and $p\,n$ represent the outlines of a luminous cone touching the edges $a\,b$ of the diaphragm aperture and based on the mirror A B, then the incidence is found by construction (in tracing back the angle of incidence equal to that of reflection) at s and t.

But from the concave mirror C D the lines of incidence are found at s' and t', the central ray being the same for both mirrors (Fig. 5). If there be sufficient sky surface uniformly illuminated and nothing intervene between s and t to obstruct the passage of light, it is a

Fig. 4.
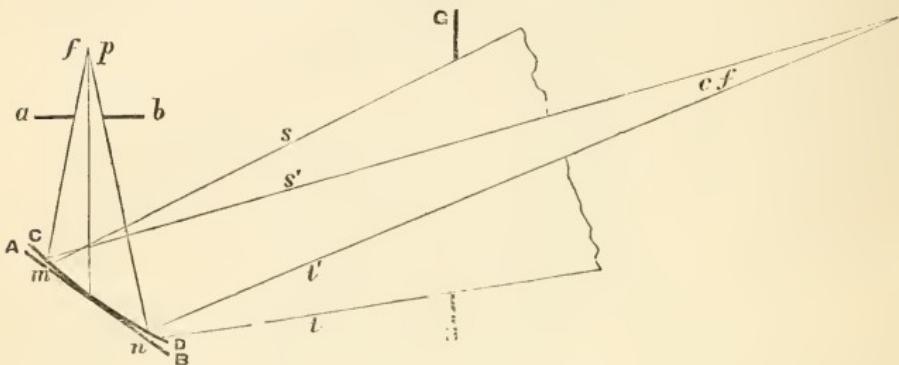
Fig. 5.
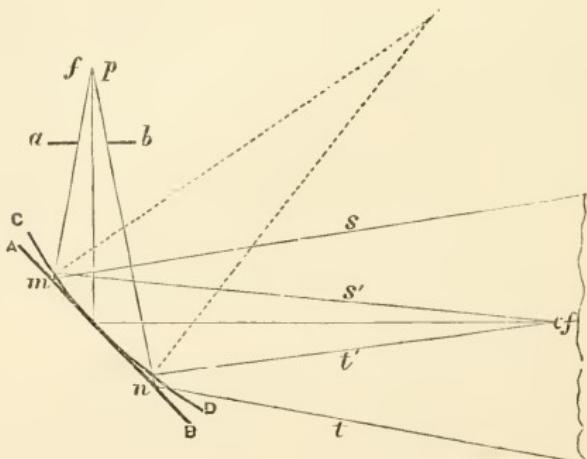
matter of indifference whether the incident rays converge at $s\,m$, $t\,n$, or diverge at $s'\,m$, $t'\,n$. But when anything intervenes to obstruct or occasion loss of light, then the form and position of the mirror surface becomes important, and that particular combination will act best which avoids the impediment, or the loss of light occasioned by it. For instance, if dark clouds occupy with bright clouds the expanse required for illumination with the plane mirror, the concave mirror disposed so as to receive rays from the bright cloud and reunite them in p, would give a maximum light; and

similarly the concave mirror will produce a more intense light whenever the light-source has a limited extent (e. g. flame of a lamp), provided that the source of light and the object stand to each other in the relations of conjugate *foci* (as in Wollaston or Brewster " condensers ").

Fig. 6.
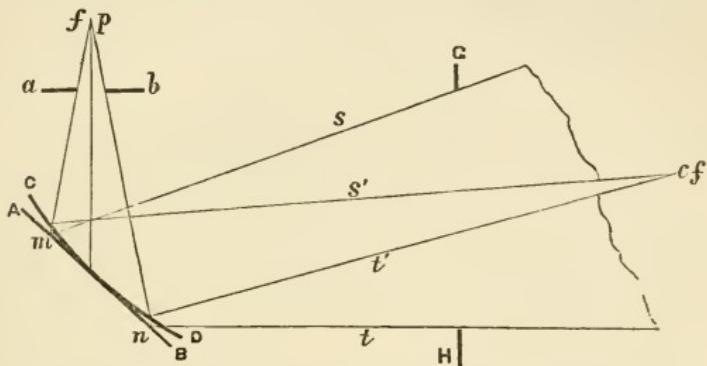
FIGS. 4-6, showing action of concave and plane mirror compared.

    Fig. 4, Mirror inclined at 35°.
    Fig. 5,   „   „   40°.
    Fig. 6,   „   „   45°.

$f p$, Focal plane of object.
$a b$, Aperture of diaphragm.
C D, Concave mirror.
A B, Plane mirror.
$s t$, Converging beam on plane mirror reflected to $f p = 20°$.
$s' t'$, Diverging beam on concave mirror reflected to $f p = 20°$.

Supposing sufficient extent of light-source (sky, e. g.), and sufficient mirror surface, the plane mirror gives an equal illumination with concave mirror.

N.B. The conjugate focus of concave mirror varies with inclinations of mirror towards axis of instrument.

The diaphragm aperture determines the angle of convergence within limits prescribed by extent of light-source and mirror surface.

It must then be accepted as a general proposition that the illumination of any and every single point in the field of vision is of necessity always effected by *converging* light. The illuminating rays cross each other at the plane of the object when the plane mirror as well as when any concave mirror or condensing lens is used. And it is inconceivable that such directions should be given (and called *excellent !* upon Sir D. Brewster's authority) as may be found in 'The Microscope,' by Jabez Hogg, 1854, page 51, as follows: " Only a portion of the object should be viewed at one time, and every other part excluded. The light which illuminates that part should be admitted through a small diaphragm (!)—*if in the day-time close a portion of the window-shutters* " (!). The customary manner of speaking of parallel or diverging rays as being employed to illuminate according to circumstances (!) the

field of vision, meaning thereby each constituent point of it, is equally opposed to the simplest law of optics.

With reference to the various lens combinations interposed in the course of the incident light, it is easy to show that their effect is exerted only *under special circumstances,* as has been shown of the form and position of the mirror. Thus, if we take Sir D. Brewster's condenser (Fig. 8), where F is a point in the plane of the
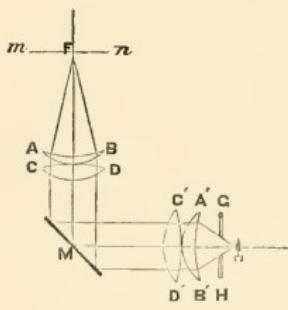
FIG. 7.   FIG. 8.
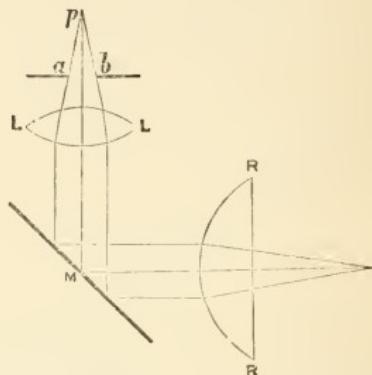
FIG. 8 (from pp. 95 N. and 1 S. 'Das Mikroskop'), to illustrate theory of action of *Cata-dioptric* illuminator.

    p, Plane of object and focal point of illuminator.
    a–b, Diaphragm aperture regulating the angle of convergence.
    L, Lens emitting converging pencil.
    M, Mirror.
    R, Bull's-eye condenser.

FIG. 7, Condenser designed by Sir D. Brewster.

    A B C D, Lens combination sending converging pencil on F focal point in plane of object *m n.*
    A′ B′ C′ D′, Lens combination for collecting light from light-source and transmitting to mirror M.
    G H, Diaphragm aperture.

In both diagrams the luminous source is practically the surface of the lens immediately under the plane of object, and *a b* is manifestly better placed than G H for regulating the size of illuminating pencil.

object, G H the diaphragm aperture which determines the size of the incident cone,* then A B, the last refracting surface of the combination, simply represents an area of light-source, and is in effect self-luminous, since the light received by the lens system A B C D is

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* It should be noted that H G is a screen supplied with different circular apertures and "a variable rectilinear aperture," the image of the slit being thrown upon a lined object parallel with its lines. And a final recommendation is made by Sir David Brewster, which I here quote. "It would be desirable to have circular and rectilinear apertures of different sizes to be placed immediately *beneath* F, so as to allow no part of the field to be seen excepting that which is occupied by the object or part of it under examination." The action of such supplementary diaphragms would modify (beneficially) the incidence of light if the aperture were not so fine as to occasion diffractive effects. (!)

emitted from the surface of A B in rays variously converged upon the object; and whether the rays received by A B reach it by direct incidence or indirectly (that is, after previous reflections or refractions) does not signify, as there is here no question of the manner in which the rays incident from the original light-source are directed upon the mirror, neither any question of the extent of the light-source. The two sets of lenses A B C D and A′ B′ C′ D′ have obviously no other effect than to occasion various changes in the course of the rays during their transference from the light-source to the object. As before explained, the whole effect consists in producing an image of the flame in direct contact with the object; and in considering the question of intensity of illumination it must be borne in mind that an image of the light-source brought to the plane of object upon which the instrument is focussed, is by the operation of the lenses of the Microscope brought up to the eye. The brightness is thus increased, because the light is made by optical means to touch the retina, not because it is " condensed " on the object.

It may be laid down as a general principle that any plane below the diaphragm (i. e. section across the light-cone), or even the diaphragm aperture itself, may be taken as the illuminating surface, whatever changes may have occurred previously in the course of the incident rays from refraction or reflection.

Putting now the case where the magnitude of incident light-cone is not regulated by a diaphragm aperture, and where the interposition of a collecting lens brings about a greater convergence of rays, and under circumstances (where the aperture of light-cone is not determined by the mirror) a large illuminating cone: it is always possible to place the lens in such a position that its whole surface should deliver light upon the point *p*, Fig. 9. The effect produced in this case is the same as when light is reflected from a mirror large enough to subtend as a base the cone whose outlines are formed by prolonging the outlines of the cone delivered by the lens until they meet the mirror. The illumination given by the lens would be proportioned to its proximity or distance from the object; but an equal light would be gained by increase of mirror surface. It is obvious, however, that a practical advantage is obtained by the collecting lens when the light-source is of limited extent, and especially when—which is the more common case—both mirror and light-source are limited. Yet, as a matter of theory, the maximum of light that can be obtained by any " condenser " cannot exceed that which a sufficiently large mirror and expanse of light-source (sky light) would produce.

Thus it appears that an illuminating apparatus of whatever kind is efficient in two ways only. First, by equalizing the intensity of the rays over the whole area of illumination; secondly, by

increasing its angular convergence on the object. Any simple
collecting lens will perform the same service as the most compli-
cated lens combination if it have suitable focussing arrangements,
and its refracting surfaces are so controlled by diaphragm apertures

Fig. 9.
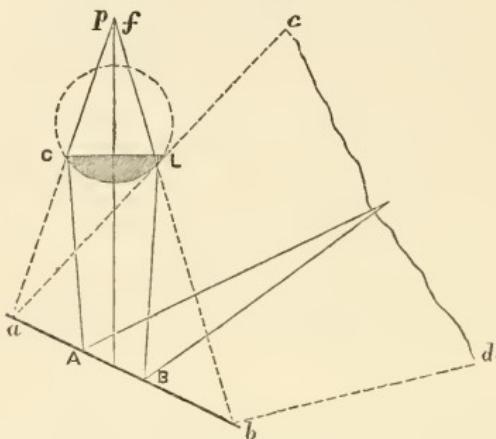
Fig. 9, to show action of plane mirror and collecting lens without diaphragm
aperture.

P f, Focal plane of object.

C L, Collecting lens.

C P L, Illuminating cone emitted from C L, whose light is derived from
the surface of mirror A B.

Its angle of convergence and specific intensity = that which the larger mirror
surface *a b* reflects without intervention of lens, and supposing the light-source to
have sufficient extent to give the incident cone *c a b d*.

N.B. It thus appears that, 1, where the angular convergence of illuminating
cone depends on plane mirror reflections, the size of mirror and requisite exten-
sion of light-source set limits to its use; 2, that an artificial light-source of
small extent, the reflection of which from mirror gives a diverging cone, is (within
certain limits) more conveniently converged on the object by a collecting lens
properly arranged.

as to exclude colour; a concave mirror being employed when the
light-source is of limited extent. The magnitude of the incident
light-cone will be in proportion to the proximity of the diaphragm
to the object. Its focal point need not fall exactly on the object,
though the maximum of light is attained when it is so focussed.
But a diaphragm aperture, which, being too large or too near the
object, allows an excess of light to fall on it, is disadvantageous; as
also when the aperture bounds a light-cone to which the mirror
offers an insufficient base.

To satisfy every condition the apparatus should in addition to
the diaphragm *over* the last refracting surface * which regulates

* See the Handbook of Professors Nägeli and Schwendener, p. 97, para-
graph 87.

the aperture of the illuminating cone, be supplied with the means of excluding light from any part of it. Many objects are best seen when central rays are excluded, others when oblique illumination is employed. To regulate the illumination according to requirement a second diaphragm is needed: a revolving disk or sector fitted over the first with a set of differently shaped stops to be rotated over the openings. Any arrangement may be introduced which suits the mechanical requirements of the instrument; but the diaphragms should be placed above the lens, and not, as is generally the case, beneath it.

In the foregoing observations the optical principles upon which the various apparatus for illumination of microscopic objects by transmitted light depend, have been indicated in general terms, which may be thus summed up:—

Whether concave or plane mirror, prism, collecting lens, or achromatic "condenser" be employed, the cross section of the illuminating beam shows a plane which is bounded either by diaphragm aperture, or by limits of reflecting or refracting apparatus, and which may be considered as self-luminous in relation to the object, inasmuch as each point of its surface conducts light from the primary source with the same illuminating power as that source, excepting the insignificant loss by reflection from the lens surfaces through which the light is made to pass. The size and position of the effective light-giving surface define the extent of a *converging* cone falling upon each point of the object, which, traced towards the Microscope, offers a diverging cone from each transparent point of the object to the objective. The aperture of the objective defines in its turn the basis of the diverging beam admitted into the objective, and therefore the brightness of the image formed. When diffraction pencils are occasioned by the action of the object, their course differs from that of the ordinary pencils, and the admission of such diverted pencils depends on increased aperture. The track of the ordinary and diffractive pencils can be observed as an image of the light-giving surface at the upper focal plane of the objective. And this method of examining the performance of the objective shows, amongst other things, the illusory character of the general belief that illumination is effected by parallel or diverging as well as by converging rays. This subject and its illustration by experiment and diagram is reserved for another opportunity.

The intensity of light transmitted by any kind of "condenser" cannot be greater than that which the original source yields. But by the production of an intermediate illuminating surface the light from the original and more distant source is brought nearer, and the convergence upon the object greater (under circumstances determinable at will) while the intensity is equalized over the whole illuminating surface.

Professor Abbe has given the following formula or theorem capable of general application for the solution of the several problems relating to intensity of illumination :—

" Leaving out of calculation any loss occasioned by reflection from the lenses of the microscope, the brightness of the completely or partially transparent parts of the object is exactly the same as that with which it would appear to the naked eye looking through a diaphragm aperture immediately in front of it, the size of which aperture corresponds with the area of the image of the light-giving source, as seen at the eye-point of the microscope : the object being supposed to be viewed in its magnified dimensions against the light of the primary source as a background.

" As direct corollaries from this theorem it results—1. That the brightness of the microscope picture can in no case exceed that with which it would appear to the naked eye. But that for each angular value of the image-forming pencil, whether limited by the objective aperture or by the area of illuminating surface, there is a given amount of amplification, *below* which the brightness of the image is always equal to that of the object as seen by the naked eye. And this amount of amplification is reached when the image at the eye-point has the same diameter as the pupil of the eye.

" 2. The intensity of brightness increases with the increase of angular aperture of the objective, so long as that aperture is not as large as that of the illuminating cone. But when the objective aperture is larger than that of the illuminating cone (and this is the usual case), the brightness diminishes. This happens with all the higher amplifications.

" 3. *Cæteris paribus*, the brightness of image is inversely proportional to the square of the linear amplification when the area of eye-point image is smaller than the pupil opening. Whether the amplification be obtained by a strong objective and weak ocular or by a weak objective with strong ocular, the amount of light with each amplification is the same. And all objectives whose aperture exceeds the maximum angular value of the incident light-cone transmit an equal amount of light when an equal amplification is obtained by using oculars which equalize the magnifying power. The appearances which seem to contradict these corollaries are explained by the circumstance that all differences of sharp and clear definition are unconsciously interpreted as differences of brightness." *

Finally, attention must be directed to the physiological conditions

* The above extract is quoted from Professor Abbe's article in vol. ix. of Schulze's 'Archiv für Mikr. Anat.,' entitled, " Contribution to the Theory of the Microscope," published in 1874. The theory above enunciated with its corollaries is confirmed by Helmholtz, and agrees exactly with the results stated in the treatise of Helmholtz on the capacity of performance of the Microscope translated by the present writer for the Bristol Naturalists' Society's 'Proceedings.'

of the perception of light. When looking through the Microscope at a given luminous surface (field of vision), the intensity of light transferred to the retina depends upon the conditions of its transmission. The arithmetical expression of this intensity is found in the ratio which the light cast on the retina by the Microscope bears to that cast on an equal surface of the retina when the same luminous surface is viewed by the unarmed eye. Professors Nägeli and Schwendener give in their book an exposition of this subject, of which the following is an abstract:—The intensity of light cast on the retina when a given luminous surface is viewed by the unarmed eye does not vary with the varying distance of the eye from the light, because the image formed on the retina becomes larger or smaller in exact proportion with the increase or diminution of the angular spread of the pencils emitted from each point of the object viewed. One might suppose that the same relation would continue when objects were viewed through the Microscope, that is to say, that the amplification of the Microscope image would rise and fall in corresponding ratio with the magnitude of the light-cone incident on the objective. If this were so, we should see every object as bright in the Microscope as with the naked eye. That is, the intensity of light (Lichtstärke) of the Microscope would equal unity. But the diameter of the Microscope image (and therefore also of the retinal image) increases with the rise of amplification in vastly greater ratio than does the angular spread of the light-cone incident from the object and transmitted by the objective to the eye.

In vision with the naked eye, taking the pupil aperture = $\frac{1}{10}$ or $\frac{1}{12}$ inch, and the distance of clear vision = 10 inches, the angular divergence of the pencil may be about half a degree. In vision through the Microscope, on the contrary, it may amount to 90° or 100° or over, according to the construction of the objective and its magnifying power. In this case the amount of light entering the eye through the Microscope from every point of the field is greater than the amount which the unarmed eye takes in the ratio of 100^2 to $(\frac{1}{2})^2$ or $200^2 : 1$. But this light is distributed over a retinal surface larger than that occupied by the retinal image of the object seen by the unarmed eye in proportion of the square of the linear amplification, which we will call m^2. The resulting brightness of field (which we will call v) is therefore represented by $v = \dfrac{200^2}{m^2}$, or, generalizing this formula, and setting ω for the angular aperture of the objective, and $\frac{1}{2}$ for that of the pupil, then $v = \left(\dfrac{\omega}{m}\right)^2$. Hence the light intensity is = unity when $m = 2\omega$, but less than unity when $m > 2\omega$, which is the common case. Here it is assumed as understood that the incident light-cone is large enough to fill the whole aperture of the objective, a condition seldom realized. In

place therefore of the full aperture ω the angular aperture fixed by the diaphragm opening (we will call it δ) must be substituted, and then the formula becomes $v = \left(\dfrac{2\,\delta}{m}\right)^2$; that is to say, with the same illumination, the brightness of field will vary in inverse proportion of the square of the linear amplification. For example, make $\delta = 30°$ (magnitude of illuminating cone), and use amplifications of 240, 300, 360, 420, &c., and we get for brightness of field in the several cases $\frac{1}{16}$, $\frac{1}{25}$, $\frac{1}{36}$, $\frac{1}{49}$ respectively. Raising, however, the value of δ to 60° or 90° by increasing diaphragm aperture or employing a lens, the brightness will reach from four to nine times the intensity in the respective cases, provided always that the objective aperture admit cones of such angular incidence.

The above rough calculation is corrected in greater detail by the authors, with the final conclusion that the sectional areas of the corresponding light-cones (those, namely, of the final Microscope image, and of the incident light on the objective) are to each other as the squares of the numbers representing their respective magnitude. When, then, the light emerging from the ocular (at eye-point) just fills the area of the pupillary opening, the corresponding cone of light entering the objective is therewith determined. For if the latter exceed the dimensions calculated on the above-stated relation of proportion, the excess of light could not be utilized. And, as the sectional area of a cone is always somewhat larger than the interior area of its "calotte," * we arrive at the conclusion that a luminous surface seen through the Microscope can under no circumstances possess greater intensity than when seen with the naked eye.

Since this paper was written the author has been enabled, by the courtesy of Mr. Crisp, to examine a simple Microscope made (date ?) on the plan of Wollaston's instrument. The optical conditions are, however, changed by *removal of the diaphragm*, and by giving a sliding *vertical motion to the "condenser."* The distance of mirror from condenser when the lens is raised so as to bring its focus to the level of the object, is 4 inches: the distance between surface of lens and plane of object being then ·9 inch. The lens is worked to radius of ·5 inch, and has a front surface of ·5 inch. The diameter of mirror is ·7 inch, and being distant 4 inches from the lens, allows, when inclined at 45°, the reflection of a parallel beam of light to fall upon the surface of the condenser, occupying its full diameter. In this position, therefore, the light-cone thrown on the plane of the object has a radiant base of ·5 inch, its apex being distant about ·9 inch, and the outer rays have consequently considerable inclination to the axis. When the lens is moved down towards the mirror as far as the mechanical arrangement permits, the distance from object to lens is 1·4 inch, and from

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* Because the light-intensity of the respective cones does not *exactly* bear the ratio of the squares of their respective angular magnitudes, but of the respective portions of interiors of spheres conceived to be described from the apex of each cone, on diameters drawn at equal distance from their apices (*calotten-fläche*). See pp. 76, 77, second edition of Professors Nägeli and Schwendener's Handbook, 1877.

thence to the mirror 3·4 inches. In this position, therefore, a parallel beam of incident light would focus below the object, but a slightly divergent incident light-cone coming from a near light source, would fall with conjugate focus on the object. Between these extreme positions the vertical movement of the condensing lens ($\frac{1}{2}$ inch) would afford various intermediate incidence of light rays. The absence of the diaphragm and the fixed distance of mirror render the mobility of condenser essential for regulation of light and disposition of conjugate focus.

The mechanical arrangements of this simple Microscope are specially worthy of notice, as indicating transitional phases in construction. The tube form of body and fixed distance of mirror are retained as in Wollaston's instrument—obviously the prototype of the "petit tambour" model so common in Swiss and French instruments. The absence of diaphragm no less clearly marks the fact that its function as a regulator of the magnitude of the illuminating pencil was not recognized, or at least not acted upon, as an optical principle to be taken advantage of in construction of the illuminating apparatus. On the other hand, a great advance in the general mechanical arrangements beyond those of Wollaston's instrument, is noticeable in the addition of a small traversing stage, with revolving object carrier, and of a "fine movement" screw to the stem and bar, carrying the simple or doublet lenses. Thus we find in Dollond's developments of the Wollaston instrument the same mechanical aids which characterize the modern stage movements of the compound Microscope with the exception of those introduced in the more complete arrangement of the sub-stage and movable mirror which followed the later practice of oblique illumination and the application of various accessory apparatus.

The main interest attaching to this instrument lies, however, in the attempt to develop the means of illumination upon scientific principle.

XXIX.—*Observations on Notommata Werneckii, and its Para-sitism in the Tubes of Vaucheria.* By Professor BALBIANI.*

(*See ' Proceedings,'* 11*th June,* 1879.)

PLATE XVIII.

I.—*Historical Summary.*

IN the preliminary part of his ' Histoire des Conferves d'Eau Douce,' after describing the horn-like or tubercular excrescences which originate on the side of the filaments of the Ectosperms (*Vaucheria*), and constitute the male and female reproductive organs of these unicellular algæ, Vaucher adds, that " we must not confound these horns or swellings with another kind of corpuscle frequently met with on the Ectosperm, whose function was long unknown. It differs from the oogonia properly so called, in being larger and of varied form, though always enclosing a rounded black spot, which sometimes seemed to me double. Continuing to observe this black spot, I recognized it as the insect called by Müller *Cyclops lupula.* Apparently it lays its eggs on the tube of the Conferva, and causes a similar development to that called *gall* in plants." † In the

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EXPLANATION OF PLATE XVIII.

Parts of the Animal.

b o, mouth. *c c,* ciliated cavity. *ch,* external chorion. *ch',* internal chorion. *c n,* nervous centre. *e,* stomach. *g c,* caudal glands. *g g,* gastric glands. *g r,* fatty globules arising from the destruction of the gastric glands. *g s,* salivary glands. *in,* intestine. *l,* superior lip of the buccal vestibule. *m s,* stomachal mass. *o,* summer eggs. *o',* their empty shells. *o'',* winter eggs. *od,* oviduct. *œ,* eye. *o r,* rotatory organ. *œs,* œsophagus. *o s,* segmental organs. *ov,* ovary. *ph,* pharynx. *t,* external integument with the subjacent cellular layer. *v b,* buccal vestibule. *v c,* contractile vesicle. *v g,* germinal vesicle.

Parts of the Plant.

b, branch bearing the organs of reproduction. *b a,* adventitious branches at the summit of the gall. *b a',* adventitious branches of the base. *c a,* antheridian cell empty and open. *f c,* false septum. *g,* galls formed by the parasite. *o,* organs of sexual reproduction. *r a,* antheridian branch. *r s,* sporangiferous branch. *sp,* sporange. *x, x'',* points where openings of the parasitic pockets occur.

FIG. 1.—Tubes of *Vaucheria terrestris,* with a low power. They show at *o o* the reproductive organs, and at *g g* the capsules or galls inhabited by *Notommata Werneckii,* whose presence is indicated by the internal black point.

FIG. 2.—*Notommata Werneckii* (adult)—dorsal face.

FIGS. 3, 4, and 5.—Cephalic extremity, in profile. These figures are intended to show some of the variations of form due to the contractions of this part.

FIGS. 6 and 7.—Same extremity—ventral face. In Fig. 6 the buccal vestibule is represented widely open, in Fig. 7 it is half closed.

FIG. 8.—Posterior extremity. A summer egg is in the oviduct *od.*

FIG. 9.—Full-grown *Notommata,* its body distended by eggs nearly mature. In

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* Translated and *abridged* from ' Annales des Sciences Naturelles (Zoologie), vol. vii. (1878) No. 1.
† ' Histoire des Conferves d'Eau Douce,' 1803, p. 18.
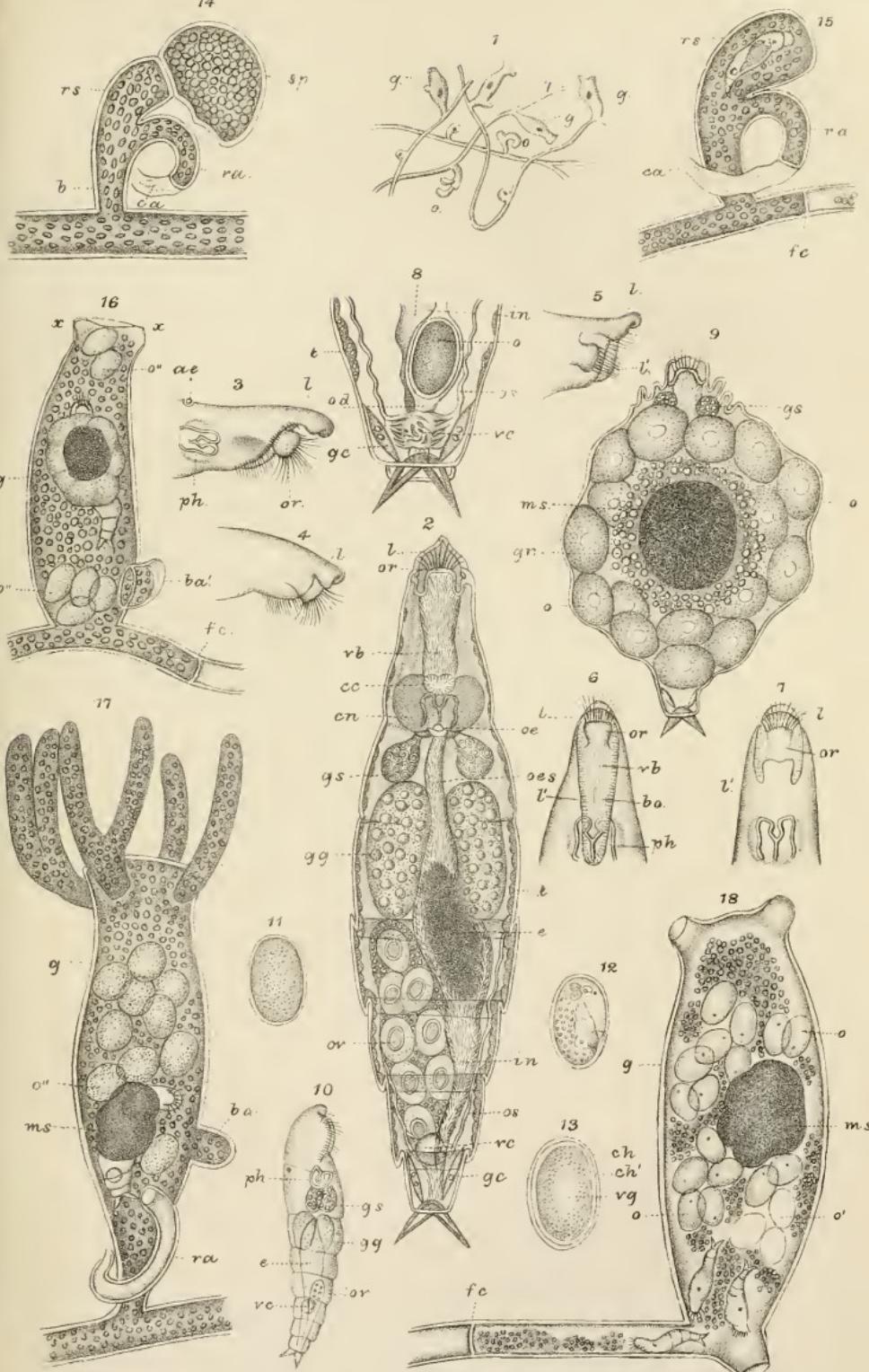
G. Balbiani del.

West, Newman & Co. lith.

Notommata Werneckii & its galls on
Vaucheria terrestris.

explanation of his figures, Vaucher speaks throughout of these oogonia as galls inhabited by *Cyclops lupula.*

After Vaucher, Lyngbye * observed similar excrescences on *Vaucheria dichotoma,* without, however, seeing the parasite inside.

In 1827, Unger † also described and figured the parasitic swellings on *V. dichotoma.* Unger remarked that the forms described by Roth ‡ under the names *Conferva dilatata* var. *clavata* Rth., and *C. dilatata* var. *bursata* Rth., were only *Ectosperma clavata* attacked by the same parasite.

In 1833, Wimmer § showed animalculæ enclosed in the excrescences of a *Vaucheria* of undetermined species, but failed to recognize their nature. The excrescences he considered with Vaucher to be "galls." Dr. Valentin, who undertook their microscopic study, was equally unsuccessful, and only pointed out that the small bodies enclosed with the parasite in the capsules were eggs.

In 1834, Dr. Werneck examined some excrescences enclosing animalculæ on *Vaucheria cespitosa,* received from Professor Unger; and from a drawing which he made, Ehrenberg was able for the first time to establish their true nature, classing them with Rotatoria of his genus *Notommata,* and calling them *Notommata Werneckii.*‖

In 1836, Ehrenberg ¶ himself observed the excrescences on

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the centre is seen the black stomachal mass *m s,* surrounded by a circle of fatty globules arising from the destruction of the gastric glands.

Fig. 10.—Young *Notommata* during the free period of its existence.

Fig. 11.—Summer egg just laid.

Fig. 12.—Summer egg containing an embryo on the point of being hatched.

Fig. 13.—Winter eggs recently laid.

Fig. 14.—Reproductive organs of *Vaucheria terrestris* after fecundation.

Fig. 15.—The same organs after the destruction of the spore. A young *Notommata* is in the interior of the sporangiferous branch *r s.* A false septum *f c* is formed in the tube of the plant, not far from the branch which carries the reproductive organs.

Fig. 16.—Parasitic pocket or gall of *Vaucheria terrestris,* containing a female in the act of laying summer eggs.

Fig. 17.—Gall containing a female which has finished laying its winter eggs *o''.* The antheridian cornicule *r a* is entirely empty of its contents.

Fig. 18.—Old parasitic capsule formed at the extremity of a filament, and containing a great number of summer eggs in the act of hatching. At the base of the capsule, three young *Notommata,* recently hatched, are looking for an exit. The body of the female is destroyed, and only the black stomachal mass *m s* remains. *f c,* false septum in the tube of the plant, closing the passage on this side.

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* 'Tentamen hydrophytologiæ danicæ,' 1819, p. 82.

† 'Die Metamorphose der Ectosperma clavata Vauch.,' Bonn, 1827, and 'Ann. des Sc. Nat.,' 1828, xiii. p. 428, pl. xvi.

‡ 'Catalecta botanica,' fasc. ii. p. 194, and fasc. iii. pp. 183–4.

§ 'Uebersicht der Arbeiten der Schles. Ges. für väterl. Cultur,' 1833 (1834), p. 71.

‖ "Organisation in der Richtung des Kleinsten Raumes," 'Beitr.,' iii. 1834, p. 72.

¶ 'Die Infusionsthierchen als volkommene Organismen,' 1838, p. 429.

V. dichotoma and *V. racemosa*, which, however, only contained eggs
which died before hatching.   He succeeded, however, in extracting
the embryo by breaking the shell, and observed among other
characters, the eye, and the jaws with a single tooth.

Notwithstanding the interest of Ehrenberg's discovery, we find
but few observations recorded during the succeeding forty years.
In 1839, Morren found club-shaped excrescences on *Vaucheria
clavata*, and within them the parasite and its eggs.   Opening
one of the cysts, Morren saw the animalcule, instead of coming
out, bury itself in the tube of the plant.   He took it to be *Rotifer
vulgaris.**

In 1840, Meyen found it no less difficult than Morren had done,
to explain the introduction of the animalculæ into the tubes of the
plant.†

In 1853, the late Professor Hofmeister, in conjunction with
Professor Cohn, observed the filaments of a *Vaucheria* which had
pushed out short lateral club-shaped branches, in each of which
was a rotifer, which moved its cilia briskly.   Hofmeister supposed
that the animalcule had penetrated into the tubes by piercing the
cellulose membrane without any damage to the plant.‡

In 1876, Dr. Magnus§ observed in *Vaucheria geminata* whose
filaments were found floating in the ponds of the Thiergarten
(Berlin), numerous galls almost always laterally placed, in each of
which was a female of *Notommata Werneckii*, surrounded with
eggs and newly-hatched young, which differed much in shape
from the mother.   Observing that some of the old and empty galls
were perforated at the summit, Magnus supposed that the young
had escaped from these openings, whilst the mother remained inside
and soon died, exhausted by her numerous layings.

Kützing fell into a similar mistake with Roth, describing
V. geminata, whose filaments bear parasitic galls, under the name
of *Vaucheria sacculifera*, and mistaking the eggs of *N. Werneckii*
for zoospores.‖

We see, therefore, that beyond the specific determination of
the parasite, which we owe to Ehrenberg, we know very little of
N. Werneckii, either as regards its mode of reproduction, or the
details of its organization.   This ignorance is doubtless owing to
the fact that *N. Werneckii* is almost always observed by botanists,
who naturally pay more attention to the plant than to its parasite.

* " De l'existence des Infusoires dans les Plantes," ' Bull. de l'Acad. de
Bruxelles,' 1839, vol. vi. p. 298.

† Wiegmann's ' Archiv für Naturgesch.,' 1840, vol. ii. p. 79.

‡ ' Handbuch der Physiol. Botanik,' vol. i. ; ' Die Lehre von der Pflanzen-
zelle,' 1869, p. 77.

§ ' Verhandlungen des botanischen Vereins der Provinz Brandenburg,' 18
Jahrgang, 1876, p. 125.

‖ ' Tabulæ phycologicæ,' vol. vi. p. 22, pl. lxiii. fig. 3.

In 1874, M. Maxime Cornu sent me some filaments of *V. terrestris*, on which he observed numerous swellings containing animalculæ which he recognized as Rotatoria. I saw that they were *N. Werneckii*, and eagerly proceeded to study this curious rotifer.

II.—*Organization of N. Werneckii.*

On examining the tubes of the *Vaucheria*, I distinguished on the greater number two kinds of laterally placed excrescences:— the one easily recognizable as the organs of reproduction, from their characteristic form (Plate XVIII., Fig. 1, *o, o*; Fig. 14); the other much larger, generally club-shaped, representing a kind of pocket, or elongated capsule, nearly at right angles to the principal filament, and having the same green colour (Fig. 1, *g, g*).

I opened one of these, and saw the parasite gradually disengage itself from the green matter. It was a blackish and extremely soft body, continually contracting and modifying its shape. At its centre was a large round spot with ill-defined edges, black and opaque with transmitted light (Fig. 9, *m s*); this spot represents the contents of the digestive tube, and is the *black spot* observed by Vaucher in the capsules of the Ectosperms. It is surrounded by a circle of colourless refractive globules, having all the characters of oil drops (Fig. 9, *g r*). Outside this was a wide, greyish, granular zone, forming the cortical layer of the animal. With a magnifying glass it appeared to be homogeneous, but under the Microscope was seen to be composed of numerous elliptical bodies, which were easily recognizable as nearly mature eggs (Fig. 9, *o*).

At intervals there appeared at opposite points of the body two short prolongations, one bearing, anteriorly, vibratile cilia; the other ending in a little tail with two triangular points (Fig. 9). These characters classed the animalcule with the Rotatoria, and finally, its red eye-spot and its situation in the tube of a Vaucheria proved it to be the *Notommata Werneckii* of Ehrenberg.

This summary description refers to the adult animalcule, ready to lay, when its body is much distorted and the internal organs so much modified as to be almost unrecognizable. To form an exact idea of its organization, it is advisable to take an adult animalcule whose ovary does not yet contain mature eggs.

Notommata Werneckii is a small rotifer not exceeding 0·30 mm. in length. The body is fusiform when elongated, the swollen portion being nearer to the anterior than to the posterior extremity, which is thinner than the former. It is divided, more or less distinctly according to its age, into seven segments, formed by transverse folds of the cuticle, and capable of being retracted one within the other (Fig. 2). The cephalic is the longest, the three middle,

which form the swollen portion, being nearly equal, and the three terminal ones diminishing successively in length. The last segment terminates in a foot or forked tail, formed of two small triangular points, which can be separated or brought together at pleasure. This segmentation becomes less and less distinct with age, in consequence of the distension of the body caused by the eggs, and finally it is transformed, as was said above, into a rounded sac, with two prolongations formed by the head and tail (Fig. 9).

Seen in profile, the body seems in its anterior part obliquely bevelled, at the expense of the ventral face. The dorsal face is prolonged into a projecting and protractile superior lip (Fig. 3), from the base of which descends on each side a fold of the external tegument, furnished with vibratile cilia at its edge, and uniting beneath with that of the opposite side, so as to circumscribe the opening of what is called the mouth, but which is more correctly the *vestibular orifice,* as it gives access to a cavity, at the bottom of which is the true mouth and the rotatory organ. To this cavity I give the name of *buccal vestibule* (Figs. 2, 6, *v b*).

The superior and lateral lips are soft and wonderfully contractile. The former especially is endowed with surprising agility, the movements being evidently tactile. (See Figs. 2–7, *l.*)

Inside the buccal vestibule is the *rotatory organ* (Figs. 2–7, *o r*), which is the apparatus of locomotion and the organ of touch. It shares the excessive mobility of the surrounding parts. (See Figs. 3, 4, and 5.)

Ehrenberg and Leydig * differ in describing the rotatory apparatus, but it is certain that in *N. Werneckii* the cilia form, on the surface of the rotatory disk, an isolated bundle completely independent of the other cilia of this region.

I have never discovered the long threads which Ehrenberg, from Werneck's description, said existed at the sides of the mouth in the adult.

It is only at a very early stage that the animal uses its rotatory apparatus for progression, as it soon commences its parasitic existence in the tubes of *Vaucheria,* where it is of course incapable of swimming in the dense plasma.

In the free stage the young Notommata advance rapidly in the water, either gliding with a uniform movement or " *striding* " along after the manner of the rotifers; that is, by resting alternately on the two opposite extremities of the body.

The energetic contractions imply a pronounced development of the *muscular system* which I have not been able to observe with sufficient accuracy to describe here.

The *digestive organs* are composed of the buccal cavity, of the

* See Leydig's " Ueber den Bau und die systematische Stellung der Räderthiere," ' Zeitschr. wiss. Zool.,' vi. 1855, p. 68.

pharyngeal bulb, the salivary glands, the œsophagus, the stomach, the gastric glands, and the intestine.

On the median line of the buccal vestibule, between the rotatory organ and the pharyngeal bulb, but nearest to the latter, is a longitudinal slit whose sides are so exactly in contact that it requires great attention to discover them. It properly represents the *buccal aperture* (Fig. 6, *b o*), which has been hitherto completely overlooked by observers, the cavity which we have called the buccal vestibule being commonly described as the mouth. When the vestibule is more or less shut, the mouth is hidden by the lips of the vestibule (Fig. 7, *l'*), but when open it is visible by the retraction of the lips (Fig. 6, *b o*).

The *pharyngeal bulb*, or *mastax* of the English naturalists, is a rounded pale mass, of homogeneous appearance, and without trace of the striæ caused by muscular fibrillæ so visible in several other Notommata (Figs. 3, 6, 7, *ph*). This absence of striation, an index of a feeble development of the contractile elements, is in keeping with the almost rudimentary condition of the jaws which the pharyngeal muscles move. The masticatory apparatus is far less complicated than in the greater part of the other species of the same genus. It most resembles *N. vermicularis* as figured by Dujardin.[*] Each jaw is composed of the small lateral branch called by Dujardin *scapus*,[†] which is articulated at its extremity with a small horizontal piece bent inwards, which constitutes the tooth proper (*acies* of Duj.). This tooth rests on a single median part, bifurcated anteriorily, which forms the support (*fulcrum* of Duj.).[‡]

Ehrenberg knew the extreme simplicity of the masticatory apparatus of *N. Werneckii*, through the drawings of Werneck, and remarked that the jaw had only one tooth. The feeble development of this apparatus is probably acquired, secondarily, by its parasitic life, and when the food (the vegetable plasma) is soft and easily divided, as the stronger and more complicated jaws of the free species are adapted to seize and eat hard and resisting substances.

At the posterior part of the pharynx are observable a pair of small, glandular, ovoid organs, disposed symmetrically, which are fixed by an attenuated extremity to the posterior edge of the pharyngeal bulb. From their forward position in the digestive tube, I consider them *salivary glands*, opening into the cavity of the pharynx by the attenuated part which represents the excretory passage. In the young individual these organs are comparatively large (Fig. 2, *g s*); in the old they are very small and driven into

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[*] 'Histoire Naturelle des Infusoires,' 1841, pl. xxi. fig. 7.
[†] These pieces constitute the *mallei* of Ehrenberg.
[‡] This is the *incus* of Ehrenberg.

the interior of the head by the mass of eggs which the body contains (Fig. 9, *g s*).

Behind the pharyngeal bulb, the alimentary canal constitutes a simple fusiform pocket which goes almost in a straight line through the cavity of the body (Fig. 2). The narrow part following the pharynx may be considered as an *œsophagus* (Fig. 2, *œs*), the median dilated region (Fig. 2, *e*) as a *stomach*, and the narrow elongated portion which terminates in the cloaca, as an *intestine* (Fig. 2, *in*). In the thin walls of the digestive tube I have not succeeded in seeing the large cells of which it is usually composed in the large species of Rotatoria.

The whole length of the digestive tube is furnished with very thin, long, vibratile cilia, causing a current towards the posterior part. After killing the animal by compression, I saw these cilia continue to move some time after death, whilst those of the buccal vestibule and rotatory organ ceased immediately, a proof of the influence of the will over the movement of the latter. In all adult individuals the stomach (Fig. 2, *e*) encloses a black pulverulent mass, the residue of digestion. This mass (the *black spot* of Vaucher) is in a state of slow rotation which continues under the action of the vibratile cilia. Small portions are detached from time to time, and are carried by the ciliary movement to the extremity of the intestine and expelled.

At the sides of the stomach are the two glandular organs called by Ehrenberg *pancreatic cæca*, and more appropriately by Leydig, *glands*, or *gastric appendages* (Fig. 2, *g g*). These glands are much larger in *N. Werneckii* than in other species of the same genus. They are convex at the external, and flattened at the internal surface, which is applied to the sides of the stomach from the termination of the œsophagus to nearly the middle of the gastric pocket.

These gastric glands are modified with age. Colourless, fatty drops are deposited in their midst, and their communication with the stomach becomes larger. They are finally drawn into the gastric cavity, where they are blended with a circular mass surrounding the granular black mass placed in the centre of this cavity. These changes are easily accounted for by considering that the gastric glands are placed in two folds of the wall of the stomach, which gradually unfolds with age.

The *excretory organs*, sometimes considered as an apparatus of aquatic respiration, are composed of a contractile vesicle placed in the posterior part of the body (Figs. 2, 8, *v c*) and of the two sinuous canals which open laterally into this vesicle (Figs. 2, 8, *o s*), and seemed to me to ramify in the thickness of the wall of the contractile vesicle before opening (Fig. 8, *v c*).

My observations on these, however, are as incomplete as those

on the *nervous system*. On the dorsal face of the body, above the pharyngeal bulb, I distinguished a pale, rounded, finely granulated mass, evidently representing the central nervous organ (Fig. 2, *c n*); but I could not see any of the peripheral nerves proceeding from it, and which Leydig has figured.[*]

The single median eye is placed, as in all *Notommata*, in the neck, and corresponds with the posterior border of the brain (Fig. 2, *œ*). It is composed of a small, refractive, spherical, crystalline lens set in a small mass of red pigment. In some *Notommata* the eye is fixed to the anterior part of a vesicle filled with opaque (calcareous?) corpuscles, placed behind the cerebral mass, to which it appears adherent. This is the *sacculus cerebralis* of Ehrenberg, of quite unknown functions, and is absent in *N. Werneckii*.

We must not confound with the preceding organ a small cavity on the dorsal face, in front of the eye, from which it is separated by the whole width of the brain (Fig. 2, *c c*). It seems to be bifid in its anterior half, and is furnished internally with very fine vibratile cilia, and contains a clear and transparent liquid. Its functions appear to be as obscure as those of the *sacculus cerebralis*. These problematical organs are frequent amongst Rotatoria, and are thought by some authors to be sensitive organs on account of their more or less distinct connection with the nervous centre.

In the posterior part of the body, in front of the caudal fork, are the two elongated organs general amongst Rotatoria, and which Leydig, on account of their general form, calls *club-shaped organs*. In our species they are short and fusiform, and do not reach beyond the last segment of the body (Figs. 2, 8, *g c*). Thanks to the observations of Leydig,[†] Cohn,[‡] Grenacher,[§] and Möbius,[‖] we know that they are the glandular organs producing the glutinous substance which enables the animal to fasten its foot to surrounding bodies.

III.—*Reproduction.*

All the individuals which I observed were females. The ovary, in the form of an elongated sac, rises in the cavity of the body, beside the digestive tube, as far as the inferior part of the gastric glands (Fig. 2, *ov*). Its posterior part, contracted into the form of an oviduct (Fig. 8, *od*), opens, as in all Rotatoria, into the cloacal canal. Its structure is very simple. In a kind of granular stroma are numerous ovules, presenting the same degree

[*] 'Ueber den Bau,' &c., p. 24, pl. vi. figs. 16 and 17.

[†] Müller's 'Archiv,' 1857, p. 410.

[‡] "Ueber die Fortpflanzung der Räderthiere," 'Zeitschr. wiss. Zool.,' 1859, vol. vii. p. 439.

[§] "Einige Beobachtungen über Räderthiere," 'Zeitschr. wiss. Zool.,' 1869, vol. xix. p. 494.

[‖] "Ein Beitrag zur Anatomie des Brachionus plicatilis," 'Zeitschr. wiss. Zool.,' 1874, vol. xxv. p. 111.

of development in the same individual. The vitellus, at first homogeneous and colourless, encloses a clear germinal vesicle, having itself a bulky Wagner's spot. Later on it becomes granular and yellowish, the germinal vesicle forming a clear rounded spot, and looking like a solid brilliant nucleus when treated with acetic acid. As the eggs approach maturity they are piled one on another in the ovary, mutually flattening each other. The distension they cause ends probably by rupturing the ovarian sac, for later on they are found free in the cavity of the body, immediately beneath the external integument. The animal then presents the rounded form of Fig. 9, with two short prolongations, one at the head, the other at the tail.

Like many other rotifers, *N. Werneckii* produces *summer eggs* and *winter eggs*, the former destined to be immediately hatched, the latter passing through the cold season, and only hatching the following year. They differ from each other from the moment they are laid, the summer eggs being smaller than the winter eggs (the former being 0·056 mm. by 0·042 mm., and the latter 0·062 mm. by 0·050 mm.). They present other differences in their contents, and the number and character of their envelopes. The summer egg has a clear, transparent vitellus, uniformly granular; a thin chorion constitutes the sole envelope (Fig. 11). In the winter egg, the vitellus is brown and opaque; it has a diffused, clear, rounded spot in its centre, probably due to the persistence of the germinal vesicle (Fig. 13). There are two envelopes separated from one another by a space filled with a clear liquid; the external one thicker (*ch*), forming a somewhat solid shell, and the internal one thin and membranous, closely applied to the vitellus (*ch'*).

Since Dalrymple's [*] discovery of the existence of small male individuals of *N. (Asplanchna) Anglica*, two opinions, diametrically opposed to each other, have existed among scientific men on the mode of development of summer and winter eggs. Some maintain with Huxley that the summer eggs alone require for their development the male element, whilst the winter eggs are produced without previous fecundation. Cohn [†] and others think, on the contrary, that the latter require sexual impregnation, whilst the former develop by virtue of an intrinsic fecundity (parthenogenesis). Cohn supports this opinion by the fact that in all the species where winter eggs are found, their appearance always coincides with that of the males, as in many Hydatinæa and Brachionæa; whilst in the whole family of Philodinæa, where these eggs are unknown, no males have been observed.

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[*] "Description of an Infusory Animalcule allied to the genus Notommata of Ehrenberg," 'Phil. Trans.,' 1849.

[†] "Ueber die Fortpflanzung der Räderthiere," 'Zeitschr. wiss. Zool.,' 1856, vol. vii. p. 483; 1858, vol. xi. p. 293.

My own observations have led me to a different opinion to that of either Huxley or Cohn. As I have already said, all the individuals which passed under my notice during April and May were females. I do not conclude from this the absolute absence of males, as these may only appear in autumn. At the beginning of my observations it was exclusively summer eggs which were produced. Later on these eggs were mixed in increasing proportion with winter eggs; and finally, at the end of April and the beginning of May, nearly all the eggs were of the latter kind. Not only was the production of summer eggs very considerably diminished, but a great number remained sterile, or if an embryo was formed it died without hatching, even when it had arrived at an advanced stage, as shown by the eye spot visible through the envelope. These facts show the gradual exhaustion of the vitality of the germ in the non-fecundated summer eggs. As to the winter eggs, I conclude that the assistance of the male sex was not necessary to their production or development, not merely from the fact that no male individual was ever presented to my observation, but from the fact that seminal corpuscles were absent in the females extracted from capsules containing winter eggs. A final proof of the absence of males is to be found in the complete identity presented by all the summer eggs. We know, by the researches of Dalrymple, Leydig, Cohn, Gosse, and others, that the sex of the future embryo of the Rotatoria is indicated in the egg, by various characters, such as form, size, and colour, which differ in male and female eggs, but I have never remarked this in the species under observation, where all the summer eggs resemble each other, even in the smallest details.

Cohn * has raised the question whether the same female can produce, either at the same or different epochs, summer and winter eggs. He negatives it, claiming to have established that each female only lays eggs of one kind. He even thinks that, when in one species there are male eggs besides, the production of the three sorts of eggs devolves on three different kinds of females. My observations do not agree with the opinion of Cohn. *N. Werneckii* enables the point to be easily decided, as the females enclose themselves in separate capsules, in most of which I have found the two sorts of eggs mixed in variable proportions, from which I conclude, contrary to the assertion of Cohn, that one and the same female can produce the two sorts of eggs. The earlier layings of the year are composed nearly exclusively of summer eggs, whilst it is winter eggs which predominate in the latter.

In spite of their name, the laying of the winter eggs sometimes begins from the early spring. The name was founded on the fact that the eggs pass through the winter and only hatch in the fol-

* *Loc. cit.,* p. 431.

lowing spring. The name of "*durable eggs*" (*Dauereier*, Cohn), expresses better their physiological character, of opening only after a long period of repose.

Some days before hatching we can distinguish in the egg a well-formed embryo, and recognize the greater part of the organs. It is doubled upon itself, the head and tail curved on the ventral face, and in contact with one another (Fig. 12). Just before hatching it moves energetically, and turns round in all directions, vibrating its buccal cilia. These movements are to break the shell of the egg. The young animal escapes out of the opening, and soon afterwards the margins of the opening join so exactly that the envelope (absolutely empty) seems intact. The newly hatched young are vermiform and from 0·10 mm. to 0·12 mm. in length (Fig. 10).

IV.—*The Galls of Vaucheria terrestris.*

We must now consider the excrescences of the *Vaucheria*, and try to decide whether or not they ought to be assimilated to the galls produced by the action of some insects on phanerogamous plants.

V. terrestris is composed of tubular filaments, without internal septa, and filled with green matter. The organs of fructification, the antheridium and the sporangium, are borne on a small secondary branch rising at right angles from the side of the principal filament (Figs. 14, 15). This common branch is itself divided into two branches, the inferior of which is bent downwards in the shape of a horn, bearing the antheridian cell at its extremity. The superior, which is the continuation of the secondary branch, becomes club-shaped at the summit, and terminates in a transversal partition to form the oogone or sporangium.

Passing from the organs of reproduction to the excrescences inhabited by *N. Werneckii*, a simple comparison will show the complete morphological identity of the two. The parasitic cysts are only the persistent branches which bore the organs of reproduction, and which under the influence of the parasite have enlarged considerably and modified their form. We sometimes find young rotifers lodged in capsules which in no wise differ in form and size from the normal sporiferous branches (Fig. 15, *r s*), which removes all doubt concerning the nature of these productions.

As the parasite grows, the capsule which encloses it sometimes increases to five times its original bulk (Figs. 16, 17, and 18). At the same time the wall of cellulose thickens over all the periphery.

It is always at a very early age that the parasite is introduced into the plant, to pass there the remainder of its life. It is nourished exclusively on the *colourless* plasma of the capsule, as is seen by the entire absence of green colour in the digestive tube. This confirms

the observations of M. Chautard * and M. Felix Plateau,† that chlorophyll is not an assimilable substance.

The animalcule lays its eggs inside the capsule, without any regularity, either singly or in groups amidst the green matter. It then dies, leaving no vestige but the black mass (Fig. 18, *m s*), and between the laying and hatching of the eggs the capsule begins to decompose, the chlorophyll loses its homogeneousness (Fig. 18) and colour, and the eggs hatch from ten to fifteen days after being laid. The Notommata forthwith anxiously seeks an issue from the capsule.

We have seen that under the influence of the parasite the small lateral branches of *Vaucheria*, which bear the reproductive organs, instead of becoming atrophied, after the fulfilment of their functions, are hypertrophied to four or five times their normal size. I think that this arises from a stimulation, caused by the secretion of an acrid liquid, of the same nature as that which forms galls on phanerogamous plants, from the bite of insects, which introduce into the plant a liquid secreted by the salivary glands. These glands exist also in *Notommata*, at least I so consider the appendages of the digestive tube which open into the pharynx (Fig. 2, *g s*) Their relatively considerable size, compared to that of the organs to which some authors have attributed an analogous signification in other rotifers,‡ seems to indicate that they are destined to fulfil special and important functions in this species These glands are also largely developed in the gall insects.

The parasitic excrescences on *Vaucheria* present another analogy with certain galls of the higher plants, in being the seat of a vegetative development which gives rise to the formation on different points of their surface of filaments filled with green matter. They are rarely found at the base, the summit being their more usual position. In the latter case, the upper part of the capsule begins to flatten, and to take an angular form; then at each of the angles a protuberance is formed, into which the plasmic matter penetrates (Fig. 16, *x x*). The capsular wall becomes considerably thinner at the culminating point of the protuberance, which continuing to elongate becomes a green filament (Fig. 17, *b a*), which is often many times the length of the capsule. Some bifurcate, some curve upwards like horns, and others take a horizontal or oblique position.

It frequently happens that instead of throwing out filaments the excrescence becomes perforated at its summit, thus forming a communication between the inside of the capsule and the surrounding

* 'Comptes Rendus,' 1873, vols. lxxvi. p. 103, lxxvii. p. 597.
† 'Recherches sur les Phénomènes de la Digestion chez les Insectes,' 1874, pp. 56, 119.
‡ 'Zeitschr. wiss. Zool.,' vol. vi. p. 73; Cohn, ibid., vol. vii. p. 475; Möbius, ibid., vol. xxv. p. 110.

liquid (Fig. 18). The young Notommata sometimes make their escape through this opening. The proof that the parasites do not themselves make the opening, as might be supposed, is that the capsules are often found perforated whilst still enclosing unhatched eggs.

The filaments at the base of the capsules (Figs. 16, 17, *b a'*) are formed in the same way. In this case also openings are sometimes formed (Fig. 18, *x''*) for the escape of the animal. Sometimes the antheridian tube itself at the base of the capsule, with its open extremity, serves as the exit (Fig. 17, *r a*).

Sometimes the young animals penetrate into the principal filament and reach another capsule which has an opening by which they can pass out. Their passage is, however, sometimes barred by the false septa (Figs. 15, 16, 18, *f e*), which are formed with such facility in the filaments of *Vaucheria* wherever there is a lesion, a septum of cellulose on either side isolating the part affected and preventing it spreading to the sound parts.[*]

Gradually the capsule becomes empty of animalculæ, and various Infusoria invade it and complete the destruction of the green matter.

The young Notommata move about very quickly when free in the water. They take no food during this period of free life, and soon return to the plant, never again to quit it. This re-entrance is effected through the various openings of the capsules which I have just described, from which they pass into the young green branches. Thus is explained their introduction into the tubes of *Vaucheria*, which was an enigma to all observers, with the exception of Dr. Magnus.

I will now speak of the destiny of the winter eggs. As we have seen already, they began to be laid in April, at first with summer eggs, then alone. About the middle of May, the laying of summer eggs had ceased, and the capsules contained only winter eggs. They were in much greater number than the summer eggs. In spite of all my care the *Vaucheria* died, but the eggs remained unaltered in the capsules, presenting no sign of development during the summer, autumn, and first half of winter. Unfortunately my observations were interrupted, and at the end of March I found all the eggs had hatched. This hatching must have taken place at the end of winter or beginning of spring, and the young had probably perished from want of food, as I found none in the water.

This interesting animalcule is not the only species of the genus *Notommata* parasitic on an Alga. Ehrenberg has made us

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[*] See Hofmeister, 'Handbuch der Physiol. Bot.,' vol. i. p. 76, and Hanstein, 'Lebensfähigkeit der Vaucheriazellen ('Niederrh. Ges.,' Sitz. V., 4 Nov. 1872, and 'Bot. Zeit.,' 1873, p. 697.

acquainted with *N. parasita*, which inhabits the spheres of *Volvox globator*.* Another species, *N. Petromyzon*, lives also in *Volvox*, often in company with the preceding.†

After Ehrenberg, *N. parasita* was the object of interesting observations by John Williams,‡ Gosse,§ and Ferdinand Cohn,‖ who discovered the male smaller than the female, and destitute of digestive organs, like all the males of the Rotatoria. Cohn proved also that *N. parasita* lays three kinds of eggs. 1st, numerous summer eggs with smooth envelope, which give origin to females; 2nd, eggs similar to the preceding, but smaller, whence issue males; 3rd, winter eggs in fewer number, but larger, and with an envelope bristling with short spines.

I will close with the following *résumé* of the principal results of my researches.

Notommata Werneckii presents two periods in its existence, one free, the other parasitic in the tubes of *Vaucheria*. In each of these two phases of its existence it takes a very different form. In the first it is elongated, vermiform, and divided into very distinct segments externally; in the second, in which it attains maturity, it is dilated, sacciform, very contractile, and without segmentation.

To these external changes correspond important modifications in the internal organs, characterized chiefly by the enormous development of the ovary and the atrophy of the appendages of the digestive tube (the salivary and gastric glands).

Like many other Rotatoria, it lays two sorts of eggs—summer and winter eggs, distinguished by their structure no less than by their mode of development.

The same female can produce either summer or winter eggs exclusively, or a mixture of the two kinds in the same gall of *Vaucheria*.

The winter eggs are produced in the spring; their laying commences later and is prolonged longer than that of the summer eggs: the latter develop immediately, while the former pass through the winter, and only hatch in the following year.

I have not observed any males, and on the other hand I have never found any spermatozoids in the females, from which I conclude that the winter eggs, like the summer eggs, develop without previous fecundation.

The galls of *Vaucheria*, in which *N. Werneckii* lives and is

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* ' Die Infusionsthierchen,' 1838, p. 426, pl. l. fig. 1.
† *Op. cit.*, p. 427, pl. l. fig. 7.
‡ " On the occurrence of Parasitic Rotifera in *Volvox globator*," ' Trans. Micr Soc.,' 1852, vol iii. p. 129.
§ " On the *N. parasita* inhabiting the spheres of *Volvox globator*," ibid., p. 143.
‖ " Bemerkungen über Räderthiere," ' Zeitschr. wiss. Zool.,' 1858, vol. ix. p. 291.

reproduced, are due to a hypertrophy of the branches of the plant, which bear the organs of fructification. They differ from galls, properly so called, which develop on the higher plants, in being pre-existing parts, which have simply undergone an increase in bulk, under the action of the parasite. This exaggeration of the vegetative functions is also often shown by the formation of adventitious branches at different points of the surface of the gall.

The exit of the young Notommata born in the galls, and its re-entry into the tubes of *Vaucheria* to form new galls, is effected through the openings which are spontaneously produced at the summit of the adventitious branches. They also sometimes make use for the same object of the small projection or male organ of reproduction, which persists at the base of the capsule in the form of a tube open at its two extremities.

RECORD

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

including Embryology and Histology generally.

ZOOLOGY.

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

Nucleus in Blood-corpuscles.*—Upon reading some months ago Böttcher's demonstration of a nucleus in the mammalian blood-corpuscle after bleaching by corrosive sublimate and alcohol, it occurred to Dr. W. T. Belfield, of Chicago, that the asserted nucleus might be artificial, due to coagulation of albumen and extraction of water by the reagents used. It seemed that if bleaching alone were to be accomplished the same results should follow bleaching by other methods.

With this idea he procured specimens of fresh blood from man, the dog, rat, and turtle, exposed the corpuscles to the action of various bleaching agents—chlorine, sulphurous acid, acetic acid, a freezing temperature—then, when the colouring matter had been removed, he immersed them in weak solutions of anilin and carmine, and mounted them in distilled water. He was careful to produce as nearly as possible identical effects upon all the specimens treated by each re-agent, using the same solutions for the same periods upon them all. By each method nuclei were clearly demonstrated in the turtle's blood, but in no other specimen was there any differentiation of colour. It is true that some mammalian corpuscles after prolonged immersion in the colouring fluid showed staining, but that staining was invariably uniform from centre to circumference, proving conclusively the absence of a nucleus so far as carmine staining can prove anything.

On these observations he bases a strong suspicion that the alcohol and corrosive sublimate used are responsible for the appearance of nuclei in corpuscles treated by Böttcher's method. This suspicion receives support from recent discoveries as to the structure of nuclei. In the July number of the 'Quarterly Journal of Microscopical Science' Dr. Klein relates a series of observations, as a result of which he affirms the nucleus to consist of a fibrillar network, imbedded in which is a ground substance; that this intranuclear network is continuous with a similar intracellular network; that nucleoli are merely the thickenings and shrivellings of these fibrils. The natural shrivelling effect of alcohol might readily produce a pseudo-nucleus in a blood-corpuscle from condensation of this intracellular network.

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 238.

Division of Cartilage Cells.[*]—In a short paper on this subject Dr. W. Bigelow states his disagreement with Butschli's view that the division of the cell-body always goes hand in hand with that of the nucleus, and that the common case of a single cell with two nuclei is not an instance of commencing division. Bigelow's observations on the cartilage of all classes of Vertebrata lead him to the opinion that division of the nucleus always precedes that of the cell-body. He finds, in fact, cells with constricted (biscuit-shaped) nuclei, cells with two nuclei which are considerably larger than the neighbouring uninucleate cells, cells with two nuclei and a faint partition wall. In no case was a septum seen before the division of the nucleus was completed.

Amongst the ordinary cartilage cells of the sclerotic of amphibia and fishes were found some of especially large size, separated from surrounding cells by a great thickness of ground substance, which often exhibited concentric striation, and was stained with gold chloride. They often contained two or three nuclei, and were of very irregular form. Their protoplasm was stained red with gold chloride, instead of bluish like the other cells. The surrounding cells were often arranged radially around these large cells, of the origin and significance of which the author proposes to treat in a future communication.

Final Changes in Meckel's Cartilage.[†]—The process of retrogressive metamorphosis undergone by Meckel's cartilage in mammals has been studied in the pig by Dr. Baumüller, of Würzburg, who sums up his results as follows:—

After previous calcification of its intercellular substance, the posterior portion of the cartilage undergoes degeneration by fibrous metaplasis, this process extending from the tympanic cavity to about the middle of the alveolar portion of the mandible. Next, an increase in size of the hinder half of the remaining part takes place, connected with changes of form produced chiefly by the growth of the mandible. The most important of these changes are the constricting off of small pieces, which, enclosed by the lower jaw, contribute to its increase in size, by their subsequent ossification.

The second step in degeneration consists in the ossification of the remainder of the cartilage, with the exception of the symphysis, where, finally, the same process of fibrous metaplasis takes place, to which the disappearance of the hinder part of the cartilage was due.

Histology of Nerve-fibre.[‡]—B. Rawitz comes to the conclusion that the constrictions observed by Ranvier are formed, in the living organism, by a circle of pale substance, which surrounds the axis-cylinder and destroys the continuity of the medulla; that the "double contour" represents the whole of the medullary sheath, but is not to be made out in the fresh state; it surrounds the axis-cylinder. The crimped appearance observed by Lautermann is due to the breaking up of the nerve-fibre.

        * 'Arch. f. Mikr. Anat.,' xvi. (1879) p. 458.
        † 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 466.
        ‡ 'Arch. f. Anat.' (His and Braune), (1879) p. 57.

Microscopical Phenomena of Muscular Contraction.[*]—The microscopical phenomena of muscular contraction have recently been studied by Professor Th. W. Engelmann, of Utrecht.

During the contraction of the transversely striated muscular fibres there are produced, parallel with the changes of form of the muscular elements, changes in the optical properties of the isotropic and anisotropic layers.

These changes are of an opposite nature in the two layers, the isotropic stratum in its totality becoming more and the anisotropic less refractile.

In consequence, at a certain degree of contraction, the fibre seen by ordinary light may appear homogeneous without appreciable transverse striæ—the stage of homogeneity or of transition.

If the contraction is carried further, the transverse striæ corresponding to the isotropic disks reappear.

At any given phase of the process of contraction, consequently even in the transition stage, the isotropic and anisotropic substances may be recognized by means of the polarizing Microscope as well-defined and regularly alternating layers. They do not, at the time of contraction, exchange their respective places in the muscular compartment (i. e. that portion of the fibre included between the middle of the isotropic layer and that of the next).

The thickness of both layers decreases during contraction, that of the isotropic layer much more rapidly than that of the anisotropic. The total volume of each compartment does not vary sensibly during contraction.

The anisotropic layers increase in volume at the expense of the isotropic, as during contraction liquid passes from the latter to the former.

Development of the Olfactory Nerve and Olfactory Organ of Vertebrates.[†]—In the course of an investigation into the development of the cranial nerves of the chick, by Dr. A. Milnes Marshall, certain facts came to light indicating that the olfactory nerve, instead of being, as usually described, a structure differing totally in its mode of origin from all the other nerves in the body, in reality " exactly corresponds in mode of development and in appearance with the other cranial nerves, and with the posterior roots of the special nerves."[‡] A further paper by Dr. Marshall gives the results of further investigations on this point; it deals also with some features in the development of the vertebrate olfactory organ and with certain questions of a more general nature affected by the conclusions arrived at. The more important conclusions, as regards the development of the olfactory nerve, are stated in the following propositions :—

(*a*) The olfactory nerves do not arise from the cerebral hemispheres, but from the single unpaired forebrain.

* ‘Arch. Néerland.,’ xiii. (1878) p. 437.

† ‘Proc. Roy. Soc.,’ xxviii. (1879) p. 324.

‡ ‘Proc. Roy. Soc.,’ xxvi. p. 50, and ‘Q. Journ. Micr. Sci.,’ xviii. (1878) pp. 17–23.

(*b*) There is no trace of an olfactory lobe in the early stages of development of the olfactory nerve.

(*c*) The olfactory nerve is a primary nerve comparable to the segmental cranial nerves.

The facts recorded concerning the development of the olfactory nerve and olfactory organ, point towards the same conclusions as the morphology of these structures, viz. that the latter is the visceral cleft, that the former is the segmental nerve supplying that cleft in a manner precisely similar to that in which the hinder clefts are supplied by their respective nerves, and that the Schneiderian folds are gills; conclusions which, if accepted, will considerably simplify our conception of the segmentation of the vertebrate head.

B. INVERTEBRATA.

Digestive Ferments of the Invertebrata.[*]—The paper of Dr. Krukenberg (of Heidelberg) on this interesting subject is reviewed in the 'Archives de Zool. Exp.'

In the most lowly developed forms (*Myxomycetes* and *Porifera*) there are digestive ferments, of which the best developed is the peptic; in most *Echinoderma* the formation of the ferment is not fully localized, and it seems possible that the nutriment may in them undergo ferment action outside the intestine; the liver of the *Asterida* is completely analogous to that of the *Arthropoda* or *Mollusca;* an analogous gland has been noted in the Holothurian *Cucumaria planci,* and in the Echinid *Toxopneustes lividus* and *T. brevispinosus;* in some *Vermes* the thryptic ferment (isothrypsin) is different to that of the *Vertebrata, Arthropoda,* and *Mollusca,* though probably identical with that of the *Asterida;* the hepatic follicles of *Aphrodite* have not this function; and it appears that there is nothing in the *Invertebrata* similar to the "stomach" of the *Vertebrata.*

Mollusca.

New Facts in the Anatomy of Molluscs.[†]—Dr. H. von Jhering contributes a short note on some recent discoveries he has made in the anatomy of molluscs.

He states that in the *Nudibranchiata,* urticating organs (Nessel-elemente) occur, sometimes having the form of simple rods, as in Turbellaria, sometimes having the complicated structure of a Cœlenterate thread-cell. They arise invariably in the interior of ectodermal cells, and are formed in an urticating sac (Nesselsack), a structure surrounded with strong muscular walls, and situated at the extremity of the dorsal papillæ. In many genera this sac is prolonged at its proximal or hinder end into another, thin-walled sac, which is in close contact with the prolongation of the alimentary canal extending into the papilla: in many cases, even, the two run together, thus establishing a communication between the alimentary processes and the urticating sacs. In these same genera, also, each alimentary process opens externally by a small aperture at the apex

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[*] ' Arch. Zool. Exp.' (Lacaze-Duthiers), vii. (1878) No. 3, p. xxxi.
[†] ' Zool. Anzeiger,' ii. (1879) p. 136.

of its papilla, so that, besides the anus, the gut has several dozen external apertures, of use, probably, in the ingestion of water.

In *Pleurobranchœa*, another curious arrangement was found, namely, a duct opening in front of the gill, and placing the surrounding water in communication with the auricle of the heart. There is also a duct running alongside the kidney, and, as in *Doris*, placing the pericardial cavity in communication with the kidney.

Generative Organs of the Cephalopoda.[*]—Dr. Brock points out how little is really known as to the characters of these structures, with the exception, of course, of those two remarkable points which have long attracted the attention of naturalists—the spermatophore and the hectocotylus.

The male organs are highly differentiated, and consist of the seminal gland, together with an efferent apparatus, which is made up of several parts, and has various accessory organs, of remarkable structure and unknown function, connected with it. Of all the curious points, perhaps the fact that—so far as is yet known—there is no Cephalopod in which the efferent duct is directly connected with the testis, is the most striking, although there is a very close analogy between this arrangement and that which obtains in the females of the Vertebrata. The testis is ordinarily tubular in structure; the efferent portion consists of a long canal, which is divided into a thinner and a thicker portion; the latter is probably glandular in structure, and is in function connected with the formation of spermatophores (*vesicula seminalis*—Cuvier); the third portion is only well developed in the Decapoda, and received consequently no name from Cuvier, who busied himself most largely with the anatomy of *Octopus*. Dr. Brock proposes to call it the *vas efferens*. With this longish duct is connected the prostate and a cæcal sac; it leads into the sac for the spermatophores. This organ, perhaps most commonly known as "Needham's pouch," has had various functions assigned to it; it ordinarily forms a wide flask-shaped receptacle, which, in the Decapoda, opens into the mantle cavity by a wide neck, and in the Octopoda into an elongated muscular penis, which likewise floats freely in the mantle cavity. The arrangements found in *Sepia officinalis*, *Loligo vulgaris*, *Sepiola Rondeletii*, *Eledone moschata*, and *Octopus* are then described in detail, as are also the female organs of the same forms. As to these, the arrangements of the Octopoda are simpler than those of the Decapoda, and the same, it may be observed, applies to the male organs; the former have two symmetrical oviducts, but only one pair of accessory glands, while in the Decapoda there are a number of accessory glands, but only one—the left—oviduct. The large flask-shaped nidamental glands seem to be found in all Decapoda; the glands accessory to them are compact (*Sepiola*), or are formed of two symmetrical halves, connected by a narrow isthmus (*Sepia*), or of two separate glands (*Loligo*); and the orifices of these glands are so arranged that their secretions must mix, if both sets secrete at the same point of time.

Histological examination reveals the fact that not only can two

[*] 'Zeitschr. wiss. Zool.,' xxxii. (1878) p. 1.

portions be made out in the so-called vesicula seminalis, but that the epithelium of the whole glandular tract is of the same character throughout; this points to the physiological similarity of the secretion, and to the generalization that, howsoever greatly these glands may vary in external characters, they form histologically and physiologically a *single* glandular organ, the function of which is the formation of spermatophores. The cause of the variations in form appears likewise to be due to the formation of these bodies. In the female Decapoda the presence of the accessory nidamental glands reveals the existence of two sets of organs. Dr. Brock is of opinion that not only is the glandular epithelium of the nidamental gland exactly similar in its primitive condition to the epithelium of the accessory male glands, but that whatever changes do obtain never exceed the limits of individual modification. When the organ is in function, the epithelium becomes changed in character; in the male there is the formation of cells in great quantity; the separate cells are smaller, and vary in form. In the nidamental glands the cells become arranged in two rows, the upper ones ciliated, and the lower developing rod-shaped and regular elements, in the protoplasm of which a number of vacuoles appear. At first sight the differences in the water canals which connect the genital capsule with the renal sacs are such as to lead to the supposition that they are homologous structures; but if we consider that the thin pouch of the ovary of the Decapoda only differs from that of the Octopoda by the absence of a muscular layer, we shall see that the differences between the firm canals of the one and the lacuna-like canal spaces of the other group may be well referred to this cause. In the opinion of the author, what is now seen of the water canals is but the remnant of a more extended system, which he hopes to be able to trace out in the *Nautilus*.

Observations on the Organization of Solenopus. [*] — *Solenopus nitidulus* was first found by Koren about thirty years since, and subsequently by Professor M. Sars, by both of whom it was considered to be a mollusc, though they were not able to make a thorough examination. Dalyell, however, in the 'Powers of the Creator,' refers it to the Vermes.

Koren and D. C. Danielssen having obtained numerous specimens of different species, have made more extended investigations into the organization of the animal, of which a brief preliminary description (without figures) appears in the 'Archiv for Mathematik og Naturvidenskab' of Christiania, 1878. They decidedly confirm the reference of *Solenopus* to the Mollusca, but as it differs considerably from previously known molluscs, they have not been able to bring it under any of the established orders of Mollusca, although it may well be referred to the great subclass Opisthobranchiata of Milne-Edwards. They have accordingly formed for it a third order of that subclass, which they call Telobranchiata, [†] because the branchiæ are situated at the hinder extremity of the animal.

The Telobranchiata are naked marine animals, with more or less

[*] Translated by W. S. Dallas, in 'Ann. and Mag. Nat. Hist.,' iii. (1879) p. 321.
[†] From τέλος, end, and βράγχια, gills.

worm-like bodies. They are hermaphrodite, and have neither tentacles, eyes, radula, or jaws. The foot is long and narrow, and can be completely concealed by the mantle. The branchiæ, which are placed at the posterior extremity of the animal, are retractile. Heart with a pretty well developed vascular system. Generative organs situated along the back, above the stomach and intestine. Nervous system composed of an œsophageal ring with one cerebral and two pedal (infra-œsophageal, Tullb.) ganglia.

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Family 1. *Solenopodidæ* K. and D.

(*Neomeniadæ* Jhering.)

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Along the ventral surface a furrow, within which the long narrow foot is concealed. Branchiæ filiform.

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Genus 1. *Solenopus* M. Sars, 1868.

Vermiculus Dalyell, 1853. *Neomenia* T. Tullberg, 1875.

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Body cylindrical, with filiform branchiæ at its posterior truncated extremity. Above the branchial cavity in the posterior margin of the mantle a genital pore, and in the bottom of the branchial cavity an anal orifice. Buccal mass, thick, muscular, capable of being completely covered by the mantle which is covered all over with diversely formed calcareous spicules. Along the ventral surface a furrow in which the foot is concealed.

Six new species, in addition to *S. nitidulus* M. Sars, are described, viz.:—*S. affinis, S. Dalyellii, S. incrustatus, S. margaritaceus, S. borealis,* and *S. Sarsii.*

Organ of Bojanus in Anodon.*—Dealing with the view that the blood of the Lamellibranchiata becomes intermixed with water in the kidney (for such the "organ of Bojanus" is), Mr. Marcus Hartog points out that this can hardly be so, and that the true function of the water which enters its canal is that of flushing the renal ducts filled with what is now known to be, on the whole, solid excreta (Lacaze-Duthiers). The author points out that the foot is provided with a number of orifices without any rigid elements adapting them to resist compression, and with a supply of cilia which work inwards; the water which thus gains ingress must, on the contraction of the foot, pass away partly by its pores, partly through the "vena cava," and partly through the pericardium, whence it must escape through the kidney, which, as is well known, has an orifice into the pericardium; it is further pointed out that the cilia of the renal canals work towards the exterior, and that the external orifice is so arranged as to prevent water passing in from without.

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Molluscoida.

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Development of the Salpidæ.†— The question whether these interesting forms do or do not exhibit true alternation of generation is, curiously enough, bound up with the history of the development of their testes. According to one of the few naturalists who have

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* 'Journ. Anat. and Phys.' (Humphry), xiii. (1879) p. 400.

† 'Zeitschr. wiss. Zool.,' xxx. (Suppl.) (1878) p. 275.

observed them, Mr. W. K. Brooks, of America, these organs are developed from the remarkable aggregation of cells, which, as containing fat in large quantities, has been called the *elæoblast*, found at the hinder end of the so-called foetal or solitary form. With this view Professor Salensky disagrees; by the older, and indeed by the majority of naturalists, it has been held that the testes are developed at a later period than the ovary; in an early stage of the development of the " chain-Salpæ " there is found at the hinder end of the body an aggregation of cells; later on this commences and continues to grow forward, and, investing the hind-gut, forms a testicular layer, from the lateral portions of which the testes are developed, while its superior and inferior portions take no part in the formation of the testes, and in all probability disappear altogether. According to Professor Salensky's observations this organ has no relation to the elæoblast, as Brooks supposed that it had. What relation has this mode of development to the question of alternate generations? And, firstly, as to one striking peculiarity, which is this: the ova of the chain-Salpæ attain a comparatively high degree of development before the chain breaks free from the mother. This is an arrangement altogether unlike that which obtains in other forms that present this method of generation, and has led to the view that the solitary *Salpæ* are females, but that their ova are developed in the chained forms to which they give rise.

The chained forms are, according to this view, males, and the part homologous to the elæoblast is that which gives rise to the testes; but as Salensky does not regard this view of the origin of the ovaries as correct, and believes that he has shown that the testes have no homologous relation to the elæoblast, it follows that he looks upon the generation of these forms as being truly of the alternate mode.

On comparing these *Salpæ* with allied forms, a very great similarity is found to obtain between them and *Pyrosoma ;* in this latter the ovum gives rise to a " cyathozooid " (Huxley); this develops by gemmation from its " stolo prolifer " the ascidiozoids, which are, like all *Ascidiæ*, hermaphrodite; the mother-form or " nurse " gives rise to an ovarian tube, which passes into the daughter-forms, and there produces ova; the only difference between them lies in the fact that *Pyrosoma* first gives rise to four ascidiozoids only, and that these undergo further gemmation; in the *Salpæ* there is nothing that is analogous to this.

Leaving the other forms of which the author treats, and merely indicating that he regards the aggregation of cells found in the tail of *Doliolum* as intermediate between the chorda of the Ascidian larva and the elæoblast of the *Salpæ*, we would note that he considers this last-mentioned organ as being obviously of greater morphological importance than a mere store of nutrient material, and as being provisional only; if this view be just, there is no obstacle to prevent our regarding the solitary form of *Salpæ* as exactly similar to the " nurse-form " of *Doliolum*, and, speaking more generally, we find that the " nurse " of the *Salpæ* corresponds to the larvæ of other

Tunicata, and is only a more or less modified form of the primitive type of larva.

Affinities of the Polyzoa.—The subject of Professor Allman's Presidential Address to the Linnean Society, on May 24, was, "Recent Progress in our Knowledge of the Endoproctal Polyzoa," in the course of which he stated that whilst still supporting the molluscan affinities of the Polyzoa as the most strongly marked, yet at the same time he could not overlook the fact that recent research had been bringing out features which pointed decidedly in the direction of the Worms.

Among these, one of the most significant is the presence of a pair of symmetrically placed gland-like organs, recently discovered in *Loxosoma*. These organs open on the surface of the body, and vividly suggest the well-known "segmental organs" of worms. It is in the Endoprocta (which now include the four genera, *Pedicellina*, *Umatella*, *Loxosoma*, and the curious *Ascopodaria* discovered by Busk among the collections of the 'Challenger') that the most decided vermal approximation can be demonstrated.

Loxosoma.[*]— The Rev. A. M. Norman, M.A., writes to point out that what he considered tentacular appendages attached to the caudal extremity of a Gephyrean which he described in 1861 (dredged in Bantry Bay) were obviously Vogt's *Loxosoma phascolosomatum* described in the 'Archives de Zoologie Expérimentale,' vol. v. (1877) and 'Quart. Journ. Micr. Sci.' n.s. vol. xvii. (1877). The mistake into which he had fallen is attributable to the fact that in 1861 *Loxosoma* had never been heard of, nor was any genus known at all like it, added to the fact that the parasite was so firmly attached to the epidermis of the host that it was almost impossible to remove it unmutilated.

Mr. Norman thinks that now attention has been directed to the subject several other species of the semi-parasitic Polyzoa will be found in British waters. They should be especially looked for on the Annelida, also on Hydrozoa, Sponges, &c.

Some valuable remarks of Oscar Schmidt[†] upon the memoirs on *Loxosoma* are translated in a subsequent number of the 'Annals.'[‡]

Barbed Hooklets on Spines of a Brachiopod.[§]— Dr. Young, of the Hunterian Museum, Glasgow, writes that Mr. Thomas Davidson describes on p. 275 and figures in plate xxxiv. of the Supplement to his 'Carboniferous Brachiopoda,' now on the eve of publication, some important points in the structure of *Spirifera lineata* Marten which specimens in his collection revealed. In this species the shell structure is minutely punctate, and the flattened spines, which are usually broken off short, contain in their interior a double canal that terminates upon the outer surface of the shell in a series of double pores. Dr. Young recently found a specimen having the spines in

      * 'Ann. and Mag. Nat. Hist.,' 5th ser., iii. (1879) p. 133.
      † 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 68.
      ‡ 'Ann. and Mag. Nat. Hist.,' iii. (1879) p. 303.
      § 'Nature,' xx. (1879) p. 242.

place. It appears that these spines are provided with numerous
marginal opposite hooklets, usually pointing towards the free end of
the spine, a structure which, so far as Dr. Young is aware, is unique
amongst the brachiopods, and to which he draws the attention of
palæontologists, as perhaps similar structures may be found in other
brachiopods.

Arthropoda.

Structure of the Cerebrum and Retina in the Arthropoda.[*]—
Emil Berger finds that the optic ganglion of the *Arthropoda* consists
of two parts, one of which is in direct relation to the facetted eye,
and goes to aid the layer of rods in making up the retina, while the
other part is more directly connected with the cerebrum, and is to be
regarded as a proper part of that organ. The *retina* consists of five
layers, which, passing inwards, are (1) The layer of rods, separated
by a fenestrated membrane from (2) the layer of nerve-bundles ;
(3) The granular layer, where the nuclei are coarsely granular ;
(4) The molecular layer, containing a finely granular substance, just
as in the *Vertebrata ;* and (5) The layer of ganglionic cells, which
were ordinarily found to be nucleated. Simplest in *Artemia*, the eye
becomes more complicated in the higher *Arthropoda*. The relations
of the retina to the cortical layer of the cerebrum are particularly
interesting in the bee; it is directly continuous with that of the optic
ganglion and the ganglionic portion of the retina, and this arrange-
ment seems to show that the last-mentioned structure is merely a
modified part of the cortical layer. It is interesting to compare this
arrangement with the well-known history of the development of the
Vertebrate eye.

The pair of nerves which, in the bee, arise from the subœsophageal
ganglion are shown to take their origin from the supra-œsophageal
ganglion in great part, as it is but little of them that arises from the
cortical region of the lower ganglia; this observation explains the
presence of the number of transverse commissures which were stated
to exist in this region by Leydig. In the *Insecta* the supra-œsophageal
ganglion is invested by a cortex containing ganglion-cells, while in the
higher *Crustacea* the ganglion-cells are arranged in a number of peri-
pheral and disconnected layers.

Formation of the Blastoderm and of the Germ-layers in Insects.[†]—
Dr. Bobretzky, in his observations on this subject, draws attention to
the views of Weissmann and of Metschnikoff. According to the former,
the formation of the blastoderm is preceded by the development of a
clear and almost homogeneous substance on the surface of the egg ; this
" blastema " encloses nearly the whole of the egg, and is readily distin-
guished from the dark granular yolk. In it there appear nuclei, which
are, later on, converted into the cells of the blastoderm ; and according
to Weismann, these nuclei are freshly developed structures, and not
descendants of the germinal vesicle. Metschnikoff, however, believes
that they owe their origin to the continual division of the germinal

* ' Arb. Zool. Inst. Univ. Wien,' ii. (1878) p. 221.
† ' Zeitschr. wiss. Zool.,' xxxi. (1878) p. 195.

vesicle. Brandt is also of opinion that the blastoderm owes its origin to the germinal vesicle; he says that the protoplasm of the blastoderm corresponds to the germinal vesicle, and the contained nuclei to the germinal spot.

Dr. Bobretzky agrees with the latter in his general results, inasmuch as he finds in two species of *Lepidoptera* which he specially examined, that (1) previous to the formation of the blastoderm, morphological elements having the value of true cells, appear in the yolk; (2) some of these gradually pass to the surface, where they form the blastoderm; while (3) others remain in the yolk, and, later on, bring about the formation of the so-called yolk-spheres, which are likewise to be regarded as true cells. The author was not, however, enabled to observe the connection of these cells with the germinal vesicle; and he is still in opposition to Brandt, and in agreement with the great majority of observers, in regarding this structure as the true nucleus of the ovarian cell. As to the blastema of Weissmann, its existence is denied by Brandt, and was never observed by Bobretzky, unless, as he says, the peripheral vitelline layer represents it; but this takes no share in the formation of the blastoderm.

The author rightly insists on the necessity of extended and comparative investigations before deducing any generalizations; and he points out that, in a spider, elements have been observed by Ludwig very similar to those found by him in the egg of the *Lepidoptera*. As to the cleavage in these latter, he points out that as the protoplasmic elements are not all used up in the formation of the blastoderm, they so far differ from what has been observed in the *Crustacea* and *Arachnida*, where the cleavage is complete; but he explains that he is of opinion that the above-mentioned yolk-spheres do ultimately go to form the endoderm, while he believes that the blastoderm really corresponds to the ectoderm. In connection with other observations lately made, it is of interest to observe that the mesodermal bands begin to be segmented some time before the ectoderm.

Mode of Recognition among Ants.[*]—The Rev. H. C. McCook has made experiments upon two species of ants ("Pavement" Ant—*Tetramorium cæspitum*, and Pennsylvania Carpenter Ant—*Camponotus Pennsylvanicus*) as to their mode of recognizing each other and distinguishing fellow-formicarians from those of alien nests, with whom they at once fight when they meet.

It occurred to him that this recognition was based upon a certain odour which, *in different degrees of intensity*, is emitted by the respective factions; or, which seems less likely, upon the presence in the individuals of the combatants of *two distinct odours*. This degree of odour, or difference in odour, he supposed might be dependent upon some temporary difference in the physical condition, age, or environment of the antagonists. Supposing that there were any basis of truth in this theory, it further occurred to him that the presence of an artificial and alien perfume of sufficient strength to neutralize the distinctive animal odours or degrees of odour, and environ the combatants

with a foreign and common odour, would have the tendency to confuse the ants, and disturb or destroy their power of recognition; in which case he conjectured that the result might be their pacification and reconciliation. He therefore made the following tests.

He introduced into a jar, in which he had placed (with some soil) a number of combatants whom he found engaged in battle (" pavement " ants), a pellet of paper saturated with eau de Cologne, the battle being then again at its height. The effect was instantaneous. The ants showed no signs of pain, displeasure, or intoxication—indeed, some ran freely over the paper, but in a very few seconds the warriors had unclasped their mandibles, released their hold of enemies' legs, antennæ, and bodies, and after a momentary confusion, began to burrow galleries in the earth with the utmost harmony. On the part of some there was the appearance of thus escaping from the artificial odour, but there was no renewal of the battle, and the quondam foes lived together for several days in harmony. Thus the perfume proved an eminent pacificator, and so far verified the theory. A second and a third experiment was tried, with the like results.

Attention was next directed to the " carpenter " ants, and a similar series of experiments made, the results of which did not, however, at all agree with the previous ones, the perfume having no effect in preventing the decapitation of alien ants introduced into the nests.

Mr. McCook hopes, when a favourable opportunity again presents, to continue this line of observation. The results are put on record, inconclusive as they appear, not only because they seem to be in themselves interesting and valuable, but in order to stimulate the inquiry among others in the same direction, and to invite suggestions and information which other observers may be able to furnish.

Toilet Habits of Ants.[*]—The Rev. H. C. McCook also states that the Agricultural Ant (and the remark applies to all other ants with which he was acquainted) is one of the neatest creatures in her personal habits. The whole body is frequently and thoroughly cleansed, a duty which is habitually attended to upon eating and after sleep. In this process the ants assist one another, and it is an exceedingly interesting sight which is presented to the observer when this general " washing up " is in progress.

The operation is conducted as follows. The ant to whom the friendly office is being administered (the cleansed, she may be called) is leaning over upon one side as we begin the observation. The cleanser (as we may name the other party) is in the act of lifting the fore-leg, which is licked, the mouth passing steadily from the tarsus up to the body; next the neck is licked, then the prothorax, then the head. The cleanser now leaves, and the cleansed begins to operate upon herself as hereafter described. This process may be seen throughout the entire group. We take another couple. The cleanser has begun at the face, which is licked thoroughly, even the mandibles being cared for, they being held apart for convenient manipulation. From the face the cleanser passes to the thorax, thence to the haunch, and so

* ' Proc. Acad. Nat. Sci. Phila.,' 1878, p. 119.

along the first leg, the second and third in the same manner, around the abdomen, and thence up the other side of the ant to the head. A third ant approaches and joins in the friendly task, but soon abandons the field to the original cleanser. The attitude of the cleansed all this while is one of intense satisfaction, quite resembling that of a family dog when one is scratching the back of his neck. The insect stretches out her limbs, and as her friend takes them successively into hand, yields them, limp and supple, to her manipulation; she rolls gently over upon her side, even quite over upon her back, and, with all her limbs relaxed, presents a perfect picture of muscular surrender and ease. The pleasure which the creature takes in being thus " combed " and " sponged " is really enjoyable to the observer. He had seen an ant kneel down before another, and thrust forward the head, drooping quite under the face, and lie there motionless, thus expressing as plainly as sign-language could her desire to be cleansed. He understood the gesture, and so did the supplicated ant, for she at once went to work.

The ants engaged in cleansing their own bodies have various modes of operating. The fore-legs are drawn between the mandibles, and, as far as could be ascertained, also through or along the lips, and then are passed alternately back of the head, over and down the fore-head and face by a motion which closely resembles that of a cat when cleansing with her paw the corresponding part of her head. Some-times but one side of the head is cleansed, in which case the foot used is drawn through the mandibles or across the teeth of one mandible after every two or three strokes upon the face. These strokes are always made downward, following thus the direction of the hairs. The hairs upon the tibia and the tarsus seem to serve the purpose of a brush or comb, and he had thought that the object in drawing the leg through the teeth or between the mandibles is to straighten up the hairs, and thus increase their efficiency for service. Not only the fore pair, but also the other legs, are passed, as above described, through the mouth. The second and third pairs are also and oftener cleansed by the fore-legs, as follows : The ant throws herself over upon her side, draws up the middle and hind legs, which are interlocked at the tarsi, and then, clasping them with one fore-leg, presses the other downward along the other two. The fore-legs alternate in this motion. When the legs of one side are cleansed, the ant reverses her position, and repeats the process. When the antennæ are cleansed, they appear to be taken between the curved spur at the extremity of the tibia and the tibia itself, as one would clasp an object between the base of the thumb and the hand, and are drawn toward the lip of the flagellum, evidently with some pressure. He had thought that he could notice this spur also used as a brush or scraper, in the general application of the fore-leg to the body. It seems to have an articulation at its junction with the tibia. Evidently moisture is conveyed from the mouth and rubbed upon the abdomen, as evidenced by the glossy appearance, which showed the presence of moisture upon the surface.

The amount of time devoted to these toilet duties is very great

with imprisoned ants, but is probably not so great in a state of nature. No doubt, with ants, as with men, an artificial condition of society gives an inducement to a larger devotion to personal appearance. Invariably at night, when the gas-lamp is lit and placed near the glass formicaries, the heat and light, both of which appear to be grateful to them, tempt them out, and they begin operations. So also after eating and when awaking from sleep. In short, whenever they are in a particularly comfortable state, they express their satisfaction by making their toilet.

Malformation in an Insect.[*]—Dr. H. Dewitz describes a larva of *Atta insularis*, in which the last leg on the left side, instead of lying beneath the larval cuticle like the other five, projected through a hole in the cuticle, its last four joints being exposed. The aperture through which extrusion had taken place had been formed by the partial detachment of an ellipsoidal shred, which remained attached along the outer side of the aperture like a valve. Both this valve and the edge of the aperture were strongly chitinized.

Parasitic Insects.[†]—Dr. Gurlt gives a new list of vertebrates (76 mammals and 519 birds), on which various species of parasitic insects live; the name of each host being followed by those of its parasites.

Notes on Phryganeæ.[‡]—Fritz Müller, writing from Brazil, makes some remarks upon this group, first stating that he has found (rudimentary) persistent tracheal gills (as in *Pteronarcys*) in one species (? *Tetracentron*), while in another these gills were cast off at the assumption of the imago condition. The same imago had on the anterior edge of the third to the sixth rings of the abdomen peculiar processes, which were absent from the remaining somites; on the end of the fifth ring there were also two dark chitinous plates. All these structures, quite useless to the adult insect, are the persistent remains of tooth-like plates, so strongly developed in corresponding positions in the larva, and assisting it in creeping in and out of its tube. The insect in question, therefore, affords an example of two kinds of rudimentary organs; first, organs inherited from an adult ancestor to whom they were of use; and secondly, organs having reference only to the larval condition, and subsequently transmitted to the adult.

The pupa of a species of *Rhyacophila*, the larva of which lives amongst the branches of *Podostema*, has well-developed claws terminating the first and second legs. These are useful to the insect as it creeps through the tangled branches of the plant.

According to the characters of the pupæ, the *Trichoptera* may be divided into two groups : in one (*Rhyacophilidæ* and *Hydroptilidæ*), the larvæ are quiescent in closed webs ; in the other (*Leptoceridæ, Sericostomidæ, Hydropsychidæ, Limnophilidæ,* and *Phryganidæ*), the webs or cases have an opening at each end, through which a stream of water, due to the movements of the pupa, is constantly passing.

* 'Zool. Anzeiger,' ii. (1879) p. 134.
† 'Arch. f. Naturg.,' xliv. (1878) p. 162.
‡ 'Zool. Anzeiger,' ii. (1879) p. 283.

Habits and Intelligence of Vespa maculata.*—This hornet is, according to Mr. Meehan, gifted with great intelligence; on one occasion he observed one with a summer locust several times its own size, endeavouring to rise with it from the ground, but failed from the great weight of the locust. It then walked with its prey about thirty feet to a tall maple, which it ascended to the top, and then flew off with its burden in a horizontal direction. There was more than instinct in this act. There was reasoning on certain facts and judgment accordingly.

Observations on Peripatus.†—Mr. F. M. Balfour, of Cambridge, has lately made some observations on this animal, the discovery of whose tracheal system is, as he justly points out, "one of the most interesting results obtained by the naturalists of the 'Challenger.'"

Describing the segmental organs which, though noticed by Grube and by Saenger, are not mentioned by Mr. Moseley, he states that he has found them in all segments of the body, except the first two or three post-oral; placed at the bases of the feet, each organ, when fully developed, consists of (1) a dilated vesicle opening externally at the base of a foot, (2) a coiled glandular portion, and (3) a short terminal portion, which, as he believes, opens into the body cavity; they are further stated to resemble more nearly those of the leech than those of any other form with which the author is acquainted. The œsophageal commissures are shown to form what must be regarded as subœsophageal ganglia, which give off large nerves to the oral papillæ; on their ventral side the ventral nerve cords are covered by a thick ganglionic layer, and at each pair of feet dilate into a distinct ganglionic swelling; from each of these there is given off a pair of large nerves to the feet, and the swellings of the two nerve cords are connected by a pair of commissures containing ganglion cells. This observation is of great interest and importance, inasmuch as it has been hitherto stated that there were no ganglia in the ventral commissures of *Peripatus*; in other points also, as for instance in the fact that the nervous system lies between the circular and longitudinal muscles of the body, and is not "in proximity with the skin," there are signs of the organization of the nervous system being of a high character.

Mr. Balfour also states that he believes that he has evidence of a paired sympathetic system. The organ which, with some doubt, was regarded by Moseley as a fat-body, is now shown to be a glandular tube, which opens into the mouth; not the same as the slime-glands, it "may perhaps be best compared with the simple salivary gland of *Julus*," and if it be homologous with this structure, its presence is of interest as showing that in *Peripatus*, as in the *Tracheata*, there are true salivary glands.

Basilica Spider and her Snare.‡—The Rev. H. C. McCook, in an interesting paper, describes the snare of a spider which he observed

in Texas, and which has been named *Epeira basilica*, " her architecture having suggested the dome-bearing temples of the earlier Christians of the Eastern Church."

The snare was hung about two feet from the ground, upon a bush which stood in the midst of a grove of young live-oaks, and had the composite structure imperfectly represented in the figure.   The general
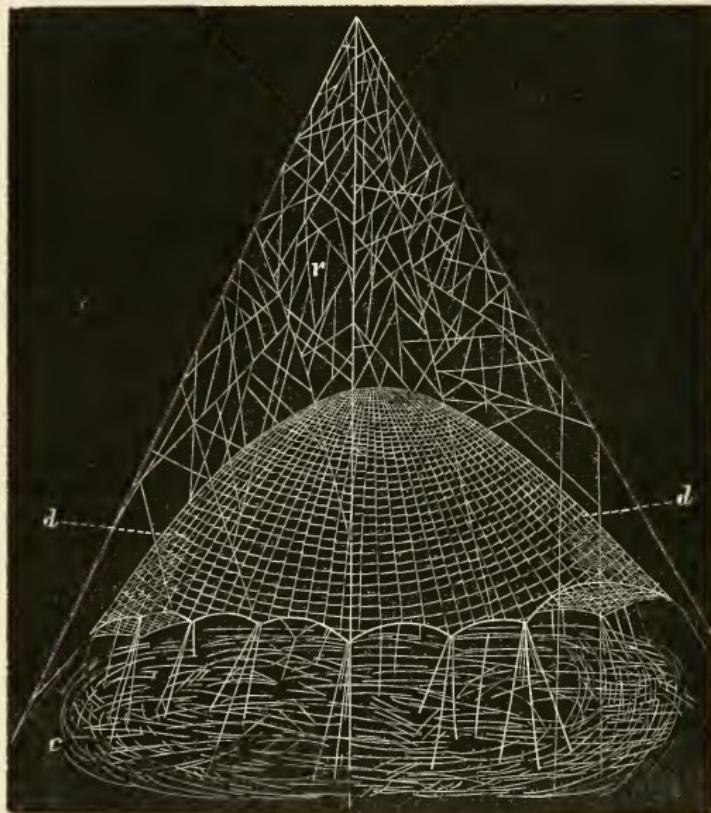
Snare of *Epeira basilica*.   *d*, dome ; *c*, curtain beneath ; *r*, retitelarian snare.

form of the snare was that of a pyramid, the upper part of which, *r*, was a mass of right lines knotted and looped, and crossing in all directions. Within this mass was suspended an open silken dome *d*, constructed of a vast number of radii, crossed at regular intervals by concentrics after the manner of the snare of the common orb-weaving garden spider. The radii were about one-sixteenth of an inch apart at the bottom or circumference of the dome.   The concentrics extended entirely and with equal regularity to the summit.   They did not cross the radii in circular lines, but presented that notched appearance which is observed in the webs of some orb weavers, particularly those whose snares are horizontal, as, for example, Hentz's *Epeira hortorum*.   The meshes formed by the radii and spirals had thus much the shape of the

meshes in a fisherman's net. The diameter of the dome was from seven to eight inches at the base, the height nearly the same. It was suspended in the midst of the mass of right lines by silken guys of like character, which thoroughly steadied the delicate structure, and perfectly preserved its form. Beneath the dome, from two to three inches removed, was a light sheet of cobweb *c*, irregularly meshed, of waving and straight lines. It had a decided convexity upward, and was supported, like the dome above it, and of which it seemed to be a protecting curtain, by silken threads or guys, so stretched as exactly to meet this purpose.

This spider seems to form a perfect link between the orb-weaving and the line-weaving spiders in the characteristic spinning work of the two groups, and the main object of the paper, which is illustrated by nine woodcuts, is to exhibit this fact.

Aeronautic Flight of Spiders.*—In 1877 the Rev. H. C. McCook published† some observations on the ballooning habits of spiders, which he now supplements by several important items, and which he considers make quite complete the mode of ballooning, at least among the citigrade, and perhaps also the saltigrade spiders.

The whole process may be briefly given as follows :—1. The spider seeks a high position, as the top of a fence post, as the point of ascent; 2. The abdomen is elevated to as nearly a right angle with the cephalothorax as may be; 3. A *pencil of threads* is emitted from the spinnerets, the face being meanwhile turned to various points until it looks in the direction of the wind; 4. The legs are stretched upward, thus raising the body aloft; 5. They gradually incline in the direction of the breeze, the joints straighten out, the legs sink forward and down till the first pair are almost on a level with the post, the whole attitude of the animal being that of one resisting some force exerted from above; 6. Suddenly and simultaneously the eight claws are unloosed, and the spider mounts with a sharp bound, apparently, 7, and floats off with the back downward generally, but sometimes with this position reversed; 8. At first the abdomen seems to be in advance, but generally the body is turned so that the head rides in front; 9. The pencil of threads is caught apparently by the feet, and floats out in front, upon which, 10, sometimes the spider will climb upward, as though to adjust the centre of gravity; 11. Meanwhile a thread or pencil of rays issues from the spinnerets, which floats out behind, leaving the spider to ride in the angle of the two pencils, or 12, as it sometimes happens of three which diverge widely at the upper free ends; 13. The feet seem to be united by delicate filaments, which would serve to increase the buoyancy of the balloon; 14. The spider is now carried forward by the wind, riding for long distances in an open space, and often borne high upwards upon ascending currents; 15. Its anchorage appears at times to be in its own volition, by drawing in with the claws the forward pencil, and gathering it in a white roll within the mandibles, but 16, most frequently the balloonist is stopped by striking against some elevated object, or by the subsi-

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* 'Proc. Acad. Nat. Sci. Phila.,' 1878, p. 337.   † Ibid., 1877, p. 308.

dence of the breeze; 17. A bright warm day in October is commonly chosen for the ascent; and 18. Judging from the presence of a number of dry moults upon many posts, apparently of the same species of spider observed in flight, the animals had recently cast their skins. Of the above points, Nos. 3, 7, 9, 10, 11 in part, 12, 14 in part, 15 in part, and 18 are those which were determined by the last observation.

The object of this interesting habit seems to be the distribution of species.

New and other Pycnogonida.*—Dr. Böhm has a technical paper on the *Pycnogonida* of the Royal Zoological Museum at Berlin, and on the forms found by the corvette ' Gazelle.'

The following new forms are described :—*Nymphon phasmatodes* from the Cape of Good Hope; *N. horridum* from Kerguelen; *Pallene lappa* from the Mozambique, where it was found on *Ophiocoma erinaceus; Phoxichilidium digitatum* from Singapore; *Pycnogonum chelatum* (habitat unknown); and the new genus *Corniger (Achelidæ),* which is remarkable for having the antennary jaws composed of one segment, whereas in *Achelia* there are two, and in *Zetes* three segments. A beautiful series can now be made out; in the *Nymphonidæ* these organs have three joints and are scissor-shaped, in the *Achelidæ* they are simple, but may consist of one, two, or three joints, and in the *Pycnogonidæ* they are absent. The species of this genus is named *Hilgendorfi,* and was obtained from Enosima, Japan. It is also pointed out that the accessory ova-bearing appendages of *Nymphon* have eleven, and not, as Semper says, nine joints, and that the species obtained from Kerguelen is not the same as the *N. gracilipes* Heller of the Northern seas, and it is therefore called *Helleri.* The characters of the genus *Pallene* are reconsidered, and the new species are figured, with some already known, in two plates. The paper is of value to those who are interested in the study of these curious but difficult Pseudarachnoid forms.

Form of the Muscular Contraction in the Crayfish.†—M. Richet is rightly of opinion that it is of interest to compare the phenomena observed in this crustacean with what has been seen in the frog; he shows that all the caudal muscles have a short period of contraction; that of the pincers is much longer than that of any muscle in the frog, save only the cardiac; it lasts nearly ten times as long as that of the tail-muscle; the "time lost" when the muscle is excited through the agency of the ganglionic chain is very great, amounting as it does to 2·5 hundredths of a second; the tail-muscles soon lose their contractility after repeated shocks, and it is pointed out that this is quite in accordance with the habits of the animal, which never swims for a long period at one time; the muscles of the pincer behave very differently, and this too is what we should expect from the holding power of the animal; finally, this organ, under appropriate conditions, retains its power of contractility four days after separation from the body.

* ' MB. K. Akad. wiss. Berlin,' 1879, p. 170.
† ' Comptes Rendus,' lxxxviii. (1879) p. 868.

Amphion and Polycheles (Willemoesia).*—J. E. V. Boas, of Copenhagen, gives an account of the relations between these two genera, and is of opinion that " probably — or at least, not improbably "—*Amphion* is the larva of *Polycheles.* The structure of *Amphion* shows its affinity to the *Phyllosomidæ*, and proves it not to be a shrimp-larva ; and by comparing it with other forms, the author comes to the conclusion on anatomical grounds that it must be referred to the macrurous genus *Polycheles*, one of the *Astacidæ.*

The paper opens with an announcement of the classification of *Decapoda* adopted in the author's forthcoming work on that group. He proposes to take the bold step of separating the *Carididæ* (Garneelen) from the *Macrura*, and making of them a primary subdivision of decapods which he calls *Natantia*: the remaining *Macrura* being united with the *Brachyura* and *Anomura* as a second subdivision, the *Reptantia.*

Life-history of the Bopyridæ.†—Dr. Fraisse gives an account of the life-history of *Entoniscus Cavolinii* n. sp., and of the *Bopyridæ* in general, in which there are ordinarily two larval stages, *Entoniscus* being the sole exception, and that, perhaps, because the second phase has not yet been observed; in the second stage he finds that (1) the form of the body is cylindrical, and somewhat flattened on the ventral surface ; (2) the outer antennæ are composed of a large number of joints, and are much longer than the inner ones, which have three joints and are provided with olfactory filaments ; (3) the eyes are completely developed ; (4) the heart, situated posteriorly, may be easily observed to be beating ; (5) the movements of the animal are very lively. *Cryptoniscus* differs from *Bopyrus, Gyge*, &c., in having at this stage the sexes separate, a very penetrating smell, and a flask-shaped diverticulum to the rectum ; while the seven thoracic segments are not equally developed, and in *Cryptoniscus curvatus* the last two are atrophied.

The paper, which ends by a bibliographical list of more than fifty papers or books on the subject of the *Bopyridæ*, contains an interesting list of the hosts of *Cryptoniscus ;* of the twelve species of which it deals, five are parasitic on the *Cirripedia* (one on the *Pedunculata ;* four on the *Operculata*), and seven on the *Rhizocephala* (four on *Peltogaster*, and three on *Sacculina*). The author's observations, which are illustrated by twenty-seven figures in two plates, were based on specimens obtained chiefly at Naples.

Vermes.

Development of the Annelides.‡—Dr. Hatschek describes in some detail the development of *Criodrilus* and *Polygordius ;* these observations lead to some interesting observations and speculations on the morphology of the *Bilateria.*

Criodrilus.—The eggs of this form were found in cocoons of a size (5 cm. long) much beyond that of most *Oligochæta*, on the banks

* ' Zool. Anzeiger,' ii. (1879) p. 256.
† ' Arb. Zool.-Zoot. Inst. Würzburg,' iv. (1878) p. 382.
‡ ' Arb. Zool. Inst. Univ. Wien,' iii. (1878) p. 1 (277).

of the Danube; the earlier stages appeared to be very similar to those of *Lumbricus*; the mesoderm is first represented by two large cells, which persist for a long time, and the ectoderm by three large cells, which occupy the anterior end, the dorsal surface, and the sides of the embryo; the two mesodermal cells grow out into a row of cells on either side, for which the term of "mesodermal stripes" is now proposed; the old term "germ-stripe" has been used for so many different sets of organs that a more accurate terminology seems indeed to be justifiable, and for it the name "embryonic stripe" (or streak) is now proposed. In the process of histological differentiation the cells of the ectoderm become more clear, but the three large cells, already spoken of, remained filled with dark, coarse granules; albumen is rapidly ingested, and as a consequence the cells of the ectoderm and of the mesodermal stripes increase greatly in number; of the latter two rows appear shortly after the development of the œsophagus, and the two primitive cells become more separated from one another. It is in the same layer that segmentation is first seen, and in it only; this process begins in the most anterior region, and is soon followed by the development of the different organs; still the two primitive cells go on dividing, and so adding to the mesodermal stripes. Co-temporaneously with this the cephalic region, which is characterized by the presence of a ciliated groove, which persists till development is all but complete, develops a cavity, which is at once distinguished from the cœlom or body-cavity by its origin from the separation of the ectoderm and endoderm, and not by the cleavage of the mesoderm; it is also single, and not double; the mouth, with its gullet, and the supra-œsophageal ganglia become developed, and this nervous region gradually separates from the ectoderm, although it for a long time remains connected with it in its most anterior portion.

The primitive segments are formed by the separation of parts of the mesodermal stripes, which form small multicellular and quadrangular plates; a single layer of cells from them forms the enteric fibrous layer, the most anterior and the most posterior layer form the dissepiments of the now developing cœlom, and the outer portion becomes converted into the rudiments of the segmental organs and of the setæ; the former set of organs commences with one large cell in each segment, which is connected with a row of smaller cells, which extend into the next segment; these all become differentiated into three parts, the two terminal straight, and the middle one looped; while the whole apparatus leaves the ectoderm to take a deeper position in the body. These segmental organs are found in all but the first trunk-segment, but even in this Dr. Hatschek has observed a collection of cells which disappear later on, but which would seem to be similar in character. The more final stages of this form are not described, as they differ in no important points from what is already known to be the course of development in *Lumbricus*.

Polygordius.—With regard to this somewhat enigmatic creature, it is interesting to be reminded of Schneider's discovery of the fact that the so-called "Lovenian larva," first described by Professor Loven in 1842, and since examined by Professor Alexander Agassiz, is without

doubt the larva of *Polygordius;* of the six stages into which the author divides the history of this form the first, or that prior to segmentation, is the most interesting. Small and transparent, the larva is more broad than long, and is divided into two parts by two parallel circlets of cilia in the middle line; the mouth is placed between these and the anus, which is found at the inferior pole of the body: superiorly there are two eye-spots; the cuticle is, for the most part thin, and in the region of the trunk forms a layer of cubical cells; the region of the anterior circlet is invested by a thick cuticle, which is traversed by pore-canals for the long cilia, which seem to be nourished from a mass of cells set anteriorly, and containing fatty and albuminous granules: the cuticle of the cells of the posterior circlet is but slightly thickened, but the same pore-canals are again to be observed. The pigment spots are dark brown, and the region with which they are connected will form in time the supra-œsophageal ganglia; connected with this, on each side, are three nerves, one of which is much larger than the others, and all of which go to form the peripheral nervous system. As in *Criodrilus*, the primitive segments are first developed in the mesodermal stripes, and as, not only in it, but in *Unio* among Lamellibranchs, and in *Pedicellina* among the Bryozoa, there are, for a long time, two distinct primitive mesodermal cells at the posterior end of these stripes. A number of muscular fibres are early developed in the head, as is also a delicate ciliated canal on either side, which forms the head-kidney, and gives rise in the future to the "segmental organs" of the trunk. This canal communicates with the body-cavity by the funnel-shaped orifice so characteristic of this organ.

As to the enteric canal, we have to observe that, as so often happens, it is the mid-gut only that is developed from the endoderm; there is a diaphragmatic elevation in the lumen of the fore-gut which is provided on the side most remote from the mouth with long cilia, which appear to be able to act as a kind of sieve; the hind-gut has muscular fibres connected with its walls, which are apparently of assistance in the special function of this part.

The succeeding stages are characterized (2) by the appearance of the primitive segments of the trunk, the further development of the mesoderm, and of the posterior circlet of cilia; (3) the greater elongation of the larva and the differentiation of the ventral cord and antennæ, as well as of a ciliated pit on either side of the head, which seems to represent the future olfactory organ. (4) In this stage the walls of the enteric canal become strengthened by the apposition of the proper division of the mesoderm, and the posterior circlet of cilia becomes greatly developed. (5) The cuticle of the trunk becomes thicker, and the region of the head becomes much more like what it will be in the adult, while its circlets of cilia begin to disappear. (6) Two distinct regions are apparent in the head, the tentacles project on either side, the walls of the mid-gut are considerably thickened, and there is still a mass of rounded indifferent cells, which appear to be the rudiments of the generative products.

As to the systematic position of *Polygordius*, Dr. Hatschek agrees with Uljanin in regarding it as belonging to the Annelides, although

it exhibits many points in adult structure, which are merely embryonic in other forms; thus segmentation never affects any other than the mesodermal structures, the central nervous system is never placed otherwise than just below the ectoderm, the supra-œsophageal ganglion retains its early (anterior) position, and the ventral cord does not develop ganglionic enlargements. Connecting this form with the higher Chætopoda is the interesting *Saccocirrus*, which may be taken as the type of the Archi-chætopodes, just as *Polygordius* may represent the Archi-annelides; regarding the Hirudinea and Gephyrea as belonging to the same series, we get an arrangement of this kind:—

Annelides.

1st order. *Polygordiidæ.*

        2nd order. *Chætopoda.*

             1st suborder. *Saccocirridæ.*

             2nd ,, *Polychæta.*

4th order. *Gephyrea.*   3rd ,, *Oligochæta.*

        3rd order. *Hirudinea.*

The head of the annelid is regarded, in opposition to Professor Semper, as consisting of a single segment, which is characterized by the possession of an œsophagus and of a supra-œsophageal ganglion, and in having a cavity derived from the primitive cœlom, while there are never, as there are ideally in all the rest, generative organs. Whether the annelid is a colony of segments with an anterior sterile individual (the head), or whether it consists of a head and trunk, which latter undergoes a process of gemmation, must still remain a moot question; but it is not, in any case, to be compared with the Cestoid Worms, which differ altogether in having the *youngest segments nearest the head.*

The name *trochophore* is proposed for the larva of *Polygordius.* This is, from any point of view, a very instructive form. Found adult in the Rotatoria, it is continually met with in the developmental history both of the Annelides and of the Mollusca; its oral circlet of cilia consists of a double-rowed pre-oral portion, a single-rowed post-oral circlet, and a ciliated groove separating the two. The frontal nervous plate, which is the rudiment of the supra-œsophageal ganglion, appears very early; it has been recognized in the Rotatoria and the Mollusca, and the primary tentacles which become connected with it appear to be homologous with the "tentacles" of the last-named group. Difficulties presented by the characters of the so-called segmental organs are dealt with in a very ingenious manner; while as to the generative organs, it is suggested that in the Rotatoria they have disappeared on one side. Having in mind all these similarities, Dr. Hatschek proceeds to suggest the existence of a common ancestor for the Rotatoria, Annelides, and Mollusca, for which he proposes the name of *Trochozoon.*

The *Bilateria* are those animals in which there are three distinct layers, and in which the genital products are derived from the mesoderm. To deal with the different groups:—

Echinodermata.—The larvæ of these forms have no excretory organs and no frontal plate, while the vaso-peritoneal organs are formed from the endoderm, and the adult is of a radiate form. As these animals

were undoubtedly fixed in the earlier periods of their time-history, this radiate character is, in them, just as in certain fixed Annelids or the fixed Tunicate (*Octacnemus*) described by Mr. Moseley, probably due to their mode of life. The views of Haeckel as to the colonial character of these forms, and of Alex. Agassiz with regard to their affinities to the Ctenophora, are rejected : the Gasterotricha and the Nematodes (*Vermes archicœlomati*), the Platodes (by degeneration *V. acœlomati*) as well as the Nemertini and the Bryozoa are regarded as close allies of *Trochozoon ;* while as to the Brachiopoda, which are regarded as Molluscoidea, and as to the Mollusca proper there appears to be sufficient evidence of their rightful position in a similar category ; the Nemertinea are, in the adult stages, difficult forms, but the *Pilidium* larva is sufficiently indicative of their phylogeny.

The adult Annelides are characterized by the development of the dermo-muscular tube, the formation of the secondary cœlom in the trunk, and the appearance of the ventral ganglionic cord, after the development of the supra-œsophageal ganglia ; with these the Arthropoda are regarded as undoubtedly connected, while the absence of any Trochozoon-like larva is explained by the characters of the *Nauplius*, in which the presence of chitin in the cuticle and of the characteristic locomotor appendages are sufficient reasons for the absence of cilia.

Dr. Hatschek has no doubt as to the correctness of the views of Anton Dohrn as to the degraded character of the Tunicata of the present day, and as to their direct relations to the Vertebrata on the one hand, and the unsegmented Worms on the other. As to the Annelides and Vertebrata there are ample indications of their affinity ; neither the dorsal region nor the mouth are homologous, but in the rudiments of their nervous apparatus, of their circulatory system, of their renal organs, and of the disposition of the muscular tracts there is ample evidence ; the sensory organs are arranged on the same plan, and the only point of difference in their renal organs is the retention by the Vertebrata of the unsegmented excretory canal. The two groups are regarded, finally, as having had a common ancestor, less differentiated than *Polygordius*, from which the Vertebrata have most strikingly diverged by the development of a *chorda dorsalis* of endodermal origin, and by the formation of a new mouth and of branchial clefts, coupled with the loss of the primary œsophagus.

Anatomy of Magelona.*—Dr. W. C. McIntosh's paper on this subject (published in abstract by the Royal Society) finds a home in a German journal.

The animal in question, long since known to Johnston, but only described by name (*Mœa mirabilis*) in the British Museum Catalogue of Worms (1865), was made known to science by Fritz Müller in 1858. Found in large quantities at St. Andrews, it has also been found at Southport ; from 150–200 mm. long, it is of a pale rose colour anteriorly, and of dark greyish-green posteriorly ; the cephalic lobes are eyeless, considerably flattened, and diminish towards the

* 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 401.

margin. On either side of the head there is a long tentacle, provided on its anterior surface with cylindrical papillæ. The segments of the body are numerous, and gradually decrease in size as they proceed backwards; terminally there is a broad papilla with a style-shaped appendage on either side and bounding the anus. The body may be divided into two distinct regions; the anterior one is provided with nine double pairs of bundles of setæ, and in this point presents some resemblance to *Heterospio longissima*, described by Ehlers. The setæ of the ninth segment are remarkable for the characters of their tips, and seem to be homologous to those that are found on the third segment of *Disoma*, the fourth of the Chætopteridæ, and the fifth of *Polydora*; the segments behind the ninth are severally provided with two rows of setæ on either side; as to their position on the segments, it is to be noted that those in the anterior portion are found towards the most anterior edge of each segment; but those of the ninth have a more extensive origin; and behind it the setæ gradually pass from the anterior towards the posterior edge of each segment.

As to the integument, we have to note its high degree of development in the cephalic and anterior regions, which appears to be correlated with the large amount of friction to which the animal is subjected in moving through the sand; and in connection with this observation it is interesting to observe that Claparède had noted the delicacy of the integument in sessile annelids. The hypodermis is exceedingly well developed. The lateral lamellæ consist typically of a delicate cuticular layer investing the hypodermis; at their base there is a bundle of simple setæ, but no vessel has been observed to pass to them. In the anterior region the dorsal lamellæ are larger and more transparent than the ventral.

In structure the hypodermis is very similar to the integument of the Nemertinea; it consists of a number of flask-shaped cells or glands, the contents of which have the form of clear and of granular spheres; in the region of the cephalic lobes especially it is possible to observe a number of rod-cells, which form a transverse band across the body, behind each row of hook-like setæ; these are also well developed in the caudal region. In the tentacles there are a number of small, but distinctly granulated hypodermal cells.

The muscular system of the cephalic end of the worm consists of a median and of a lateral pair of longitudinal muscles; the lateral muscles are connected by a chitinous portion, which gives off a thin lamella on either side; the function of this portion is evidently connected with the habitat of the animal; it replaces a circular muscle, and supports the vessels; while the completeness of the arrangement is spoken to by its connection with the base of the tentacles. In the space on either side of the mouth there is a series of vertical muscular fibres, which have a dorsal origin, and are inserted into the superior margin of the mucous membrane of the mouth, for which tissue they appear to serve as retractors. The muscles to the setæ are, as a rule, feebly developed, but are very similar to those of allied forms. It is impossible for us to follow the author through all his details, but it may be of interest to point out

that the muscular system of this animal is evidently capable of enabling it to pass through the damp sand with great rapidity, as well as to circle through the water with great ease.

The mouth is triangular or T-shaped in form; the upper lip is not, as is the lower one, cleft; both are in life capable of great power of movement; the intestinal tract appears to be somewhat complicated, as is also its appendage, the proboscis; with regard to which it is pointed out that its structure is such as to enable it to bore unceasingly into the sand, and so to make a passage for the more delicate hinder parts of the body; it is of a pale reddish colour. The anterior region of the enteric canal is well provided with muscles, and is very firm, thanks especially to the chitinous investment of its glandular layer; it has a close homology to the œsophageal region of the Nemertinea, which it strikingly resembles in the possession of a *rete mirabile;* the cilia of the other form are here replaced by chitin; a further point of resemblance is to be found in its retention of irritability long after death. *Magelona* is shown to subsist on the cast chitin of Crustacea, on Foraminifera, and so on, while the ingestion of sand appears to be a necessity of its existence. The blood is richly supplied with blood-corpuscles of a pale red colour; in 1852, Dr. T. Williams stated that there was no species of annelid in which the true blood contained morphotic elements; but this statement, which is now shown not to hold for *Magelona,* and has been lately shown to be untrue of the earthworm, is also untrue of *Terebella* (R. Wagner), *Glycera, Phoronis,* and *Syllidia armata* (Quatrefages), and of some *Staurocephalida, Cirratulida,* and *Opheliida* (Claparède).*

The cœlom is very indistinct in the anterior region, and in it no perivisceral corpuscles were to be observed; behind the ninth segment it widens out, and has, in section, a circular form; it is divided by a median ligament, and its contained clear fluid is provided with corpuscles, which are not very numerous, and vary a good deal in form. The central nervous system is situated in the hypodermis, and the nerve-trunks run in a very distinct neural canal. The tentacles are completely devoid of cilia, but the vas efferens has a remarkable contractility, so that it takes the place of the cilia in respiration. Having made some remarks on the generative organs, the author concludes that *Magelona* has several points of affinity to *Prionospio* and *Heterospio,* and others to *Spiochætopterus;* the structural arrangements of the proboscis, cephalic lobes, and circulatory organs are *sui generis.*

Arrangement of the Nerve Cords in the Annelides.†—The arrangement of the nerve cords varies so greatly in the Annelides, and a knowledge of the subject is so important from many points of view, that it seems well to give a separate note on this subject, the basis for which is to be found in Dr. McIntosh's paper on *Magelona.*

(1) In some, the trunks lie internally to the muscles, or in a ventral cleft between them; the transverse band between the ventral muscles and the hypodermis lies externally to them; among others

* The account of the circulatory system reappears in the 'Journ. Anat. and Phys.' (Humphry) for April, 1879.

† *Loc. cit.*

this arrangement is found in the Euphrosynida Amphinomida, Aphro-
ditida, Polynoida, Phyllodocida, Syllida, Nereida, Eunicida, Chlor-
hæminida, and Amphictenida.

(2) The nerve trunks are placed externally to the muscular layer
and in the hypodermis; the oblique muscles taking their origin from
a transverse band set superiorly or laterally to them, as in the Siga-
lionida, Hesionida, Ariciida, Chætopterida, Spionida, Cirratulida, Am-
pharetida and Terebellida.

(3) The trunks are embraced by the closely approximated ventral
or other longitudinal muscles; as in the Glycerida and Telethusida.

(4) In the substance of the ventral longitudinal muscles, as in the
Hermellida.

(5) Beneath the ventral long muscle, or at its margins, or inter-
nally to the circular layer, as in some Sabellida and Serpulida.

In some families there are neural canals, which are largest in the
Spionida, and are best seen in *Magelona*.

Gills of Serpula.[*]—Dr. L. Löwe, of Berlin, deals with the struc-
ture of these organs, and enters into the question of the relations of the
Annelides to the Vertebrata; his observations are based on the form
known as *Spirorbis*, which differs from *Spirographis*, already examined
by Kölliker and Claparède, in the absence of the cartilaginous gill-
skeleton.

About thirty branchial filaments spring from a branchial lobe
on either side of the mouth; each of these has the form of an
elongated cone, in which it is possible to distinguish a shaft and a
vane; the former, which decreases in size towards its apex, consists
of (1) an external cuticle, (2) a closely applied cellular layer, (3) a
vascular layer, and (4) a cuticle; the vane is made up of a central
part, which is the continuation of a vascular layer, and of a marginal
portion, which consists of a cuticle and a chitinogenous epithelium;
all these structures are described from a histological standpoint, and
the changes which the gill undergoes during growth pointed out; the
concluding portion of the paper is occupied by an extremely ingenious
comparison of the gill-apparatus of these forms with the branchial
clefts of the Vertebrata.

Two observers, working independently, have lately shown that
the Eustachian tube and the tympanic cavity are primarily formed
by a diverticulum of the oral cavity, while the external auditory
meatus is formed by such part of the first gill-cleft as is not
obliterated; Dr. Löwe has confirmed the essential points of these
observations, and gives a figure of an embryo of the sheep in
support of them; this displays the following points; from the oral
cavity there is given off outwards and backwards a long narrow cleft,
which is the rudiment of the Eustachian tube; this at its outer end
widens out and forms the tympanic cavity; there comes to meet this
an invagination of the epidermis which forms the external meatus,
while between these two processes there is a region in which appear
the auditory ossicles and the tympanic membrane.   Turning now to

* 'Zeitschr. wiss. Zool.,' xxxii. (1878) p. 158.

Spirorbis, we see that of the depressions derived from the lumen of the enteric tube the one which is placed most dorsally is the longest and deepest, or, in other words, has just the same relations to the other depressions as has that one in the sheep which goes to form the Eustachian tube; of the clefts between the branchial filaments the longest one is found between the first and second, and it appears to have just the same relations as the branchial cleft in the mammal. We have not space to follow out the descriptions of the relations of the nasal organ and of the other clefts in *Spirorbis*, or that of the palatal portions of the upper jaw and the connecting pieces of connective tissue found in the oral region of the worm, but we would observe that with regard to that most vexed of questions—the relations of the nervous system of Annelids and Vertebrates—the observations of Dr. Löwe point to the absence in the Annelid of anything homologous to the dorsal medulla of the Vertebrata; these views, though now held by various morphologists, do not, as is pointed out, agree with the speculations of Kowalewsky, who looks upon the whole of the supra-chordal nervous system of the Vertebrata as homologous with the whole nervous system of the Annelides; or of Semper, who identifies the ventral medulla of the latter as the dorsal medulla and brain of Vertebrates; or of Dohrn, who looks upon the whole brain of the Vertebrates as homologous with the cephalic ganglion of the Annelides.

New Annelids from the Philippines.*—Professor Grube has communicated to the Academy of Sciences at St. Petersburg a memoir on the forms collected by Semper in his voyage; four new genera and 142 new species are described by the learned zoologist, who points out that the Alciopidæ, Nephthydæ, Ariciadæ, and Cirratulida are altogether unrepresented in the collection, and that the genera to which the new species are assigned have, in many cases, been hitherto represented by one or two species only. The value of this paper, which extends to 300 pages (illustrated by 15 plates) is enhanced by the diagnoses of the families under which they are grouped, so that so far this essay may be regarded as a revision of some families of the Annelides.

Trichinosis in a young Hippopotamus.†—M. E. Heckel describes some observations made by him upon a young hippopotamus, about two years old, which died on the 10th of May last in the Zoological Garden of Marseilles, having been received from Egypt about four months before. The animal was in bad health all the time of its residence at Marseilles, and its skin showed an eruption of confluent boils. When removed, the skin showed several lesions in the shape of deep ulcerations, which, having originated around a hair, had attacked the bulb, and thus formed a canal leading generally into a great purulent cavity. Smaller ulcerations led into smaller cavities, bounded by a proper membrane like true cysts, and filled with creamy pus. The examination of a section of the muscular tissue surrounding

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* 'Mém. Acad. Imp. Sci. St. Petersbourg,' xxv. (1878).
† 'Comptes Rendus,' lxxxviii. (1879) p. 1139; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 99.

one of these cysts, showed it to contain great numbers of *Trichina* cysts resembling those of *Trichina spiralis*, with which also the enclosed worm agreed. The cyst, however, seemed to be much more developed than in the pig or in man.

Upon this curious and interesting fact the author makes the following remarks:—" I am ignorant what relations may exist between the presence in the same animal of *Trichina* and of enormous cysts filled with pus; but the fact indicated by me appears to possess some interest .... because it seems to prove that the Pachyderms, more than other animals, are exposed to the spontaneous developement of this terrible parasite—an important point which may serve to throw some light upon its hitherto unknown migrations. It has been attempted to explain the frequency of the *Trichina* in the pig by the consideration of the voracity and filthy habits of that animal. The fact to which I now call attention seems to protest against this opinion, for the hippopotamus by no means shares in the mode of existence and the tastes of the pig, and we can hardly suppose that captivity, by the special diet which accompanies it, could have a marked influence upon the development of the Nematoid worm.

New Diseases of Hot-house Rubiaceæ.[*]—M. Max Cornu says, that a disease, hitherto unknown, devastated the hot-houses in France last February, attacking the roots and forming swellings on the small and even on the large roots.

Transverse sections of these swellings showed, under the Microscope, amidst the hypertrophied portions, cysts enclosing the eggs of *Anguillulæ* in great number; the Rubiaceæ (*Ixora* and *Hamiltonia*) attacked, lost most of their leaves, the rest being dried up. This malady presents great analogy with that described by M. Jobert,[†] which ravages the coffee plantations, a species of the same family in Brazil.

Adult individuals are very rare; and the eggs exist singly, and should be destroyed in this form.

These eggs are enclosed in cysts with rather thick walls opening on the outside. When hatched the *Anguillulæ* immediately issue and make their way towards the new roots; once established in the tissues they are safe.

It is worthy of remark that the encystment, the date of which seems coincident in the two species, is in France hibernal; in Brazil it would correspond with the dry season, and be æstival; the plants preserving in the hot-houses the seasons of their country.

Female Organs of Echinorhynchus.[‡]—Dr. Angelo Andres describes these structures in *E. gigas*, his short and very condensed paper being illustrated by a folding plate of remarkably clear figures. The complication of the organs renders it quite useless to attempt a description of these without drawings, especially as the real nature of many of the parts is by no means thoroughly understood.

* 'Comptes Rendus,' lxxxviii. (1879) p. 668.
† This Journal, ii. (1879) p. 168.
‡ 'Morph. Jahrb.,' iv. (1879) p. 584.

Jensen's Turbellarian Worms of Norway.—Marine zoologists will be interested in the appearance of this valuable work on the marine flat-worms of the Norwegian coast. A number of new forms are described in considerable detail, with excellent figures, while the descriptive portion is preceded by full anatomical details. The work is done in the careful, conscientious manner characteristic of Scandinavian zoologists. The descriptions are both in Latin and Norwegian, so that the work is accessible to students in general.

Reproductive Organs of the Marine Ectoparasitic Trematoda.[*]— It is impossible in an abstract to do full justice to M. Carl Vogt's careful descriptions of the generative apparatus of several of these forms, which he has lately been examining at Roscoff. A point of especial interest is the discovery of the characters of the orifice of the common reservoir or ootyp (Van Beneden). This opening has a well-marked contour, and is surrounded by short fibres, arranged radially, at the edge of which there were obscure indications of ciliary movements; but what was more remarkable was that, from time to time, the orifice effected movements which could only be compared to those of swallowing, and it is proposed therefore to call it the "swallowing orifice" (Schlucköffnung); its function is evidently to aid the germs in their passage through their duct. The writer says that he cannot describe his extreme astonishment when he first saw this orifice in action in Dactycotyle, where the yolk-spheres and ova were thrown about, just as a juggler plays with his balls.

As to the female organs in general, it may be observed that the germ-gland is in all cases simple; it may be spherical as in *Udonella* and others, or it may be elongated; the branched vitelline ducts do not vary much in character, and generally open directly into the ootyp; this latter organ is formed at the point where the ovarian germ, the masses of yolk, and the semen meet; in some it is saccular, and in others canalicular. The oviduct varies in length, and the uterus in capacity, in some cases being so small as to be only able to contain a single egg. The most important differences are to be found in the copulatory organs. In *Polystomum* and *Calicotyle* the parts are most highly differentiated, and there are two female copulatory orifices in addition to the opening into the uterus by which the mature ova are evacuated; in *Microcotyle, Udonella,* and others, this uterine orifice appears to serve also as the copulatory orifice; in *Diplectanum* there is a special copulatory duct, which is completely separated from the uterus and its orifice, and has a common aperture with the penial pouch.

The male organs exhibit greater variety. *Udonella* has a single rounded testis; in *Phyllonella* and *Epibdella* two testes lie on either side of the median line, while in *Dactycotyle* and *Diplectanum* and others there are a number of testicular tubes scattered in the parenchyma or collected together about the median line. As to the efferent ducts, they have, in *Phyllonella, Epibdella, Udonella,* and *Calicotyle,* no other connection with the female organs than what is afforded by the possession of a common orifice. In *Dactycotyle* a canal passes from

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[*] 'Zeitschr. wiss. Zool.,' xxx. Suppl. (1878) p. 306.

the seminal duct into the ootyp, and this has been observed by Vogt as filled with semen; in *Polystomum* Zeller has reported the presence of a duct connecting one of the testicular tubes with the ootyp; in *Microcotyle* the testicular bodies open directly into the ootyp. As to the appended structures, penis, penial glands, and so on, the variety is extreme. Great difficulties surround the explanation of the arrangements that obtain in *Diplectanum*, which M. Vogt hopes to be able to resolve on another visit to Roscoff.

This paper is reviewed in part iii. of M. Lacaze-Duthiers' 'Archives' for 1877, which was only published early *this* year.

Organization of Axine and Microcotyle.[*]—The specimens for Herr Lorenz's examination of these interesting Trematodes were chiefly obtained at the Zoological Station at Trieste.

Axine belones is a parasite of the fish *Belone esox*, on the gills of which it lives; first described by Abilgaard in 1794, it has since been observed by various zoologists, among whom are Van Beneden and Hesse, and in the opinion of Herr Lorenz the form described by them, *A. orphii*, is identical with Abilgaard's species. From four to eight mm. long, with an acute anterior, and a broad hinder end, it is of a milk-white colour, and almost transparent; but it is chiefly remarkable for its asymmetry; the right side is the longer and is convex, while the left is faintly concave; four groups of hooks or chitinous rods surround the anus; in the centre there are eight to twelve hooks, and on either side there are from twelve to twenty hook-shaped rods, while at the base of the cirrus there are from sixteen to twenty-four. The external integument is formed by a delicate cuticle, between which there is a thin layer of finely granular protoplasmic substance. Of muscular fibres there are two kinds; one longitudinal, and ending in fine filaments, and the other formed by a tissue of much more delicate fibrillæ, which run in three distinct bands. The seizing organs, which are not suckers, though they have their function, occupy the whole of the hinder edge of the body: the nerve-centre is apparently represented by a curved band, which lies in the parenchyma of the body above the œsophagus, and consists of yellowish-coloured fibrous and finely granular substance; the fine fibres given off from it are very soon lost in the parenchyma of the body. Anteriorly to the mouth there is a funnel-shaped cavity, with a right and left sucker; these latter are formed of a thick muscular integument, which is traversed by a number of closely set radial muscular fibres. The œsophagus forms a simple tube as far as the common generative orifice, where it divides into the two arms of the enteron, which soon take on a dendritic appearance, owing to the presence of short cæca. The two arms do not unite at their distal end; the enteron does not seem to have any special wall, but to be merely a cavity in the parenchyma of the body; it is, however, provided with a number of pigment cells, which are filled with small dark-brown granules. The *excretory vascular system* of *Axine* is very well developed, and has the form of two internally ciliated longitu-

dinal canals, which run parallel to and above the arms of the enteron; the primary trunks give off a large number of small canals, which extend into the parenchyma and seem to traverse every space in it. There are two large testes, a seminal duct with a vesicle, and a well-developed cirrus (penis); the female organs are composed of an ovary, an efferent duct, receptaculum seminis, vagina, uterus, paired yolk-glands and their ducts. This form seems to be distinguished from all other *Polystomeæ* by possessing three ducts carrying the deuto-plasm into the oviduct; the ovum seems to be matured as in other *Trematoda*, but only one comes to development at a time.

The genus *Microcotyle* was established by Van Beneden and Hesse, but its points of difference from *Axine* have never yet been very clearly put out; its most striking variation is now shown to lie in the fact that, unlike *Axine*, it is completely symmetrical; it is also distinguished by the absence of the penis, and the position of the vaginal orifice in the median dorsal line of the body (in *Axine* this orifice is marginal in position); while, again, *Microcotyle* does not present merely one mature egg in its oviduct, but a number, which may come to be as high as twenty-four.

The new species, *M. mormyri*, is described by Herr Lorenz: Van Beneden and Hesse had described four species, *M. labracis* from *Labrax lupus*, *M. Donavani* from *L. Donavani*, *M. erythrini* from *Pagellus erythrinus*, and *M. canthari* from *Cantharus griseus*; as to the first two the author is certain that his species from *Pagellus mormyrus* is quite distinct; as to the third species, the difficulties as to their proper identity are removed not only by the difference in the arrangement of the bands on the body, but by the more important character of the bundles of chitinous rods, which are found around the genital orifice; in *M. erythrini* they are arranged in two small groups set one in front of the other, but in *M. mormyri* there are two sets; 8 to 12 are arranged radially and in a curved manner, and behind and on either side there are 25 to 30, which have their hooks directed forwards; the points of difference to *M. labracis* are brought out in the full description of the new form; in many points of its internal structure it is shown to agree with *Axine*; but the vagina forms a large vesicle, placed in the middle of the body and provided with a wide orifice; its superior portion and margin have an almost chitinous character, but the lower part has its wall thin, and is continued into a canal which is formed by the union of the branches of the paired vitelline duct. The coverings of the egg are proportionately very large; they are of an elongated oval form, and pass into a gradually diminishing appendage, which is coiled at its tip; in which character it also differs from *M. canthari*, as described by the Belgian zoologist.

Life-history of the Tape-worm of the Shrew.* — M. Villot announces the discovery of the cystic forms of two of the four species of *Tænia* which infest the European Shrews, and which have hitherto only been known in the sexual stage.

The two species of bladder worm are placed by Villot in a new

* 'Ann. Sci. Nat. (Zool.),' viii. (1879) No. 2–3.

genus *Staphylocystis* : one species, *S. micracanthus*, is undoubtedly the immature form of *Tænia pistillum*, parasitic on *Sorex* (*Crocidura*) *araneus* : the tape-worm with which *S. bilarius* is connected is uncertain, but it is certainly nearly allied to *T. scutigera* (of *Sorex tetragonurus*), and to *T. scalaris* (of *S. araneus*).

Both species are found in the little myriapod *Glomeris limbatus*, where they occur in clusters like grape-bunches on the outer surface of the Malpighian tubules. Each cluster is a colony of bladder-worms, and consists of a number of transparent ovoidal sacs, attached by a short stalk at one end, and having at the other a short funnel-like depression. Each sac is the *caudal* cyst of a cystic worm ; the latter consisting, besides this vesicle, of a head and body. The head is provided with four suckers and a circlet of hooks, and is invaginated within the oval body, which represents the posterior part of a scolex, and is itself invaginated into the caudal cyst, the funnel-like depressions at the free extremity of which allow of the extrusion of the head and body.

Each colony proceeds, by a process of budding, from a simple vesicle or *blastogen*, the result of the metamorphosis of an ovum of *Tænia*. The ova, passed out of the body of the shrew with the fæces, are taken in by the myriapod, and probably make their way from the alimentary canal into the Malpighian tubes, finally penetrating the walls of the latter, and taking up their abode in the surrounding adipose tissue. If the *Glomeris* is then eaten by a shrew, the head and body are extruded from the caudal cyst, and proglottides are formed by budding from the scolex in the usual way.

Besides its life-history, Villot gives an account of the histology of *Staphylocystes*.

Echinodermata.

"**Comet-forms**" **of Starfishes.**[*]—The " corm theory " of Professor Haeckel, according to which, as is well known, that distinguished zoologist believes that it is alone possible to give any reasonable explanation of the characters of the Echinoderms, is forcibly supported by the arguments and facts which he brings forward in a paper under the above title.

In the historical introduction he points out that three explanations have been given of the problem raised by the organization of the adult Echinoderm ; the first, and earliest, was propounded by Cuvier, who, insisting on the *radiate* character of their organization, placed them with the Hydroida, the Medusæ, and the Ctenophora ; the two Professors Agassiz, father and son, have done their best to further this view, and the Russian zoologist Metschnikoff has not been behind. In the year 1848, a year famous in the annals of zoology, as being that in which Frey and Leuckart separated the Cœlenterata from the rest of the "Radiate mob," a new view was taken, inasmuch as these authors, more especially Leuckart, regarded the Echinoderms as having their closest allies with the Worms, and especially with the

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[*] ' Zeitschr. wiss. Zool.,' xxx. (Suppl.) (1878) p. 424.

Gephyrea; as to these latter, we find the following striking points of resemblance between them and the Holothuroid Echinoderms: the "sausage-shaped" elongated body is enclosed by a firm and naked integument; the mouth opens at the anterior and the anus at the posterior pole, while in both cases the former is surrounded by a circlet of tentacles; nor is the resemblance confined to their external characters, in both cases a pair of "tree-like" organs are connected with the rectum of a large number of forms. Many of what are now called Gephyrea the earlier zoologists placed, indeed, with the Holothuroida, and the view that there is a close relationship is still held by a number of zoologists, of whom Professor Claus is cited by our author.

The third view is that put out by Professor Haeckel. The similarities between the Holothurian and the Gephyrean are due to the action of similar external circumstances, and not to descent or close genetic relation—they are not *homologies*, but only *analogies*; thus the tree-like organs are primitively five in the one, and primitively two in the other group; the arrangement of parts is *dipleural* in the one, and *pentamerous* in the other; the Echinoderms are, in fine, pentate colonies of worm-like or dipleural persons, each of which is comparable to a segmented worm; the history of these forms is only rendered intelligible when we regard the bilaterally symmetrical larva as a nurse, and look upon the history of their development as involving an alternation of generation. This view is supported by Sars, both father and son, by Gegenbaur, and by Lange.

To turn to the "Comet-forms" which in Professor Haeckel's opinion support these views; these are those starfishes in which a separated arm has produced afresh the central disk and the other arms. It is impossible for us to give an account of the observations of Martens, Kowalewsky, Sars, and Studer, but those of Sir John Dalyell may well be taken as a type; on the 10th of June this observer found an arm, which had evidently been lately separated from a starfish; five days afterwards four new rudimentary rays appeared on it; on the evening of the same day (the 15th) a new mouth began to be formed, and on the 18th the animal was again completely developed, save only that the four new arms were very small; a month afterwards the animal spontaneously freed itself of its original arm. The true comet-form is always distinguished by one completely developed arm, to which, at its central end, the newly formed disk and four or five arms are connected; at first there is no disk, and no madreporic plate, while the mouth is formed by the open central end of the primary arm. When the new arms have attained a certain size, a small median disk appears, the mouth takes up a central position, and a small madreporic plate appears on either side of the primary arm. These observations lead to the following law, from which there seems to be no escape. In certain Asteroida the arms break off spontaneously from the disk, and each separated arm reproduces the whole disk and the other arms. Further observations show that the point of fissure is so placed that a small portion of the lost arm

remains connected with the disk, and here a new arm may be developed.

If these observations are not shown to be altogether misreported, it will follow that there are in the Echinoderms two modes of metagenesis ; the one in which the so-called "larva" (*Pluteus, Bracholaria,* &c.) functions as the nurse, and produces the Echinoderm by *internal* gemmation, and the other, more rare, in which the spontaneously separated arm functions as a nurse and produces the seastar by *external* gemmation.

These facts, in Professor Haeckel's opinion, largely confirm his "corm theory." Dealing with Metschnikoff, who regards the arms of the starfish as comparable to those of the cephalopod, he points out that no cephalopod arm, no lizard's tail, no crab's limb, ever produced a crab, cephalopod, or lizard ; and he further insists on the high development of the locomotor apparatus of the Echinoderms. To help forward the discussion, Haeckel proposes the name of *Astrotithene* (τιθήνη = a nurse) for the larval, and *Astrocormus* (κορμός = a colony) for the adult starfish ; the former is an unsegmented bilaterally symmetrical person, the latter is made up of five *parameres,* each of which is composed of two symmetrical *antimeres* ; in the adult there is further to be distinguished the *astrodiscus* made up of five congruent parameres (or five pairs of antimeres), and five *astrolenæ* (ωλένη = an arm), each of which is composed of a pair of antimeres. Traced in their developmental history, we see the multiplication of the organism ; looked at genetically, we find the ancestor of the astrotithene in an unsegmented worm, most nearly allied to the Rotatoria and the ciliated larva of the Annelides.

The paper concludes with dividing the Echinoderms or Estrellæ into three primary classes (subphyla), and six classes.

Subphylum 1. *Protestrellæ. Estrellæ* without internal centralization, with complete morphological autonomy of the astrolenæ ; enteric system consisting of a simple central intestine, and five (or more) bifurcated special intestines. 1st class, *Asteriæ.*

2. *Anthestrellæ. Estrellæ* with partial internal centralization ; the proximal portion of the astrolenæ together with the whole of the enteric system pass into the central astrodiscus ; no special intestines. 2nd class, *Ophiuræ.* 3rd class, *Crinoida.*

3. *Thecestrellæ. Estrellæ* with complete internal and external centralization ; the five astrolenæ pass completely into a single spheroidal or tubular astrodiscus ; no special intestines. 4th class, *Blastoida.* 5th class, *Echinida.* 6th class, *Holothuriæ.*

Professor von Martens, whose descriptions of Echinoderms are among the most valuable, has a note * on this subject. Speaking of the great difficulties connected with Haeckel's hypothesis, he points out that the arm of the sea-star contains all the representatives of all the essential organs of the animal, and that we know of no other example of a compound animal with a common mouth and all the other organs separate, but that in all cases where a colony is formed by gemma-

* 'Naturforscher,' xii. (1879) p. 103.

tion, the mouth or the end corresponding to the mouth is peculiar to each separate animal, and does not form part of the common colony.

Genital Organs of Asterina gibbosa.*—Dr. Hubert Ludwig, who has devoted considerable time to the study of the Echinoderms, now reports that, in the examination of the generative organs of the Asteroida, he has come across a very remarkable and quite unexpected arrangement. In all cases which have as yet been observed, the genital organs of the Asteroida have been found to open on the dorsal surface of the disk, and zoologists were coming to believe that this arrangement was an important aid in distinguishing between the Sea-stars (Starfishes proper) and the *Ophiurida* (Brittle-stars); it was therefore a matter of some astonishment to find in *Asterina gibbosa* Forbes (= *Asteriscus verruculatus* M. Tr.) the genital orifices on the *ventral* side, and that the more since in *Asterina pentagona* E. v. Martens they are on the dorsal side. The first supposition that the arrangement was " pathological " was corrected by the examination of twelve specimens ; in all of these it was observed that in every inter-radial region there were two slit-like pores, set symmetrically to the median plane of the interradius, and parallel to the adjacent ambula-cral groove. Counting from the corner of the mouth, we find the slits between the fifth and sixth interambulacral plates ; each opening leads into a canal, the inner surface of whose walls is thrown into longitu-dinal folds ; this canal passes in a curved direction to the dorsal wall of the body, where it enters the basal portion of the genital tubes ; these latter, it should be observed, have just the same position as in *A. pentagona*.

It is somewhat difficult to imagine what has caused the difference in the position of the pores, but Dr. Ludwig imagines that they have merely changed their position in *A. gibbosa*, and that it is not a newly developed arrangement. The allied species, *A. cephœa* Edm. Perrier, has been examined, and has been found to have the genital pores dorsal in position, while the species of F. Gasco, *A. panceri*, is shown to be merely a variety of *A. gibbosa*. *Palmipes membranaceus* is reported to have been examined by Gasco, who did not find the genital orifices on the ventral surface ; but as this author does not seem to have been struck by the peculiarity exhibited by *A. gibbosa* as compared with the rest of the Asteroida, it is only possible to say of it that its genital orifices have not yet been observed.

Anatomy of Brisinga.†—Dr. Ludwig also contributes a paper on this most interesting form, which is regarded by Sars, its discoverer, as forming the type of a special family of the Asterida, and by Professor Gegenbaur as the representative of a group distinct both from the Asterida and Ophiurida.

Dealing first with the blood-vascular system, as to the existence of which Sars was not able to convince himself, the author com-mences by recapitulating the results of his investigations on the

* ʽZeitsch. wiss. Zool.,ʼ xxxi. (1878) p. 395.   † Ibid., p. 216.

vascular system of the Asterida; this consists of the following parts:—

1. An oral blood-vascular ring placed in the peristom.
2. A dorsal blood-vascular ring.
3. A vascular plexus connecting these rings—the so-called heart.
4. A radial vessel given off from (1) to each arm.
5. Vessels given off from the dorsal vascular ring, and passing to the generative organs.
6. Two gastric vessels given off from the dorsal vascular ring.

To turn to what obtains in *Brisinga*, and following the author in first discussing the genital vessels, which are the easiest to find, we discover a vessel to the right and to the left of the series of joints of which an arm is made up; as it reaches the genital organs this vessel nearly doubles in breadth; examined in cross section, it is seen to contain a plexus of vessels, so that it is a "peri-hæmal canal"; plexus has just the same characters as in the rest of the Asterida, save only that it is more distinctly plexiform; in its terminal characters it exactly resembles the genital vessels of the true sea-stars. The radial blood-vessels were examined by the aid of sections made through decalcified arms, and were found to be in all essential characters exactly similar to the same parts in the Asterida; the same is the case with the vascular apparatus of the disk; therefore we are relieved from describing it here.

On the dorsal aspect of the disk Sars observed a pore, which was subcentral in position, but which he only regarded as the orifice of an excretory apparatus, as he was unable to discover any connection between it and the enteric tract. Ludwig now shows that this pore communicates with the lumen of the interradial cæcal sacs, which are given off from the stomach, and which are shown by further examination to be nothing else than processes of the rectum, so that the pore is a veritable anus. In another point, also, Ludwig extends the observations of Sars, to make which clear it is necessary to draw attention to the fact that our author, in his examination of the peristomial skeleton of the Asterida, has discovered that the first two joints of the arms undergo more or less complete union. Now, according to Sars, this region consists of two joints, with their adambulacral plates, for each radius, and two paired "dorsal marginal plates" for each interradius; while there are, in addition, in each interradius, two "parietal" plates; these last are now shown to be the first and metamorphosed joints, and, just as in the rest of the Asterida, the so-called first joint is really double, for Sars erred in regarding them as interradial instead of radial.

A few words must be said as to that peculiarly interesting structure—the stone canal. A series of transverse sections has demonstrated that, as in all other *Asterida* which have as yet been examined, it commences by a simple lumen; just as in *Echinaster fallax*, its structure is not at all complicated, as it is, for example, in *Asterina pentagona;* its investing epithelium is high and ciliated, and the cuticle is traversed by small but quite distinct pore-canals for the passage of the cilia, and each pore-canal seems to belong to a proper epithelial cell.

As may now be supposed, Ludwig inclines to the view of Sars

rather than to that of Gegenbaur, with respect to the systematic position of *Brisinga*; the classification of the latter is based on two reasons, one of which is that in *Brisinga*, as in the Ophiurida, the enteric tract does not send cæca into the anus; but it has lately been shown that they do extend along the first third of these parts; while to the second reason, that the arms of *Brisinga* are separated from the disk, is opposed the statement that the Ophiurid appearance is due to the small (three) number of joints which pass into the skeleton of the disk. The difference insisted on by Sars as obtaining between *Brisinga* and the other *Asterida*, the absence of respiratory processes, is regarded as being of small moment, on account of the extreme tenuity of the integument in this form; while the ancient character of the creature is not regarded by Ludwig as being in any way distinctly proved. This very interesting and important paper is illustrated by a plate of twelve figures.

Aspidura.[*]—Dr. Hans Pohlig gives a fresh definition of this interesting Triassic Ophiurid, from the muschelkalk of Germany, which he divides into two subgenera, *Amphiglypha* and *Hemiglypha*, of which the former is broader and has shorter arm-spines than the latter; in each case a single species is alone known. He regards this form, which is the only Ophiurid as yet found in this stratum, as representing an extinct genus, which is distinguished from all its allies by the possession of larger, closely connected, radial shields, and by the bilateral groove on its oral shields; belonging to the Ophiolepidæ, it is intermediate in character between *Ophioglypha* and *Ophiopus*. *Hemiglypha* has many points of resemblance to the Asterida, and appears to occupy a similar position among the Ophiurida to that held by *Brisinga* among the Asterida.

It may be interesting to observe that Pohlig agrees with Haeckel in regarding the Asterida as the older forms.

Cœlenterata.

Classification and Phylogeny of Actinozoa.[†]—Dr. W. Haacke, of Jena, gives a supplement to his paper in the current volume of the 'Jenaische Zeitschrift,' in which he proposes the following classification of *Actinozoa* :—

A. DIASEPTIGERA	I. *Corallarcha*	{	1. Protocorallida. 2. Tetraseptata.
	II. *Octocoralla*	{	3. Alcyonida. 4. Tubulosa. 5. Gorgonida. 6. Pennatulida.
	III. *Heterocoralla*		7. Cereanthida.
B. ZYGOSEPTIGERA	IV. *Tetracoralla*	{	8. Tetractinida. 9. Rugosa.
	V. *Hexacoralla*	{	10. Actinida. 11. Antipatharia. 12. Tabulata. 13. Perforata. 14. Aporosa.

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[*] 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 235.
[†] 'Zool. Anzeiger,' ii. (1879) p. 261.

The *Cerianthida* are separated from the *Hexacoralla*, with which they are usually associated, from the fact that their sarcosepta (mesenteries) are not arranged in pairs the number of which is half that of the tentacles; in this respect they agree with the *Octocoralla*.

The subdivision *Corallarcha* is an entirely hypothetical one, made to contain the supposed stem-forms of the Actinozoa, with an indeterminate number of sarcosepta (*Protocorallida*), and those in which the number had become fixed at four (*Tetraseptata*). This latter group is taken to be quite distinct from the *Tetractinida*, the hypothetical ancestors of the *Rugosa*, in which the number of sarcosepta was at least eight.

The author gives the following genealogical tree of the class :—

DIASEPTIGERA.		ZYGOSEPTIGERA.
Heterocoralla.	Octocoralla.	Hexacoralla.
	Tetraseptata.	Tetracoralla.
		Tetractinida.

Protocorallida.
Corallarcha.

Archydra.
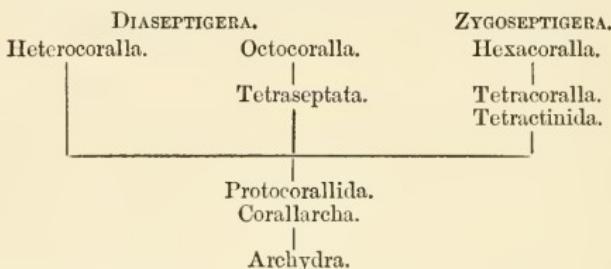
New Paludicolous Medusa.[*]—The *Medusæ* are almost exclusively pelagic zoophytes, inhabiting the open sea, and they dread nothing more than fresh water, which is a destructive poison to them. Even brackish water kills them instantaneously. Moreover, they constantly need a water rich in oxygen, fresh and incessantly renewed by the perpetual movement of the waves and currents. The *Medusæ*, in fact, have an almost equal dread of fresh water, of stagnant sea-water, and of a slightly too high temperature.

All these considerations will enable the reader to understand, says Dr. Du Plessis, how he was surprised, at the end of the month of June, 1876, at finding, in the middle of the discharging canal of the saltworks of Villeroy, near Cette, a charming *Medusæ* of a new species, which inhabits these salt marshes in the summer. It belongs to the genus *Cosmetira*, a section of the numerous group of the Oceanidæ; and it is curious that it is a miniature copy of a much larger species, *Cosmetira punctata*, which occurs frequently in the sea near Cette, and at Nice, Naples, and elsewhere.

The interest possessed by this creature is concentrated in the novel conditions to which it must have accommodated itself to be able to exist in the locality where it is now met with. The canal is not more than two or three metres broad, and not more than one metre deep. The soil is a black putrid mud, stinking of sulphuretted hydrogen. The water is perfectly stagnant and very brackish. It is without any shade, is almost all day long exposed to the burning sun of Languedoc, and often exceeds 77° F.

The *Medusa* always inhabits the lower surface of islets of floating

[*] ' Bull. Soc. Vaud. Sci. Nat.,' xxi. (1879) p. 39.

algæ. On removing these it is seen clinging like a flake of jelly, shining like crystal. The season of their occurrence is limited to June and July. They were not found in September and October, any more than in the spring.

Every zoologist who has attempted to keep these creatures in captivity has been reduced to despair by seeing them perish in a little time, whatever may have been done to render the aquarium comfortable for them. But this marsh species, forced no doubt by vital competition to accommodate itself very gradually to great vicissitudes, has become hardened by this process ; and the proof of this is that it may be very well preserved for weeks together in the smallest bottles, with a few hundred grammes of the water of the canal and a few green algæ to keep up a small supply of oxygen. Under these circumstances, specimens have been transported with the greatest facility from Cette to Lausanne, and kept there for months without the least trouble. This species, being so accommodating, will be very welcome to those who desire to observe these animals for a long time in captivity. *Cladonema radiatum* Duj., and other microscopic *Medusæ*, also bear captivity, but these are scarcely visible to the naked eye, whilst this, being of the size of a half-franc (Swiss money), is much more suitable for all sorts of manipulation.

Moreover (and this is the most interesting point), it presents one of the clearest examples of the influence of the circumambient medium upon the gradual modification, and finally, transformation of one species into another ; for certainly our *Medusa* has originated from an importation of the large *Cosmetira punctata*, the form of which it reproduces on a small scale, repeating its whole organization *en diminutif*. Thus reduce the larger animal to the dwarf size of a half-franc piece, colour the canals and the stomach green, change the rose-colour into violet, blacken the tentacles, and you have by these modifications transformed the *Cosmetira* of the sea into that of the salt marshes.*

Charybdea marsupialis.† — This *Medusa*, which lives at the bottom of the sea, and exhibits a large amount of asymmetry, is interesting especially on account of the different reports given of it by Gegenbaur and Fritz Müller. Difficult to obtain, and its systematic position have long remained uncertain : it was distinguished by F. Müller from the genus *Tamoya*, on account of the following characters ; the edge of the bell (velum) was divided into lobes, the stomach was provided with accessory canals, the "grappling lines" opened into the lateral canals and not into the lateral pouches, the stomach and oral infundibulum were confluent, and the gastric filaments hollow and not solid.

Professor Claus now states, that in the first three points *Charybdea* does resemble *Tamoya*, that point four is of no value, and that as to the hollow filaments connected with the stomach there are no such in any *Medusa*; they are, in fact, always solid. The ectodermal investment is reported as having just the same characters as in other

* 'Ann. and Mag. Nat. Hist.,' iii. (1879) p. 385.
† 'Arbeit. Zool. Inst. Univ. Wien,' ii. (1878) art. 2.

Acalephæ; as in all Craspedota, there are transversely striped muscle-fibres in the subumbrella and velum, and smooth fibres on the surface of the lobes of the umbrella, and internally to the gelatinous layer of the tentacles. All these muscle-fibres are products of the ectodermal cells, and are in connection with them. Circular muscles are not present except in the subumbrella and in the corresponding surface of the velum; the fibrous layer which invests the supporting lamella of the subumbrella is, at the four radii, broken into by radial fibres, which are not transversely striated. The Charybdeidæ do not merely show their relationship to the Craspedota by the presence of a velum, but also by the characters of their nerve-ring; this structure is, however, remarkable for its position at some considerable distance from the edge of the umbrella and by its great size; at the base of the marginal bodies the nerve-ring is exceedingly well developed. The mode in which its fibres enter into the conical basal portion of the marginal body is a matter of some difficulty; it might be supposed that they passed through the tissues of the wall of the bell, and through the supporting lamella of the subumbrella with the parts connected thereto; as a matter of fact, their course is simple, for so soon as they have passed the supporting plate they immediately bend towards the epithelial surface of the base of the marginal body. Through his further details of these and of the other sensory organs we have not space to follow the author.

As to the gelatinous substance of *Charybdea*, it is shown to want those oval or star-shaped cells which are found in so great abundance in the similar parts of *Rhizostoma*, *Aurelia*, and *Discomedusa*; but the rigidity of the structure is clearly increased by the number of fine elastic fibres which go to make it up. The endodermal epithelium varies greatly in character according to its position; it may be said, as a general rule, that in the Craspedota the superiorly lying epithelium of the umbrella consists of flat cells and the inferior of cylindrical cells; the changes which are seen in it at the points where the substance of the gelatinous matter of the umbrella unites with the supporting lamella of the subumbrella are very interesting; contrary to what happens in the Acalephæ and Craspedota, the bands are here delicate, and the radial vessels consequently form, as in Lucernaria, wide pouches. In the gastric wall of the subumbrella the endodermal cells are high and cylindrical, while the character of their contents leads us to suppose that this epithelium, like that of the small intestine of higher animals, is able to absorb albumen; at the surface of the oral infundibulum the cells are not so high, and enclose a number of goblet-shaped cells, while on the oral disk the epithelial cells are cylindrical in shape and provided with rounded ends; it is probable that they secrete a digestive ferment. Treating shortly of the generative organs, Professor Claus comes finally to the conclusion that the position he had already assigned to *Charybdea* is the right one.*

Halistemma tergestinum.†—In describing this new species, Claus takes the opportunity of making some general observations on the

* See this Journal, ii. (1879) p. 431.
† 'Arbeit. Zool. Inst. Univ. Wien,' i. (1878).

histological characters of the Physophoridæ. The form under description was observed at Trieste, and in nearly all its most important characters agrees with the other species of *Halistemma ;* of this group it would be one of the smaller representatives, as its whole length is not more than ten inches. The stem, as in all Physophoridæ, is spirally coiled, and this spire follows two directions; on the axis of the stem and at the base of the tentacles and of the gonophores there are irregularly stellate spots of a red colour, which is most distinctly marked on the male gonophores.

Our space does not permit us to enter into the details of this paper, and we must leave it with some brief remarks. The swimming bells of this form are noted as being considerably smaller towards the superior pole and the inferior end of the swimming column, and as presenting a bilateral symmetry so distinct that they may well be called dorsal and ventral ; as compared with the body of the Hydromedusæ, the bell of the Siphonophora displays many very striking points of agreement, not only in its histological structure, but in its mode of development. In *Halistemma* the male and female buds are reported as appearing on each tentacle, where they form distinct racemose groups, placed on a short stalk ; their medusoid structure is feebly developed ; the male medusoids, which are distinguished by their reddish-brown pigment, are, when mature, set free from the stalk, and for some time swim about freely by the aid of a rich supply of cilia ; the female buds are, so far as Claus has observed, devoid of pigment ; the egg is relatively large, and has a large germinal vesicle with a nucleolus which is ordinarily homogeneous ; this body always lies close to the distal pole, and appears to leave the egg when this is matured.

The view that the Siphonophora are polymorphous, first put out by Leuckart, has been opposed by that of Professor Huxley, who regards the various appendages of the Siphonophora as organs of a *Medusa ;* this latter view has been lately and independently supported by P. E. Müller and by Metschnikoff; the processes of development do indeed seem to bear out their conclusions, but Professor Claus points out that the presence of an air-sac, which has a tendency to be repeated, seems rather to point to the Siphonophore being a complex of self-repeating parts of a *Medusa,* and therefore to confirm the view of the polymorphism of these animals ; the whole difficulty lies perhaps in the conception of the "person" and of the "colony"; in these forms, as in the Cestodes, the difference is not one that is to be insisted upon, but is one rather that is most marked when they are regarded comparatively.

Tubularia mesembryanthemum.*—An exhaustive study of the histology and embryology of this species has lately been made by Ciamician.

1. *Methods.* For examination of the tissues as a whole, the author recommends treatment with 0·25 to 0·05 per cent. osmic acid ; for isolation of the separate elements of the tissues, maceration in 1 per cent. chromic acid, staining with eosin, and teasing out in glycerine.

* 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 323.

2. *Histology.* The fibres of the mesoderm, instead of being, as in *Hydra*, mere processes of the ectoderm cells, are independent spindle-shaped muscular cells with nuclei. *Tubularia* has thus the most differentiated mesoderm of all the hydroid polyps, the simplest conditions being represented by *Hydra*, *Syncoryne*, and *Podocoryne*, while *Hydractinia* affords an intermediate state, its muscle-fibres having separate nuclei, but being in connection with the ectoderm cells. There are two layers of muscular fibres in *Tubularia*, an inner longitudinal layer, in contact with the gelatinous connective lamina, and an outer transverse or circular layer.

An account is given of the mode of formation of the thread-cells. The cnidoblasts or smaller ectodermal cells in which these are formed, are in direct continuity by means of fine protoplasmic processes with the muscular fibres of the mesoderm. The thread-cells begin as a sort of vacuoles in these cnidoblasts, in the neighbourhood of the nucleus, but soon increase until they fill the cell. In all Hydrozoa yet observed, the protoplasm of the cell is entirely absorbed *pari passu* with the development of the thread-cell, but in *Tubularia* Ciamician finds that a small portion of protoplasm surrounding the nucleus becomes separated as a distinct cell, which may then itself give rise to a new thread-cell.

The connective lamina (Stützlamelle) which lies between the muscular layer and the endoderm, can be isolated by long maceration in water and in ammoniacal solutions of carmine. The side turned towards the mesoderm is seen to be smooth, while the inner side is indented, the indentations corresponding to the large endoderm cells. It is very resistent, about 0·003 mm. thick, and shows no structure under the highest powers.

3. *Ontogeny.* The development of the gonophore is first considered, but little is added to the author's former paper,[*] except a more exact account of the mode in which the spadix breaks through the distal wall of the gonophore, and a description of structures, in the latter, which evidently represent the marginal tentacles of a medusa. These occur in the form of eight elevations arranged in a circle, at the distal end of the gonophore, around the projecting spadix; they are formed from the combined ectoderm and "medusoid lamella" (the double layer of invaginated endoderm) of the wall of the gonophore.

As in *Hydra*, only a few (four to eight) egg-cells in each gonophore attain maturity, and become actual ova; the remainder serve as food-material for them. As in *Hydra*, also, sharply defined protoplasmic spheres (*pseudo-cells*) appear amongst the clear yolk-spheres of the egg, and these, Ciamician finds, multiply by a process of division, which process, however, does not resemble these cell-divisions, but is rather like a falling to pieces of the pseudo-cell. The egg is devoid of a vitelline membrane.

The interesting observation is made that some of the undeveloped egg-cells may undergo division from true seminal cells.

The process of yolk-division was actually followed in the living

* This Journal, ii. (1879) 66.

ovum. The first cleavage furrow is vertical, the second equatorial, the egg becoming divided into two micromeres and two macromeres. Both of these undergo further multiplication, and the micromeres gradually grow round the macromeres (epiboly), forming the epiblast or primitive ectoderm, while the included macromeral cells constitute the hypoblast or primitive endoderm.

The solid oval embryo thus formed elongates until it acquires a fusiform shape; the two ends of the spindle being the rudiments of the first two tentacles. The gastro-vascular cavity is formed as an excavation in the solid mass of endoderm.

The author further traced the changes by which the newly freed larva (Actinula) is converted into the attached *Tubularia* polyp; he describes the gradual differentiation of the larval body into hydrocaules and hydrorhiza, the formation of the perisarc, &c.

Protozoa.

Tintinnus semiciliatus, a new Infusor.[*] — Dr. V. Sterki describes a new species of the genus *Tintinnus*, found by him at Schleitheim, in Switzerland.

The body is of a wine-glass shape, truncated anteriorly, and behind passing gradually into a long stalk by which it is attached to the bottom of its tube. The animal was sometimes found without its tube; whether this was an accidental or a normal state of things is uncertain; when free the stalk was always wanting, the posterior end of the body being rounded off, or, at most, was represented only by a small stump. In some cases a constriction was observed near the posterior end of the body; probably this was due to pressure, not to commencing division. The length of the body without the cilia is 0·04 to 0·06 mm., with the stalk 0·1 to 0·12 mm., the diameter 0·03 mm.

The anterior end of the body is surrounded by a raised circular rim of firm consistency, from which spring the fifteen to twenty large adoral cilia or membranelles, each of which is flat and band-like, inserted obliquely on the rim, and split up distally into about six filaments. Round the inside of the rim, near its base, is a row of shorter, fine cilia of the ordinary character, and perhaps homologous with the paroral cilia of *Oxytrichina.*[†] Also the anterior or free half is sparsely covered with short, fine cilia.

Within the ciliated rim, the anterior end of the animal is slightly convex, quite soft, and presents an irregular depression or peristomial space, without, however, any distinct mouth or gullet. Neither cilia nor undulating membrane occur in the peristome, but its inner wall undergoes continual movement, acting like a sort of lip or tongue. This fact is interesting as showing the possibility of independent movement on the part of the soft endosarc or internal parenchyma.

The body-substance is clear and slightly yellowish. There are no muscle-striæ, and no discoverable structure in the stalk. In the posterior end of the oval nucleus is a strongly repeating globular

body, probably representing the nucleolus. There is a single contractile vesicle, near the peristome. Many "serous" spaces are also to be seen. No anus could be discovered.

The development was not made out, although the author had evidence that multiplication takes place by transverse fission. The tube is formed by the animal out of bits of decaying plants, and small fungoid and algal filaments.

Blepharisma lateritia.[*]—A short note on the conjugation of this infusor is contributed by Duncker, of Berlin. He states that the process lasted for about an hour, and that while it was going on the nucleus appeared to move somewhat farther backwards. On one occasion two individuals in conjugation were seen to make vigorous efforts to separate themselves by swimming backwards against the grains of sand found in the fluid; these seemed to act as wedges between the two animals, gradually prising them apart; the separation being effected after forty or fifty attempts. The separated animals, or at least one of them, showed a degeneration of the nucleus, the further changes in which were not observed. Red masses were, however, found in the vessel, which bore a close resemblance to the altered (? impregnated) nucleus, and were possibly germ-masses, although no movement was observed in them, and they were not seen to develop further.

Haptophrya gigantea, a new Opalinid from the Intestine of the Anourous Batrachia.[†]—The intestine of Batrachians harbours a whole world of parasites, which live and multiply with a truly surprising abundance. Microscopists especially may thus make the finest harvests of Infusoria and Bacteria. M. E. Maupas says that he has often examined the contents of the intestine of *Bufo pantherinus*, *Discoglossus pictus*, and *Rana esculenta*, from Algiers, and always found them richly populated. He was able to recognize the following species: *Nycthotherus cordiformis, Balantidium elongatum, B. entozoon, Opalina dimidiata, O. intestinalis, O. obtrigona,* and *O. ranarum*. With these large ciliated Infusoria swarmed myriads of Bodos, Monads, Amœbas, Bacilli, Vibrios, and Bacteria. All these species are European, but he also very often found in the intestine of the *Bufo* and the *Discoglossus* (less frequently in the frog) a very fine species of Opalinid, which appears to be undescribed, and which, from several very curious details of its organization, must greatly interest proto-zoologists.

This Opalinid may be regarded as the giant of the Infusoria, for individuals were measured the length of which exceeded 1 mm. The body has a very elongated cylindro-conical form, tapering from the front backwards. The anterior extremity is pretty strongly depressed, and is nearly twice the breadth of the posterior region, which measures from ·08 to ·09 mm. This depressed portion is occupied by a circular sucker, formed by the retreat inwards of the wall of one of the broad surfaces, which may be called the *ventral surface*. The action of the sucker is ensured by cords of sarcode, which start from

* 'Zool. Anzeiger,' ii. (1879) p. 260.
† 'Comptes Rendus,' lxxxviii. (1879) p. 921.

its inner wall, and attach themselves to the opposite dorsal wall. The concavity caused by the traction of these cords is of course very slight, but nevertheless clearly visible with the Microscope. The animalcule attaches itself to objects by means of this sucker. The surface of the body is covered with very close rows of cilia. Four or five rows may be counted in ·01 mm., and in the concavity of the sucker they are half as numerous again. The cilia, whose length is ·005 mm., are very close together, about thirteen or fourteen in ·01 mm. These cilia are the only organs of locomotion, and the progress of the animal is never very rapid.

The integument or ectosarc has a thickness of ·045 mm., and is composed of two very distinct layers—one external, in which the prolongation of the cilia may be followed in the form of bacilli, the other internal, composed of transparent and absolutely amorphous sarcode. This integument is entirely destitute of proper contractility, so that the animalcule cannot in any way modify its form spontaneously ; but on the other hand it possesses great elasticity, which allows the body to resume immediately its normal contour when modified by an obstacle. The endosarc is composed of clear and liquid sarcode, at the periphery of which exists a layer of large, opaque granulations.

The nucleus is free in the general cavity, and following the movements of the body, can move from one extremity to the other. Its form is that of a very elongate and rather flat ellipsoidal shuttle ; it may measure as much as ·185 mm. Its substance consists of an opaque, slightly yellowish gangue, in which are seen numerous spherical corpuscles of nucleolar appearance. When, from the crushing of the body, a fresh nucleus is placed directly in the water, its substance contracts, and at the surface there appears a fine amorphous membrane, as in many other Infusoria.

The body is traversed throughout its length by a long contractile canal attached to the dorsal face, the pulsations of which, from one systole to the next, last a little more than a minute. This canal is not rectilinear, but describes numerous sinuosities irregularly disposed. Its diameter in diastole is ·018 mm. It is furnished with proper walls, and thus constitutes a true vessel. By this character it differs from the contractile vacuoles of the other Infusoria, which are only temporary cavities hollowed out in the endosarc. The wall of the vessel, visible even in the living animals, becomes still more apparent with coagulating reagents. This vessel, moreover, is provided with orifices, which traverse the integument and open outwards in the form of very clearly visible pores in the midst of the rows of cilia. These pores place the vessel in communication with the exterior, and serve for the exit of the interior liquid at the moment of systole, and very probably for the entrance of the exterior liquid during diastole. The pores, seven or eight in number in the large individuals, are placed exactly in a straight line at irregular distances on the course of the vessel. They are of an oval form, and measure ·003 mm. in length.

This Infusor multiplies by dividing transversely into segments. The segmentation is at first indicated at the middle of the length of

the body by a clear band in the endosarc. The nucleus divides in two, a constriction contracts the body at the point of segmentation, and the vessel becomes divided into two. The two segments remain united together. The same operation is repeated, for a first time, at the middle of each of the segments, so that we see four segments soldered together, then a second time at the middle of each of these four new segments, and the body is cut into eight segments still attached to one another, and completely recalling by their external aspect and arrangement the zoonites of the Tæniæ. These segments then separate, and many of them are always found isolated in the rectum of the hosts.

This fine Infusor much resembles the Opalinid found by Von Siebold in *Planaria torva*, and figured by Max Schultze under the name of *Opalina polymorpha*. If we adopt the generic divisions established in the family of Opalinida by Stein, it will have to be placed by the side of this latter species in the genus *Haptophrya*. On account of its large size, M. Maupas names it *H. gigantea*.

Stein's 'Organismus der Infusionsthiere.' *—After an interval of eleven years, the first part of the third volume (comprising the Flagellate Infusoria) of this work has appeared. It is the result of long and patient original investigation, and constitutes, as the author says, the most laborious of his productions. The second part, containing the characters of the genera and description of the species, is announced as shortly to follow, completing the work.

The following is the classification adopted by Stein for Infusoria which move by means of flagelliform filaments. It will be seen that, returning to the traditions of Ehrenberg and of his school, he brings back to the animal kingdom a number of organisms that most modern authors consider as of a vegetable nature.

Infusoria Flagellata.

1. *Monadina.*
    Cercomonas; Monas; Goniomonas; Bodo; Phyllomitus; Tetramitris; Trepomonas; Hexamita; Lophomonas; and Platytheca.
2. *Dendromonadina.*
    Dendromonas; Cephalothamnium; Anthophysa.
3. *Spongomonadina.*
    Cladomonas; Rhipidodendron; Spongomonas; Phalansterium.
4. *Craspedomonadina.*
    Codonosiga; Codonocladium; Codonodesmus; Salpingœca.
5. *Bikœcida.*
    Bikœca; Poteriodendron.
6. *Dinobryina.*
    Epipyxis; Dinobryon.
7. *Crysomonadina.*
    Cœlomonas; Rhaphidomonas; Microglena; Chrysomonas; Uroglena; Syncrypta; Synura; Hymenomonas; Stylochrysalis; Chrysopyxis.

* M. J. Deby in 'Bull. Soc. Belg. Micr.,' v. (1879) p. 99.

8. *Chlamydomonadina.*
   Polytoma ; Chlamydomonas ; Chlamydococcus ; Phacotus ;
   Coccomonas ; Tetraselmis ; Gonium.
9. *Volvocina.*
   Eudorina ; Pandorina ; Stephanosphæra ; Volvox.
10. *Hydromorina.*
   Chlorogonium ; Chlorangium ; Pyramidomonas ; Chloraster ;
   Spondylomorum.
11. *Cryptomonadina.*
   Chilomonas ; Cryptomonas ; Nephroselmis.
12. *Chloropeltidea.*
   Cryptoglena ; Chloropeltis ; Phacus.
13. *Euglenida.*
   Euglena ; Colacium ; Ascoglena ; Trachelomonas.
14. *Astasiœa.*
   Eutropia ; Astasia ; Heteronema ; Zygoselmis ; Peranema.
15. *Scytomonadina.*
   Scytomonas ; Petalomonas ; Menoidium ; Atractonema ;
   Phialonema ; Spenomonas ; Tropidocyphus ; Anisonema ;
   Colponema ; Entosiphon.

Stein places *Volvox, Eudorina, Pandorina, Euglena,* and even *Chlamydococcus pluvialis* amongst the Flagellate Infusoria, on the ground principally of the presence of a contractile vesicle. His observations on the multiplicity of *Volvox* and analogous genera confirm those of Cohn.

Stein accepts the views of Clark on the nature of sponges, and gives figures of a great number of new species of Infusoria discovered by him, which seem to establish incontestable links between the Flagellate Infusoria and the true sponges.

He does not appear to have verified or even to have known of the observations of Dallinger and Drysdale on the life-history of Monads.

Effect of Light on Pelomyxa.*—In a very low, amœba-like organism, *Pelomyxa palustris,* Herr Engelmann recently observed a remarkable action from sudden incidence of a moderate light. Watched in the Microscope, this organism showed very slow movements, which, however, on shading the object, became much more lively. When the hand was removed the glandular mass in the interior became still, and the body contracted into a ball, as after an electric shock ; this effect occurred within a few seconds. With continued moderate light, weak changes of form appeared again, with hardly perceptible locomotion. This experiment was several times repeated with equal success, and the results were especially notable in a dark room, into which diffused daylight could be admitted. When, however, the room was illuminated—not suddenly, but gradually— the *Pelomyxa* showed no effect.

* 'Arch. f. Phys.' (Pflüger), xix. (1879) p. 1 ; 'Nature,' xx. (1879) p. 106.

BOTANY.

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

Permeability of Pellicle Precipitates.[*]—The well-known experiments of Traube on artificial cells have been repeated by Hugo de Vries, who comes to conclusions quite opposite to those of the German observer.

Starting with Traube's experiments upon the artificial cell or pellicle-precipitate produced by a copper salt in a solution of potassium ferrocyanide, De Vries says that if, as Traube maintains, the precipitated membrane is impermeable to its two membranogens (i. e. the copper salt and the ferrocyanide), the membrane will not undergo any increase in thickness; while if, on the other hand, the pellicle is permeable by the membranogens, it will continually increase in thickness until one of them is exhausted.

De Vries experimented upon a flaccid cell of copper ferrocyanide, obtained by introducing a drop of a 3 to 5 per cent. solution of cupric chloride, by means of a fine pipette, into the bottom of a tall vessel containing a 20 per cent. solution of potassium ferrocyanide. The blue drop became surrounded with a delicate, colourless, transparent pellicle, which for a half to one hour seemed to undergo no change. At the end of this time, however, brownish spots appeared on it, and increased in number and size until the whole cell-wall had a brown tint, which gradually darkened, until the whole pellicle was dark brown, opaque, and quite rigid and brittle. During the whole time —at the end of twenty-four hours, in fact—the cell had undergone no increase in size. If ruptured at this time, the rent was not closed up by the formation of a new pellicle, showing that all the copper salt had passed out of the cell; moreover, the colour of the contents of the latter was seen to be yellow—that is, to consist of the ferrocyanide.

Thus, the pellicle of cupric ferrocyanid is proved to increase in thickness, and must therefore be permeable to one or both of the membranogens. Several other experiments of similar nature were made, and all tended to prove the same thing—in all there was a progressive increase in the thickness of the pellicle, and a continual change in its physical properties.

The author concludes by remarking that, by these results, the supposed analogy between pellicle-precipitates and living protoplasm is shown to be only apparent, and devoid of all real significance.[†]

Origin of Chlorophyll-grains.—The view of Mohl, Sachs, Wiesner, and others, that grains of chlorophyll are formed directly from the starch and other carbohydrates which constitute the reserve food-

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[*] 'Arch. Néerland.,' xiii. (1878) p. 344.

[†] This remark can hardly be said to apply to Traube's experiments with gelatin-tannate pellicles, although the fact of the copper-ferrocyanide pellicle growing by deposition of layers, and not, as Traube thought, by intussusception, renders a repetition of these experiments necessary. (See Sachs' 'Textbook of Botany,' p. 594.)

materials of plants, has been subjected to rigid investigation by Mikosch,* who has arrived at the following results:—

1. In all young organs which are filled with starch-grains, the chlorophyll-grains are formed by the investiture of the starch-grain with a green or yellow protoplasm. Within this envelope a gradual absorption of the starch goes on, followed, when the starch-grain is compound, by its breaking up into its derivative grains. Grains formed in this way he calls starch-chlorophyll-grains.

2. The starch-chlorophyll-grains are, as a rule, parietal; only in the leaf-stalks of the primordial leaves, and in the young axial organs, do they more often originate from a mass of protoplasm which surrounds the central nucleus.

3. The starch-chlorophyll-grains are functional when fully developed; they assimilate, and multiply by division. The only exception to this rule occurs in the case of the large grains found in the cotyledons of the pea, in which no vital activity was ever observed.

4. When no starch is present in the tissue in the form of grains, the chlorophyll-grains are formed in the way already described by Sachs, by the breaking up of the hyaline parietal layer of protoplasm into separate green portions, which eventually become yellow. These grains, formed directly out of the protoplasm, without a starch-grain taking any apparent share in the process, Mikosch calls protoplasm-chlorophyll-grains. The differentiation of the protoplasm goes on both in the light and in the dark; but is more rapid in the former case, and, within certain limits, the more rapid the greater the intensity of the light.

Heliotropism of Plants.—Professor Wiesner reprints from the 'Denkschriften der math.-naturw. Classe der kais. Akad. der Wissen.' of Vienna, vol. xxxix., the first part of an important monograph, 'Die heliotropischen Erscheinungen im Pflanzenreiche.'

After a copious historical sketch of previous investigations, he divides the subject as follows:—In the first chapter the influence of the intensity of light on heliotropism is investigated; and the author shows that a maximum effect is produced by a certain intensity, on each side of which there is a gradual decrease to zero. In the same manner he found an upper limit of light-intensity for growth in length, and also that the upper limit for heliotropism is above or below that for growth in length. Direct sunlight may completely arrest growth in length. In the second chapter he shows, in opposition to the received theory, that all rays of light, with the exception of yellow, even the dark and ultra-violet (red ?) rays of heat, may produce heliotropism; in plants which are but little sensitive to heliotropism, the action of the colours of the spectrum decreases in proportion to their heliotropic power. The hypothesis that the heliotropic power of light is in proportion to its mechanical intensity or thermal power is altogether disproved. The third chapter is devoted to the investigation of the connection between heliotropism and geotropism; and in the

* 'SB. Akad. Wiss. Wien,' lxxviii. (1878) p. 265.

fourth it is proved that free oxygen is essential to heliotropism, and that all heliotropic curvatures are dependent on unequal growth. The fifth and last chapter treats of photo-mechanical induction in heliotropism ; the important fact being here demonstrated that the inductive actions of light and gravitation do not cooperate, but are in opposition to one another, and that heliotropic induction is virtually mechanical.*

Symbiosis.†—Professor L. de Bary, in his address at the last Meeting of German Naturalists, proposed the term " symbiosis " as a general designation for parasitism and analogous phenomena (" mutualism," &c.) in the vegetable kingdom, for which the terms used in zoology are not always exact or appropriate. He distinguishes two principal divisions—" antagonistic symbiosis," in which there is a struggle ; and " mutualistic symbiosis," in which the two organisms receive a reciprocal advantage.

Is the Ovule an Axial or a Foliar Structure ? ‡—The theory that the ovule is of the nature of a bud was powerfully upheld by the great morphologist, Von Mohl. Of recent years the opposite view, that it has more the character of a leaf or of a part of a leaf, advocated with great weight of argument by Celakovsky, and finally supported by Eichler, has met with favour from the majority of botanists. Great ingenuity has been displayed on both sides in adapting to each theory, facts which appear at the first sight plainly to contradict it, especially in the case of malformations, on which both parties greatly rely to prove their case.

Under the title " Ueber Placentarsprosse " Peyritsch supplies another contribution to the literature of the subject. He starts with the assertion that cases, in his opinion, unquestionably occur, of placental shoots or buds taking the place of ovules, with regard to which there is no reason for regarding them as adventitious shoots. This view he supports by the description of abnormal placental structures in *Reseda lutea*, *Sisymbrium Alliaria*, and other cases. He believes that neither of the two rival theories can be accepted as of universal application, but that a series of intermediate forms exists between the normal ovule and the nucleus-bearing segment of a leaf. Notwithstanding all that has been said to the contrary, the normal ovule has more the characters of a bud than of a leaf, and can best be compared to a minute bulb, while malformations often partake much more of a foliar character. He regards, therefore, the ovule as a structure adapted for sexual reproduction, of a variable morphological nature, and is not of opinion that abnormalities are of any great value in determining this last question. As an analogical structure he adduced the cyathium of the Euphorbiaceæ, intermediate between an inflorescence and a true flower, and regarded by the best authorities in different lights.

* See ' Bot. Zeit.,' xxxvii. (1879) p. 341.
† ' Rev. Internat. Sci.,' iii. (1879) p. 301.
‡ ' SB. Akad. Wiss. Wien,' lxxviii. (1878) p. 220.

Starch-transforming Ferments.*—Substances which possess the power of producing fermentation in starch, i.e. of transforming it into sugar, were found by Baranetzky in dormant and germinating seeds which contain starch, in germinating starchy tubers, in stems and leaves, and also in receptacles for reserve materials which contain no starch, as in germinating turnips and carrots. The result was the same whether the plants grew in the light or in dark. The product of the fermentation of starch was determined by quantitative analysis to consist of a mixture of glucose and maltose, the analysis being made as soon as the starch reaction with iodine failed. The formation of these sugars was hindered by elevation of the temperature. From the similarity of its action, Baranetzky concluded the identity of the ferment obtained from different plants. He believes, in accordance with Payen, that the chemical process which takes place is, that dextrin is first formed, and subsequently sugar by absorption of water; not as O'Sullivan thinks, a division of the molecule of starch into dextrin and sugar. The granulose in the starch-grains is first acted on, then the cellulose (farinose). The action takes place with very different rapidity in different starch-grains; those of wheat and buckwheat ferment speedily; those of rice and potato only with great difficulty; and this is not altogether dependent on the relative proportion of the two ingredients in the starch; since the grains of the scarlet-runner, which leave behind a tough skeleton of farinose, are acted upon very rapidly, those of the horse-chestnut only with great difficulty, although they leave but a very delicate skeleton. The actual ferment he believes to be an albuminoid, and its action to be dependent on the presence of oxygen. The distribution of this ferment in the vegetable kingdom he concludes to be very general.

Krauch differs from Baranetzky in maintaining diastase to be a definite chemical compound, which he has detected in onions and the seeds of the gourd. He agrees with that writer in regarding diastase as a widely distributed substance in organs which contain starch, and generally in proportion to the amount of starch. It sometimes exists in the organ while in a dormant state; sometimes it is only found when active growth begins.

Tannin in Vegetable Cells.†—J. B. Schützler records the results of some experiments on this subject. The test employed was the action on ferric chloride or some other iron salt, which causes the protoplasm to contract, kills it, and then produces a black precipitate when tannin or a substance belonging to the same series is present. This was first observed in the glands which cause the oily feel of the upper surface of the leaves of *Paulownia imperialis*, and subsequently in the leaves of *Prunus Laurocerasus*. Tannin was also found in fresh-water algæ belonging to the genera *Vaucheria*, *Spirogyra*, *Conferva*, &c., in sufficient quantities for a good ink to be prepared from the

* ' Die stärkeumbildenden Fermente in der Pflanzen,' von Dr. J. Baranetzky, Leipzig, 1878. ' Beiträge zur Kenntniss der ungeformten Fermente in der Pflanzen,' von K. Krauch, Erlangen, 1878. See ' Bot. Zeit.,' xxxvii. (1879) p. 156.

† ' Arch. Sci. Phys. et Nat.,' i. (1879) p. 344.

alcoholic solution of their chlorophyll. A marine alga, *Ulva Lactuca*, showed no precipitate of tannin when treated in the same way; and the same was the case with a moss, *Hypnum triquetrum*, examined in the month of March.

Functions of Vessels.*—In a somewhat elaborate article on this subject, J. Böhm gives two reasons for arriving at conclusions in some respects at variance with the views hitherto entertained.

The dictum dogmatically asserted by Schleiden, that the mature vessels, and especially the spiral vessels, never contain water, but only air —an assertion made on his authority by most subsequent writers—Böhm maintains, from the result of a series of observations, to be incorrect. The original fluid contents of the cambial vessels are in most plants partially, in others completely absorbed by the sap-conducting cells, without any corresponding volume of air being given off. When the vessels have become older, they are filled from the adjoining cells either more or less completely with sap or with air of ordinary tension. In those vessels whose gaseous or fluid contents are subject to less than the ordinary atmospheric pressure, drops of gum or protoplasm are given off from the adjoining cells through the bordered pits, the latter being enveloped in cellulose, and developing into the so-called "Tüllen" or "thyllæ." Air-dried branches in which the vessels do not possess thyllæ absorb only a small quantity of water. Branches cut off and placed immediately in water in the summer increase considerably in weight, but if laid for any time in dry or damp air before being placed in water, they absorb only so much water as they lose by evaporation. In the first case the vessels immediately absorb water; in the latter case their open ends become filled with air, and hence less easily permeable to water.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Embryology of Vascular Cryptogams.†—Leitgeb contributes a paper on this subject to the 'Proceedings of the Vienna Academy of Sciences,' relating chiefly to the Rhizocarpeæ. The following are the principal results arrived at :—

1. The position of the first partition-wall in the embryo of *Marsilea* is a definite one, and independent of that of the macrospore and prothallium, inasmuch as it in all cases includes more or less exactly the axis of the archegonium ; but it is movable round the latter, and, as soon as the axis of the archegonium deviates from the vertical, assumes such a position that the embryo is divided into two superposed halves.

2. The embryos of *Marsilea* and *Salvinia* resemble in their development those of the Polypodiaceæ until the formation of the octants. The organs are developed after the formation of the octants ; up to this time the embryos are thallomes.

3. The "pedicel" of *Salvinia* is developed from that half of the

* 'Bot. Zeit.,' xxxvii. (1879) pp. 225, 241.
† 'SB. Akad. Wiss. Wien,' lxxvii. (1878) p. 222.

embryo from which the stem is formed ; the posterior half of the embryo (the " hypobasal " half, from which in *Marsilea* and Polypodiaceæ the root is formed) appears in *Salvinia* only as a swelling or " bulb " at the base of the pedicel.

4. The " pedicel " of *Salvinia* corresponds therefore, in its origin and development, to the pedicel of the sporogonium in Hepaticæ.

5. The embryo of *Salvinia* bears a closer resemblance than that of any other vascular cryptogams to the embryo of Hepaticæ, since in the latter the " bulb " and " pedicel " are similar in origin and development ; the ultimate difference depends on the " apical octants," which in the Hepaticæ enter partially or entirely into the formation of the sporogonium, while in *Salvinia* they take part in the formation of the " peltate leaf " and the stem.

Adventitious Buds in Ferns.[*]—Accepting Mettenius's definition of adventitious buds as " those which arise, equally independently of the base of the leaf with those which result from dichotomy, in the form of a new formation beneath the growing-point of the main axis," the lateral buds described under this category by Hofmeister in *Pteris aquilina, Aspidium filix-mas, Asplenium filix-femina, Struthiopteris germanica*, and *Asplenium Belangeri*, must, with the exception of those of the last-named species, be excluded from it. To the list of ferns producing true adventitious buds on the lamina of the frond Heinricher now adds *Diplazium celtidifolium, Asplenium bulbiferum*, and *A. viviparum*. The following is an epitome of the results of his observations :—

1. The adventitious buds of ferns are united to the parent organ by the course of the vascular bundles.

2. The position of the buds varies ; but is constant in the same species within certain limits.

3. In all the cases examined, in their later stages, at all events as soon as a frond is formed, the buds grow by an apical cell which becomes segmented triangularly.

4. In earlier moderately advanced stages, but before the formation of a frond, an apical cell is scarcely ever to be recognized.

5. But in the youngest stages observed, an apical cell with triangular segmentation could be detected.

6. The origin of all the buds is exogenous, and the series of their stages of development points to an acropetal succession.

7. The buds may proceed from a single superficial cell, in which a triangular apical cell is formed.

8. The origin of the buds is at a very early period. The separation of the parent-cells of the adventitious buds can apparently not take place too far from the apex of the frond or of the pinna.

Production of the first vegetative Shoot of Equisetum palustre.[†] —From the prothallium of *Equisetum arvense, palustre, variegatum* and probably other species, is produced first of all a vegetative shoot, which soon perishes, distinguished from the permanent ones by the

leaf-sheaths having only three teeth.   A. Tomaschek has succeeded in keeping these first shoots alive for a space of two years. The cells of these shoots possess an active power of vegetative reproduction, and the writer believes that, in favourable circumstances, sporangia may arise on them.   The secondary stems produced from them have also leaf-sheaths with only three teeth.

Muscineæ.

Origin of Tubes in the Nostoc-colonies in Blasia.*—The formation of colonies of Nostoc in the thallus of *Blasia*, especially in its thalloid appendages or "auricles," has been fully described by Janczewski, Leitgeb, and others. They have also spoken of the production of long tubes penetrating these colonies, a phenomenon which has received further elucidation from M. Waldner. The following are the main results arrived at :—

1. The formation of tubes in the auricle of *Blasia*, when infected by Nostoc, proceeds from the papilla (trichome) which projects into the cavity of the auricle; this papilla consisting of a bluntly conical basal cell and a capitate terminal cell.

2. The tubes developed from this papilla, in consequence of the infection by Nostoc, are not constituted of a single cell.

3. In most cases the tube is developed from the basal cell, while the terminal cell remains unchanged and then dies off, or less often also developes into a tube.

4. The formation of the tube commences by the upper margin of the basal cell swelling out on one side into the form of a cushion, or putting out protuberances on all sides, which become separated by septa from the parent-cell, grow at their apex, and branch, the lateral branches also becoming separated by septa.

5. No regularity can be observed in the development of the tubes. The numerous modifications in their origin, number, and branching, are dependent on the development of the Nostoc.

Fungi.

Endophytic Fungi in Pollen-grains.†—A. Tomaschek has investigated the occurrence of parasitic fungi within pollen-grains, especially in the largest or "antheridial" cell of the multicellular grains of some Coniferæ.

Among the pollen of *Pinus sylvestris* were found cells from which zoospores were occasionally seen to escape, and which were identified by Cohn as being closely allied to the *Chytridium pollinis pini* of A. Braun. The writer, however, prefers to establish it as a distinct genus under the name *Diplochytrium*, distinguished from *Chytridium* by possessing a double cell-wall, and also by not being actually endophytic within the pollen-cells. The organism may, however, be simply the resting-stage of a *Chytridium*. The *Chytridium pollinis pini* is readily detected within the largest pollen-

cells of *Pinus americana*, as many as twenty or thirty of the parasites being found in a single grain. The escape of zoospores from these may occasionally be observed. *Chytridia* were also observed in the pollen-grains of *Typha latifolia*, *Lilium lancifolium*, and *Cannabis sativa*. *Chytridium luxurians*, also endophytic in the pollen of *Pinus sylvestris*, is distinguished by the fact that it never leaves the pollen-grain, but, when mature, emits a tube which projects outside the pollen-grain, through which the zoospores are ejected. The development of these truly endophytic fungi is often obscured by the growth of other fungi among the pollen-grains, the germs of which have been floating in the air, &c.; especially of *Apisporium pinophilum* Fuckel, which first appears as a torula, and then develops dark brown, club-shaped perithecia.

Rate of Germination of Fungus-spores and Growth of Mycelium.*—Dr. G. Winter has made a series of experiments on this subject, extending over a considerable number of species belonging to several different orders of fungi.

The germination of the spores he found to be dependent on a variety of circumstances, such as sufficient access of oxygen and a sufficient supply of moisture, some germinating in moist air, others only when swimming on or actually submerged in water. In some species the development of the germinating filaments takes place at the expense of the food-materials stored up in the spore; others require an external supply. For the germination of most fungus-spores a temperature of from 12 to 20° C. is necessary. Of a large number of fungus-spores which were subjected to experiment, the most rapid germination was exhibited by *Nectria cinnabarina*, viz. in 2½ hours; the least rapid by *Actrostalagmus cinnabarinus*, viz. in 65½ hours. The slowest development of the germinating filament was manifested by *Mucor Mucedo*, viz. at the rate of 2·5 mmm. (micro-millimetres) per minute in a nutritive fluid, ⅔ mmm. per minute in water; the most rapid by *Pilobolus crystallinus*, viz. at the rate of 36 mmm. per minute.

New parasitic Phycomycete.†—In the 'Sitzungsberichte des bot. Vereins der Prov. Brandenburg' W. Zopf describes a new fungus allied to the Saprolegnieæ, which is parasitic on *Spirogyra* and other filamentous Conjugatæ, and which he names *Lagenidium Rabenhorstii*. The biciliated swarmspores attach themselves to a cell of the host, invest themselves with a cell-wall, perforate the wall of the infected cell by means of a filament, and develop into a unicellular mycelium. The hyphæ afterwards become septated, and each cell is a zoosporangium, containing from two to thirteen zoospores. The sexual plants are produced from zoospores which penetrate a cell of the host in pairs, one giving rise to a male, the other to a female plant. The male plant becomes divided into a number of cells, all but one of which produce zoospores, the other becoming an antheridium; it does not give birth to antherozoids, but pierces the female cell, into

which its protoplasmic contents pass. The female cell resembles a sporangium, but has no perforating filament. After fertilization the oosphere develops into a yellowish brown double-walled oospore, the epispore of which is covered with elegant spines.

The "Carolo vero" and "Carolo bianco" of the Rice.*—The cause of these two diseases to which rice is subject is described by Professor Garovaglio in a pamphlet entitled ' Del Brusone o Carolo del Riso.' It is a fungus belonging to the genus *Pleospora*, to which he gives the name *P. Oryzæ*, and of which he describes the spermogonia, perithecia, and pycnidia. In the " carolo bianco " the parasite has attained only an earlier stage of its development; in the " carolo vero " it has reached a more perfect stage. Its presence is shown by the dry, dull-red leaves and leaf-sheaths, the blackish, often torn nodes, which have sometimes altogether disappeared, and the dark, smutty spike which falls out on the least touch. The grain is empty, both embryo and endosperm having completely disappeared. The fructification makes its appearance over the whole plant.

Sporormia, a Subgenus of Sphæria.†—R. Pirotta proposes to re-establish, with some modifications, De Notaris's genus *Sporormia*, nearly synonymous with the *Hormospora* of the same author, usually sunk in the enormous genus *Sphæria*.

The following is his diagnosis of the genus:—Stroma none or simple; perithecia scattered or gregarious, half-immersed or superficial, never enclosed, smooth, globose or oblong-conical, black, sometimes transparent, papillose, prolonged into a mamillæform or irregular conical neck; asci cylindrical, subclavate or widest in the middle, containing usually eight ascospores, prolonged into a pedicel, rarely sessile; paraphyses, when present, filiform, undivided or septate, simple or branched, numerous, flaccid, gelatinous; ascospores cylindrical, composed of from four to twenty jointed or moniliform sporidioles, dusky or nearly black, sometimes encircled by a hyaline gelatinous ring; when mature breaking up into the separate sporidioles. The description of the genus is followed by that of twenty species.

Sclerotium Oryzæ.‡—This form of " sclerotium " is described by Cattaneo as appearing in enormous quantities on the lower portions of the haulm of the rice beneath the water, to which it is excessively destructive, appearing especially in the hollow of the stem, and in the leaf-sheaths. It is globular and very small, with brownish membrane and yellowish protoplasm. The writer states that cavities are developed within the sclerotium, which increase and finally coalesce; and that spores are then formed by abstriction from the ends of hyphæ which appear within the cavities. Their germination was not

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* See ' Bot. Zeit.,' xxxvii. (1879) p. 359.

† ' Nuov. Giorn. Bot. It.,' x. (1878) p. 127.

‡ ' Archivio triennale del lavoratorio di Botanica Crittogamica di Pavia,' vol. ii. ; see ' Bot. Zeit.,' xxxvii. (1879) p. 327.

followed out. The disease thus caused has only recently made its appearance.

Structure of Depazeaceæ.—Under this head M. Crié includes[*] a section of Pyrenomycetes comprising the genera *Diplodia*, *Septoria*, *Glœosporium*, *Sphæropsis*, *Hendersonia*, *Phyllosticta*, *Pestalozzia*, *Morthiera*, *Depazea*, and their allies, all of very minute size, which cause the coloured spots on the leaves of many trees that contribute so much to the autumn tints of foliage. The fungi described as *Xyloma* and *Ectostroma*, generally regarded as distinct organisms, but treated by De Bary as merely pathological products of the leaves, M. Crié considers to be stages in the development of other Depazeaceæ. The Depazeaceæ are distinguished from other foliicolous Sphæriaceæ by the thalloid spots which serve as a support to the reproductive organs. Their first appearance is in the form of a simple black dot, in which state they form the genus *Ectostroma*. The reproductive organs are spermogonia with their spermatia, pycnidia with their stylospores, and perithecia with their asci and ascospores; these do not present anything especially different in their structure from that of other Sphæriaceæ. The spermatia of *Depazea*, Crié considers, along with Berkeley and Cooke, to be not sexual organs of reproduction, but a kind of non-sexual spore less perfectly developed than the stylospores or ascospores. He finds that they germinate only with difficulty, and never produce a mycelium comparable to that which proceeds from the other kinds of spores. The stylospores he found to germinate, after they had been preserved in a herbarium for half a century, just as if they were fresh gathered.

Two New Vine-Parasites. — In the 'Archivio triennale del Lavoratorio di Botanica Crittogamica di Pavia,'[†] Dr. Cattaneo describes two new fungus-parasites on the vine which have made their appearance in North Italy, *Sphærella fumaginia* and *Phoma baccæ*, the latter closely allied to the *P. uvicola* which is so destructive to the vine in America. The nearly ripe berries shrivel up and become more or less strongly coated with a sweetish granular substance soluble in water. The black conceptacles are formed inside the berry, and finally burst the skin; the spores are yellowish and unicellular.

Conjugation of Swarmspores of Chroolepus. — Although this phenomenon had not been observed during the careful investigation of this alga by Frank, Wille claims to have detected it [‡] in a few instances in *Trentepohlia umbrina* (*Chroolepus umbrinum*) growing on the horse-chestnut. Of a very large number of swarmspores observed, the immense majority disappeared without conjugating or becoming invested with cellulose. In a very few instances conjugation was detected, the swarmspores thus proving to be planogametes, in De Bary and Strasburger's use of the term. In only one or two instances was the subsequent investment with cellulose detected. The question needs further investigation.

[*] 'Ann. des Sci. Nat. (Bot.),' vii. (1878) p. 5.
[†] See 'Bot. Zeit.,' xxxvii. (1879) p. 358.
[‡] 'Botaniska Notiser,' 1878, p. 165; see 'Bot. Zeit.,' xxxvii. (1879) p. 294.

Formation of Conidia by a Bacillus.[*]—M. Engel draws attention to the discovery of the fact that certain *Bacilli* taken from a woman during childbirth produced, when placed in Pasteur's solution, conidia; he points out that this observation was published before the paper of Koch on the same subject, and he states that he has applied to the *Bacillus* in question the specific name of *puerperalis*. The body from which the blood containing the *Bacillus* was taken had a peculiar odour; and the blood when injected into a rabbit produced death in thirty-six hours, whereas the conidia had no poisonous effect. The author further draws attention to what he believes to be an error in the statement[†] that a species of *Leptothrix* had produced illness, and is of opinion that the form, if immobile, is probably one of the *Bacteridia*, and, if mobile, is in all likelihood the *Bacillus* discovered by M. Spillmann, and examined and described by himself.

Fermentation of Cellulose.[‡]—As long ago as 1850, Mitscherlich announced the fact that cellulose can be made to ferment; and in 1865, Trécul found that this fermentation is due to minute amylaceous particles to which he gave the name *Amylobacter*. Van Tieghem has now determined that the various forms of this body which Trécul described, are different states of the same bacterium belonging to the genus Bacillus, to which he gives the name *Bacillus Amylobacter*.

This bacterium attacks the cell-wall, which it finally destroys, without in any way affecting the cell-contents, whether albuminoid or amylaceous. It does not however attack all cell-walls indifferently, except in the case of the embryo. Those tissues have the greatest powers of resisting its attacks which are cuticularized, suberized, lignified, or encrusted with mineral substances. Gelatinous tissues are especially liable to be disintegrated by it. In aquatic plants the cellulose, even of the stem and leaves, has a remarkable power of resisting the attacks of this agent. The spores of *Amylobacter*, like those of other bacteria, have the power of resisting without injury a lengthened exposure to a temperature of 100° C., or that of boiling water. The first effect of *Amylobacter* is to transform cellulose or soluble starch (it has no effect on insoluble starch) first into dextrin and then into glucose, with elimination of carbonic acid, and production of an acid the exact composition of which is not yet determined. The action of the *Amylobacter* on cellulose appears to be direct, without the intervention of a diastase.

Resistance of Germs to a Temperature of 100° C.[§]—M. Ch. Chamberland has already shown the existence of a microscopic organism (*Bacillus subtilis?* of Cohn) having the following properties:—

1st. It is exclusively aerobian, and does not develop at all in a perfect vacuum or in pure carbonic acid.

2nd. It grows in almost all organic liquids (infusions of yeast, hay, carrots, &c.), provided they are previously neutralized by potash. There is no development in acid liquids.

3rd. It gives rise to germs or spores which, in neutral media, resist

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[*] 'Comptes Rendus,' lxxxviii. (1879) p. 976.
[†] See this Journal, ii. (1879) p. 454.
[‡] 'Comptes Rendus,' lxxxviii. (1879), p. 205.   [§] Ibid., p. 659.

for many hours a temperature of 100° C. In infusions of yeast or hay they may resist for five hours, whilst in distilled water they are killed by two or three hours' boiling. A temperature of 115° kills them very rapidly.

4th. When boiled for a few minutes in a slightly acid medium these spores are not killed, for they develop when the liquids are placed in sterile neutral media.

5th. A temperature of 40° seems most favourable to the growth of these organisms, though they still develop at 50°.

Whilst pursuing these researches he encountered another organism, also a *Bacillus*, which is both aerobian and anaerobian. When in air it absorbs oxygen from it, but in vacuo it acts as a ferment, and disengages a mixture of carbonic acid and hydrogen; thus resembling the yeast of beer.

It develops also in neutral or slightly alkaline media, and not at all in very acid liquids.

Its germs or spores resist a temperature of 100°, but for a much shorter time than the spores of *Bacillus subtilis*. In distilled water at 100° they resist for thirty minutes, but are killed in forty minutes.

Like *Bacillus subtilis*, the spores are not killed when sown in slightly acid liquids and boiled for some minutes.

The temperature most favourable to their development is that which suits *Bacillus subtilis*.

The liquids in which the new *Bacillus* multiplies become distinctly acid, whereas *Bacillus subtilis* produces no change.

These results lead to important conclusions.

1st. The boiling of water in an apparatus for some minutes, and even for more than an hour, may not be sufficient to deprive it of all living germs, since the germs of the organisms here referred to are found in ordinary water, although in variable proportions.

2nd. In manipulating neutral or slightly alkaline organic liquids the apparatus used must have been previously subjected to a very high temperature.

It is doubtless because apparatus was made use of which it was believed was freed from germs merely by the boiling of the water, that natural milk fresh from the cow's udder could not hitherto be preserved.

By the use of the above apparatus, however, M. Chamberland proved two years ago that such milk will keep indefinitely, without producing organisms, in contact with pure air.

Many experiments claimed as favouring the spontaneous generation theory are therefore explained in a very simple and rational way.

Lichens.

Observations on Microgonidia.[*]—The Rev. J. M. Crombie, writing on the investigations of Dr. Minks and Dr. Müller [†] on what the former calls *microgonidia* (or the minute corpuscules which, according to him and Dr. Müller, are in their evolution changed into gonidia, and constitute the initial state of the latter), says that he does not

* 'Grevillea,' vii. (1879) p. 143.   † See this Journal, ii. (1879) p. 311.

hesitate to affirm that every competent observer will entirely coincide in the view of Dr. Nylander, who declares that the "*microgonidia*" are no new discovery whatever, have nothing at all in common with gonidia, and in fact are simply what is called in vegetable anatomy "molecular granulations," which never, if present in the cellules, go forth from them, and never present any cellular metamorphosis; that so far from their being any novelty, their existence has been well known to every microscopic observer, and that vainly in these granulations shall we seek for anything having any special relation to gonidia or their origin.

Mr. Crombie considers therefore that "the labours of Dr. Minks" cannot in any way, in so far at least as his discovery of "microgonidia" is concerned, be regarded as "profoundly modifying the anatomical notions which were entertained concerning the thallus of lichens." Rather is it to be regretted, in the interest of true science, and for the final suppression of Schwendenerian opinions, that these labours, valuable in some respects as they may be, should have resulted in the promulgation of another theory as untenable as that which Dr. Minks set himself to destroy.

In regard to the "zoospores or zoosporoid corpuscles," which Dr. Müller mentions as having been observed by him in certain gonidia, "contento contracto," gyrosely agitated (and also in the spores of *Agaricus rimosus*), Mr. Crombie considers this a discovery of exactly the same nature as that of *microgonidia*, and that they are in reality nothing more than the same "molecular granulations." The motion which he saw is evidently the well-known Brownian movement, an ordinary property of molecular granulations to agitate themselves where sufficient space is allowed them.

Leighton's 'Lichen-Flora.'—The third edition of the 'Lichen-Flora of Great Britain, Ireland, and the Channel Islands,' has been issued, and is the consequence of the extensive discoveries of Mr. Larbalestier in the west of Ireland, and the inferior, but very interesting, ones of Mr. Crombie, Dr. Stirton, and others, in the north of Scotland, and the author's own extensive researches in North and South Wales, whereby our lichen-flora has been raised to an equality in numbers, rarity, and novelty with that of any other country in Europe.

The number of species and varieties or forms comprised in the second edition of the work amounted to 1156, whilst in this third edition they have risen to 1710. The work is preceded by an introduction to the study of lichens, with their geographical distribution, general and local, and their uses. The descriptions have been revised and corrected throughout, and measurements of the spores from the works of Mudd, Nylander, T. M. Fries, and the author's own, have been added. A copious glossary, list of authors and exsiccati quoted, and an exhaustive index have been appended.

Microscopical Slides of Lichens.—Messrs. Holmes and Joshua's first fasciculus of a series of microscopical slides of British lichens, announced some time since,* has now been issued. The fasciculus

* See this Journal, i. (1878) p. 379.

contains 48 slides, very neatly mounted and secured in a suitable box. These slides are intended to illustrate groups of lichens, and to be of use also in teaching amateurs and beginners the outlines of lichenology by making the appearance of the different parts of lichens familiar to the eye. Special care has been taken to exhibit the final organs of reproduction—the spores—of much use in determining the systematic position of lichens; and we may venture to suggest that a similar attention to the earlier stages of the reproductive organs and the thallus would improve future fasciculi. A considerable number of the specimens are rare, or recently discovered in Britain, and from this point of view will be interesting to the expert lichenologist Such a series as this must be of more use to the microscopist for the purposes of reference than the illustrations of any lichenological work we know of. We have had the opportunity of examining, at the British Museum, a parallel series of slides of Algæ and Hepaticæ.

Algæ.

Structure and Mode of Reproduction of Cutleriaceæ.[*]—The history of development of the Cutleriaceæ has been carefully followed out by Reinke in the cases of *Cutleria multifida, Zanardinia collaris,* and *Aglaozonia reptans.*

As regards the vegetative development, he finds that the margin of the thallus becomes dissociated into a number of threads, which he calls "cilia," a term obviously open to objection. At the basal part of these threads is a meristem; and here the threads coalesce into a solid thallus. The increase in breadth of the frond is due to branching of these threads. The reproductive organs of *Cutleria,* Reinke terms antheridia and oogonia. The former, arranged in groups on the thallus, are septated chambers placed on a multicellular pedicel. The antherozoids are formed in pairs in a cell. The oogonia, which occur on separate plants, are far less numerous. They resemble the antheridia in form and arrangement, but are considerably larger. From them are developed sixteen or thirty-two oospheres, which escape in the form of biciliated swarmspores, to which the antherozoids attach themselves and disappear, probably becoming absorbed in the substance of the swarmspores. These lose their cilia and secrete a cellulose envelope; their further development has scarcely been traced. Thuret found the swarmspores germinate without assistance from the antherozoids. The development of the thallus of *Zanardinia* agrees with that of *Cutleria.* In addition to the sexual organs Reinke found "neutral spores" formed in unicellular sporangia, which break up into four or six pear-shaped swarmspores. The antherozoids force their way into the oosphere, which then germinates. In *Aglaozonia* no sexual organs were found, but non-sexual sporangia similar to those of *Zanardinia.*

These observations, and those of Göbel on *Ectocarpus* [†] seem to

[*] 'Nova Acta Leop.-Carol. Akad. Naturf.,' xl. p. 37 ; see 'Bot. Zeit.,' xxxvii. (1879) p. 142.
[†] 'Bot. Zeit.,' 1878, Nos. 12, 13.

indicate that the Phæosporeæ form a connecting link between the Zygosporeæ and the Oosporeæ.

New Parasitic Alga.[*]—J. Kühn has made the interesting discovery of an alga parasitic on the leaves of *Arisarum vulgare* (*Arum Arisarum*) in the neighbourhood of Mentone and Nice.

On otherwise normally developed leaves, specks were observed of a roundish form, usually 10 or 12 millimetres in diameter, having all the appearance of a parasitic fungus. Closer examination showed, however, that the parasite consists of filaments always densely filled with chlorophyll-grains; in fact, that it is an alga nearly allied to *Vaucheria*, and propagating in the same way, by the whole contents of the cell breaking up into microgonidia, which remain for a considerable period in a dormant condition. The author proposes for it the name *Phyllosiphon Arisari*. He considers the discovery to be of considerable interest from a systematic point of view, in forming a connecting link between the two sections of Sachs's subclass Cœloblasteæ, those containing chlorophyll, viz. the Siphoneæ, and those destitute of chlorophyll, the Saprolegnieæ and Peronosporeæ. It is a very interesting addition to the small number at present known of truly parasitic algæ.

Siphonocladaceæ, a new Group of Green Algæ.[†]—In a descriptive article of the green algæ of the Gulf of Athens, T. Schmitz describes a new species and genus under the name *Siphonocladus Wilbergi*, which he proposes as the type of a new group, the *Siphonocladaceæ*, to include a number of genera of hitherto uncertain affinity, viz. *Chætomorpha, Cladophora, Pithophora, Microdictyon, Anadyomene, Valonia, Botrydium,* and *Struvea.*

The characters of the proposed group are to be found in the structure of the thallus, but still more in that of the protoplasmic cell-contents. The parietal primordial utricle is sometimes, though not always, furnished with a number of reticulate and anastomosing strings which run across the cell-cavity; imbedded in this are a number of small, flat chlorophyll-grains of irregular angular form and very variable size, which multiply by bipartition. The parietal protoplasm invariably contains a number of nuclei, scarcely distinguishable by their refractive power, but only by the application of reagents. The vitality of the protoplasm shows a remarkable power of resistance to external influences. As the mode of reproduction is not at present known in all the genera, and presents a variety of differences where it is known, it is probable that the group may hereafter be broken up into several subdivisions. In *Cladophora* and *Botrydium* non-sexual macrozoospores and sexual microzoospores are described; in *Chætomorpha, Anadyomene, Valonia,* and *Siphonocladus,* only zoospores of one kind; in *Microdictyon* and *Pithophora* no organs of the kind have yet been detected. The bodies described by Wittrock in the last genus as "spores," Schmitz believes to be gemmæ of peculiar form.

* 'SB. Nat. Gesell. Halle,' 1878; see 'Bot. Zeit.,' xxxvii. (1879) p. 322.
† Ibid., Nov. 30, 1878; see 'Bot. Zeit.,' xxxvii. (1879) p. 167.

Resting Condition of Vaucheria geminata.[*]—It has long been known that the unicellular vegetative thallus of various species of *Vaucheria* is liable to segmentation as the result of injury, the attacks of parasites, &c. In addition to this, in certain circumstances they are capable of undergoing a change, visible to the naked eye by the brighter green colour by which it is accompanied, in which the filaments become divided into a large number of cells of nearly equal size by thick gelatinous septa. In this state they form the genus *Gongrosira* of systematic works.

E. Stahl has made a special study of this condition of *Vaucheria geminata*. The *Gongrosira* is multiplied by the production of filaments from the various cells. A not unfrequent phenomenon is also the escape of the entire contents of one of the cells surrounded with cellulose, which thereupon proceeds to germinate. But more common is the breaking up of the protoplasm of a cell into a variable number of portions, at first, as they escape from the mother-cell, enclosed in a thin membrane, which subsequently swells up and bursts. The separate portions of the protoplasm then move about with an amœboid motion, slowly creeping over the substratum. The motion ultimately ceases, the protoplasm assumes a spherical form, and clothes itself with a thin membrane. All these changes may take place, and the resting-cyst be formed, even within the mother-cell. These cysts sometimes develop immediately into new filaments, but more often they remain for a time in a resting condition, in which they entirely lose their green colour. Their germination is marked by the reappearance of chlorophyll.

This condition of *Vaucheria* bears a striking resemblance to one of the forms of another of the Siphoneæ, *Botrydium*, described by Rostafinski and Boronin.

Italian Algæ.—The first volume (1878) of the ' Atti della Società Crittogamologica Italiana' is chiefly occupied by Ardissone's study of the Italian Algæ belonging to the family Rhodomelaceæ, which comprises the genera *Chondriopsis, Acanthophora, Alsidium, Digenea, Polysiphonia, Rytiphlœa, Vidalia, Dasya,* and *Hanovia*. Of *Polysiphonia* alone there are forty-eight species. The volume includes besides a description of a new form of *Melosira Borrerii*, by F. Castracane; an enumeration of the diatoms collected at Ostia, by M. Lanzi (a little over 100 species, no novelties); and a diagnosis of the genera belonging to the family Hypocreaceæ of Pyrenomycetes, by P. A. Saccardo, several of them new.

Subalpine Desmidieæ.—The last part of the 'Mem. della real. Accad. delle Scienze di Torino,' vol. xxx. 2nd ser., is occupied by the continuation of J. B. Delponte's 'Specimen Desmidiacearum subalpinarum,' the first part of which was published in 1876. It is intended to be supplemented by additions to our knowledge of the subject which have come to hand since the publication of the first part. The present part is illustrated with fifteen plates, and the whole will form a magnificent monograph of the subalpine Desmi-

[*] ' Bot. Zeit.,' xxxvii. (1879) p. 129.

diæ, and will include the description of a very large number of new species.

Algæ from Lake Nyassa.[*]—Dr. G. Dickie describes in a paper to the Linnean Society some Algæ collected by Dr. Laws, of the Livingstonia Mission, Lake Nyassa, East Africa, all the genera of which are well-known European, &c., forms.

Of the Diatomaceæ thirty-two species are enumerated, nearly all of which are also very widely diffused elsewhere; the exceptions are few, *Diadesmis* for instance, hitherto confined to the West Indies.

The only peculiar form is *Epithemia clavata*, n. sp. :—" Mediocris, plus minusve clavata, apicibus rotundato-obtusis, costis validis subparallelis, 15 in ·001; latere superiore (dorso) convexo, inferiore subrecto. Long. = ·001 — ·007 poll." It was more or less plentiful on aquatic Phænogams, but especially on *Spirogyra*. The clavate form at once distinguishes it from any known species; at first sight it has a resemblance to *Surirella* (see figures). The striæ proper are not represented here; they are 30 in ·001.

Epithemia clavata.
A, frontal; B, lateral view;
C, small frustule in outline;
all " greatly magnified."

Thallus of the Diatomaceæ.[†]—Mr. J. Deby differs from the observations of Dr. Lanzi on this subject referred to in a paper by Mr. Kitton, which will be found on p. 38. What Dr. Lanzi describes as the " thallus," and as forming part of the living matter of the diatom is, Mr. Deby points out, nothing beyond what has been hitherto a matter of common observation, no species during a part at least of its existence being without a thin protecting envelope resting directly on the external surface of the siliceous envelope, and often so hyaline that to see it it is necessary to employ chemical reagents. The " thallus " is, in fact, nothing but an exudation, a special secretion.

He also considers that the " spores " which Dr. Lanzi found enveloped in the thallus are either granules of endochrome, drops of oil, &c., or unicellular algæ common in all stagnant waters, and which are often met with enveloped in a mucous mass similar to that described by Dr. Lanzi.

Mr. Deby still further doubts the assertion of Dr. Lanzi as to his having found a diatom in all its intermediate states from small spores up to frustules arrived at complete maturity, and asks for additional proofs of such assertions; the proper proof he considers would be to follow step by step, without discontinuing the observation, the exist-

* 'Journ. Linn. Soc. (Bot.),' xvii. (1879) p. 281.
† 'Brebissonia,' i. (1879) p. 113.

ence of an *isolated individual* from the moment of its birth to its complete transformation and maturity.

In a subsequent paper * Dr. Lanzi replies to M. Petit's criticisms and reaffirms his belief in the correctness of his previous observations.

Systematic Position of the Volvocineæ.†—M. E. Maupas criticizes in a recent number of the 'Comptes Rendus' the view put forward by Stein (in his 'Flagellate Infusoria'), that the Volvocineæ are Infusoria, thus returning to Ehrenberg's opinion and reopening the old discussions which after the researches of Cohn might be supposed to have been closed for ever.

According to Stein the true criterion which distinguishes a Protozoon from a Protophyte is the presence of vibratile flagella, contractile vacuoles, and a nucleus combined in one organism. The Protozoa alone combine these three, and it is upon this view that he excludes the Volvocineæ from the vegetable kingdom, and places them among the Flagellate Infusoria.

M. Maupas considers Stein's criteria to be without value, the three characteristics being found in algæ, whose vegetable nature Stein would not venture to dispute.

Everyone knows that all zoospores are provided with *vibratile cilia*.

As to the *contractile vacuole* it is astonishing that such an exact and generally well-informed observer as Stein should still deny the existence of this organ in the vegetable kingdom. It has been seen by Leitgeb, De Bary, Fresenius, Strasburger, Dodel-Port, and Cienkowski, in the zoospores of the Saprolegnieæ, Myxomycetes, *Ulothrix*, &c., and the writer himself has observed it in *Microspora floccosa* and *Stigeoclonium tenue*, and is satisfied that it would be found in many other zoospores if the research was made with sufficiently high powers and in good conditions of observation; at any rate the numerous facts already established are sufficient to disprove Stein's assertion.

With regard to the *nucleus*, Stein in denying its existence in the zoospores of algæ is no doubt in accord with most authorities. All observers who since Thuret have studied these organisms have failed to discover a nucleus, and Strasburger very recently ‡ allows that the nucleus of the zoospores of *Ulothrix* does not exist during its free life and is reconstituted at the moment of germination. M. Maupas, however, by using methods of observation which he has long employed for the study of the nucleus and nucleolus of the Infusoria, has succeeded in discovering a very clearly defined nucleus in the zoospores of *Microspora floccosa*, and of an *Œdogonium*.

He places a small drop charged with zoospores of *Microspora* on a piece of glass, covering it with the cover-glass and sucking out water so that the zoospores should be somewhat compressed and rendered nearly immovable; he then cements with paraffin two of the opposite margins of the cover-glass and draws under it a drop of

* 'Brebissonia,' i. (1879) p. 129.
† 'Comptes Rendus,' lxxxviii. (1879) p. 1274.
‡ 'Bot. Zeit.,' April 25, 1879, p. 274.

alcohol by sucking out the water with blotting-paper, by which means the zoospores are killed suddenly. The alcohol is then replaced by water, and that by saturated carmine. At the end of some minutes the latter is sucked out by blotting-paper, and replaced by water, and that finally by crystallized acetic acid which instantaneously clarifies the objects. There can then be seen in the rostral region of the zoospores a small spherical nucleus coloured an intense red and very clearly defined, the rest of the body remaining very pale. As acetic acid is very volatile, it is only necessary to place at the side of the cover-glass a drop of glycerine, which penetrates and replaces the acid which has evaporated, preserving the form of the zoospores ; a preparation is thus made which on being sealed down will be permanent.

For the zoospores of the *Œdogonium* the process is somewhat different ; they are killed by exposing the drop of water for a minute to the vapours of a 1 per cent. solution of osmic acid, and then cemented beneath the cover-glass by paraffin, coloured by carmine, and clarified by acetic acid and glycerine ; the action of the carmine should be more prolonged than with the alcohol method. The nucleus, situated at the median region of the body rather nearer the posterior end, appears as a small sphere coloured red.

These zoospores were killed during their period of mobility—the nuclei could not be confused with the amylaceous corpuscles which are met with in many of the Volvocineæ by the side of the true nucleus, as the corpuscles are never coloured red in preparations prepared as above—we have therefore a true nucleus combined with vibratile cilia and contractile vacuoles.

The two algæ studied have zoospores of two different types, those of *Microspora* being flagellated, and of *Œdogonium* furnished with a crown of vibratile cilia, and M. Maupas is persuaded that if the zoospores of other algæ are examined they will all be found to have a nucleus.

MICROSCOPY, &c.

Corrosion as a Histological Method.[*]—The process of corrosion has been applied with considerable success to anatomical preparations. Dr. Richard Altmann, of Geissen, now proposes to apply the process to the investigation of certain microscopical structures.

The method adopted is, in the first place, to impregnate the tissue, or to inject its vessels, with olive or castor oil, then to place it in osmic acid until the oil is hardened and blackened, and finally to transfer it to a solution of potassium or sodium hypochlorite (eau de Javelle), which completely destroys the tissue, the fatty material being left, and retaining the form of the vessels or spaces into which it was injected.

Thin membranes may be placed, immediately after injection, into osmic acid, but as that reagent has very little penetrating power, large organs have to be frozen, thin sections of them cut, and these sections

* ' Arch. Mikr. Anat.,' xvi. (1879) p. 471.

placed in the acid until properly hardened.   An immersion of twenty-four hours in 1 per cent. osmic acid is recommended.

During the actual process of corrosion it is advisable to place the section, or other fragment of tissue, in a glass vessel, so that it may be examined from time to time, under a low magnifying power, by transmitted light.   This is rendered necessary by the fact, that if the hypochlorite is allowed to act after the tissues have been eaten away, it begins to act upon the blackened fat itself, discolouring and finally disintegrating it.

When the section has been acted upon for the right time, it is taken out of the fluid on a lifter of platinum foil, any hypochlorite adhering to it is removed with bibulous paper, and it is then examined in glycerine.   A good deal of care is required in manipulating the sections, as they become by corrosion extremely tender, although the osmic acid imparts a really astonishing firmness and elasticity to the olive oil.

The eau de Javelle may be diluted, either for the purpose of watching the stages of the process of corrosion, or in the case of very delicate structures, which would be destroyed by a strong solution.

The method of oil injection and subsequent corrosion is very satisfactory for demonstrating the blood-vessels of the kidney, and those of the iris and choroid ; with the latter it is especially useful, as the pigment which interferes with the examination of an ordinary injection is removed.   In some cases also the oil will extravasate, fill all the cell-spaces in the tissues, and thence pass to the lymphatics. Good preparation of the minutest lymph-capillaries may thus be obtained in such cases as the frog's-skin and mesentery, the cornea of Triton, and the periosteum of the skull of mammals.   In the latter case the injection is best performed by a pressure of about 3 metres of oil applied for 12 to 24 hours.

When tissues are to be impregnated instead of injected with oil, a special *modus operandi* is employed.   The oil is mixed with half its volume of absolute alcohol, and with as much ether as suffices to make the mixture clear when shaken—usually about the same quantity of ether as of alcohol is required.   A fluid is thus obtained which will take up a certain quantity of water, but which, if this quantity be exceeded, undergoes a separation of its constituents.   Instead of olive oil, alcohol, and ether, a mixture of two parts of castor oil with one of alcohol may be employed ; the oil being soluble in all proportions in alcohol, the addition of ether is rendered unnecessary. Larger pieces of tissue, and smaller quantities of fluid, may be used with the latter than with the former mixture.

In either case, the tissue is placed in the oil mixture for 5 to 8 days.   It is then transferred to water in order to precipitate the fat in the interstices of the tissue, and to wash away any that may be adhering to the surface.   Next the tissue is placed for 24 hours in a 1 per cent. solution of osmic acid, and finally corroded with *aqua Javelli*, and mounted in glycerine.

Altmann has employed this method for the investigation of medullated nerve, striped muscle, epithelia, cornea, choroid, and retina.

The memoir is illustrated by three plates, which show the very striking effects produced by the corrosion process: two of his figures are reproduced on Plate XVIII.

> Plate XVIII. Fig. 1.—Kidney of rabbit. Injected from renal artery with olive oil, frozen, treated with osmic acid and aqua Javelli (× 100). The large veins are seen accompanied by the finer arteries, on the branches of which are the glomeruli; one of these is filled with the blackened fat; the vasa efferentia are seen to pass into the capillaries.
>
> Fig. 2.—Vessels of iris of tortoise. Injected from aorta with olive oil, and treated with osmic acid and aqua Javelli (× 10). The circlet of vessels is complete, but separated in preparation. From a photograph.

Staining-fluids *—Prof. H. Grenacher publishes a notice of some new methods of staining, which he considers superior to those already known, especially as applied to nuclei.

1. *Alum-carmine.*—A 1 to 5 per cent. solution of common or ammonia alum in water is boiled for 10 to 20 minutes with ½ to 1 per cent. of powdered carmine, and the solution filtered when cold. The solution is of a rich red colour, inclining to purple, and, when concentrated, stains a section in 5 to 10 minutes. Sections, when washed in water for a couple of minutes after staining, have a purple or lilac colour, the staining also is less diffuse, and more confined to the nuclei, than in the case of the ordinary solution of carmine, or picrocarmine. It also has the advantage of not overstaining even if a section is left in it for a whole day, and if it dries up by evaporation (in a watch-glass for instance), the addition of a little water will render it once more ready for use—no precipitate being produced. It is advisable to add a few drops of some antiseptic, such as carbolic acid, to the solution: it will then keep for years.

2. *Borax-carmine.*—A 1 to 2 per cent. aqueous solution of borax is boiled with ½ to ¾ per cent. of powdered carmine. To the dark purple solution acetic acid is continuously added, drop by drop, with constant shaking, until a bright red colour is attained. It is then filtered, or, as it filters very slowly, allowed to stand, and decanted.

This solution stains sections very rapidly, in from ½ to 3 minutes, but quite uniformly. If, however, they are washed with water, and placed in a watch-glass of 50 to 70 per cent. alcohol, containing a drop of hydrochloric acid, the colouring matter is removed from all parts of the tissue except the nuclei, which remain deeply stained.

3. *Alcoholic-carmine.*—To 50 cub. centim. of strong alcohol (60 to 80 per cent.) 3 or 4 drops of HCl are added, as much powdered carmine as will lie on the point of a knife is added, and the whole boiled for 10 minutes, and filtered when cold. The exact proportion of carmine and acid depend upon the quality of the former. If a section placed in the fluid stains in 5 to 10 minutes uniformly, there is not sufficient acid, and more must be added. If after standing for some days the solution acquires a yellowish-red colour, too much acid has been

* 'Arch. Mikr. Anat.,' xvi. (1879) p. 463.

Kidney of Rabbit.

Iris of Tortoise.

Corrosion as an Histological Method.
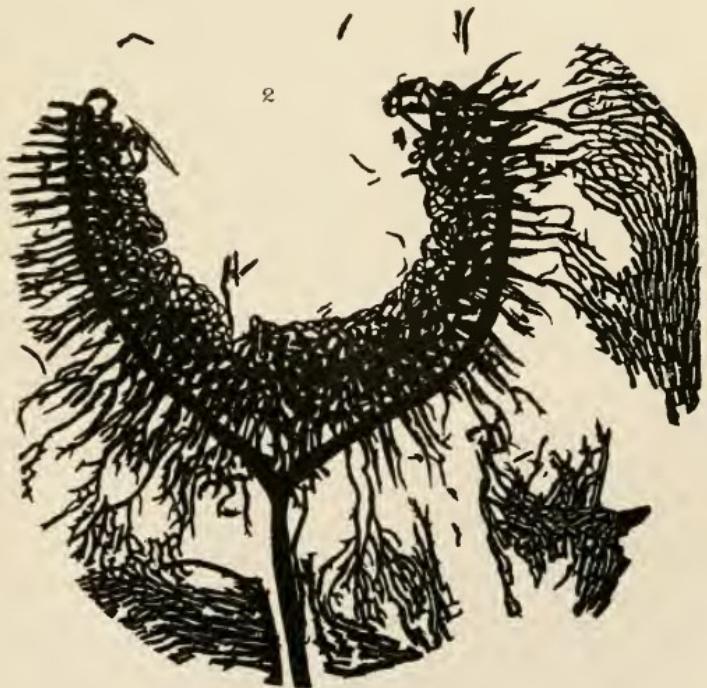
added, and the excess must be neutralized by cautious addition of ammonia.

After staining, the sections must be rinsed in alcohol, not in water: also if the solution be too strong it must be diluted with alcohol, as water precipitates the carmine.

4. *Purpurin.*—About as much purpurin as will lie on the point of a knife is boiled in 50 c.c. of glycerine, the latter may be concentrated, or may have a little water added to it. The resulting orange-red fluorescent solution is allowed to stand for two or three days, and is then filtered. Unlike Ranvier's solution of purpurin, it may be kept for months without precipitation.

All the above fluids are stated to be quite permanent in the case of balsam preparations: if glycerine is used as the mounting fluid it should be slightly acidulated.

Dr. Seiler's Staining Processes.*—Dr. Carl Seiler, continuing the paper which we referred to at p. 329, gives the details of two processes, which he has found to be so universally successful that he has discarded all others.

The first is a simple carmine solution (published by Dr. J. J. Woodward in the 'Lens'), and is made as follows :—

Best carmine (No. 40)	gr. xv.
Borax	ʒi.
Water	fl. ℥ vss.
Alcohol (95 per cent.)	fl. ℥ xi.

Mix and filter, dissolve the crystals in 8 ounces of distilled water, and evaporate over a water bath to 4 ounces.

Sections placed in this fluid will become stained very evenly in a few seconds, and be of a violet red when removed. They are then immersed in a solution of

Hydrochloric acid	1 part.
Alcohol	4 parts.

until they assume a bright rose colour, which appears in a very few seconds. The sections are then well washed in several changes of alcohol, after which they are ready for mounting.

A specimen thus treated exhibits only the nuclei with the granules stained, while the cell-contents and fibrous tissue are not tinted. This is, in many cases, of great advantage, as a much clearer picture results than if the colouring matter is also seen in the non-nucleated structures, and the nuclei are marked only by a deeper staining. If, however, for purposes of diagnosis, it is desirable to stain the contents also, this can be accomplished by using a concentrated solution of oxalic acid in alcohol, or by employing a very weak solution of hydrochloric acid after the specimen has been stained.

The second is a double staining with carmine and indigo. The sections are first stained with carmine as described above, care being taken to wash all traces of acid out of the tissues ; they are then immersed in a solution of two drops of sulphindigotate of soda solution in one ounce of 95 per cent. alcohol, which should be filtered before

using, and are left therein from six to eighteen hours, according to the rapidity with which the elements take up the indigo. When sufficiently stained the sections are placed in strong alcohol, and are ready for mounting.

The sulphindigotate of soda solution is prepared, according to the process devised by Mr. Bullock, by first digesting best Bengal indigo with Nordhausen sulphuric acid. The excess of acid is then removed by washing, the colouring matter precipitated with chloride of sodium, and left standing for several days. The precipitate is then separated from the mother liquor by filtering through flannel, and the excess of chloride of sodium washed out by pouring cold water through the filter until the colouring matter begins to dissolve. The washing is then stopped, and the precipitate dissolved in warm distilled water to saturation, which makes a solution of a deep greenish-blue colour.

The effect of this mode of staining is to leave the nuclei bright red, while the formed material of the cell is slightly tinged with blue. The connective tissue fibres become stained with a deep blue colour, while the blood-vessels are purplish and mapped out with surprising distinctness. Epithelium and hair take this staining in a very curious manner, inasmuch as the cells of different ages take different colours, ranging from a brilliant emerald-green to purple-violet and olive-green, thus affording a valuable means of differentiation, especially in epitheliomas, where the so-called pearls are brought out with great distinctness, being of a different colour from the rest of the cells.

This process seems somewhat troublesome, especially if the microscopist attempts to make the indigo solution himself. But, even if it should prove so, the result obtained is well worth the pains taken, and fully repays the outlay of time and patience bestowed upon it.

Isolation of the Optic Nerve Fibres and Ganglion Cells of the Mammalian Retina.*—Dr. George Thin, in an article in the 'Journal of Anatomy and Physiology,' says that the isolation of the ganglion cells and optic nerve fibres of the retina has certainly not been found by histologists to be invariably an easy task, and he can testify from experience that methods which are well fitted for the observation and study of other parts of the retina, destroy the processes of the ganglion cells and the nerve fibres. Max Schultze has acknowledged this difficulty in his article on the r tina in Stricker's 'Handbuch,' published in 1872. Dr. Thin is induced, therefore, to believe that the publication of a method by which he found the isolation of these elements singularly easy, may be considered justifiable.

The method holds good for the retina of the cat and the sheep; but there can be little doubt that it will prove equally useful in the case of many other mammalia. His observations have been limited to the eyes of these two animals.

It is well known that if a sheep's eye be placed in a sufficient

* 'Journ. Anat. and Phys.' (Humphry), xiii. (1879) p. 139.

quantity of alcohol for twenty-four hours, and at the end of that time be laid open, and the retina be then examined in glycerine, the optic nerve fibres and ganglion cells will be found more or less well preserved. But it is a matter of no small importance to regulate the strength of the alcohol, and diluted alcohol will be found more useful than strong alcohol. A mixture of equal parts of methylated alcohol and water is a strength that he used for some time, with such excellent results that he adhered to it during most of the time that he was engaged in examining this part of the retina; but latterly he found that, in most respects, a weaker strength secured as good preparations, and for some purposes produced better ones. For the preservation of the processes of the ganglion cells, mixtures of one part of methylated alcohol with two of water, and of one of methylated alcohol with three of water, are peculiarly well adapted. The fibres of the optic nerve expansion are well seen, whichever of these strengths is used. They may be isolated in great numbers, and for great lengths, after the bulb has been in equal parts of water and alcohol. When only a fourth strength of alcohol was employed, the nerve fibres were, unless well teased out, slightly obscured by adherent granules—probably the remains of connective substance of the layer.

When the strengths of a third and a fourth were used, the bulb was allowed to remain in the fluid for thirty-six or forty-eight hours.

Although both the ganglion cells and the nerve fibres in eyes, treated by the above methods, can be examined at once in glycerine, it may be found advantageous to subject the retina to other processes, through which the hardened nerve elements can now pass without injury. It may be placed first in water for a short time, and then may remain overnight in staining fluids, and finally be examined and preserved in glycerine, or, after being stained, it may be passed through alcohol and oil of cloves, and preserved in dammar varnish. The glycerine preparations show both the fibres of the optic nerve expansion and the ganglion cells. The dammar preparations are useful as permanent specimens of the nerve fibres. In either case some careful manipulation with needles is necessary to disentangle the nerve fibres, a process which is particularly troublesome in the dammar preparations. Of all the staining fluids tried, a solution in water of aniline blue was found to be by far the best. For the nerve fibres aniline blue alone is sufficient; for the ganglion cells a double staining with aniline blue and eosin is useful.

Eyes which have been placed in alcohol, as above directed, may be preserved for a long period in glycerine without the nerve fibres or ganglion cells suffering in the least. The effect of the glycerine by its affinity for water is to produce a complete collapse of the eyeball. The lens preserving the shape of the anterior part of the bulb, the posterior half is doubled up into the anterior half, forming a cavity at the bottom of which is the stump of the optic nerve. It is thus possible to prepare eyes at any time, and keep them ready for examination. He had excellent preparations of the optic nerve fibres and ganglion cells from the eye of a kitten, which, after being twenty-

four hours in equal parts of methylated alcohol and water, had been kept sixteen months in glycerine.*

Preparation of Diatoms in situ: means of avoiding Air-bubbles.†—M. Petit, referring to the process of Brebisson of preparing *Odontidium Tabellaria,* viz. by placing the filaments on thin glass or mica, and heating on a plate of platinum, says that this presents serious difficulties to amateurs who regard the beauty and cleanness of their preparations. In the first place, it is rare that we are able to carry the calcining sufficiently far to completely destroy the cellulose, which reduced simply to charcoal blackens the frustules; secondly, preparations thus calcined are with difficulty penetrated by Canada balsam, even although care may have been taken to make it sufficiently fluid by the addition of an essential oil, &c.; thirdly, in calcining on the cover-glass only one of the faces of the diatom is ordinarily seen, whilst it is often essential in determining the species to see the two aspects.

He therefore proposes the following method to get rid of these inconveniences. He places the diatoms (previously washed in fresh water if they are marine) in concentrated cold nitric acid for twelve hours; this time is sufficient to "nitrify" the cellulose, without destroying it or dislocating the filaments   After sufficient washing, they are placed on the cover-glass, and calcined to a red heat on a plate of platinum until the deposit has become white; it is then easy to make dry preparations in which there is no deposit of charcoal; for in this case the cellulose, owing to the action of the nitric acid, is destroyed without appreciable residue.

To avoid bubbles of air with Canada balsam, he makes use of oil of lavender, placing a small drop, after the calcination and when the preparations have got cold, on the cover-glass; this infiltrates into all the cavities, and facilitates the penetration of the balsam. The cover-glass should then be placed on a drop of balsam deposited on the slide, and heat applied with a spirit lamp, so as to drive away the oil of lavender and to evaporate a part of the balsam.

In order to prepare diatoms *in situ* in their various aspects on one slide, he boils about the third part of the collection, and mixes this, after washing, with the two other parts, treated with cold nitric acid as above mentioned, and thus obtains excellent preparations containing both diatoms *in situ* and those separated, which is of great advantage for study.

Mechanical Turntables.‡—Mr. Spencer Rolfe, referring to Mr. Rogers' electrical mounting table,§ says that some time since he

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* The method is one that might be used for the examination of the retina of rare animals when the eyes have to be procured from a distance. After the remarkable observation of the anastomosis of the ganglion cells of the elephant's retina by Corti, to which there has been as yet no parallel, a further examination of the retina of that animal is very desirable. The eyes of elephants in a condition suitable for such an examination are not easily procurable, but by the use of the above method available specimens might be had from India.

† 'Brebissonia,' i. (1879) p. 121.   ‡ 'English Mechanic,' xxix. (1879) p. 139.
§ This Journal, ii. (1879) p. 469.

thought he would apply clockwork to a table, but on considering the matter, it seemed unnecessary to give it a continuous motion, as a slide can be ringed in a very short time, and the table must then be stopped to remove it. He therefore adopted a method which he considers simpler, more convenient, and less costly.

The milled portion which is used to spin an ordinary turntable is replaced by a small cog-wheel, and in a horizontal slot in the mahogany support, in a line with this wheel and gearing into it, is a segment of about one-sixth of a cog-wheel, say 4½ inches diameter; this segment is continually pressed by a strong spring to the left-hand side, against a small indiarubber stop, and has then moved so far as to be out of gear with the small wheel, and plenty of clearance. A trigger in the form of a hook, working vertically in the mahogany—the hook catching the lower side of the segment when pushed over—completes the arrangement. The action is as follows:—The segment is pushed over and is held by the catch, the slide being in position. On placing the hand holding the brush on the support, the catch is released, the segment flies round, carrying the table round in the opposite direction; and clearing it, the table continues to revolve. If we could only manage to remove and replace the slides, a moderately well-balanced and weighty table would turn a sufficient time to ring, perhaps, five or six slides.

Improved Turntables.[*]—Mr. Rolfe also communicates the following (the apparatus having been exhibited at a recent meeting of the Quekett Microscopical Club):—My object has been to remove the following objections which I have experienced whilst using the ordinary turntable. A slide having been partly finished and allowed to dry, it is very difficult to replace it with the cell or ring of varnish perfectly centered, and indeed with great practice such can only be done by a considerable expenditure of time and patience. Again, should a very delicate object be mounted, it is very often driven with the rush of fluid near the outside of the cell, and unless the finishing ring of varnish can be put on correctly it stands great chance of being covered by it. With only the springs to hold the slide it is constantly shifting about, and I have found it most annoying when, as has frequently happened, I have spoilt a carefully mounted object from this cause.

My first endeavour to avoid these disadvantages is shown in Fig. 1. It consists of a parallel system of levers, actuating two clips, working in slots in the table, each clip embracing one corner of the slide. The clips are constantly drawn together by an elastic spring. I found this work admirably for a time, but by wear the slides were not correctly centered, and I found moreover that nearly every slide I used was a trifle out of square, and it was therefore necessary to take care that the same corners were always engaged by the same clips. This fact gave me the idea of a far simpler and equally efficient turntable, shown in Fig. 2. The top A has two small pins B B projecting about the thickness of a glass slide, and diagonally opposite

* 'English Mechanic,' xxix. (1879) p. 365.

these is a catch C, a pin from which projects through a slot in the table, and is drawn towards the centre by a spring, shown dotted. This I find acts admirably in every way, and provided the slide to be

FIG. 1.
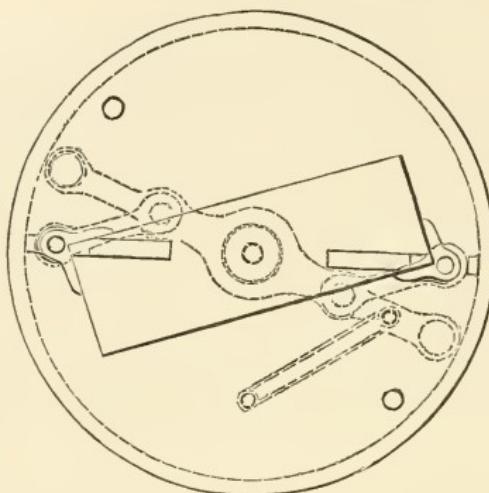
re-ringed has been previously ringed in it, it will always go back truly centered. The stops B B are placed in such a position that the centre of the slide is a little out of truth with the centre of the table, and it

FIG. 2.
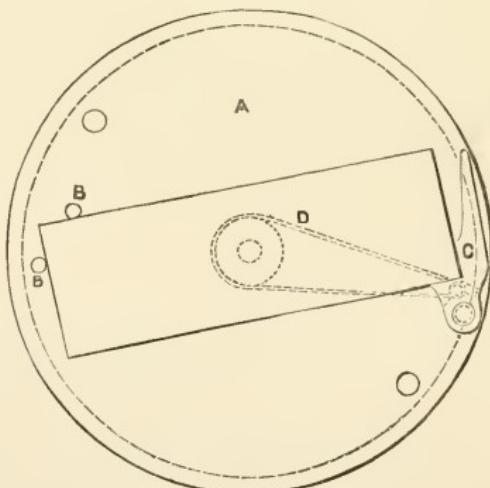
is then seen in a moment, when a slide is placed in the clip, if the right corners are engaged, and if not correct it only requires reversing end for end. Glass cannot be held in a rigid grip, and I find the

pressure given by common elastic bands admirable, and they can be renewed at a nominal cost.

The two holes shown in both the tables are to take springs in order to be able to use it in the usual way for old slides. I have found it of great advantage to make the support for the hand (not shown in the figures) slide back so as to be able to take in exceptionally large or deep cells.

Large Micro-photographs.[*]—Dr. S. Th. Stern says that to obtain a micro-photograph on a large scale the screen of the camera has to be placed at too great a distance from the objective for the operator to be able to adjust the focus without complicated machinery for connecting the fine adjustment with the camera which is uncertain in action, troublesome to work, and of considerable cost. He dispenses with the machinery by simply placing a mirror behind the ground-glass screen. The image thrown upon the screen is reflected in this mirror, and may be viewed through an opera-glass by the operator as he stands by the objective and adjusts it. The adjustment is effected by this means with the greatest ease.

Dr. Sorby at Cambridge.—The following neat reference to Dr. Sorby's labours made by the Public Orator at Cambridge on the occasion of conferring the LL.D. degree, may appropriately find a place in this Journal which numbers so many readers "*qui minuta curiositate arcana illa quæ oculorum aciem fugiunt instrumentorum novorum auxilio perscrutantur*" :—

"Quam magna est rerum natura, in magnis quam immensa, in minimis quam magna! Quam multa miracula, antiquis ignota, illis nuper ostendit qui minuta curiositate arcana illa quæ oculorum aciem fugiunt, instrumentorum novorum auxilio perscrutantur! Hic autem ille est qui, et terrestrium et de cælo delapsorum lapidum investigandis elementis primis, primus inter Britannos talium instrumentorum usum accommodavit. Nuper Societatis Geologicæ præses electus, annorum triginta labores oratione cumulavit in qua vere marmoreum sibi monumentum exegit.[†] Illud vero acutissimum quod crystallis etiam minutissimis exploratis in quibus (ut fit) pars altera est aquæ plena, altera aëris quoque vacua, olim indicavit qua potissimum caloris temperie inclusa illa aqua totum illud vacuum implere, quo potissimum rerum statu saxum illud, quondam ignibus prorsus liquidum, primum durescere potuisset. Scilicet crystallum illud (ut Claudianus ait)

> 'Non potuit toto mentiri corpore gemmam,
>   Sed medio mansit proditor orbe latex
> Auctus honos; liquidi crescunt miracula saxi
>   Et conservatæ plus meruistis aquæ.'

Suo phaselo vectus quot maria mox lustrabit, in terra iam pridem unum saltem Argonautarum, qui terram oculis penetrabat, eatenus æmulatis, quod in intima saxorum materia perspicienda, ipse oculo

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* 'Zeitsch. Mikr.,' i. (1879) p. 321.
† In allusion to Dr. Sorby's Presidential Address "On the Structure and Origin of Limestones."

potuit 'quantum contendere Lynceus.' Duco ad vos Henricum Clifton Sorby."

Unit of Micrometry.*—Referring further to this subject, Professor Romyn Hitchcock points out that the resolution of the Indianapolis Congress did not deal as is sometimes supposed with a unit for micro-meter-makers to subdivide, for which the $\frac{1}{100}$ of a millimetre would probably be the most appropriate subdivision, but with a *unit* in the sense of the smallest whole number used in giving dimensions.

The $\frac{1}{1000}$ mm., the so-called micromillimetre, or *micra* of the French (designated μ), appears to him more suitable for the *unit*. A few examples of its application may serve to support this view.

The diameter of a human blood-corpuscle is about 7·7 μ (·0077 mm.). In birds, the corpuscles measure from 12 to 14 μ in one direction and from 6 to 8 μ in the other (·012 to ·014 mm. × ·006 to ·008 mm.). The corpuscles of *Proteus anguinus* measure 58 μ, and still larger are those of *Amphiuma tridactylum*, 175 μ (·058 and ·175 mm.).

If the reader will assume some other unit, as the cm., or mm., or even the $\frac{1}{100}$ mm., and endeavour to express the same dimensions in these terms, the advantage of the micra will, he thinks, be obvious. With it a single decimal is sufficient for ordinary purposes.

Formation of the Paraboloid as an Illuminator for the Micro-scope.†—In an article in the 'American Quarterly Microscopical Journal' Mr. Wenham gives some useful information relating to practical methods of obtaining parabolic forms.

The glass parabolic illuminators are ground up to form by means of templates. These may be accurately formed by a purely mechanical method, based on the principle that every section of a cone taken in a plane parallel to the opposite side, is a parabola. Proceed as follows :—

FIG. 1.
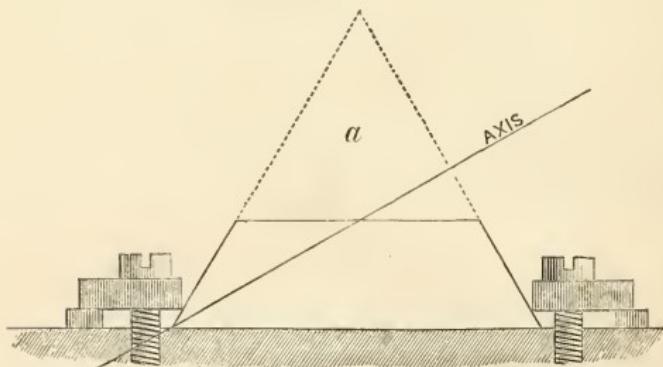
Turn a cone either of metal or hard wood, between the lathe centres, then on the face plate (which of course should run quite true) chuck the cone on one side, either by cement or clamps as shown in Fig. 1.

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* 'Am. Quart. Micr. Journ.,' i. (1879) p. 235.   † Ibid., p. 186.

With the slide rest take off the section a, remove the cone, and on the parabolic face screw a well-flattened piece of sheet brass slightly exceeding it in size; back this up by a block of the same wood as the cone; fix both thereto by two countersunk screws passing through holes drilled in the brass plate. The cone is now returned to the lathe centres and the surplus piece of wood turned down, together with the edge of the brass plate, by means of the slide rest till the cone is again complete. A dead smooth file may then be held against the
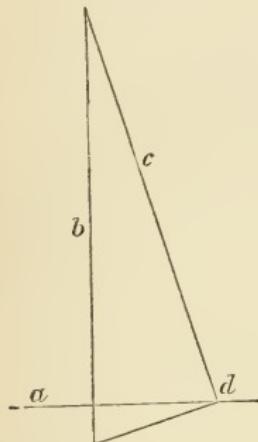
FIG. 2.   FIG. 3.
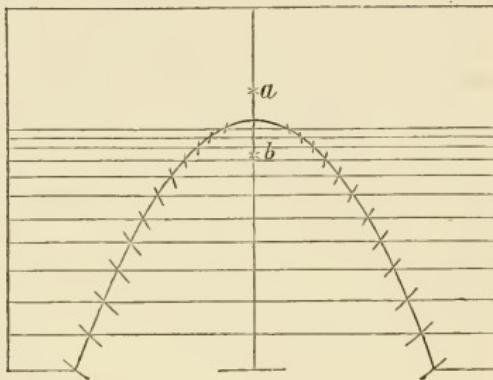
revolving cone; this trims the edge of the contained template which comes out as a true parabola. Unless this is made to match a parabolic figure of known focus, it may be necessary to ascertain the focal point of the blank parabola. This can be easily found as follows (Fig. 2):—
Draw a line a equal to the diameter of the base of the parabola; take a perpendicular to this b, equal to the height from the base to the

EXPLANATION OF FIGURES.

FIG. 1.—A wooden cone clamped down by screws on to the face plate of a lathe. The axis from which the cone was turned inclined in the direction shown. The dotted section a is turned off parallel with the opposite side; on the parabolic face the template is formed.

FIG. 2.—Method of finding the focal distance of a blank parabolic figure.

a. Diameter of base.
b. Distance from base to vertex.
d Half the semidiameter.

Connect d with end of b by line c; a perpendicular from this, taken from d at the point where it intersects the axis below the base, will be equal to the focal distance below the vertex.

FIG. 3.—Outline of rectangular brass plate to form a template for paraboloid.

b. Focal distance.
a. Equal to focal distance above vertex of parabola.

Cross lines drawn at irregular but increasing distances, as shown, measurements on the axis, by compasses, from a to each of these lines; each line bisected by the same measurements from the focus or point b describes the outline of a parabola.

The dotted segment of a circle is struck from the focus b representing a non-immersion paraboloid.

vertex; from the termination of the perpendicular take a line c inter-secting the half-diameter of the base line at d; another line is set off from this point at right angles to c; the distance at the inter-section of the axis beyond the base line will be the required focal distance of the parabola.

To those not possessing the requisite tools, this method of cutting out a template, of course, cannot be available. The plan of drawing with a square and piece of string, described in all elementary works on geometry, is so irregular in its action, as to be useless for small parabolas; bisection must therefore be resorted to, which by careful manipulation gives a very true figure. This operation depends upon the following property of a parabola: that any point taken on the axis at a distance beyond the vertex equal to the distance of the focus within it, to any transverse line on the axis, will be equidistant from the same line to the focus. Proceed as follows:—

Provide a thin brass plate (Fig. 3) perfectly square and flat, of sufficient size to enclose the required parabola for which it is to serve as a template. In a centre line quite parallel with the sides, prick off two equidistances, the directrix a without, and the focus b within the vertex of the parabola. Draw a number of parallel lines at right angles across the centre line; these lines need not be set at any par-ticular distance, but may be ruled at sight, taking the precaution of setting them close together towards the vertex, and progressively in-creasing the distance between them towards the base. With fine-pointed dividers, take the distances of these lines on the axis from the directrix or outside mark a in succession. For each measurement, shift the point to the focus b within the vertex, and bisect the line from which the distance was taken on both sides; the intersection of all the lines by the arcs from the focus will give the outline of a true parabola. The crossing points are now to be dotted in with a thin, sharp-pointed centre punch applied at the right spot under a hand magnifier. The surplus brass is cut out with a fine saw, and the template carefully filed up till the punch marks appear as sunk in the metal.

The block of glass if intended for a flat-topped or immersion para-boloid, should have both its base and apex polished off to the right thickness before it is cemented to the lathe-chuck with black sealing-wax. By means of the rough edges of an old saw-file, ground on one side and used with plenty of turpentine, the glass is turned away at a very slow speed till it is seen approximately to fit the template. The edges of this are then slightly smeared with reddle and oil, and the paraboloid fine turned with a keen edge, until the template marks it evenly all over. In order to take out the rings left from the turning, a block of brass, not larger than half an inch square, is traversed over the revolving glass with coarse and then smoothing emery, till all scratches disappear. The glass is then polished with a buff-stick, and crocus and water, and finally a piece of hard beeswax is held against it with finer crocus, in order to obtain the last degree of polish.

If the paraboloid is to be a non-immersion one with a cupped top, it may be turned flat on the end till the required thickness is arrived at and the hemispherical cavity roughly turned out to a half-circle

template till the centre is brought to the focus; the cavity is then finished in the same way as a concave lens. Finally, while rotating in the lathe the paraboloid is perforated through the axis with a steel drill and turpentine.

Paraboloids can be made true enough for most purposes if finished as above described; but if great accuracy is a desideratum, the figure may be corrected after the rough turning by means of the following appliance.

It is a property of the paraboloid that the face of every section taken parallel to the axis, is an exact counterpart, and, in form, is the same parabola. This enables us to verify and correct the figure. From the further end of a base board, clamped to the bed of the lathe, hinge a piece of board about two inches wide. Let this be so adjusted that when the front edge is raised, the upper plane of the board falls exactly parallel with the lathe centres. Rough file out a piece of sheet brass, something like the template, to serve as a grinder. Lay this on the face of the hinged piece of wood, and press it up on the revolving glass, smeared with fine emery and water. After a few turns, lower the board and shift the brass grinder endways to another position, either in or out. Repeat this continually, occasionally turning the brass over to equalize the sides. By this operation the parabolic figures, of both the grinder and the glass, will soon correct each other. Of course a piece of the swing board must be scooped out sufficiently to admit nearly half the paraboloid.

In accordance with the above mode of procedure, the parabola is originated and its size predetermined by the given focal distance. The ordinary dry parabolic illuminator is usually made about $\frac{1}{8}$ inch focus; for an immersion $\frac{1}{10}$ will do better; but if this is to be used as an animalcule-holder, $\frac{1}{15}$ will be found sufficient.

Black-Ground Illumination.—Mr. Wenham in the same article says, that he has never seen minute organisms or animalcula so beautifully displayed as by the truncated paraboloid described in a paper published in the 'Transactions of the Microscopical Society of London' in 1856. The paraboloid is mounted so as to be used also as an animalculæ cage or live box, the object to be placed in water on the flat top, and confined by a thin glass cover; rays from a lamp made parallel to be sent in beneath, using a dry object-glass. The minutest details are visible in their true colours on a black field. He is not aware that anyone has provided himself with this piece of apparatus, and the knowledge of its effects probably does not extend beyond the half-dozen friends who have seen his demonstration.

Rotating Clips for Cheap Microscopes.*—The rotating stage, when well made, is acknowledged to be a most important and useful addition to any Microscope. It has this objection, however, that when well made it is expensive, and when badly made it is worthless. Moreover, it adds considerably to the thickness of the stage, thus interfering with the use of very oblique light.

* 'Am. Journ. Micr.,' iv. (1879) p. 93.

In the new Microscope of Mr. George Wale these difficulties are obviated by means of a rotating clip, shown in the annexed woodcut.

In this form the stage is circular, but immovable; near the outer edge of the stage, both on the upper and the under sides, are two narrow circular grooves, in which slide two pins attached to a bar, which lies beneath the stage (as shown in the figure) and which carries the clips. To the middle of the bar is attached a spring, which keeps the frame of the clips in place on the stage.
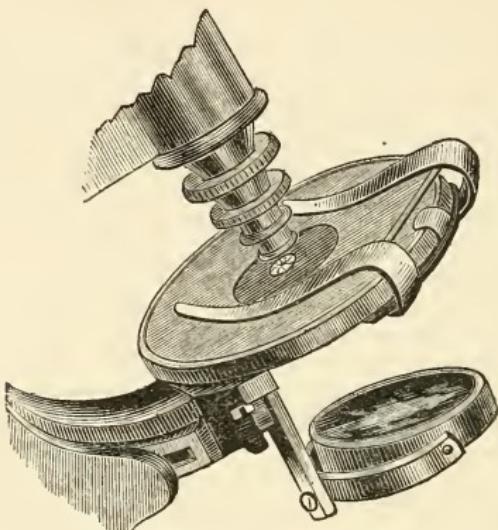
This arrangement not only allows the clips to rotate round the stage, and thus permit the object to be placed in any direction as regards the light, but it enables the microscopist to remove the clips instantly from the stage, and thus leave a clear space for work when the Microscope is used in a vertical position. The clips may also be placed on the under side of the stage, so as to hold the slide from beneath. In this way light of the utmost degree of obliquity may be used, as the stage then virtually has no thickness whatever.

Contrivance for holding Objects beneath the Stage.*—Dr. Phin himself describes in his Journal the contrivance which we quoted and figured under this heading (at p. 466) from an English contemporary. In addition to what is there said, Dr. Phin remarks that another important feature of the sub-stage is that if the spring clips be made very light the arrangement serves as a safety stage, and the most delicate slides may be used even by bunglers without danger of having the slide or cover fractured.

* 'Am. Journ. Micr.,' iv. (1879) p. 92.

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LEWIS, T. R., M.B., &c.—The Microphytes which have been found in the Blood, and their relation to Disease. (1 plate and 18 woodcuts.)
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LIVON, Prof. Dr.—Injections of Bacteria into the Blood without any Phenomena of Poisoning.   *CR. Soc. Biol. Paris*, XXIX., pp. 355–6.

MACCHIATI, L.—On some Parasitic Fungi of Sardinian Phanerogams. [In 'Giornale del Laboratorio crittogamico ed entomologico per lo studio dei parassiti vegetali ed animali delle piante fanerogame della Sardegna.'] pp. 36–40 Sassari, 1879.

Magnus, P.—The Uromyces of Euphorbia. (*Transl.* from 'Hedwigia' for May, 1877.)   *Grevillea*, IV., pp. 147–50.

NAGELI, C. v.—Theory of Fermentation.
Abh. Bay. Akad. München, XIII., Part 2, pp. 75–205.

PASTEUR, L.—Observations on M. Feltz's paper.
Comptes Rendus, LXXXVIII., pp. 1216–17.

PHILLIPS, W., F.L.S.—A new British Peziza. [*P. Asterostoma* Broome, Shropshire.]   *Grevillea*, IV., p. 140.

QUÉLET, Dr. L.—The Tribe of the *Nuclei* (Pyrenomycetes of Fries).
Rev. Mycol., I., pp. 68–71.

REINKE, J., and G. BERTHOLD.—The Destruction of the Potato by Fungi. (9 plates.)   *Untersuch. Bot. Lab. Univ. Gött.*, I., pp. 1–100.

ROUMEGUÈRE, C.—On the Cultivation of Edible Fungi in France, England, Belgium, and Italy.   *Rev. Mycol.*, I., pp. 73–80.

ROUTIER and REGNARD.—A Case of Anthrax observed at the Hôtel-Dieu—Analysis of the Products of Respiration— Examination of the Blood—Death.
CR. Soc. Biol. Paris, XXIX., pp. 442–5, 465–6.

Saint-Gal, M.—The Sclerotium of the Jerusalem Artichoke. (From 'Ann. Soc. Acad. Nantes.')   *Rev. Mycol.*, I., pp. 122–3.

SCHULZER, S.—Mycological Notes.   *Oesterr. Bot. Zeitschr.*, XXIX., pp. 191–2.

SEYNES, M. DE.—On the Amyloid Appearance of Cellulose in Fungi.
Comptes Rendus, LXXXVIII., pp. 1043–4.

THÜMEN, F. DE.—Hyphomycetes nonnulli novi Americani. [13 nov. sp.]
Rev. Mycol., I., pp. 58–61.

VEEDER, M. A.—The Propagation of Cluster-cups.   *Am. Nat.*, XIII., p. 467.

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Lichenes.

COOKE, M. C., M.A., &c.—The Dual Lichen Hypothesis (*concluded*).
Grevillea, VII., pp. 117–26.

CROMBIE, Rev. J. M., F.L.S.—Additions to the British *Ramalinei* [11], with Note on *Lecidea farinaria* and on *Bacidia Arnoldiana.*   *Grevillea*, IV., pp. 141–3.
    „   „   Observations on *Microgonidia*.
Grevillea, IV., pp. 143–5.

DUTAILLY, G.—Observations on the Nature of Lichens.
Rev. Mycol., I., pp. 119–21.

EGELING, G.—List of the Lichens hitherto observed in Brandenburg.
Verh. Bot. Ver. Brandenburg, XX., pp. 17–50.

JOSHUA'S (W.) Preparations of Lichens for the Microscope.
Grevillea, IV., pp. 145–6.

LARBALESTIER's (C.) Lichens of Ireland.   *Grevillea*, IV., p. 146.

MÜLLER, Prof. Dr. J.—Lichenological Contributions, IX. (*continued*).
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    „   „   Note on the Nature of Lichens.
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NYLANDER, W.—Circa Lichenes vitricolas Notula.   *Flora*, LXII., pp. 303–4.

REESS, Prof. M.—On the Nature of Lichens. (10 figs.) pp. 47. 8vo. Berlin, 1879.

ROUMEGUÈRE, C.—Researches of Dr. Müller on the Nature of Lichens.
Rev. Mycol., I., pp. 61–3.

STEIN, B.—Cryptogamic Flora of Silesia. 2nd vol. 2nd half. Lichens. 400 pp. 8vo. Breslau, 1879.

ZUKAL, H.—See Muscineæ.

Algæ.

BORNET, E. — On some Marine Algæ. (Review of Dr. E. P. Wright's papers in ' Transactions of the Royal Irish Academy.')   *Nature*, XX., pp. 155–6.

COX, J. D.—*Surirella Craticula*, an abnormal form of *Navicula cuspidata*. (2 figs.)   *Am. Journ. Micr.*, IV., pp 97–100.

DICKIE, G., M.D., F.L.S.—Notes on Algæ from Lake Nyassa, E. Africa. (1 fig.)   *Journ. Linn. Soc. (Bot.)*, XVII., pp. 281–3.

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FALKENBERG, P.—The Fecundation and Alternation of Generation in *Cutleria*. (1 plate.)   *Mittheil. Zool. Stat. Neapel*, I., Part 3, pp. 420–47.

FARLOW, W. G., C. L. ANDERSON, and D. C. EATON. — Algæ exsiccatæ Americæ Borealis.—List of Species in Fasc. III. [31].   *Grevillea*, IV., pp. 139–40.

LANZI, Dr. M.—The Thallus of the Diatomaceæ. (1 plate.)   *Mém. Soc. Belg. Micr.*, IV., pp. 1–15.

MANOURY, C.—The Diatomaceæ of the Mouth of the Seine.   *Rev. Internat. Sci.*, III., pp. 532–9.

MAUPAS, E.—On the Systematic Position of the Volvocineæ, and on the Limits of the Animal and Vegetable Kingdoms.   *Comptes Rendus*, LXXXVIII., pp. 1274–7.

REINSCH, P. F.—A new Genus of Chroolepideæ. (Plate to follow.)   *Bot. Zeit.*, XXXVII., pp. 361–6.

RICHTER, P.—New Bacillariaceæ. [*Homæocladia germanica*; *H. conferta*.]   *Hedwigia*, XVII., pp. 65–7.

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TIEGHEM, P. VAN.—On the "Gum" of Sugar Works, *Leuconostoc mesenteroides*. (1 plate.) (Continued.)   *Ann. Sci. Nat. (Bot.)*, VII., pp. 185–203.

WITTROCK, V., & O. NORDSTEDT.—Algæ aquæ dulcis exsiccatæ præcipue Scandinavicæ, &c. Fasc. 5 & 6. Nos. 201–300. Upsaliæ, 1879.

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BROECK, E. VANDEN—Instructions for the Collection of Living Foraminifera.   *Journ. de Micr.*, III., pp. 237–42.

Brösicke, Dr. G.—Another Method of Staining Microscopical Specimens. [*Abstr.*] [Osmic and Oxalic Acids.]   *Sci.-Gossip*, No. 175, p. 160.

CERTES, A.—On a Method of Preserving Infusoria.   *Journ. de Micr.*, III., pp. 242–5.

DYMOND, C. H.—On Mounting Seeds.   *Sci.-Gossip*, No. 174, pp. 131–2.

Exner, Prof. S.—Guide to the Microscopic Examination of Animal Tissues. (*Transl.* into French from the second German edition by Dr. F. Schiffers.) (7 figs.) 100 pp. 8vo. Paris and Liége, 1879.

FELL, G. E., C.E. – Practical Hints on the Preparation of Opaque Objects for Microscopical Examination. [Read before the Buffalo Microscopical Club.]   *Am. Journ. Micr.*, IV., pp. 106–11.

HART, J. N. DE.—The Microscope in its Relation to Medicine and Cerebral Pathology. 12 pp. (Reprinted from ' Chicago Med. Journ. and Exam.') 8vo. Chicago, 1879.

RENAUT, J.—On Hæmatoxylic Eosin and its Employment in Histology.   *Comptes Rendus*, LXXXVIII., pp. 1039–42.

Robertson, D., F.G.S.—Information as to the Mode of Collecting Marine Microzoa. (*Transl.* from 'Trans. Geol. Soc. Glasgow,' in 'Ann. Soc. Acad. Nantes.')   *Bull. Soc. Belg. Micr.*, V., pp. 199–207.

SCHÄFER, Dr. H.—On Injection Methods.   *Zeitschr. Micr.*, I., pp. 10–16.

SMITH, Prof. H. L., Hon. F.R.M.S.—Some Remarks on Microscopical Manipulation. (4 figs.)   *Am. Journ. Micr.*, IV., pp. 102–6.

UNDERHILL, H. M. J.—Preparation of Insects for Microscopical Examination (*concluded*).   *Sci.-Gossip*, No. 174, pp. 121–2.
WACKERNAGEL, P.—Preparation of the Diatomaceæ. (2 figs.)
                                              Zeitschr. Mikr., II., pp. 57–68.
WICHMANN, Dr. A.—A Microscopical Study of some Huronian Clay Slates.
                                        Quart. Journ. Geol. Soc., XXXV., pp. 156–64.

APPARATUS for Cutting Thin Covering Glass. (1 fig.)
                                              Zeitschr. Mikr., II., pp. 77–9.
BROECK, E. VANDEN.—Description of a New Kind of Slide for Mounting Dry Preparations, and specially applicable to Collections of Foraminifera, Entomostracæ, &c. (1 plate.)   *Mém. Soc. Belg. Micr.*, IV., p. 111–18.
D'ARSONVAL.—Remarks on the Microscope.
                                        CR. Soc. Biol. Paris, XXIX., pp. 124–5.
GUNDLACH, E.—New Quadruple Objective for Astronomical Telescopes. (4 woodcuts.)   *Proc. Am. Assoc.*, 1877 (1878), pp. 127–34.
KAISER, Dr. E.—Microscopy at the Berlin Technical Exhibition in 1879. I.
                                              Zeitschr. Mikr., II., pp. 69–73.
LOCOCK, W.—" Centerer " for Slides. (1 fig.)   *Sci.-Gossip*, No. 175, p. 160.
M. Dr.—Microscopic Cleanliness. [" Patent Chequered Pumice Tablet," for Removing Stains of Balsam, Pigments, Varnishes, &c.]
                                        Sci.-Gossip, No. 175, pp. 159–60.
MICROMETRY, National Committee on.   *Am. Journ. Micr.*, IV., p. 114.
PELLETAN, Dr. J.—The Oil Question at the Royal Microscopical Society of London.   *Journ. de Micr.*, III., pp. 234–7.
VEEDER, M. A.—Lead Cells.   *Am. Nat.*, XIII., p. 409.
WARD, R. H.—A Modification of Wenham's Reflex Illuminator.
                                        Proc. Am. Assoc., 1877 (1878), pp. 205–6.
ZEISS'S Travelling Microscope. (1 fig.)   *Zeitschr. Mikr.*, II., pp. 16–19.

PROCEEDINGS OF THE SOCIETY.

Meeting of 11th June, 1879, at King's College, Strand, W.C. The President (Dr. Beale, F.R.S.) in the Chair.

The President having called upon the Secretary to read the minutes of the preceding meeting,

Dr. Millar asked leave to make an amendment to one portion of the report—that which related to the thanks of the Society having been voted to the library committee for their services in arranging the new room. He thought that special reference should have been made in that vote to Mr. Crisp and to his donation of the three handsome chairs for the President and Secretaries now before them, and he begged to move that the thanks of the Society be given accordingly.

Mr. Glaisher said that Mr. Crisp seemed determined to lay the Society under as much obligation as possible, for in addition to his other services, and to his great share in the production of a Journal which they might justly be proud of, he had made them this present. He had much pleasure in seconding the vote of thanks.

The motion having been put and carried unanimously, the minutes of the preceding meeting were read and confirmed.

The President said that before proceeding to the business of the meeting, he had a sad duty to perform in announcing the loss of one of their most valued Fellows, Mr. Charles Brooke, F.R.S., who was well known amongst them from his past services as member of the Council and twice President.

Mr. Glaisher said that the loss which they had experienced was indeed a serious one. Having known Mr. Brooke for many years, he could speak to the deep interest which he took in the welfare of their Society, and his readiness at all times to do his best to advance microscopical science. He had therefore risen to move that a letter of condolence should be forwarded to Mr. Brooke's relatives on behalf of the Society, expressing their sense of the great loss which the Society had sustained, and their appreciation of the benefits which it had derived from Mr. Brooke's association with them.

Dr. Millar having seconded the motion, it was carried unanimously.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors; special reference being made by the President to the handsome volume presented by Mr. Glaisher.

	From
Certes, A.—Sur une Méthode de Conservation des Infusoires. (Extracted from 'Comptes Rendus.') 1 plate	*The Author.*
Hyatt, J. D.—The Sting of the Honey-Bee. (Extracted from the 'Am. Quart. Micr. Journ.') 9 pp., 2 plates	*Ditto.*
Report upon United States Geographical Surveys West of the One Hundredth Meridian. Vol. iv. Palæontology. 4to. Washington, 1877. 219 and 370 pp., 83 plates	*Mr. Glaisher.*

The President said he had much pleasure in announcing that they were favoured that evening by the presence of a distinguished Honorary Fellow of the Society—Professor Abbe, of Jena—who would read a paper " On a New Method of Correcting Spherical Aberration."

Professor Abbe on rising was very warmly received by the meeting, and proceeded to explain the method which he had adopted for correcting spherical aberration, illustrating his remarks by diagrams on the black-board as he proceeded. He also exhibited an objective in its complete form made upon the new principle.

The President, in moving a vote of thanks to Professor Abbe for his communication, felt sure that the meeting must have been highly gratified by his very clear explanation of a difficult subject.

Mr. Wenham said it appeared to him that Professor Abbe had mooted a very important question in reference to the difference between the magnifying power of the centre and the margin of the field, which had not yet been properly investigated. He wished to ask Professor Abbe whether he found that this distortion bore any regular ratio to the angle of aperture?

Professor Abbe said that the difference of amplification was not the same as distortion. It was a difference of amplification which might arise in the centre of the field of view from difference of conjugate points. It was quite distinct from the distortion due to different amplification in different parts of the field.

Mr. Palmer inquired what particular form of front lens was employed.

Professor Abbe said he had brought one with him to show the construction. It was a lens about 5° greater than a hemisphere, and was mounted on a very thin plane plate of glass, of somewhat greater diameter than the plane face of the lens, the projecting zone serving for the mounting in the metal cell. This the Professor exhibited, also giving a diagram showing the posterior lenses in the combination, and explaining wherein the new arrangement differed from previous combinations. Very great difficulty had been met with in producing accurate figure to the edge of this new front lens; he could, however, vouch for the fact that excellent figure had been obtained up to 5° or 10° beyond the hemisphere.

Mr. Beck thought they must all feel very much indebted to Professor Abbe for bringing this subject before them, but he wished to inquire whether the plan which he had suggested for doubling up

(so to say) the red and blue rays at the margin of the object-glass was not somewhat similar to the effect produced in the eye-piece of the telescope by making the red and blue rays cross over.

Professor Abbe said that there was a certain similarity, but there was also a considerable difference. He then further explained by means of drawings the course taken by rays departing from different points and passing through the object-glass.

Mr. Ingpen hoped that in passing a cordial vote of thanks to Professor Abbe, they would not omit to compliment him upon having taken a course so very rarely pursued by those who worked at the theory and practice of optics; he had not only made a most valuable improvement in objectives, but had at once explained its principles and method of construction.

Mr. **Crisp** said that they had to signalize the presence amongst them that evening of an Ex-officio Fellow, elected under the amended Bye-laws—Dr. H. E. Fripp, the President of the Bristol Naturalists' Society—who was, he believed, the first Ex-officio Fellow (not being also an Ordinary Fellow) whom they had yet had the opportunity of welcoming. Dr. Fripp had (as he expressed it,— by way of recognition for the compliment paid to his Society) sent them a most valuable paper " On the Theory of Illuminating Apparatus employed with the Microscope." The paper was a long one, and at that late hour they could not do justice to it in full, but he would earnestly recommend all working microscopists to study the paper when it appeared in the Journal.

Portions of the paper were then read (see p. 503).

The President having invited Dr. Fripp to make some remarks,

Dr. Fripp said that he rose, not to speak about his paper, but to allude to the circumstance of his being present with them on that occasion, no longer as a visitor, but by the courtesy of the Society as one of its Fellows. For this courtesy he desired to show himself grateful in the directest manner which common sense dictated, namely, by accepting the good things which came in his way, and evincing his appreciation by hearty enjoyment of them. But he wished also, as one of the first of the Ex-officio Fellows under the new rule, to add that he thought the step taken by the Society in holding out a hand of fellowship and help to those at a distance who were working with less advantages to the same end rightly accorded with the true instincts of science and the enlarged spirit of the age. He therefore felt that those who were thus favoured were called upon to make whatever humble return they might be able.

Mr. Beck much regretted that an opportunity had not been afforded of having a discussion on the subject of Dr. Fripp's paper, as it had a very important bearing on the practical working of the Microscope. Just lately a person described to him some very remarkable appearances which he had observed, and he was enabled to show that they were entirely due to a defect in his illuminating apparatus. He thought that it would be well to have a full discussion on the subject.

The President said that from pressure of time, as they had other

papers before them, it would be necessary to postpone the discussion—a postponement which was the less to be regretted, inasmuch as Dr. Fripp had been kind enough to promise them a second paper on the subject at an early date, when the discussion could take place with the advantage of their having then had an opportunity of reading the present paper in print.

Dr. **W. M. Ord** then stated the chief points in his paper, "On some Causes of Brownian Movements."

Mr. Wenham said that Dr. Ord appeared to have experimented on substances which were liable to change, and inquired whether he attributed the movements to decomposition, and whether they were found eventually to cease.

Dr. Ord said that the movements he had described went on as long as they could be observed. Decomposition no doubt had much to do with the movement in question, but not putrefaction; and chemical metamorphoses appeared to play a very important part in it.

Mr. Wenham remembered about twenty years ago experimenting with a mixture of oil and albumen, and in one case he obtained a very curious effect: having confined some of the substance in a small space so as to get a narrow channel full of molecules, he found that when they could not move laterally, they kept up a continuous movement along the channel in a manner which very closely resembled cyclosis in plants.

Dr. Ord mentioned another interesting experiment. If a small quantity of white of egg was diluted with one-third its volume of water, and to this was added one-tenth the quantity of liquor potassæ, and then some oil were mixed with it (by preference neat's-foot oil), and this mixture were left for a fortnight or three weeks, they would find in the first place a number of molecules covered with laminæ of coagulated albumen. In a certain number of these they would find an interior globule with a pellicle of its own, and sometimes they would also find these filled with a number of the most minute molecules all engaged in the quickest possible Brownian movements.

Mr. Wenham said he had in his possession a slide of quartz containing a small bubble of liquid—supposed to be carbonic acid—which had a continuous motion, and this had been going on many years.

Professor **Kellicott's** letter to Mr. Crisp as to *Anuræa longispina*, described at p. 157, was read, in which he said, " It is a poor traveller, and is at present known only in the water supplies of cities along the Great Lakes, and obtained by filtering the water through muslin, by which process a sediment of dirt and living forms is obtained, with which the rotifer soon gets entangled, and then dies. When they are plentiful, usually during the autumn, clean gatherings are to be had. I have made many trials at capturing them since receiving your letter asking me to send some, but thus far without success. I will keep a look-out for them, and will send a good sample as soon as they can be had."

The following five Papers were taken as read in consequence of want of time:—

Mr. H. J. Carter, F.R.S.: On a New Species of Excavating Sponge (*Alectona Millari*); and on a New Species of Rhaphidotheca (*R. affinis*). (See p. 493.)

Mr. H. J. Carter, F.R.S.: On a New Genus of Foraminifera (*Aphrosina informis*); and Spiculation of an unknown Sponge. (See p. 500.)

Colonel J. J. Woodward, Hon. F.R.M.S.: Observations suggested by the Study of *Amphipleura pellucida*, mounted in Canada Balsam, by Lamplight and Sunlight, with various Objectives.*

Colonel J. J. Woodward, Hon. F.R.M.S.: Note on Abbe's Experiments on *Pleurosigma angulatum*.

Herr A. Grunow, Hon. F.R.M.S.: New Species and Varieties of Diatomaceæ from the Caspian Sea; Translated, with additional Notes, by F. Kitton, Hon. F.R.M.S.

Mr. Crisp said that, in accordance with the views expressed in the last report of the Council, he had from time to time prepared notes of recent observations, illustrated with diagrams, but at none of the meetings had there been any time for him to deal with them, owing to the other business. As the session was now closing, it would be useless to hold them over longer, and he proposed to print one of them in the next number of the Journal, viz. Professor Balbiani's "Observations on *Notommata Werneckii*, and its Parasitism in the Tubes of Vaucheria" (see p. 530), and later, if space allowed, Professor Malassez's "Correction of the Distortions produced by the Camera Lucida of Milne-Edwards and of Nachet," and "Note on the Measurement of Microscopic Amplifications."

The President in wishing the Fellows a pleasant vacation said that they might all congratulate themselves upon the present position of the Society. Many improvements had recently been carried out; their finances were in an exceptionally favourable state, the capital account having been increased, and the revenue for the present year being no less than 200*l*. in excess of that of last year; they had acquired the use of the excellent room in which they were assembled, and they had had nearly fifty applications for Ordinary Fellowship, which Mr. Crisp told him was an unprecedented increase in so short a time, there being still three more meetings to complete the year. He hoped that they would continue to prosper, and that the Fellows would not be idle during the recess, so that they might have a good number of interesting subjects for consideration when the meetings were resumed.

The following Objects, Apparatus, &c., were exhibited:—

Professor Abbe:—Objectives and combinations of lenses illustrating his paper.

Mr. A. de Souza Guimaraens:—Diorite (Napoleonite); Diorite (quartz); Hauyne; Lava (Vesuvius); Liparite (Sphærulitic). (Prepared by Dr. Eduard Kaiser, of Berlin.)

* The photographs did not arrive in time for the meeting, but will be exhibited at the October meeting.

Mr. Loy:—Larva of *Odonestis potatoria* (the Drinker Moth).

Mr. F. M. Rogers:—Electrical mounting table, described at p. 469.

Mr. Crisp:—(1) Professor A. de Lasaulx's apparatus for determining the angle of the optic axes of crystals with the Microscope, described at p. 191. (2) Fresh-water *Mysis* from Buffalo, referred to at p. 52, with some undetermined Rhizopods adhering to it (sent by Professor D. S. Kellicott, of Buffalo). (3) *Uroglena volvox* (from Mr. Bolton).

New Fellows:—The following were elected *Ordinary Fellows:*—Messrs. H. S. Carpenter, F.C.S., A. C. Cole, J. A. Douglas, Romyn Hitchcock, G. L. Nichols, J. Stubbins, and T. E. Watson.

The Presidents for the time being of the following Societies were elected *Ex-officio Fellows:*—

GERMANY.—K. Preussische Akademie der Wissenschaften zu Berlin. (Dresden) K. Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher. (München) K. Bayerische Akademie der Wissenschaften.

AUSTRIA - HUNGARY.—(Wien) K. Akademie der Wissenschaften (Prag) K. Böhmische Gesellschaft der Wissenschaften. (Budapest) Hungarian Academy.

HOLLAND.—(Amsterdam) K. Akademie van Wetenschappen.

DENMARK.—(Kjöbenhavn) K. Danske Videnskabernes Selskab.

SWEDEN.—(Stockholm) K. Svenska Vetenskaps-Akademien.

SWITZERLAND.—(Zürich) Allgemeine Schweizerische Gesellschaft für die Gesammten Naturwissenschaften (Société Helvétique des Sciences Naturelles).

FRANCE.—(Paris) Académie des Sciences.

BELGIUM.—(Bruxelles) Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique.

ITALY.—(Roma) R. Accademia dei Lincei.

PORTUGAL.—Academia R. das Sciencias de Lisboa.

RUSSIA.—Académie Impériale des Sciences de St. Pétersbourg.

THE ORDINARY WEDNESDAY EVENING MEETING IN THE LIBRARY, on the 18th June, was very numerously attended, to hear Professor Abbe give a demonstration of his " Theory of the Microscope and nature of Microscopic Vision," by the aid of the special apparatus belonging to the University of Jena, devised by him for the purpose.

The apparatus consists of an objective of about 1 foot focal length, with a condenser of the same power, the illuminating beam from the lamp being in the focal point of the latter, so that parallel rays fall on the objects exhibited, which consist of gratings of various forms ruled on plates of glass coated with a very fine film of lampblack. The instrument, in fact, forms a Microscope of unusually low power, and consequent large scale. The sub-stage was designed some years ago, and was the same in principle as that of Mr. Zentmayer of Philadelphia. Some of the most curious of the experiments were produced by the illuminating beam being made to fall with oblique incidence on the gratings by means of the swinging sub-stage.

The Professor explained and illustrated by diagrams on the black-board the essential points of the views he put forward in 1874, as to the manner in which the microscopic image is formed, and the causes of the appearance presented by certain details in the image, which he showed to be due to the influence of the internal structural constitution of the object upon the rays of light transmitted through it, the microscopic image of an object with very fine details being in fact composed of two images, an "absorption image" and a "diffraction image," and the ordinary theory that explained the formation of the image by the geometrical method, and attributed the action of wide-angled glasses to shadow effects, being altogether fallacious. He showed the production of spurious lines, hexagons, &c., in the same object, when different diaphragms were used, and gave other interesting demonstrations of his theory, with a perfection (by means of the new apparatus) that could not be attained with the ordinary Microscope.

The Professor's views have already been published *in extenso*,* but he added a new demonstration, of which he has promised to write a short explanation for the October number of the Journal.

SCIENTIFIC EVENING.

The second Scientific Evening of the Session was held in the Libraries of King's College, on the evening of Wednesday the 21st May, 1879.

The following were the objects, &c., exhibited:—

Dr. E. W. Alabone:
    Dissection of drone-fly, showing sucking stomach, chyle stomach, tracheal vessels, nervous system, &c.

Mr. F. W. Andrews:
    Crystals from the surface of an ancient terra-cotta Etruscan vase, and from a glazed terra-cotta Spanish mosaic of the fifteenth century.

Mr. Charles Baker:
    Model binocular and model histological Microscopes.

Mr. W. A. Bevington:
    Stephenson's erecting Microscope.
    Lung of frog.

Mr. Arthur Cole:
    A series of 24 slides of aromatic salts for the polariscope, prepared by Dr. Otto N. Witt.

Mr. Frank Crisp:
    Melicerta tubicolaria.
    Trachelius ovum.

* See 'Arch. Mikr. Anat.' (Max Schulze), ix. (1874). "Contribution to the Theory of the Microscope," translated by Dr. H. E. Fripp in the 'Proceedings of the Bristol Naturalists' Society,' n. s., i. (1875) p. 200, and extracted in part in 'M. M. J.,' xiv. (1875) pp. 191 and 245. See also Mr. J. W. Stephenson's paper, "Observations on Prof. Abbe's Experiments illustrating his Theory of Microscopic Vision," in 'M. M. J.,' xvii. (1877) p. 82 (1 plate), and Mr. Crisp's "On the Influence of Diffraction in Microscopic Vision," 'Journ. Quek. Micr. Club,' v. (1878) p. 79 (1 plate).

Mr. Charles Dunning :
  Limnoria terebrans, and *Chelma terebrans*.
Mr. Frederick Fitch :
  Œsophagus of blow-fly, showing constrictions.
Mr. Edward George :
  Spores and elaters of *Targionia Michelii, Fossombronia pusilla,*
    Aneura pinguis, and other Hepaticæ.
Mr. A. de Souza Guimaraens :
  Tooth of *Dendrodus*.
  Arborescent crystals in glass.
Mr. Henry F. Hailes :
  Foraminifera from Port Adelaide.
Messrs. How :
  Trachyte, Hypersthenite from Penig in Saxony, and Chert from
    the Middle Drift near Wood Green.
Mr. W. T. Loy :
  Series of dissections illustrating the anatomy of *Meloë cicatricosus*
    and larva of *Bombyx mori* with dorsal vessels injected.
Mr. J. Mayall, jun. :
  Abbe's apertometer, with Powell and Lealand's and Zeiss's oil-im-
    mersion objectives.
Mr. A. D. Michael :
  Nothrus theleproctus, one of the Oribatidæ, and the newly dis-
    covered nymph of *Tegeocranus latus.*
Dr. J. Millar :
  An undescribed boring sponge.
Mr. E. T. Newton :
  Sections of brain of *Blatta.*
  Model of insect's brain.
Messrs. Powell and Lealand :
  $\frac{1}{8}$ oil-immersion objective.
Mr. B. W. Priest :
  Marine alga— *Wrangelia multifida.*
Mr. Henry J. Roper :
  Fungi—*Peridermium pini* and *Aecidium aviculare.*
Mr. Walter W. Reeves :
  Fresh-water Algæ—*Bulbochæte setigera* and *B. pygmæa.*
Mr. Charles Stewart :
  Section, stained, of bud of *Fraxinus excelsior* and the growing-
    point of *Chara.*
Mr. J. W. Stephenson :
  A Salpa—prepared with $\frac{1}{6}$ per cent. of osmic acid.
Mr. Amos Topping :
  Mouth of tadpole.
  Tongue of garden spider.
Mr. F. H. Ward :
  New micro-spectroscope.
  Series of sections of plant-stems stained.

<div align="right">WALTER W. REEVES,
Assist.-Secretary.</div>

JOURNAL

OF THE

ROYAL

MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A RECORD OF CURRENT RESEARCHES RELATING TO

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

INCLUDING EMBRYOLOGY AND HISTOLOGY GENERALLY.

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.

JOURNAL

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Cothurnia corrugata.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER, 1879.

TRANSACTIONS OF THE SOCIETY.

XXX.—*On a New Species of Cothurnia.* By John Davis, F.R.M.S.

(Read 14th May, 1879.)

Plate XX.

On recently examining some sea-water, I discovered a colony of Infusoria, which for brilliancy of colour and peculiarity of form, differ, I think, from any species hitherto described.

The water was taken from the "sea-horse" tank in the vestibule of the Brighton Aquarium (by the kind permission of Mr. Lawler, the tank manager). The animals were attached to Confervæ which had been growing on the rocks for about three years, and some small twigs placed there for the Hippocampi were completely covered with them. They undoubtedly belong to the genus *Cothurnia.*

The lorica is generally indistinctly divided into three or four transverse segments, or rings, and is attached by a pedicle to the Confervæ. It is apparently horny, and is of a bright orange colour, but with a condensed, side, light inclines to a yellowish brown, similar to the colour observed on the tube of *Melicerta ringens.* This colour is deeper at the lower end of the tube, and becomes gradually fainter towards the distal extremity, where scarcely any trace of colour is seen.

EXPLANATION OF PLATE XX.

Fig. 1.—Animal protruded. *a a,* forked setæ. *b,* operculum. *c,* outer wreath of cilia. *d d,* contractile vesicles. *e,* unknown organ. *f,* clear space. *g,* posterior processes. *h,* strengthening band. *j,* prolongations of footstalk. *k,* central wreath of cilia.

Fig. 2.—Animal contracted. *a,* operculum. *b b,* contractile vesicles. *c,* unknown organ. *d,* muscular bands beneath the operculum.

Fig. 3.—Individual with young attached. *a,* unknown organ. *b,* free end. *c,* contractile vesicle. *d,* egg-like bodies. *e f,* contractile vesicles. *g,* unknown organ.

Fig. 4.—Young animal. *a,* wreath of cilia. *b,* end of lorica.

Fig. 5.—Young animal. *a,* rudimentary operculum. *b* body of adult. *c,* end of lorica, *d,* unknown organ.

In some individuals the segmentation can be distinctly seen, but in others it appears merely as a slight corrugation. The lowest segment is much larger and broader than the others.

By means of carmine, I was able to impart a brilliant hue, not only to the tube, but to the pedicle, and I then saw for the first time small Infusoria attached to the surface of the lorica and pedicle.

The free extremity of the animal, when it is extended, is of an oval form, hardly as long or as broad as the aperture of the lorica. At one end is placed an operculum, so that when the body is contracted it closes the narrow part of the neck of the lorica (see Fig. 2). In the centre there is a round protuberance, which appears to be of the same substance as the lorica.

This extremity much resembles that described by Mr. F. W. Hutton.* Its flat surface is placed transversely to the mouth of the lorica, and it is furnished with two strong cilia, or setæ, which are forked at about half their length. Besides these there are a number of much finer cilia arranged round the margin, and in the centre is a wreath of very minute cilia in constant motion.

The forked appendages and long marginal cilia move with a spasmodic jerk, and are very irregular in their action; they do not cause a vortex in the water like the central cilia.

In the anterior part of the animal are two contractile vesicles. No eye-spots were apparent.

The body, when extended, is spindle-shaped; containing granules of various shades from a pale yellow to a dark green, amongst which are a number of vacuoles. Towards the posterior extremity the body is of a dark sepia tint, but contains a light-coloured and rather large spot.

When the animal is extended it is much smaller than the lorica, but when contracted it fills the lower portion of it, as shown in Fig. 2. At the lower extremity of the tube the horny substance doubles on itself and forms a band running round the margin of the body; from which project two processes growing parallel with the pedicle. They show no signs of structure.

The footstalk is 1¼ times the length of the lorica in the adult. It is composed of a much more horny substance, as I find it always bent abruptly, forming an angle. The proximal end of the stalk is slightly expanded, and throws out a number of prolongations of various lengths, some going half round the Confervæ. I did not observe the animal at any time contract its stalk, or in fact exhibit any movement in this part.

The animals appear to possess a great amount of sensitiveness to external influences. Sometimes by darkening the stage or by the slightest movement they will instantly contract, and will not

* This Journal, i. (1878) p. 49.

fully protrude for some time, which makes them very difficult to examine. They are all solitary and very sluggish. I have never been able to cause them to imbibe coloured matter.

Size, about $\frac{1}{200}$ of an inch, including the footstalk, when full grown.

Fig. 3 shows a young animal growing on the lorica of an adult; no trace of an operculum could be seen in this individual. Fig. 5 shows the first appearance of an operculum in a rudimentary form, seven hours afterwards. The young are always colourless and transparent, and show no signs of corrugation of their loricæ.

Fig. 4 is the appearance of the distal end of the young animal eight hours after that in Fig. 3, showing a wreath of cilia.

If this species is new, I propose calling it *Cothurnia corrugata*.

XXXI.—*On some Causes of Brownian Movements.*
By WILLIAM M. ORD, M.D. Lond., F.R.M.S., &c.

THE following communication embodies the results of experimental observations on those movements of minute particles in fluids which are commonly called "Brownian." I prefer retaining this name for them in spite of the existence of the old term, "molecular," and of such terms as "titubation" and "pedesis," since, while no hypothesis is asserted, everyone at once knows what is meant when Brownian movements are spoken of, and, what is of no little importance, the term is extensively used on the Continent.

The first experiments to be noticed were made with emulsions of oil and albumen, and were suggested by phenomena observed during the repetition of Ascherson's experiments. Ascherson, as is well known to physiologists, demonstrated * that, when oil and albuminous fluid are brought into contact with each other, a tough, elastic film, the "haptogen membrane," is formed between them; and that when the oil and albumen are shaken together so as to form an emulsion, every globule of oil is instantly surrounded with a delicate pellicle, which he called a "cell-membrane." The experiment is of course easily repeated. And then it is always seen that the oil-drops are surrounded each by a thin coat of albuminous matter, which prevents them from fusing with each other, as oil-drops fuse after oil has been shaken with water or with alkaline solutions. We see the condition which exists in yolk of eggs and in milk. Under high powers of the Microscope the albumen-invested oil-drops are found to be in constant movement.

Experiment :—Some egg-albumen is well shaken with thirty parts of distilled water, and the solution is cleared by filtration. Being now mixed with an equal bulk of olive oil, it is shaken till a persistent emulsion is obtained. This, under magnifying powers of 400 to 700, is found to be composed of tiny globules of oil suspended in the albuminous fluid. The globules vibrate ceaselessly, bodies approaching in their diameter the red blood-corpuscles of man setting to one another in a vague and irregular dance with as much activity as if they were the finest molecules of indian ink or gamboge suspended in water. After a time the movements slacken as the globules float to the surface, and apply themselves to the covering glass; and when at length they stick to it they lie still, just as Dr. Bastian has shown that particles of heavy matter, such as baric sulphate, sink to the bottom of the fluid and lose their molecular motion. The point of interest in the observation is that the movements are here manifested in masses of measurable size. It may be that their shape allows more readily of free mobility;

* Müller's 'Archiv,' 1840.

but there is a further possible explanation in the fact that chemical activities are at work. The instantaneous formation of the membrane indicates the existence of a decided chemical inter-action between the oil and the albuminous solution, and to the persistence of this interaction as producing effects of surface tension I am inclined to attribute the agitation of such comparatively large granules. The method of observation here employed allows of the introduction of new and varied conditions by which the induction may be tested. And by employing such tests I am able to show that the movements are more active and more per-sistent in proportion as conditions prevail, which favour the activity of chemical changes in the fluid, or of reactions between the fluid and the oil; and, conversely, that the movements are diminished or altogether stayed by the introduction of conditions which hinder such chemical reactions. I may state what I have obtained in three lines of research, namely,—

(1) As to the influence of concentration and dilution of the albuminous suspending fluid;

(2) as to the influence of alkalies;

(3) as to the influence of acids.

1. In emulsions made with equal bulks of oil and of albuminous fluid of various dilution I have found great differences of activity of movement. With undiluted fresh white of egg the emulsion is very perfect, but the movements are sluggish or almost imper-ceptible. On dilution of the albumen the movements increase in vivacity until thirty or forty parts of water are added, beyond which dilution leads to enfeeblement of movement.

2. When a little liquor potassæ or carbonate of potash is added to the albuminous liquid before mixture of the latter with the oil, an emulsion of great fineness may be obtained by a single shake of the containing vessel. After a good shaking the fluid is found loaded with molecules of the smallest size mixed with a smaller number of granules and globules of all diameters up to that of half a blood-corpuscle. The movements of these molecules are remarkable as respects both range and quickness. If some of the emulsion produced by a single shake be compared with the above, the proportion of the smallest molecules is much less, and the globules are larger, but even here globules as large as a blood-corpuscle are seen moving with great freedom. When the smaller molecules are in great excess, as in the first case, the movements of the larger might possibly be produced by the blows of their innu-merable satellites, but where the larger are in excess their move-ments must, I think, be considered as belonging to themselves.

3. If, while an emulsion of oil and albuminous fluid with or without alkali is under the Microscope, a drop of strong acetic or of hydrochloric acid be allowed to run under the covering glass, a

momentary precipitation of albuminate is followed by solution in excess of acid. Then the small molecules disappear to a large extent. But the larger remain, and are motionless.

If, again, a solution of acid-albumen be prepared in any way (as by warming fresh albumen with dilute hydrochloric acid, or by digesting dried albumen or dried alkali-albumen with dilute hydrochloric acid) and be well shaken with an equal bulk of oil, an emulsion is formed, but with difficulty, and with no approach to the completeness of the alkaline emulsion.

The particles of this emulsion manifest tolerably active and persistent movement. But the addition of strong hydrochloric acid, which is in this case not attended with any precipitation of albumen, almost entirely stays all movement, in many cases arrests it completely. In this respect my experience is the same as that of Professor Jevons, who finds that molecular movement is hindered by acids.

Such emulsions left in test-tubes for some time show very interesting microscopical phenomena. An alkaline emulsion, made with neat's-foot oil, examined at the end of sixteen days, had a thick, white cream on the surface, the fluid beneath remaining of a pale, thin sky-blue.

The cream consisted of a mixture of minute and most vivacious molecules with larger spherules—as much as $\frac{1}{1000}$ or $\frac{1}{500}$ inch in diameter. They had thick walls, often sharply laminated, and contained either clear fluid, or one or more oil-globules floating in clear fluid, or a dense cloud of vibrating molecules of the smallest size, or, lastly, smaller vesicles enclosing globules or molecules pill-box-fashion. The conditions were at work were, apparently, 1st, an expansion of the haptogen membrane of spherical globules by osmose; 2nd, a continuous addition to the surface of the membrane; 3rd, a repetition of the original membrane-forming action, following the contact of ingoing soluble alkali-albumen with the contained oil, or solution of the oil by the alkali. In the acid-albumen (syntonin) emulsion the smallest molecules had mostly disappeared by the end of sixteen days; the general movements were sluggish and slight. Laminated vesicles of large size abounded (see Figs. 1 and 2).

Comparing these emulsion experiments with those observations in which particles of gamboge, indian ink, or china-clay, are suspended in a chemically indifferent fluid, such as pure water, the introduction of at least two new sources of movement may be contended for. 1st, the chemical surface tension already noticed; 2nd, vibrations or intestinal disturbances in the colloid suspending fluid, such as attend its decomposition, or its metamorphosis, or its resolution into a crystalloid.

As regards the first, the formation of an emulsion is most perfect, and the movements of molecules are most active, when the chemical action between the oil and the albuminous solution is most active. The acid-albumen, the simple egg-albumen, and the

alkali-albumen manifest three well-marked degrees of combining affinity for the oil, with which as many well-marked degrees of emulgence and molecular vibration correspond. The movements are produced or hindered by the same class of relations which

FIG. 1.
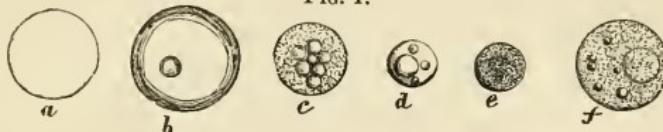
a, Simple vesicle, containing clear, not oily contents.
b, Cell with laminated walls containing oil-globule floating in aqueous fluid.
c, d, e, Vesicles containing emulsions of various fineness.
f, Vesicle containing a smaller vesicle with emulsion.

cause a piece of paper soaked in alcohol to move with violent jerks and in all directions when thrown upon a surface of water, or allow a piece of paper soaked in paraffin to float quietly with a simple linear movement to the margin determined by the attraction of the containing vessel.

FIG. 2.

a, Laminated cell, thin on one side as most are, containing oil-globule floating in aqueous fluid.
b, An irregular mass of fat, invested by a membrane, the folds of which are very plainly marked, and containing a vesicle.

As regards the second, the chemical stability or indisposition to decomposition, of the suspending fluid shows well-marked grades in the several experiments.

a. We find that egg-albumen is unfavourable to active movement in proportion to its viscosity. What may be the exact meaning of viscosity cannot be discussed here, but albumen in the viscous state is not prone to rapid decomposition, tending, indeed, when exposed in open vessels not too deep, to dry up without putrefying. This influence of viscosity is well illustrated in condensed milk.

b. Albumen being mixed with water putrefies with a readiness proportioned to its dilution; and it is seen to favour movements in proportion.

c. Alkaline solutions of albumen putrefy more readily than simple solutions. With alkali the movements are quickened.

d. On the other hand, acid-albumens do not putrefy readily. Solutions of syntonin in acid can be kept for a long time, and the durability of peptones is notorious. With acids the movements are hindered in some proportion to the strength or excess of acid.

e. But peptones being neutralized by alkali fall at once into putrefactive changes.

Generally speaking, in all chemistry, acids hinder decomposition, tending to hold water and other matter in a state of tension. Thus we use acids for pickling, in the same way as we use strong neutral saline solutions; that is to say, mixtures of water with substances having a strong attraction for it. In the experiments recorded acids come to check movements by neutralizing alkali, just as Professor Jevons has shown that they arrest Brownian movement when chemically indifferent matters are suspended in pure water. I may say that before the publication of Dr. Jevons' observations I had made many experiments to test the influence of acids, and that my conclusions entirely agree with his. In stating this, I have no intention of derogating from the originality of Professor Jevons, but simply of adding my testimony to his on a matter of some importance. Free alkalies, on the other hand, are everywhere provocative of decompositions and unrest. Beyond what we have noticed, as in peptones, we see alkalies used by the chemist to induce breakings up, oxidations, and the formation of new matters, usually of smaller out of larger molecules. They tend, in fact, to determine the formation of new matters with which they may combine, and so help to favour a tendency which seems to belong to all matter, that of coming to rest.

From these various considerations I venture to draw the inference that minute intestine vibrations of the colloid suspending fluid have a power of intensifying molecular movements in suspended particles.

This is, I submit. greatly favoured by the concomitant variations set forth, showing that the movement of particles is more or less active according to the presence in the surrounding fluid of conditions favouring or hindering chemical changes in the colloid.

I may cite an experiment in which the method of difference gives results in the same direction. One of the best mixtures for demonstrating molecular movement is that of indian-ink with distilled water. The solid ink is rubbed gently with water until a mixture of suitable thickness is obtained. This consists of particles of solid black matter suspended in water now dissolving whatever viscous matter had been used to bind the particles into a cake. What this viscous matter may be I know not exactly, but from all appearance it is some kind of gum—in other words, a colloid.

Now, if a large quantity of indian-ink be rubbed down with water, and the mixture be left in a tall vessel to allow of subsidence of particles, the viscous matter may be in process of time to a large extent washed away, leaving a mixture of particles with nearly pure water. This mixture shows an infinitely less active and persistent movement, though with particles of the same size and number.

The influence of solutions of soap upon Brownian movements, as set forth by Professor Jevons, appears to me to support my contention in the way of agreement. He shows that the introduction

of soap into the suspending fluid quickens and makes more persistent the movements of the suspended particles. Soap in the eyes of Professor Jevons acts conservatively by retaining or not conducting electricity. In my eyes it is a colloid, keeping up movements by revolutionary perturbations. Indeed, soap is a very typical colloid in its tendency to physical change without obvious decomposition. A solution of soap, at first clear and transparent, becomes usually within a few hours thicker to the eye ; and as days proceed it becomes thicker and thicker, until it has almost a granular look, though even then nothing is separable by filtration. Curiously enough, the formation of soap is involved in all our emulsion experiments. And I venture to argue that the most interesting applications made by Professor Jevons in relation to the detergent powers of soap illustrate the influence of the colloid in causing rearrangement of particles brought within its sphere of action. It is interesting to remember that, while soap is probably our best detergent, boiled oatmeal is one of its best substitutes. What this may be as a conductor of electricity I do not know, but it certainly is a colloid mixture or solution. With Professor Jevons's idea that the detergent value of soap depends upon its power of causing minute molecular disturbance rather than upon its chemical action, we may compare in support Mr. Rainey's remarkable demonstration of the erosion of the surface of glass slides by spheres of carbonate of lime deposited on the slides in solutions of gum. Here, again, no chemical action is involved, the erosion being a result of attraction exercised upon the molecules of the glass by the molecules of the carbonate sphere, the disturbing influence of the colloid allowing of rearrangement, or, indeed, favouring it by disturbing pre-existing relations of molecules.

In relation to the general subject of my paper, I would argue that the increased movements here visible as a result of the presence of colloids in the suspending fluid, are but larger forms of the movements demonstrated by Mr. Rainey as occurring in crystalloid matters deposited in colloid solutions.

He has shown that colloids interfere with the molecular arrangement of crystals, and compel them to take a spheroidal form—this he calls "molecular coalescence."

He has again shown that spheres formed by molecular coalescence may be broken up on being introduced into colloid solutions of the same nature as that in which they were originally deposited, but of different density. This he calls "molecular disintegration," and this again bears on the detergent value of soap.

Again, the susceptibility of different crystalloids to this sphere-forming power of colloids not being equal, I have shown at various times that the power of colloids to master the polarity of any crystalloid is intensified by whatever tends to increase vibration in

the colloid, e. g. decomposition or heat; or by the existence in one colloid of a higher molecular composition than in another—albumen, for instance, having a greater power, even when coagulated, than gelatin or gum. Conversely, dilution, coagulation, condensation, cold, magnetism, all hinderers of vibration, hinder sphere-formation.

Quite recently I have been able to illustrate these influences by experiments, which show the movements of molecules translated into large movements visible under the Microscope, and in one case visible to the naked eye. These experiments are before another Society and I am not in a position to quote them at present.*

To sum up, therefore, while I admit that heat, electricity, capillary attraction, chemical and other forces may each or all play a part in producing Brownian movements; while I admit the agency of surface-tension; while I do not altogether reject Mr. Rainey's theory of persistent movements in fluids,† I claim the intestine vibration of colloids as in many cases an agent in the process, and more especially in the fluid and semi-fluid parts of animal and vegetable organisms.

Indeed I am disposed to go further, and to regard this as in one aspect a manifestation of a tendency, already glanced at, in all molecules to come to rest—to rest of a physical or chemical kind; and of all molecules of one kind to find rest in association with their kind, as in the crystal. Slow movements of this kind have been at work in the yet pulpy chalk separating the flints from it. Slow movements of the kind are abundantly illustrated in the metamorphoses of minerals. Quicker movements are seen in the mixture of the kaolin and distilled water; quicker still in kaolin with soap. As I see crystalloids struggling in the grasp of colloids, and gradually extricating themselves from their grasp to revert to the crystalline from the spherical form, with constant accompaniment of molecular movements, I see the existence of a chain of force leading from the activity of movement which builds up the sphere to the rest which is possible only to the inorganic crystal, and compare this chain with the chain seen in the vaporization of water by the sun, the lifting of the vapour to the upper regions of the atmosphere, its condensation to cloud, and its subsequent descent in rain or in rivers to rest in the sea. As the one chain produces a series of actions and expenditure of power in the outer world, so in the economy of living organisms some such chain as I have compared with it may well play its part in development, in organization, in motion.

* See a paper since read before the Royal Society (June 19th, 1879), entitled "An account of Experiments on the Influence of Colloids upon Crystalline Form, and on Movements observed in Mixtures of Colloids with Crystalloids."

† See St. Thomas's Hospital Reports, vol. ii. 1871, "On Continued Movements in Fluids."

XXXII.—*Observations suggested by the Study of Amphipleura pellucida, mounted in Canada Balsam, by Lamplight and Sunlight, with various Objectives.* By J. J. WOODWARD, Surgeon and Brevet Lieutenant-Colonel U.S. Army, Hon. F.R.M.S.

<center>(*Read* 11*th June*, 1879.)</center>

IN the latter part of October, 1878, I received from Carl Zeiss, of Jena, two objectives, a $\frac{1}{8}$ and a $\frac{1}{12}$, both "oil-immersion," or as they are now called by their maker, "objectives for homogeneous immersion." To test their performance, I made with them some photographs of *Amphipleura pellucida* mounted in Canada balsam, and, for comparison, photographs of the same frustule, with several other objectives. On January 20, 1879, I wrote to Zeiss a brief account of these experiments, and sent him a set of the photographs, together with a duplicate set for Professor E. Abbe, of Jena. I learn from the Journal * that Professor Abbe promptly sent one set of these photographs, together with my letter, to Mr. J. W. Stephenson, who exhibited the photographs and read parts of the letter at the meeting of the Royal Microscopical Society, February 12, 1879.† This circumstance, which was fully in accordance with permission granted in my letter to make public use both of it and the photographs, would render it unnecessary for me to do more at present than to send duplicates of the photographs for the cabinet of the Society, but that, since writing to Zeiss, I have made photographs of the same test with several other notable objectives, especially a $\frac{1}{6}$ glycerine-immersion by Spencer, and a $\frac{1}{10}$ oil-immersion by Tolles, and that the results induced me to make a new series of comparative photographs with the best objectives at my disposal, including, of course, those of Zeiss. This new series I now send to the Society instead of the original one.

Several matters of interest were first noticed or strikingly illustrated during the progress of the work, and to these it is the object of this paper to draw attention.

I. The first point was brought out during the original series of experiments, and was detailed in my letter to Zeiss, but does not appear to have been read to the Society, viz. the best mode of projecting images upon the screen for photographic purposes with such objectives as those of Zeiss. These objectives, it will be remembered, have no screw-collar adjustment, and their aberrations are completely corrected only when the focal adjustment is such that the image is formed at a fixed distance, which, in the case of the two objectives sent me, is 10 inches. Now, to obtain the

magnifying power I desired for the photographs, from ten to fifteen times this distance is required, and it would at first sight appear necessary for this purpose to bring the objective so much closer to the object than the position for which alone it is corrected, that the resulting aberrations would quite destroy the definition of the image. This difficulty appears to have occurred to Zeiss himself before he sent me his objectives, for he voluntarily furnished with them two concave lenses said to be of 25 and 30 centimetres focal length, which he directed me to screw immediately into the posterior part of the brass mounting of the objectives when I used them for photography, and by which he supposed the aberrations introduced by distance would be corrected. One of these concaves was intended to correct the aberrations when the image was projected to 1·5 or 2 metres distance; the other was expected to answer the same purpose at the distance of 3 metres or upwards.

If Zeiss consulted his distinguished adviser, Professor Abbe, as to the formulæ for these concaves, I do not doubt that he was correctly instructed; but if so, the lenses as actually sent do not correspond very precisely with the mathematical requirements. I tried them faithfully, and wrote to Zeiss as the result of my examination, that when I came to study the images produced with these concaves at the distances directed for each, " I became painfully aware that a curvature of field had been introduced which did not belong to the image as viewed with the 10-inch tube, while great loss of definition indicated the presence of considerable spherical aberration in the new combination." Photographs taken under these circumstances were exceedingly unsatisfactory, and had no other means of projecting images with these objectives been available, I should not have succeeded in presenting a photographic demonstration of their excellent qualities.

But long before I received them I had theoretically devised a method for making these projections, which on trial fully answered my expectations, and gave, at any distance I chose to select, images quite equal in flatness, definition, and brilliancy to the best I could obtain with the 10-inch tube. This method consists in placing a suitable achromatic negative lens at the end of the draw-tube of the Microscope body, and slipping it by trial to the proper position to bring the image to a sharp focus on the screen at the distance selected, while the objective remains in precisely the same focal position that was found to give the best image with the 10-inch tube. The course of the rays through the objective under these circumstances remains the same whether the image is projected to 1 or 4 metres, or any intermediate distance, and, provided the concave has the requisite qualities, the sharpness of the image is unimpaired.

For this purpose I had selected an "amplifier" made for the Museum more than ten years ago by Mr. Tolles, of Boston. It was intended to be used at the end of the draw-tube in ordinary microscopic work for the purpose of obtaining increased magnifying power. This "amplifier" was a negative achromatic meniscus of about 6·5 inches virtual focus and ·7 of an inch in diameter. I had in the Museum collection a number of other "amplifiers" specially constructed for the projection of microscopic images, but knew by previous experience that none of them equalled the Tolles amplifier in flatness of field or freedom from spherical aberration. After failure with the Zeiss amplifier, therefore, I tried this Tolles amplifier in the manner I had originally intended, and after some little experiment to ascertain its proper position in the Microscope body for the distances at which I designed to form the images, I obtained the results at which I aimed.

It will readily be understood that the best position of the amplifier with the Zeiss $\frac{1}{8}$ or $\frac{1}{12}$ for the projection of the image to say 10 feet distance from the object, will also be the best position for all other objectives, provided their corrections are best neutralized when they are focussed on the object with the 10-inch tube, and therefore the positions of the draw-tube corresponding to the best images at a series of selected distances having been found by careful experiment with any selected objective, may be used successfully with any other objective corrected for the 10-inch tube. Indeed this method may be advantageously resorted to in the case of objectives provided with a screw collar, in place of the usual method in which the screw collar is used to correct the aberrations introduced by distance. The positions of the amplifier, as indicated by the scale on the draw-tube, having been found for the distances at which the pictures are to be taken, it is only necessary in subsequent work with the same amplifier, to set it, by means of the draw-tube, at the position known to be best for the distance selected, and then to focus with the fine adjustment in the usual way.

It was in this manner that the images were projected for the photographs I sent to Zeiss, and for those which accompany this paper. I am pleased to observe by his printed circular, dated March, 1879, that since he received my letter in which this method was explained, and the photographs sent with it, Zeiss has been influenced by them to construct and advertise for sale a concave lens of 10 or 12 centimetres focus, to be placed at the end of the draw-tube (in das Auszugsrohr des Tubus eingesetzt), for the purpose of projecting images with his objectives, instead of the unsatisfactory device he offered me last fall. I regret to find, however, that I have unintentionally misled Zeiss as to the focal length of the amplifier I used. Copying by accident from my

note-book a memorandum referring to another amplifier, I wrote him that it had a virtual focus of about 12·5 centimetres, whereas its focus is really somewhat more than 16.

I do not, however, doubt in the least that excellent results may be obtained with a properly constructed amplifier of the focal length he has adopted, and can express no opinion as to how far he has succeeded in this direction, because I have not yet seen one of those he is making. But I must point out that it is not enough to have a properly constructed amplifier, and to screw it at the end of the draw-tube ; it is also of prime importance that the proper position of the amplifier should be found for the distance selected. If this is neglected, very unsatisfactory results may be obtained with excellent instruments.

I must add, that the plan of using a negative lens behind the objective, for the purpose of increasing the size and flatness of the image formed by a solar or gas Microscope on the screen, is quite an old device, as is also the plan of using a negative lens between the eye-piece and objective (preferably at the end of the draw-tube) for the purpose of increasing the magnifying power of the Microscope. I was, however, the first to point out the advantages of employing a suitable achromatic concave in place of the eye-piece of the Microscope for the purposes of photo-micrography. I had already published a preliminary notice of this method in 1865,[*] and described it in more detail in 1866.[†] Since then I have repeatedly, in published articles, in private letters, and by word of mouth insisted upon this point, until it has become so familiar that some of my correspondents imagine it to be their own contrivance. I have not hitherto, however, nor has any other microscopist, to my knowledge, commented upon the important application of the achromatic concave described above, in which, by giving it suitable focal length and position, it is used to project the image upon the screen while the object-glass is in precisely the position with regard to the object that it would occupy in ordinary work, and the course of the rays through it quite the same.

II. The second point to which I wish to call attention relates to the obliquity of the illuminating pencil necessary to resolve difficult lined test objects, such as *Amphipleura pellucida* mounted in Canada balsam, by objectives of adequate aperture. Until a comparatively recent period many respectable microscopists still clung with affection to the singular theoretical error that the angle of aperture of immersion objectives, as measured in a medium (such as Canada balsam) of about the index of refraction of crown

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* Circular No. 6, War Department, Surgeon-General's Office, Washington, 1865, p. 149.
† 'American Journal of Science and Arts,' vol. xlii. (1866) p. 189 ; also 'Quarterly Journal of Microscopical Science,' vol. vi. (1866) p. 166.

glass (it has been the fashion to call it the balsam angle), could by no means exceed double the angle of total reflexion from glass to air, which theory indicated as the limit for dry objectives. It is now universally admitted by the physicists and mathematicians whose attention has been directed to the subject, that this limit, inflexible as it necessarily is for dry objectives, has nothing whatever to do with the question of the aperture of immersion objectives, which indeed, from this point of view, would be limited only by double the angle of total reflexion from glass to the immersion fluid. The adherence of any individual microscopist to the old error is therefore no longer of importance, and the practical opticians, acting in strict accordance with correct theory, have succeeded in constructing water, glycerine, and oil-immersion objectives, not merely exceeding 82°, but attaining 100°, 115°, and even, in the case of one well-known maker, over 120° balsam angle for an oil-immersion objective. The limit of improvement in this direction is not yet attained.

Professor Abbe has recently announced his expectation * that it will be possible in the near future to construct objectives having an aperture of 128° in a medium of 1·50 index of refraction. That this expectation will be realized, and with resulting improvement in defining power, I do not doubt in the least, but cannot believe that the limit will be found even here.

But while the correct views with regard to the aperture question are now generally accepted, and a number of practical opticians are making use of this knowledge in the construction of improved objectives, we hear it continually asserted of late, that no advantage can possibly be derived from the excess of angle in immersion objectives beyond the much-talked-of 82°, unless immersion illuminators are used to throw the illuminating pencil upon the object with an increased obliquity corresponding to the increased angle of the objective.

This statement, which is an exceedingly exaggerated one, has been so loudly reiterated, and has been accepted, without special investigation, in such high quarters, that I have thought it worth while to take this opportunity of drawing attention to the actual facts. It is quite true that when a feeble source of illumination, such as a coal-oil lamp, is employed, it is necessary to use an immersion illuminator by which the light can be thrown upon the object more obliquely than would otherwise be possible, whenever we desire to obtain the best possible resolution of difficult lined test objects with objectives whose balsam angle exceeds 82°. It is also true that the performance of these objectives on histological and

* 'Ueber Stephenson's System der homogenen Immersion bei Mikroskop-Objectiven,' "Sitzungsberichte der Jenaischen Gesellschaft für Medicin und Naturwissenschaft," Jan. 10, 1879.

other preparations, when the illumination is effected by means of a central pencil of light from a coal-oil lamp, is much improved if an immersion condenser of aperture equal to that of the objective be substituted for the ordinary dry achromatic condenser.

But notwithstanding these notable and practically important facts, it is nevertheless equally true that without these valuable accessories the new immersion objectives greatly excel any dry objectives in defining power, both by oblique and central light, provided only that the objects examined are mounted in Canada balsam, or if dry, are adherent to the under surface of the glass cover. Under the same circumstances also, immersion objectives whose balsam angle exceeds 100°, excel in definition immersion objectives of smaller angle. Thus, several of the immersion objectives in the Museum collection which have an aperture greater than 100° balsam, will resolve the 19th band of the Nobert's plate by lamplight thrown obliquely upon the under surface of the slide by an ordinary small bull's-eye condenser, a feat which no immersion objective of smaller angle, and no dry objective, can be made to perform; and the superiority of the definition of these wide-angled objectives, when used to examine histological preparations, bacteria, and the like, illuminated with central light, by the ordinary dry achromatic condenser, is readily recognizable by the practised eye.

These easily verified observations are quite in accordance with the accepted theory of microscopical vision. It has long been practically known, in the case of dry objectives, that those of great aperture exhibit to a marked degree the superior defining power thence resulting, even when the object is illuminated with perfectly central light; and the well-known theoretical explanation of this phenomenon is equally applicable to the case of immersion objectives so long as no film of air intervenes between the object and the front of the objective.

But the superior defining power of wide-angled immersion objectives, when illuminated by central or moderately oblique light, is still more manifest when monochromatic sunlight is employed; and this fact is strikingly illustrated by the photographs which accompany the present paper. A converging pencil of monochromatic sunlight, obtained by a 3-inch objective of about 12° aperture, with its optical axis inclined at an angle of but 45° to the optical axis of the Microscope, will be found quite oblique enough to give magnificent resolution of *Amphipleura pellucida* mounted in Canada balsam, without the use of any immersion illuminator, although in this case it is evident that in consequence of refraction at the under surface of the glass slide, the axis of the illuminating pencil actually impinges upon the frustule at an angle of little more than 27° to the optical axis of the Microscope. If, now, with the illuminating pencil rigidly limited to this angle, a selected frustule

of *Amphipleura pellucida* in balsam be examined successively by a series of immersion objectives, the superior definition of those of greater angle will be readily observed by the eye, and if photographs are taken, will be equally manifest in them.

In the series of photographs of *Amphipleura pellucida* that accompany this paper, those numbered from 1 to 11 were all taken with the angle of the illuminating pencil just mentioned, and will serve to illustrate the accuracy of the statement made. The explanation is quite obvious, for with sunlight the diffraction pencils that radiate from the transparent spaces in the frustule are of sufficient brilliancy to form a very conspicuous part of the image, if brought to a focus by the objective; and just what part of these pencils shall actually be brought to a focus as part of the image, depends in each case upon the aperture of the objective and not upon the obliquity of the illuminating pencil. On the other hand, by lamplight these diffraction pencils are so much less brilliant that they are inadequate to secure resolution, and it is necessary for this purpose to use much more oblique illumination than will answer the purpose by sunlight.

In view of the foregoing considerations, it is not surprising that, in the case of monochromatic sunlight, an increase of the obliquity of the illuminating pencil produces no such marked improvement in the performance of the objective as occurs under the same circumstances by lamplight. To illustrate this fact I have added the photographs numbered 12 and 13, representing the same frustule, as seen by means of an immersion illuminator, with the most oblique light that could be used with each objective without distorting the image. A comparison of these pictures with those taken by the same objectives with the smaller angle of illumination, shows that the improvement resulting from the increased obliquity is very trifling indeed. These pictures will serve to illustrate the general statement that with illumination by monochromatic sunlight, and consequently for the purposes of photo-micrography, the superior definition of objectives of greater balsam angle than 82° is independent of any excessive obliquity in the illuminating pencil, and of the use of immersion illuminators. Indeed, as I shall take occasion to illustrate hereafter by photographs, it is almost quite as manifest with histological preparations and central light as with lined test objects and oblique light.

III. Of the photographs which accompany this paper, Nos. 1 to 13 inclusive are representations of a frustule of *Amphipleura pellucida* from a slide mounted in the Hull Botanical Gardens in 1859. This slide was given to Mr. Wm. A. Sullivant, of Columbus, Ohio, and by him presented to me in May, 1867. As it came into my possession it was a dry mount with the frustules adherent to the cover; but for the purposes of these experiments I

have remounted it in Canada balsam. Of course the difficulty of resolving so delicate an object as *Amphipleura pellucida* is somewhat increased by mounting it in Canada balsam. In January, 1852, Professor Bailey, of West Point, writing to Matthew Marshall, Esq., of the surprising performance of the wide-angled dry lenses just constructed for him by Charles Spencer, declared, " In all these cases (and, in fact, whenever I allude to a test object) I mean the *balsam* - mounted specimens. The dry shells I *never* use as tests." It is amusing at the present day to note how "extraordinary" this assertion then appeared to one of the most distinguished English microscopists, who contrived then, as he has more than once subsequently done, to misunderstand completely the reasoning of the "American opticians," and who boldly wrote, " I have invariably found that when very difficult tests are mounted in balsam I cannot discover the markings."*

At the present day the value of difficult test objects mounted in Canada balsam is more correctly appreciated; and among these one of the most convenient and useful is *Amphipleura pellucida*. It is not many years since this diatom, even when mounted dry, was regarded as one of the most difficult tests. Messrs. Harrison and Sollitt indeed appear to have glimpsed the striæ on the dry mount as early as 1854; but can only have glimpsed them, for they estimated the number at 120 to 130 in the $\frac{1}{1000}$ of an inch, an estimate to which Mr. Sollitt stoutly adhered as late as 1860.† Most other microscopists were unable to verify these observations. Messrs. Sullivant and Wormley ‡ declared that they had "not been able to 'glimpse' the striæ on this diatom." And when Mr. Sullivant sent me the Hull slide he had still been unable to resolve it, as indeed was true of almost all microscopists at that date.

So far as I have been able to learn, Messrs. Powell and Lealand were the first who succeeded in resolving the dry frustules with sufficient distinctness to get correct notions of the markings. We learn by a note from Mr. Lobb, dated January 12, 1870,§ that those gentlemen had at that time succeeded in resolving *Amphipleura pellucida* with their immersion $\frac{1}{8}$, $\frac{1}{12}$, and $\frac{1}{16}$, and estimated them at 100 to the $\frac{1}{1000}$ of an inch. I myself first succeeded in resolving and photographing this diatom in January, 1871, and it was a Powell and Lealand immersion $\frac{1}{16}$ that did the work. In a memorandum published by the Surgeon-General's Office, February 1, 1871 (and republished in the 'American Journal of Science and Arts,' vol. i. (1871) p. 345), I stated that I found the striæ on medium-sized frustules counted from 90 to 93 to the $\frac{1}{1000}$ of an

* See 'Quarterly Journal of Microscopical Science,' vol. ii. (1854) p. 214.
† Ibid., vol. viii. (1860) p. 48.
‡ "On the Measurement of the Striæ of Diatoms," the 'American Journal of Science and Arts,' vol. xxvii. (1859) p. 250.
§ 'Monthly Microscopical Journal,' vol. iii. (1870) p. 104.

inch. I found no example in which the number of striæ exceeded 100 to the $\frac{1}{1000}$ of an inch. Since then I have examined a considerable number of *Amphipleura* slides, and only occasionally found one still finer. The finest I have ever counted had 107 striæ to the $\frac{1}{1000}$ of an inch. Ever since January, 1871, *Amphipleura pellucida* has been one of my favourite test objects for immersion objectives. In June, 1871, I succeeded in resolving it by an immersion $\frac{1}{5}$ of Tolles,[*] and in March, 1872, in connection with its resolution by certain objectives made by R. and J. Beck, and by William Wale, I wrote:—" This diatom is a useful and valuable test for immersion objectives of $\frac{1}{8}$ inch focal length or less. Lower powers can only hope to resolve it if possessed of excessive angular aperture." [†]

Meanwhile, although I constantly wrote and spoke of the dry frustule, because it gave more brilliant images as I then handled the test, I had already, in January, 1871, resolved with the immersion $\frac{1}{16}$ of Powell and Lealand, several balsam-mounted slides of the same diatom, which Mr. Sullivant had kindly sent me. In February, 1871, Count Castracane wrote from Rome to the Royal Microscopical Society,[‡] that the year before he had succeeded in obtaining a photograph of *Amphipleura pellucida* on a Möller's test-plate, balsam mounted, first with a Hartnack immersion No. 10, and afterwards with an objective of the same number by Nachet. The degree of success attained by this distinguished microscopist may be inferred from his own frank acknowledgment:—" Unfortunately my negative was blurred and rather faintish, so that it could not give good positive images. Nevertheless, the striæ are there so finely and so distinctly drawn out, that they may be perceived clearly enough, though the magnifying power of the Microscope was not higher than 640 diameters." [§] I myself in March, 1872, wrote in a general way of the resolution of the balsam-mounts:—" I may add that any of these objectives, including the Beck's $\frac{1}{10}$, will resolve *Amphipleura pellucida* in balsam, as in fact was done by Count Castracane, with objectives by Hartnack and Nachet." ‖

But all this was by monochromatic sunlight, and it was not until I began to use immersion illuminators with objectives of more than 82° balsam angle, that I succeeded in obtaining satisfactory resolution of the balsam-mounted frustules illuminated with an ordinary coal-oil lamp. Even then it was by no means with every immersion objective of sufficient aperture that satisfactory resolution could be obtained; but during the last six years the number of

* See 'Monthly Microscopical Journal,' vol. vi. (1871) p. 150.
† Same Journal, vol. vii. (1872) p. 166.
‡ Same Journal, vol. v. (1871) p. 176.   § *Loc. cit.*
‖ Same Journal, vol. vii. (1872) p. 233.

objectives capable of resolving this test has been constantly increasing, and the sharpness of the images produced by the very best objectives has continually improved, until at the present day I have no hesitation in making the assertion that any first-rate immersion objective, even those of as low power as the $\frac{1}{4}$, ought to be able to give distinct resolution of the most finely marked frustules of *Amphipleura pellucida* mounted in Canada balsam. Those incapable of this performance must be classed among second-rate objectives, and will not willingly be employed in serious investigations by instructed microscopists. As for the appearance of balsam-mounted frustules of this diatom by sunlight, under the best modern immersion objectives, it not only rivals in vigour and contrast the finest views of the dry frustules, but greatly excels the best that can be done with these in simultaneous exhibition of the details of outline and midrib.

The frustule on the Hull slide selected for photographic representation in connection with this paper is ·0037 of an inch long, and has 102 striæ to the thousandth of an inch. At the distance of ·0011 of an inch from it, and nearly parallel to it, on the slide is a second rather more coarsely marked frustule, the appearance of which in the pictures will aid in forming a judgment of the flatness of field in each case. Near one extremity of the selected frustule appears the end of another that may be used for the same purpose, while near its other extremity the end of yet another frustule is seen, at right angles to it, which, from its position in relation to the light, is not resolved, although longitudinal diffraction lines appear upon its surface in all the pictures.

All the immersion objectives belonging to the collection of the Museum will show the striæ on the selected frustule by monochromatic sunlight; but some of them, from curvature of field and feebleness of definition, would have given but sorry pictures. I have only thought it worth while to make photographs with a few of the very best of the water-immersion objectives at my disposal, and with certain glycerine and oil-immersion objectives. The following is a list of the photographs, to which I have added a memorandum of the aperture of each objective, as measured with an instrument I have devised, a modification of the apertometer of Abbe, which I will describe fully in a separate paper. The angles are all computed for an ideal medium of 1·5 index of refraction.

(*a*) *Photographs of* AMPHIPLEURA PELLUCIDA, *illuminated by monochromatic sunlight. Condenser a* 3-*inch objective of* 12° *air aperture inclined at an angle of* 45° *to the optical axis of the Microscope.*

No. 1. Oil-immersion $\frac{1}{12}$, aperture 114°, by Zeiss, vignetted print. 2830 diameters.

No. 2. By the same objective; print not vignetted. 2760 diameters.

No. 3. Oil-immersion $\frac{1}{8}$, aperture 115°, by Zeiss. 2700 diameters.

No. 4. Oil-immersion $\frac{1}{10}$, aperture 122°, by Tolles. 2700 diameters.

No. 5. Glycerine-immersion $\frac{1}{10}$, aperture 105°, by Spencer. 2830 diameters.
No. 6. Glycerine-immersion $\frac{1}{6}$, aperture 106°, by Spencer. 1900 diameters.
No. 7. Enlarged from the last negative to 2760 diameters.
No. 8. Water-immersion $\frac{1}{15}$, aperture 91°, by Tolles. 2760 diameters.
No. 9. Water-immersion $\frac{1}{8}$, aperture 165°, by Powell and Lealand. 2700 diameters.
No. 10. Water-immersion $\frac{1}{16}$, aperture 103°, by Powell and Lealand. 2700 diameters.
No. 11. Water-immersion $\frac{2}{25}$, aperture 91°, by Powell and Lealand. 2900 diameters.

(*b*) *Photographs of* AMPHIPLEURA PELLUCIDA, *illuminated by monochromatic sunlight, with an immersion illuminator and the utmost obliquity each objective would admit without distortion.*

No. 12. Zeiss' oil-immersion $\frac{1}{12}$ (same as No. 1). 2830 diameters.
No. 13. Tolles' oil-immersion $\frac{1}{10}$ (same as No. 4). 2760 diameters.

From my examination of these objectives, I am constrained to give the Zeiss $\frac{1}{12}$ the preference, both by lamplight and sunlight, over all the others named, and, indeed, I may add, over all the objectives I have ever yet examined.

Next comes a group embracing the oil-immersion $\frac{1}{10}$ by Tolles, the glycerine-immersion $\frac{1}{6}$ and $\frac{1}{10}$ by Spencer, and the oil-immersion $\frac{1}{8}$ by Zeiss. All these objectives perform very well indeed. When I wrote to Zeiss last January, I expressed the opinion that the performance of his $\frac{1}{8}$ fully equalled that "of the best of the large collection of immersion objectives belonging to the Museum." But subsequent trial convinced me that my first photographic work with the Spencer's $\frac{1}{10}$ had not done it justice, and I afterwards received the $\frac{1}{6}$ from the same maker and the oil-immersion $\frac{1}{10}$ by Tolles. After protracted trials, I now regard these three objectives as superior in defining power to the Zeiss $\frac{1}{8}$. How they compare with it, and with each other, may be fairly judged from the photographs. Of the water-immersion objectives, the Tolles $\frac{1}{15}$ stands first in my estimation; the Powell and Lealand objectives next.

Among other points suggested by a study of these photographs is the fact that the superiority of the glycerine and oil-immersion objectives is not a mere consequence of their great aperture. The aperture of the $\frac{1}{6}$ of Spencer exceeds but little, and the $\frac{1}{10}$ not at all, that of the $\frac{1}{8}$ of Powell and Lealand, yet their performance is much better. The aperture of the Zeiss $\frac{1}{12}$ is actually less than that of the Tolles $\frac{1}{10}$, which, however, it excels in performance, and a similar comparison may be made between the Tolles $\frac{1}{15}$ and the Powell and Lealand objectives. And yet I do not doubt in the least that each additional degree of interior angle above 82° is a material advantage, provided always that the aberrations of the objective are accurately corrected; but inferiority in the formula employed or in the skill and care exercised in construction may more than neutralize the advantages that ought to be derived from this source. Nor do I doubt in the least the

superiority in a general way of glycerine as the immersion fluid over water, or of oil of cedarwood and other liquids closely approximating crown glass in refraction and dispersion over glycerine. But this superiority does not occur merely because increased angle is thus rendered possible. In fact, as the angle of total reflexion from crown glass to water is rather more than 60°, it is by no means theoretically impossible to construct water-immersion objectives with angle as great as the oil-immersion objectives of Zeiss, or the glycerine-immersion objectives of Spencer.   The difficulty in this case is to correct the aberrations which are inevitably produced by refraction at the upper surface of the thin glass cover and the flat surface of the objective front. These aberrations are entirely absent when the immersion fluid has the same refraction and dispersion as the glass on each side of it ; are comparatively slight in the case of glycerine ; much more considerable with water, and greatest in the case of the dry objectives.   Professor Abbe, in the paper already cited, has drawn attention to this circumstance, which appears to me even more important than the fact that with homogeneous immersion there is no loss of light by reflexion at the front surface of the objective, and with glycerine immersion very little; but this also must have its influence.

Taking all the circumstances into consideration, I am disposed to expect further improvement in objectives in the direction of homogeneous immersion rather than glycerine immersion. In the case of homogeneous immersion, too, we have the great advantage of being able to dispense with the screw collar for cover correction, and all the deplorable loss of time entailed by the use of that contrivance, which is absolutely required in the case of glycerine and water-immersion objectives.

For this reason, in my ordinary work I give my Zeiss $\frac{1}{8}$ the preference over the objectives I have named as somewhat surpassing it in defining power; because it gives instantly results that are not far inferior to the best I can obtain from the others with much pains and loss of time.

Finally, to illustrate the superb performance of the Zeiss $\frac{1}{12}$ on dry *Amphipleura*, I have added to the series a photograph (No. 14) of a very delicate frustule on a slide of *Amphipleura pellucida* from the Bridge of Allan, Scotland, mounted by my friend Professor Hamilton L. Smith, of Geneva, New York.   This frustule is only 29 ten-thousandths of an inch long, and has 105 striæ to the thousandth of an inch.   It is magnified 3400 diameters.

XXXIII.—*Note on Abbe's Experiment on Pleurosigma angulatum.*

By J. J. Woodward, Surgeon and Brevet Lieutenant-Colonel, U.S. Army, Hon. F.R.M.S.

(*Read* 11*th June*, 1879.)

I send herewith two photographs of *Pleurosigma angulatum* taken by the Zeiss oil-immersion $\frac{1}{8}$ and a Tolles amplifier. The magnifying power is 1850 diameters. The one exhibits the markings as ordinarily seen and described; the other, taken with oblique light and a stop, furnished for the purpose by Zeiss, behind the back lens, exhibits the fine diffraction lines parallel to the midrib, described by Professor Abbe, of Jena.

The notable point about this second picture is that the diffraction lines, instead of being limited to the part of the frustule which is adherent to the glass cover, as is the case when Abbe's experiment is performed by lamplight, appear by monochromatic sunlight, and of course in the photographs, on all parts of the frustule. Professor Abbe, who originally fell into the error of supposing the absence of the diffraction lines on the non-adherent parts to be the necessary result of the optical conditions, has pointed out with commendable frankness * that his mistake arose from not having before accurately measured the true distance of these diffraction lines apart; and has willingly admitted that under the actual conditions it is "a matter of intensity of illumination only, whether they will be visible or non-visible through a film of air." I call special attention to his lucid explanation,† because in my opinion the greater share taken by the diffraction pencils in the formation of the microscopical image in wide-angled objectives, when illuminated by monochromatic sunlight, has a great deal to do with the superiority of this mode of illumination over lamplight for the purposes of high-power definition, as well as of photomicrography. By lamplight these diffraction pencils are so much feebler in intensity, that their share in the formation of the image is considerably less. I have in a previous paper (p. 663) presented other striking illustrations of this important point, and the views there expressed are corroborated by the phenomenon observed when Abbe's experiment is performed by monochromatic sunlight.

The pair of photographs herewith presented to the Society are not from the negatives of which I sent last January to Professor Abbe the prints exhibited at the meeting of February 12th by Mr. Stephenson. Those were accidentally taken with slightly different distances, and were hence magnified differently. The present

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* This Journal, vol. ii. (April, 1879), p. 141.   † *Loc. cit.*

pictures are both taken at precisely the same distance from object to screen, and would be of precisely equal magnifying power, but that the diffraction lines are best seen in a focal position of the objective slightly different from that required to show the hexagons, and this produces unavoidably a trifling variation, which, however, I think cannot exceed one per cent. of the power, if indeed it is so great. I have added to the pair a third photograph, exhibiting the whole of the frustule used for this experiment, magnified 730 diameters by Powell and Lealand's water-immersion $\frac{1}{6}$.
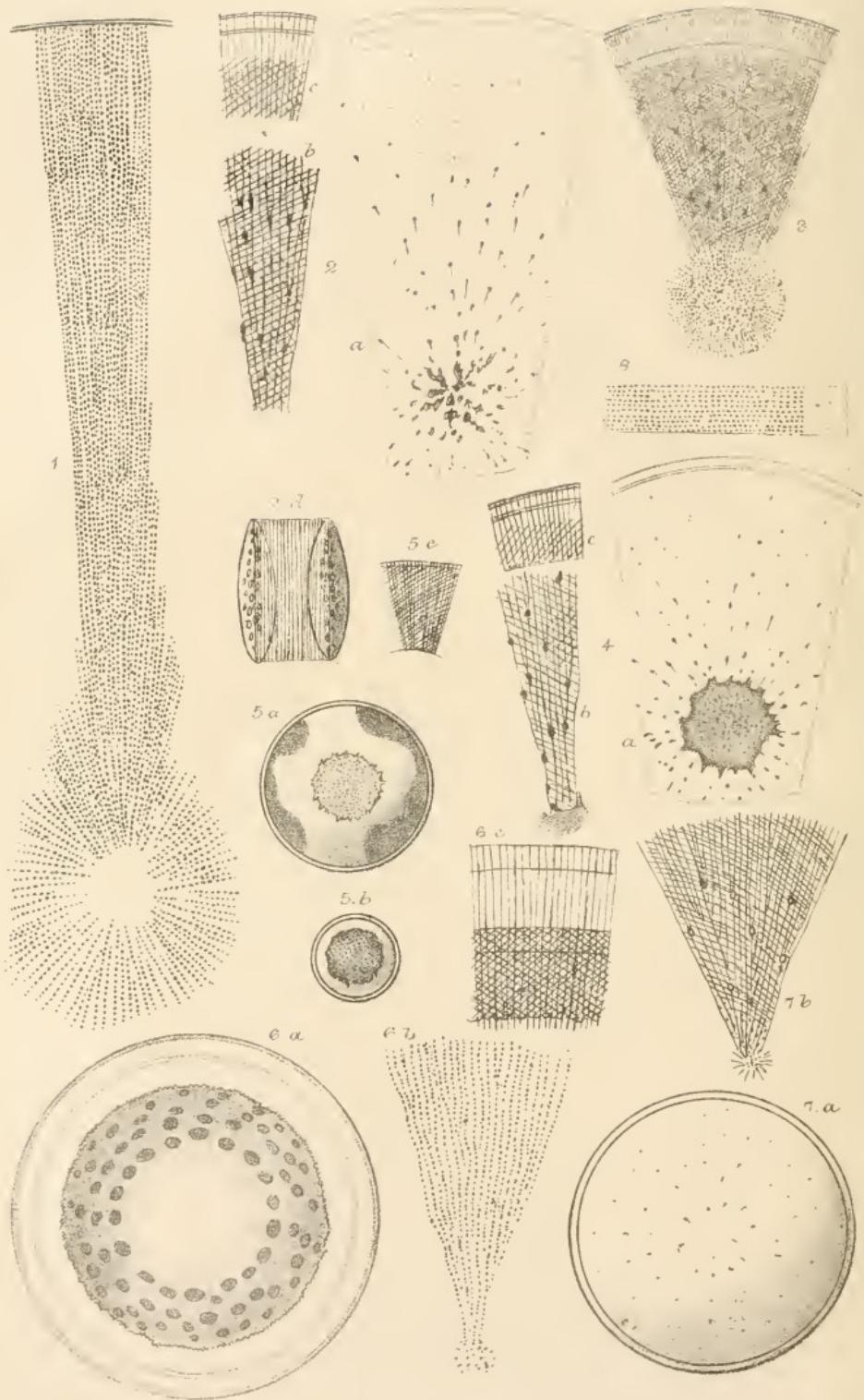
New species of Diatomaceæ from the Caspian Sea.

XXXIV.—*New Species and Varieties of Diatomaceæ from the Caspian Sea.* By A. Grunow, Hon. F.R.M.S. Translated with additional Notes by F. Kitton, Hon. F.R.M.S.

(*Read* 11*th June*, 1879.)

PLATE XXI.

Amphora (*angusta* Greg. var. ?) *oblongella* Grunow.—A. minuta, a latere primario angusta, oblonga, polis rotundatis, valvis cymbiformis obtusiusculis, ventre plano, linea media subrecta margine inferiori approximata, striis dorsalibus subradiantibus 14–16 in ·01 mm., ventralibus brevissimis. Longit. ·032–·036 mm.; latit. ·008–·0010.

Harbour of Baku, common.

Its relationship to the very imperfectly figured *A. angusta* Greg. is very doubtful. The striæ on the ventral portion appear to be much longer—Gregory gives 17 in the ·01 mm. ("about 44 in ·001′″"); still slighter is its resemblance to *A. nana* Greg., with 19 striæ in ·01 mm. The ventral striæ also appear to be shorter. The relationship of these forms is therefore scarcely probable.

A. lineata Greg. var. *subconstricta* Grun.—Frustulis in media parte levissime constrictis, striis punctatis dorsalibus 15 in ·01 mm., ventralibus tenuissimis. Longit. ·035–·045 mm.; latit. ·011.

Harbour of Baku, common.

I have frequently met with a more strongly constricted Amphora in diatom gatherings from Tahita (Tonga and Samoa Islands), which I likewise consider to be a form of *A. lineata* and have

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DESCRIPTION OF PLATE.

FIG. 1.—*Coscinodiscus nobilis* Grun., from Java, $\frac{450}{1}$.
  „ 2.—*a*, *Podosira maxima* Kg., from Peru, $\frac{900}{1}$.
          (*Cyclotella maxima*, authentic specimen.)
          b c, Structure of inner and marginal portions of valve.
          d, Two frustules of *P. maxima*, with the connecting membrane, showing the granular endochrome, $\frac{200}{1}$.
  „ 3.—*P. stellulifera* Grun., Monterey deposit, $\frac{900}{1}$.
  „ 4.—*a*, *Podosira ambigua* Grun., St. Paul, $\frac{900}{1}$.
          b c, Structure of the inner portion and the margin of the valve, $\frac{1510}{1}$.
  „ 5.—*a b*, *Hyalodiscus scoticus* (Kg.) Grun., $\frac{900}{1}$.
          (*Cyclotella scotica* Kg., authentic specimen.)
          (Fig. *a*, dried specimen with endochrome.)
          c, Structure of valve, $\frac{1510}{1}$.
  „ 6.—*a*, *P. Argus* Grun., California, $\frac{450}{1}$.
          b c, Structure of inner portion and margin of valve, $\frac{1510}{1}$.
  „ 7.—*a*, *P. hormoides*, Montague, Lima, $\frac{900}{1}$.
          b, Structure of valve, $\frac{1510}{1}$.
  „ 8.—Small fragment of outer portion of *Coscinodiscus Gazellæ*, $\frac{450}{1}$.

called it var. *constricta.* It is somewhat larger and more robust than the Caspian form, but otherwise differs but little ; striæ 12–14 in ·01 mm.

GOMPHONEMEÆ.

Gomphonema (*olivaceum* var.?) *stauroneiformis* Grun.—G. valvis lanceolatis vel subclavatis, obtusis, striis subradiantibus, subtilissime punctatis, area transversa centrali interruptis. Longit. ·053–·07 mm. ; latit. valv. ·01–·012 mm. ; striæ 10–13 in ·01 mm. Stipites plerumque longissimæ.

This Gomphonema is distinguished from *G. olivaceum* principally by its greater size and more conspicuous, smooth, central area. I have hitherto met with this form in mountain streams in the Tyrol and Switzerland and presume that it has often been mistaken for *G. dichotomum.*

The forms from the Caspian Sea are still larger (·065–·15 mm. long) and might be called var. *Caspia.* The upper part is frequently shorter than the lower ; this is often the case with the mountain species.

MASTOGLOIACEÆ.

Mastogloia Smithii Thwaites var. *intermedia* Grun.—Minor, valvis late lanceolatis parum productis, nodulo centrali vix lateraliter dilatato, striis tenuioribus, 18–19 in ·01 mm. Longit. ·032–·037 mm. ; latit. ·0125 mm.

Harbour of Baku, common.

Var. *abnormis* Grun. valvis lanceolatis, obtusiusculis, loculis ab marginis remotis, lineæ mediæ approximatis, striis subradiantibus, tenuissime punctatis, 18 in ·01 mm.

Baku Harbour, rare.

A peculiar form, in which the loculi are apparently placed between the margin and median line. I have observed something similar in a Mastogloia from Seychelles, which I have named *M. Seyshellensis.* It differs from the Caspian form by its greater length and more lanceolate valves with occasionally capitate produced apices, and its delicate striæ (26–29 in ·01 mm.).

M. (*Smithii* var. ?) *pusilla* Grun.—M. minuta, valvis lanceolatis obtusiusculis, loculis mediis ceteros magnitudine superantibus, striis subradiantibus, tenuissime punctatis, 17 in ·01 mm., nodulo centrali rotundato. Longit. ·012–·013 mm. ; latit. ·007–·0075 mm. Not common in the Harbour of Krasnowodsk. Resembles *M. exigua* of Lewis, but the valves are more obtuse and more strongly striate ; the loculi are numerous and marginal.

[I fail to detect any resemblance between the figure of *M. exigua* and *M. pusilla ;* the former has acute apices, loculi 2–5 (generally only 3), striæ obscure. In the latter the ends are obtuse, the striæ distinct, and the loculi numerous—F. K.]

NAVICULEÆ.

Navicula Trochus Ehr. var. *biconstricta* Grun.—Valves with three equal stout inflations, and slightly produced obtuse apices ·042 mm. long. Inflations ·001 mm. (this should be ·01); constrictions ·006 broad. Striæ transverse (18–20 in ·01 mm.), radiant at the centre, two large thickened sickle-shaped lines on each side of the central area.

Rare in Baku Harbour.

Although of very different form it appears nevertheless to belong to the series of which *N. Trochus* is the type, but which has only one central inflation. I have, however, many forms before me in which the ends are produced and a couple of slight depressions are visible, evidently showing a transition to the above described extreme variety. Characteristic of *N. Trochus* is the circular smooth space round the central nodule, and which has the two sickle-shaped forks on each side.

[*N. Trochus* of authors is not *N. Trochus* of Ehrenberg according to Dr. Donkin. A careful examination of the figures of *N. Follis* in the 'Mikrogeologie' will show that what has generally been considered *N. Trochus* is probably *N. Follis*. Dr. Lewis, in his paper on "Extreme and exceptional Variation of Diatoms," also refers the so-called *N. Trochus* to *N. Follis** (Professor H. L. Smith concurs in this view), but considers it to be only an extreme variety of *N. serians*, a view with which I am disposed to agree. The variety described by Herr Grunow I think more nearly resembles *N. trinode* of Lewis, *l. c. nec* Smith, and which he says is found in large rivers and brackish water, whilst *N. Follis* is only found in fresh.—F. K.]

N. Schneideri Grun.—N. major, valvis lanceolatis obtusiusculis, nodulo centrali oblongo, nodulis terminalibus minutis, sulcis duobus lineæ mediæ approximatis longitudinalibus, striis punctatis obliquis varie arcuatis 14 in ·01 mm. longitudinalibus 13 in ·01 mm. Longit. ·143–·145 mm.; latit. ·042 ·043 mm.

Rare on the pier of Cape Bail.

A well marked *Navicula*; on each side of the median line is a conspicuous line of coarse striæ, between which and the striæ is a narrow, smooth furrow, connecting it with the subsection Diploneis, but distinguished from it by the striæ which cross the valve in curved oblique lines resembling those on *N. obliquestriata* A. Schmidt, Demerara River. Atlas, pl. 13, figs. 41, 42.

[*N. Iridis* has a similar striation.—F. K.]

* The figure, in the 'Infusionsthierchen,' of *N. Trochus* is certainly very like what is usually known by that name; the probable solution is that they are both one species.

PLEUROSIGMA.

Pleurosigma attenuatum, var. *Caspia* Grunow.—Somewhat smaller, narrower, and less sigmoid than the type species, apices less acute. Striæ the same as in *P. attenuatum* and *P. Hippocampus.*

Not uncommon in Baku Harbour.

Between *P. attenuatum* and *P. Hippocampus* there exists only the unimportant distinction, a difference in the outline of the valve. The Caspian form is distinguished from both by being narrow, less sigmoid, and by its more obtuse apices. The structure of these allied forms under high powers appears very similar; between the strongly-marked lines of beads faint outlines of other beads may be seen. Whether these delicate puncta belong to a second valve or are an optical delusion must remain for the present undecided; it is certain, however, that the valves of Pleurosigma are composed of two layers, which separate when acted upon by long boiling in acids. [I have observed this in *P. angulatum.*]

[The faint markings here alluded to have been seen by other observers. It is most probable that the valves of Pleurosigma have a similar structure to many other diatoms in possessing what I call "secondary valves," which in some genera are like, and in others unlike, the primary valve. Schmidt calls them Regenerationshulle. —F. K.]

P. elongatum, var. *gracile* Grunow.—Narrower and less sharply pointed than Smith's figure. Striæ somewhat stronger. Oblique striæ, 17–18 in ·01 mm.; transverse, 19 in ·01 mm. Length, ·13–·32 mm.; breadth, ·024–·025 mm.

Common in Baku Harbour.

SCHIZONEMA.

Schizonema (minutum Kg. var. ?) *Caspium* Grunow.—Sch. minutissimum, filamentis brevissimis, subsimplicibus vel parce dichotome ramosis, inferne irregulariter transverse rugosis, superne lævibus, hyalinis, apicem versus vix conspicuis. Frustula inclusa irregulariter libera disposita, valvis lanceolatis, obtusiusculis, ·035–·052 mm. longis, ·007–·008 mm. latis, nodulo centrali parvo oblongo, striis parallelibus 12 in ·01 mm., in media parte parum distantioribus, subradiantibus, in area minuta nodulum centralem ambiente deficientibus.

On *Cladophora* in Baku Harbour common.

In *S. minutum*, Kg. Bac., pl. 23, fig. 5, the frustules occur in straight lines, in which it resembles *S. humile* Kg.; but in the latter species they principally occur in the chief filament (Hauptschlauch). In the Caspian form this is never the case.

Nitzschieæ.

[We omit the remarks of the author on this family, as we hope his monograph will be in the hands of the diatomist ere long. He unites the genus Tryblionella with Nitzschia, remarking that "long observation of this genus (Nitzschia) had convinced him that the genus Tryblionella was not sufficiently distinct to warrant their separation;" he therefore relegates the following forms to the former genus.—F. K.]

T. Hantzschiana Grun., *T. gracilis* W. Sm. = *N. Tryblionella* Hantzsch. *T. Victoriæ* Grun. and *T. levidensis* W. Sm., he considers to be only varieties of that species. Baku Harbour.

T. punctata W. Sm. Baku Harbour.

T. apiculata Greg. [not W. Sm. as stated by Grunow].

T. circumsuta Bailey = *Surirella circumsuta* Bailey = *T. Scutellum* W. Sm. Common in Baku Harbour.

The valves of this species have a longitudinal ridge (längsfaltig), but the transverse striæ are not interrupted by it as they are in many other species. By direct light the surface of the valve appears irregularly punctate (shagreen-like); this is still more conspicuous in the closely allied form *Nitzschia Brightwellii* (Kitton), in which it is clearly shown that the large puncta and the fine regular lines of striæ belong to different layers of the valve.

[The striæ on *T. circumsuta* and *N. Brightwellii* have a certain family resemblance, but the structure of the valve is conspicuously different in the former species. Close to the punctate margin runs a longitudinal V-shaped furrow, forming a ridge near the centre of the valve, which gradually descends towards the margin; a section made across the centre of the valve would be something like three-fourths of the letter W, W. This peculiarity is more or less visible in all the Tryblionellæ. *Nitzschia Brightwellii* has the surface of the valve flat, like all the true Nitzschias. *T. circumsuta* is elliptic lanceolate. *N. Brightwellii* is linear lanceolate.—F. K.]

Nitzschia Sigma W. Sm. var. *intercedens* Grun. Length, ·2 mm.; breadth, ·0065 mm. Keel puncta, 7 in ·01 mm.

N. Sigma embraces a great number of forms, the extremes of which would not with certainty be relegated to one species were it not that so many intermediate forms exist between them. The following are the principal:—

Var. ? *maxima* Grun. Length, ·9 mm.; breadth, ·9 mm.; keel puncta, 3–4 in ·01 mm.; transverse striæ, 15–18 in ·01 mm.

Var. *valida* Grun. Length, ·5 mm.; breadth, ·017–·022; keel puncta, 3½–5 in ·01 mm.; transverse striæ, 18–21 in ·01 mm.

Var. *consimilis* Grun. Length, ·4 mm.; breadth, ·013 mm.; keel puncta, 5–7; transverse striæ, 23–26 in ·01 mm.

This form stands midway in the transition from *N. Sigma* proper.

Var. *genuina* Grun. Length, ·25 mm.; breadth, ·011 mm.; keel puncta, 7–9; transverse striæ, 20–24 in ·01 mm.

Var. ? *fasciculata* Grun. Length, ·095 mm.; breadth, ·036 mm.; keel puncta, 4–6; transverse striæ, 28–30 in ·01 mm. It is the *Homeocladia sigmoidea* W. Sm., at least what I have hitherto considered to be that species. I cannot admit that it is a Homeocladia. It is distinguished from *N. Sigma* proper by its distant keel puncta as well as by its delicate striation.

Var. *intercedens* Grun. Length, ·30 mm.; breadth, ·009 mm.; keel puncta, 6–7; transverse striæ, 28–33 in ·01 mm.

Var. ? *Sigmatella* Gregory. Length, 32 mm.; breadth, ·006 mm.; keel puncta, 8–10; transverse striæ, 25–28 in ·01 mm. Valves more or less strongly sigmoid.

[*Nitzschia Sigmatella* Gregory is no Nitzschia. Wm. Smith also refers this form to the genus Nitzschia under the sp. name of *curvula*. Dr. Lewis considers it an extreme form of Surirella, and names it *S. intermedia*. I have seen authentic specimens of *N. Sigmatella* and *N. curvula* W. Sm., and am satisfied that they are identical, and also that they are not allied to Nitzschia excepting in outline.—F. K.]

Var. ? *rigida* Grun. Length, ·20 mm.; breadth, ·008; keel puncta, 8–11; transverse striæ, 28–32 in ·01 mm. According to Dr. Arnott this is *Amphipleura sigmoidea* W. Sm. (*A. rigida* Kg. ?). A small form of this is perhaps *Navicula lamprocampa* Ehr. in Kg. B. *Nitzschia flexa* Schumann appears to belong here.

Var. *anguilla* Schumann. Valves acute; 0·045 mm. in length; ·003 mm. in breadth; keel puncta, 11–12; transverse striæ, 29–30 in ·01 mm.

Var. ? *Clausii* Hantzsch. Resembles the preceding. Valves with produced rounded apices, ·045 mm. long, ·004 mm. broad; keel puncta, 10–11 in ·01 mm.; striæ very delicate.

In this series (in which the distinctions are based upon the size of valve, and distance of keel puncta and striæ) may be included some irregular forms.

Var. ? *subrecta* Grun. Valve lanceolate sigmoid, flexure very slight, often scarcely distinguishable. Length, ·11 mm.; breadth, ·008 mm.; keel puncta, 10–11; transverse striæ, 28–30 in ·01 mm.

Var.? *abludens* Grun. Valve linear lanceolate, not sigmoid. Length, ·155 mm.; breadth, ·008 mm.; keel puncta, 3–4½; transverse striæ, 22 in ·01 mm.

To the *Nitzschia Sigma* group belong the following species of Homœocladia.

H. Kotschyi Grun. Valve, ·22 mm. long, ·007 mm. broad; keel puncta, 7–7½; transverse striæ, 24 in ·01 mm.; connecting zone with strong longitudinal striæ. Salt Lake Atchin Ghöl (*leg.* Kotschy), growing singly and in tufts.

H. subcohærens Grun. Valve, ·03–·045 mm. long, ·004 broad; keel puncta, 9–10; transverse striæ, 33–34 in ·01 mm., forming slight, delicate, and frequently ramifying threads, without a definite integument. China, Bengal.

Herr Frauenfeld gathered a similar form in Leith, Scotland; it was partly in single frustules and partly in bushy tufts.

Licmophoreæ.

Licmophora flabellata Ag. Kg. Bac. tab. 12, figs. 1, 2, 4; W. Smith, B. D. tab. xxxii. fig. 234.

Var.? *gracillima* Grun. Frustules shorter and narrower (·101 mm. long, ·009 mm. broad); in the upper part linear, the lower cuneate. Rare.

I have never seen this form in a living state, but only in single frustules. I have also seen no front view, and am therefore unable to decide whether it is allied to *L. Remus* or *L. Romulus.*

Coscinodisceæ.

Cyclotella Caspia Grun.—C. minuta, margine tenuissime striato, centro undulato, irregulariter punctato. Diam. ·18 mm.; latit. marginis, ·004 mm.; striæ radiantes, 21 in ·01.

Not uncommon in the Harbour of Baku.

Approaches most nearly to *C. operculata* Kg., but is distinguished by the absence of marginal puncta (spines?) and by its delicate striæ. I reckon as Cyclotellæ only those forms with sharply-defined radiating marginal striæ. To distinguish the species requires great caution. *C. operculata* has a strongly striated margin (striæ 16–17 in ·01 mm.).

C. antiqua W. Sm. is closely allied to *C. operculata.* It is distinguished by the presence of large triangular excavations near the centre. I have observed many transitional forms in *C. operculata* var. *radiosa.*

To the large forms of *C. operculata* is allied a Cyclotella, which Eulenstein found in the Bodensee (Lake Constance) and named it *C. Bodanica,* and which I also have seen in soundings from the Traunsee (Lake of Gmunden).

The largest were ·06 mm. in diameter, with broad (·015 mm.)

margins; the puncta (spines) submarginal; the radiating striæ on the inner part of the margin 11 in ·01 mm., on the outer part about 13 in ·01 mm. The centre is marked with (excepting a small speck in the middle) delicate radiating puncta.

To *C. Bodanica* Eulenstein joins a not uncommon North American Cyclotella, which is distinguished by its smaller size and more distant punctate lines in the centre, and which I at one time called var. *affinis*.

C. Dallasiana W. Sm., a common form in brackish water localities; it is distinguished from *C. operculata* by its much greater size, stronger striation of the marginal band (9–12 in ·01 mm.), and a semicircular arch of larger puncta on the edge of the irregularly punctate centre. [The puncta are distinct on the specimens from Para River, but their presence is doubtful on those from many other localities.—F. K.] To *C. Dallasiana* may possibly belong *Coscinodiscus striatus* Kg. and *Discoplea sinensis* Ehr. Dr. Arnott, in his note on the genus Cyclotella, ' Q. M. Journal,' vol. viii. p. 247, refers *C. stylorum* * Brightwell, ' Q. M. J.,' vol. viii. p. 96, to *C. Dallasiana*. Brightwell's form I know well, and have seen the original specimen from which the figure (a very indifferent one) was made. The *C. Dallasiana* of Smith, of which I have also seen authentic specimens, differs considerably from *C. stylorum*. The marginal band is narrow and finely striate; the large granulate centre is undulate, but not the whole valve. *C. stylorum* also shows this, but in a much less degree. In the latter the marginal band is much broader, the striæ stronger, and the valves much more robust; it is moreover a much commoner form. I have it from many North American localities, the Para River mud, South America, and in mud from the mouth of the Rokelle, Sierra Leone (where Mr. Brightwell first observed it). I do not know of any British habitat. *C. Dallasiana*, on the contrary, is much less common. Smith found a single specimen in a slide of a gathering from the Medway. Mr. Roper detected it in Thames mud. It also occurs in the Para River mud. I know of no other habitats. Those from the Para are very fine, and the depression and elevation of the centre very distinct. I am disposed to refer the form called by L. W. Bailey † *Cymatopleura* (?) *Campylodiscus*, to this species. His description is as follows:—" Large, lateral view almost circular, sometimes broadly oval (his figure is perfectly circular; the oval appearance might be caused by the valve being tilted); marginal striæ short, close, and showing under a high power gland-like dots. Lateral valve with one deep undulation, surface finely striated. Hab. Honeylake Valley, foot of Sierra Nevada."

* In the work referred to, Dr. Arnott says *C. radiata:* this is an error; in the copies of his paper (privately distributed) he alters it to *stylorum*.
† ' Boston Journ. of Nat. Hist.,' vol. vii. p. 350, pl. 8, fig. F.

He does *not* notice its presence in the Para mud, where it is not very rare: this perhaps throws suspicion on the identity of the two species. He, however, notices another form, which he thinks is a var. of his *C. pulchella* (which he says is perhaps the same as *stylorum*), "and well deserves the name" (*l. c.* p. 348).

In the work just above quoted is a figure of what he calls *C. Kützingiana* var. and which he describes thus: " The central portion is large, elevated, and irregularly punctate; the striæ are minute and closely radiant, reaching the margin, but interrupted before reaching the margin by a finely undulate circle." His figure very much resembles that of *C. Caspia;* the centre is, however, larger and more finely punctate; it is also very like the small valves of *C. stylorum*.

C. compta Ehr. has a resemblance to *C. Meneghiniana* Kg., but differs in its more strongly granulate centre, and that every second, third, or fourth marginal stria is stouter than the others.

C. Meneghiniana Kg. is identical with *C. rectangulata* Breb., and like *C. Caspia*, has no marginal spine, but a more strongly striated margin (7 to 9 delicately punctate striæ in ·01 mm.). *C. Kützingiana* W. Sm. appears to be the same species.

C. Kützingiana (Ehr. ?) Chauvin, has, according to original examples from Chauvin, likewise no marginal spines, but a very delicately striate margin (12–14 in ·01 mm.). *C. Caspia* perhaps might be considered a very delicately striate form of this species. In kieselguhr from Domblitten is found a very interesting form with an oval centre and 14–15 marginal striæ in ·01 mm. This I consider a var. ? of *C. Schumanni*.

The remaining species of Cyclotella is *Discoplea græca* (Ehr. ?) Schumann; *D. umbilicata* (Ehr.?) Schumann, and *D. bipunctata* Schumann seem to be of similar structure. Most of Ehrenberg's species are unrecognizable.

C. scotica Kütz. appears, according to the original examples from Constantinople (query, identical with the Scottish form ?), to be no Cyclotella, but a Podosira; the entire valve is very delicately and irregularly punctate, and beset with a single circlet of stout spines.

Discoplea annulata Schumann seems to be allied to *Melosira Westii*, and *D. umbilicata* Ehr. to be identical with the latter.

Cyclotella bella A. Schmidt.—This is perhaps a Stephanodiscus, or may belong to the genus Coscinodiscus. The same applies to *C. punctata* W. Sm., *C. Astræa* and *minutula* Kg. (these two appear to merge completely into each other). *C. Carconensis* Eulenstein does not belong to *C. Astræa* as Eulenstein considered, but is a good species, characterized by the smooth radiating lines starting from the intramarginal spines, and which pass through the radiant puncta. *C. spinosa* Schumann is identical

with *Stephanodiscus Niagaræ* Ehr. The latter is distinguished from *C. Carconensis* by the greater number of smooth rays separating the radiating puncta, part only of which proceed from the marginal spines. The lines of puncta in *S. Niagaræ* are simple in the centre, but consist of two, or at most three, contiguous puncta as they approach the periphery, whereas the lines of puncta in *C. Carconensis* occur in groups.

Dr. Arnott, in the paper previously quoted (p. 246), says: " Smith unfortunately referred a species (*C. minutula*) obtained in Lough Mourne deposit to *C. antiqua*, a species which does not occur in any of the Irish deposits which I have examined." It is somewhat difficult to imagine how Professor Smith could have mistaken *C. minutula* for *C. antiqua*, the difference being so well marked. I have never been able to find the latter in the Lough Mourne deposit or in the marl Co. Down, but in a deposit from Strangford, Co. Down, it is not uncommon, and I think finer than in the Peterhead deposit.

MELOSIREÆ.

Melosira Borreri Greville. Sm. S. B. D. tab. 50, fig. 330.
> Var. *moniliformis* = *M. moniliformis* Ag. Kützing, Bacil. tab. 3, fig. 2.
> Var. *subglobosa* Grun.—Generally somewhat smaller. Frustules nearly spherical or elongated, the ends slightly flattened.
> Var. *octogona* Grun.—Frustules nearly cylindrical, with flat ends and broadly oblique corners, so that the frustules in f. v. appear octagonal.

The three varieties are not uncommon in Baku Harbour.

The filaments are attached by a short stipes to other algæ, particularly Cladophora. The frustules are sometimes attached to each other and sometimes connected by a short gelatinous isthmus.

The interesting var. *octogona*, which I for a long time thought a very different species, and which I first found on *Vaucheria javanica* Kg. from Java, had such oblique corners to the cylindrical frustules that I could not recognize its relationship to *M. Borreri*. I afterwards found examples which more nearly approached *M. Borreri* on algæ from Upolo, Australia, and Kamtschatka, and which stood between it and the typical *M. Borreri*, from the Lagunes of Venice. The vars. *octogona* and *suborbicularis* are usually more finely punctate than *M. Borreri;* the latter has frequently the central part of the valve smooth, whilst the former almost always have it punctate. The puncta in all the forms of

M. Borreri are in groups and irregularly disposed, so that the valves have a shagreen-like appearance.

Podosira lævis Greg. does not appear to me to differ from *P. Montagnei*.

P. hormoides (Montagne *nec* W. Smith) = *P. nummuloides* Ehr.—According to the original examples, approaches very near to *P Montagnei*, and differs principally in the valves being less convex. The structure is very similar, but the puncta are more distant (18 in ·01 mm. against 21–22 in *P. Montagnei*), and the larger puncta are fewer in number and more radiant.

[The arrangement adopted by Herr Grunow is that of Pfitzer, who divides the Diatomaceæ into two groups, Placochromaticæ and Coccochromaticæ. See O. Meara's Analysis of Dr. Pfitzer's System in 'Q. M. J.,' vol. xii., n. s., and M. P. Petit's in 'M. M. J.,' vol. xviii.—F. K.]

[Since the preceding paper was written I have received from my friend Herr Grunow the following notes on Coscinodiscus, Hyalodiscus, and Podosira.—F. K.]

Coscinodiscus nobilis Grun.—This is the form I refer to *C. regius* Wallich in my paper on Diatoms from the Caspian Sea (p. 27*: "Zu dieser durch ein glattes Centrum ausgezeichneten Gruppe gehören noch *C. perforatus* Ehr. und *C. apiculatus* Ehr., so wie *C. regius* Wallich"). It is not *C. regius*, of which, through the kindness of Mr. Kitton, I have since seen specimens. It is much larger (1·4 mm.) than *C. nobilis* whose greatest diameter is ·54 mm. *C. regius* has no smooth centre, but a wide space in the middle covered with irregularly disposed puncta, and distant, variously shaped, slightly curved spines. The valves are cylindrical and in s. v. have radiant lines of puncta (3 in ·01 mm.). On the cylindrical part (f. v.) the puncta are parallel (5 in ·01 mm.) and are separated from the radiant rows by a circular smooth space on the upper edge of the valve. The slightly convex valves of *C. nobilis* have a smooth centre and closer and smaller puncta (about 7 in ·01 mm.) which become hexagonal as they approach the margin, and are separated into groups by radiating lines which are sometimes scarcely visible. I have a smaller form from the Samoa Islands (·06–·13 mm.) with a smooth centre and more radiating puncta (5 in ·01 mm.). It resembles *C. apiculatus* Ehr., and might be named *C. apiculatus* var. *Samoensis*. A similar form occurs in the Monterey deposit. *C. nobilis* was collected by Krock, and communicated to me by Professor Cleve. Pl. XXI., Fig. 1, $\frac{450}{1}$.

* Not noticed in my *résumé*.—F. K.

C. Gazellæ Janisch.—Diameter of valve (as far as can be ascertained from fragments), 1·8 to 1·9 mm., thus exceeding even *C. regius* in size. Centre smooth, like *C. nobilis*, but bordered by a circle of small spines similar to those occurring in *C. regius;* the radiating rows of puncta are somewhat closer than those in that species (6–7 in ·01 mm.). Upper edge of valve smooth, precisely as in *C. regius*. Near the margin numerous short irregularly curved striæ (consisting of darker puncta) are visible.

'Gazelle' sounding, No. 125, 30° 53′ S. lat., 177° 6′ E. long.; depth 4151 metres. 'Challenger' sounding, station 265, depth 2900 fathoms. This form was named by Herr Janisch in remembrance of the scientific expedition made by the German ship, 'Gazelle,' in the years 1874–1876. Pl. XXI., Fig. 8 ($\frac{450}{1}$).

I have found fragments that can only belong to this species in a sample of Nottingham deposit in which it was not uncommon.

C. regius was originally distributed under the MS. name of *Rex*. It is undoubtedly the largest diatom, excepting *C. Gazellæ*, hitherto discovered. *C. regius* was first found, in the Bay of Bengal in 1857, by Dr. Wallich. The lighter portions of one of the 'Challenger' dredgings (station 265, depth 2900 fathoms) consist almost entirely of fragments of this species. *C. nobilis* is by no means an uncommon form; I have found it in the stomachs of Noctilucæ collected at Gorleston Pier (Norfolk), associated with *C. concinnus*, for which it is sometimes mistaken. I have also seen it in gatherings from Harwich, Hong Kong, Arafura Sea, and Sea of Java. It differs from *C. concinnus* in its large smooth area and its more distinct puncta and radiating lines. The rows of puncta in *C concinnus* terminate in a small central rosette of small cells. *C. tenuis* Bailey * is undoubtedly the same species,† as is *C. centralis* of Schulze.

In 'Casp. See Algen,' Herr Grunow says, "Allied to *Podosira hormoides* is a form which I provisionally call *Hyalodiscus maximus*. It is without doubt identical with *Cyclotella maxima*." In the communication now received are the following additional remarks.

Podosira maxima (Kützing) Grunow, in Cleve and Grunow's 'Arctic Diatoms.' *Cyclotella maxima* Kütz. ad specm. authent., *Hyalodiscus maximus* Grun. *l. c.* ex parte, *Actinoptychus interpunctatus* Brightwell. — I have adopted with some hesitation

* 'Boston Journ. of Nat. History,' vol. vii. p. 393, pl. vii. fig. 9.
† Bailey (*l. c.*) also says, "that he has seen from the same locality (Para River) a similar form with three processes." (I have seen *C. radiatus* with similar processes.) This is no doubt the same species as that found in the Java Sea. The so-called processes are not constant, and are probably only abnormal growths; see Prof. H. L. Smith, 'Amer. Jour. of Micr.,' Aug. 1877.—F. K.

M. Petit's views in separating *Podosira* from *Hyalodiscus* on account of the granular arrangement of the endochrome, and therefore remove this species from *Hyalodiscus*. The puncta are in radiant and oblique lines 13–15 in ·01 mm. in the middle and 18 on the margin of the valve. The beginning of new rays of puncta is mostly marked by a small blank space which appears under certain focussing like a small dark spot. The centre of the valve is more irregularly punctate, and occasionally a very small irregularly bordered umbilicus is visible. Californian specimens reach a diameter of ·24 mm. and have somewhat coarser puncta (12–14 in ·01 mm.), but it is impossible to separate them into distinct species, and they can only be considered as a variety "*Californica*" of *P. maxima*. Pl. XXI., Fig. 2 a ($\frac{900}{1}$), authentic specimen of *Cyclotella maxima* Kg. from Peru (*leg.* Hayne). Fig. 2 b, structure of the inner part of the valve ($\frac{1510}{1}$). Fig. 2 c, structure of the margin ($\frac{1510}{1}$). Fig. d, two frustules cohering by a broad connecting membrane, of rare occurrence, but which evidently shows how nearly allied *P. maxima* is to *P. hormoides*. The two frustules exhibit the granular arrangement of the endochrome ($\frac{200}{1}$).

P. hormoides Montagne (*nec* Smith) is nearly allied to *P. maxima*, and differs only by its smaller size, more convex valves, and somewhat closer puncta. The cell contents are granular. As with other diatoms, we find in some gatherings of *P. hormoides* and *P. maxima* certain specimens not varying much in size, which lead to the conclusion that we have to do with distinct species; but in gatherings from other localities intermediate forms appear, and I have scarcely any doubt that *P. maxima* is only a large form of *P. hormoides*. Pl. XXI., Fig. 7 a ($\frac{900}{1}$), authentic specimen from Lima. Fig. 7 b ($\frac{1510}{1}$), structure of the valve.

P. ambigua Grun. in Cleve and Möller, 'Arctic Diatoms.' (*Hyalodiscus stelliger* Grun. *nec* Bailey Novara ex parte.)—This species is distinguished from *P. maxima* by a much larger and more sharply defined dark umbilicus, its smaller size and somewhat closer rows of puncta (15–17 in ·01 mm. in the middle of the valve). Common at the island of St. Paul, Cape of Good Hope, Kerguelen's Land, &c., and is very constant in these localities, where *P. maxima* does not occur. I have seen specimens of *P. maxima* from other localities with a small umbilicus, and other intermediate forms may probably be detected. The cell contents are granular. *Hyalodiscus subtilis* is distinguished by its much finer striation and coherent endochrome, which sometimes form radiant lobes easily visible even in dried specimens. A very large form of *P. ambigua* (var. *Kamschatica*), attaining a diameter of

·274 mm. (umbilicus ·035 mm.), occurs rarely in the Sea of Kamtschatka. From St. Paul, Southern Ocean, Pl. XXI., Fig. 4 *a* ($\frac{900}{1}$). Fig. 4 *b*, *c* ($\frac{1510}{1}$), structure of inner part and margin of valve.

P. stellulifera Grun., 'Casp. See Algen,' p. 35.—This form is distinguished from *P. hormoides* and *P. maxima* by a circle of larger puncta (spines ?) near the margin of the highly convex valve which has a broad border. The stellate appearance of the blank dots is not always so obvious as in the specimen here represented, and I have seen a specimen where the inner part very much resembled *P. hormoides.* Pl. XXI., Fig. 3 ($\frac{900}{1}$), Monterey deposit.

[In the 'Casp. See Algen,' p. 35, is the following additional description. Diameter of valve, ·08 mm. With the exception of the irregularly punctate centre (about ·01 mm. in diameter), the valve has delicate radiating puncta (17–18 in ·01 mm.). The larger puncta are irregularly scattered, and have a peculiar stellate appearance. The cell membrane is somewhat thick. The large marginal puncta (spines ?), 4 in ·01 mm. This form, which occurs in Herr Weissflog's collection, I name *P. stellulifera.*]

P. Argus Grun., 'Casp. See Algen,' p. 35.—Valve highly convex ; diameter, ·107 mm. ; cell membrane very thick. The inner concave valve is delicately striate ; striæ radiant (16 in ·01 mm). On the convex side is a sharply defined circular space, with a finely dentate margin, within which are three to four concentric circles of large oval dots (depressions ?). California, in the collection of Herr Weissflog. Pl. XXI., Fig. 6 *a* ($\frac{450}{1}$) ; 6 *b*, *c*, structure of inner portions and of the broad border of the valve.

Hyalodiscus scoticus (Kg.) Grun., in Cleve and Grunow's 'Arctic Diatoms.' (*Cyclotella scotica* Kg. ad specm. authent. *Podosira hormoides* Wm. Sm. *nec* Mont. *P. Franklini* Grun., 'Casp. See Algen,' p. 34.) I have, through the kindness of Dr. Van Heurk, seen authentic specimens of *C. scotica* Kg. from two Scotch localities. I am unable to say whether the *C. scotica* from Constantinople, to which I alluded in the 'Casp. See Algen,' p. 30, is identical, my preparation being mounted dry and insufficiently cleansed, but the Scotch specimens are without doubt the *P. hormoides* of W. Smith. I have never seen the granules in the endochrome of this very common species, and there can scarcely be any doubt of its belonging to the genus *Hyalodiscus.* A stronger reason for uniting it to this genus is the absolute impossibility of specifically distinguishing it from *H. subtilis.* Anyone who doubts this has only to carefully examine the Californian gatherings, or No. 2 of Cleve and Möller's from Finnmark, in which every possible intermediate form may be seen, to

be convinced of the correctness of this view. Pl. XXI., Fig. 5 a, b ($\frac{900}{1}$), *Cyclotella scotica* Kg. from Scotland ; 5 c ($\frac{1570}{1}$), structure of valve.

In a future paper I hope to give delineations of some forms of *H. lævis* Ehr., *H. radiatus* (*Pyxidicula radiata* O'Meara), and *H. maximus* Petit.

RECORD

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

including Embryology and Histology generally.

ZOOLOGY.

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

Cell-division in Animals.[*]—An important research on this subject is published by Professor Peremeschko, of Kiew, who has studied the epidermis, connective-tissue corpuscles, white blood-corpuscles, and spindle-shaped cells from which the blood capillaries are developed, in the transparent larva of the newt (*Triton cristatus*).

Method.—For the examination of the living cells it was found convenient, although not absolutely necessary, to curarize the larva. One part of curare was dissolved in 100 of water, and 100 of glycerine added : five to ten drops of this fluid were added to a watch-glass of water, in which the larva was placed. When the movements had become slow and feeble, the animal was removed to a slide, and a cover slip placed on the tail, the most convenient part for study, and the rest of the body covered with moist blotting-paper. The larva recovers from the effects of the drug after eight to ten hours, and can therefore be used over and over again.

Immersion in 3 per cent. alcohol or ether was found useful if the observation was not to be continued long. Sodium chloride solution (1 per cent.), iodized serum, solution of sugar, &c., were also found of service, as rendering certain appearances more distinct.

Absolute alcohol was found to be the best hardening fluid : small pieces of the tail were placed in it for a quarter of an hour, stained with hæmatoxylin, fuchsin, or neutral carmine solution, and mounted in glycerine or dammar. Solutions of gold chloride and osmic acid ($\frac{1}{2}$ to $\frac{1}{5}$ per cent.), and silver nitrate ($\frac{1}{2}$ per cent.) were also employed.

Results.—After treatment with curare or sodium chloride solution, the epithelial cells of the epiderm were observed to become much better defined, and spaces to appear between them, crossed by delicate filaments ; these were evidently pseudopodial processes, arising as a result of the contraction of the cells induced by the action of the reagent.

Changes in the form, size, and arrangement of the intranuclear filaments were directly observed ; the changes, however, were so slow that no actual movement could be seen. The changes of the dividing nucleus described by other observers were seen, and it was further

[*] ' Arch. Mikr. Anat.,' xvi. (1879) p. 437.

noticed that, as the cell itself became constricted preparatory to division, pseudopodial filaments stretched across the small space between it and its neighbours, these processes being sometimes so numerous as to form a sort of fringe.

The ordinary epidermic cells showed no intracellular network, but amongst them were found a greater or less number of cells in which this network was remarkably well developed. These "reticulate cells" (Netzzellen) are often twice as large as the others, and of a more rounded form; they have compact, oval nuclei, which, as usual, may become broken up into filaments, all stages between the two conditions being observed. Nuclear filaments were seen to extend between those of the intracellular network, but no actual connection of the two seems to have been observed.

The reticulate cells are formed from those of the usual character by a network appearing around the nucleus, and gradually extending to the periphery. They may return to the ordinary condition by a reversal of the process: the filaments of the network undergoing gradual fusion, from the periphery inwards.

The entire process of division took two hours and a half in the ordinary, one hour and a half in the reticulate cells. In both cases three-quarters of this time was occupied in the division of the nucleus, one-quarter in that of the cell-body. The process is thus a slow one, not as in plant cells, according to Strasburger, rapid.

The series of events which together constitute the division process are as follows:—The nucleus, first of all, undergoes a considerable increase in size; next, there appear in it a few lumps or granules, some larger, some smaller; the number of these increases; they lengthen out, and form short, finer or coarser filaments, which are at first scattered without any definite arrangement, and intermixed with unaltered granules through the nucleus. The number of the granules decreases, the filaments become longer, the contours of the nucleus vanish, and the filaments group themselves, sometimes about a centre, in more or less regular forms, producing the filamentous differentiated nucleus of authors.

Development of the Ribs and the Transverse Processes.[*]— Herr Fick is of opinion that the ribs have an independent and separate origin to the superior arches of the vertebræ; and that, likewise, the transverse processes are not budded off from the superior arches, but are differentiated from the tissue that lies to the sides of the cartilage of these parts. Taking as an example the third myocomma, he shows that towards its peripheral end there is a rounded tongue of cartilage, which, decreasing in size, extends towards the chorda; at its most central end there are distinct cartilage-cells, and the whole structure is separated from the surrounding muscular tissue by a layer of spindle-shaped nuclei, which seems to form the embryonic perichondrium; from this the " superior arch " is in section seen to be distinctly separated.

[*] 'Arch. Anat. und Entw.' (His and Braune), (1879) p. 30.

Connective Tissue.*—Dr. L. Löwe gives the following *résumé* of the various kinds of connective tissue found in the human subject:—

A. *Interparenchymatous Connective Tissue.*

a. Lamellar interparenchymatous connective tissue.
b. Elastic   „   „   „
c. Lamellar elastic   „   „   „

B. *Parenchymatous Connective Tissue.*

a. Mucous parenchymatous connective tissue.
b. Fibrillar   „   „   „
    α. Tendon.
    β. Tissue of the fasciæ.
    γ.   „   fontanelles and osseous sutures.
    δ.   „   dura mater.
    ε.   „   perichondrium.
    ζ. Tissue of the periosteum.
    η. Erectile tissue.†
    θ. Tissue of cicatrices.
c. Elastic parenchymatous tissue.
d. Adenoid   „   „
    α. Diffuse.‡
    β. Proper tissue of the lymph glands.
    γ. Tissue of the spleen.
    δ. Tissue of granulating wounds.
    ε. Fœtal osseous medulla.
    ζ. Fœtal fatty tissue.
e. Fatty tissue.
    α. The subjacent tissue of the so-called fat-organs.
    β. The fatty tissue of the osseous medulla.
f. Chondroid parenchymatous tissue.
g. Cartilage.
h. Bones.
i. Dentine.

C. *Intraparenchymatous Connective Tissue.*

a. Mucous intraparenchymatous connective tissue.
b. Fibrous   „   „   „
c. Elastic   „   „   „
d. Neuroglia.§

Sexual Organs of Teleostei. ‖—In a monograph on the anatomy and histology of the reproductive organs of bony fishes, Dr. J. Brock describes both the coarse and the minute structure of these organs in a large number of types.   We abstract the following from the histological portion of the paper.

Male Organs.—The minute structure of the testis, like its external

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* ' Arch. Anat. und Entw.' (His and Braune), (1879) p. 43.
† This is well seen in the walls of the lachrymal duct of the rabbit.
‡ This in the mucous membrane of the digestive tract of mammals.
§ This appears to be a special form of connective tissue.
‖ ' Morphol. Jahrb,' iv. (1878) p. 505.

form, undergoes great changes during the breeding season. These changes affect not only the quality and quantity of the secretion, but even the form of the ultimate constituents of the gland.

However the structure of the mature testis may differ in different fishes, that of the unripe gland is the same in all. It is made up of polygonal acini, containing a rounded or slit-like lumen, so that the whole gland viewed as a transparency under the Microscope, presents a number of regular polygonal areas.

In respect of the structure of the ripe testis, the Acanthopteri are very sharply distinguished, from other Teleostei. The glandular substance is arranged in long, blind tubules arranged in a radiating manner around a centre formed by the hilus or place of exit of the vas deferens. In the remaining members of the group, the testis is formed on what Brock calls the Cyprinoid type. The tubuli form numerous anastomoses with one another, and so produce communicating spaces, the gland, in typical specimens (Cyprinoids), having a spongy appearance. This difference in the structure of the adult gland, notwithstanding the similarity of the young condition in the two types, is due to the fact that the increase in size of the organ, during the breeding season, comes about as a result of an independent increase of the elements of the gland in obedience to a fixed law, and is not primarily due to a mechanical dilatation by the accumulated sperm.

The author believes that the tubules are not separated from one another by interstitial tissue, and that they possess no true tunica propria, but that they rather represent a series of lacunæ (Hohlräumen), the partitions between which spring, on the one hand, from the tunica propria of the testis, while, on the other hand, they are immediately continued into the partitions of the vas deferens.

The epithelial cells of the gland are large and round, with finely granular contents, a large, clear nucleus, and no demonstrable membrane. The first step in the formation of the spermatozoa is the multiplication of the nuclei, the process not taking place simultaneously in the whole acinus, but beginning with a few cells, or it may be with but a single cell. By a repetition of this process the original epithelium disappears, and in its place are found large cells, filled with granules (Inhaltskörperchen), which stain deeply with carmine or logwood, and are probably the descendents of the original nuclei. From these granules the spermatozoa are formed. After the ripening of the latter it seems probable that the spermatic cells form multinucleate masses of protoplasm, without distinct cell-boundaries, that these divide into as many daughter-cells as there are nuclei, and so reproduce the original epithelium.

Female Organs.—The ovary presents great differences in the arrangement of the ovigerous surfaces; these will be best seen from the following table.

A. Ductless ovary.
      1. Ovary consisting of a simple lamina (*Anguillula*).
      2. Ovary consisting of numerous laminæ (*Salmonidæ*)

B. Ovary with duct.
    1. Ovigerous surface confined to a narrow strip of the wall
       of the ovary, or forming a duplicature of the wall, with
       which it is in connection by narrow stripes (*Scorpæna*,
       &c.).
    2. The greater part of the ovarian wall bears ova.
        a. Ova originate in irregular processes of the wall
          (*Lophobranchii*, &c.).
        b. Ova originate in definite lamellæ or duplicatures of
          the ovarian wall.
          1. Lamellæ parallel to long axis of ovary.
             a. Whole wall of ovary beset with lamellæ :
               canal central (*Sargus, Scomber*, &c.).
             β. Part of wall of ovary devoid of lamellæ ;
               canal lateral.   (Not yet observed.)
          2. Lamellæ parallel to transverse axis of ovary.
             a. With central ovarian canal (*Perca, Clupea*,
               &c.).
             β. With lateral canal (*Cyprinoids*, &c.).

Beyond the secondary egg-membranes, such as the gelatinous
investment of the perch and allied structures, Brock considers that the
egg has only one egg-membrane, the *zona radiata :* the existence of a
true vitelline membrane he considers still an open question.

The tuft-like processes (Zöttchen) are merely secondary appendages
of the zona radiata, and have nothing to do with either the follicular
epithelium or with the yolk.

The yolk presents externally a " zonoid layer," which may be
either entirely radially striated, or may be composed of an outer
striated, and an inner homogeneous layer.   The germinal vesicle has,
except in the youngest eggs, a distinct, often somewhat crumpled,
membrane, to the inner side of which the germinal spots are attached
like knobs.

The paper concludes with some observations and remarks on the
development of the egg and of the follicular epithelium.

**Evolution of the Embryo in Eggs put to incubate in warm
water.**[*]—M. Dareste recalls the experiment of Réaumur, who, having
placed eggs to hatch in warm water at the *incubating temperature*,
found no vestige of the embryo.   He renewed these experiments, and
proved that the development had begun, but that the embryo had died
at about the thirtieth hour, and had decomposed.   In one single case,
in which the embryo had not decomposed, it presented the monstrosity
called " *omphalocephalic* ": the heart, which was perfectly recog-
nizable, was seen above the head, evidently arrested in its formation.
In the vascular area there were no traces of vessels or blood.

Mechanical Genesis of Tooth Forms.[†]—In his articles on this
subject Mr. J. A. Ryder has made a valuable contribution to the

* ' Comptes Rendus,' lxxxviii. (1879) p. 1138.
† ' Proc. Acad. Nat. Sci. Philad.' (1878) p. 45 ; (1879) p. 47. ' Am. Nat.,'
xiii. (1879) p. 446.

doctrine of evolution. He adopts the classification of teeth proposed by Cope, and endeavours to explain by mechanical laws the phylogeny of the various existing dental types pointed out by the same author. The application of mechanical theory to this question is ingenious, and results in some very probable hypotheses. First among these is the supposed effect of lateral pressure in flattening conical cones or cusps, so that their section becomes semicircular or crescentic. Another is the probable crowding of tubercles on each other by impact transverse to their directions, producing plicate structure.

A summary of his views is stated by the author as follows :—

1. The earliest and simplest type of mammalian jaw-movement was that in which the mouth was simply opened and closed, without mandibular excursion, and co-existent with the simple haplodont or binodont molar.

2. The development of the various kinds of excursion mandibular movement has apparently been progressive.

3. As the excursive movements have increased in complexity, there has been an apparent increase in the complexity of the enamel foldings, ridges, and crests.

4. From the fact that the foldings, &c., have apparently been modified in conformity to the ways in which the force used in mastication was exerted, it is concluded that the various modes of crest and tubercular modification are related as effects to the diverse modes of mandibular movement.

5. It is apparent from the facts presented throughout the context that the mandibular articulations, and correlatively the skull, have probably been modified in shape by the movements made by the jaws and the forces exerted in executing them.

6. From the fact that the incisor teeth are partially or entirely absent, or relegated to another function, in forms which have long prehensile tongues, mobile, prehensile lips or proboscides, it is held to to be probable that such disappearance of the incisive dental elements is due to the assumption of their function by the prehensile organs indicated.

Refractive Powers of Animal Tissues.[*] — We can only draw attention to the very valuable results attained by Professor Valentin, in which the ordinary blood, the menstrual blood, and the blood of the umbilical vein of man are examined, as well as those of a large number of animals; with these are connected a series of observations on the blood-corpuscles, on the influence of coagulation, and on the characters of the serum. The bile is also examined, as is the urine and the sperm; milk and other fluids, as well as albumen, are tested, while the brain itself, the lens, and muscular fibre did not escape examination.

Innervation of the Respiratory Organs.—The fourth number of the 47th volume (1879) of the 'Bull. de l'Acad. Roy. de Belgique' contains a memoir by Dr. Fredericq on this subject, together with a re-

port on the paper by M. van Bambeke. Dealing with the action of the peripheral nervous system on the centres of respiration, M. Fredericq points out the remarkable influence of the pneumogastric nerve; after describing his methods, a description of which would be out of place here, the author states that he has repeated the ancient experiment of Traube, in which it was found that in artificial respiration the original rhythm of the respiratory movements is adapted to the rhythm of the inspirations; but that when the pneumogastric nerves are cut this relation is lost. To complete this observation it was necessary to repeat the observations of Breuer, which in the words of M. van Bambeke "n'ont pas encore passé dans le domaine classique de la physiologie." These experiments tend to prove that there are in the pneumogastric nerve centripetal fibres, which arrest respiration in the stage of active expiration, and which are stimulated by the mechanical distension of the lung. M. Fredericq has been able to convince himself of the arrest of respiration in the expiratory stage; and the final conclusion is arrived at that there are centripetal fibres in the pneumogastric passing some to an inspiratory as well as some to an expiratory centre. Anatomy offers no aid in distinguishing these two sets of fibres, but it is found that chloral hydrate diminishes the action of the inspiratory fibres (or, rather, depresses the centre to which they go); when veritably poisoned by this drug every excitation, mechanical, chemical, or electric, arrests respiration in the expiratory stage, and it appears that this drug has, in large doses, the effect of slowing the respiratory movements till they disappear.

Ovary and the Corpus Luteum.[*]—The investigations of G. R. Wagener were chiefly made on the ovary of the bitch, though human subjects, moles, rodents, and other animals were also examined; the ovaries were, when possible, taken warm from the animal, and were, after division, placed in Müller's fluid, from which they were, after three days, removed to strong alcohol. On other occasions ovaries were examined, in the fresh state, in iodized serum.

The Epithelium.—This is placed over the whole of the free surface of the ovary, and is directly applied to the fibrous cortical layer; in its cells there may be observed rods which are set perpendicularly to the surface of the ovary. The nucleus, which is rounded, and presents a double contour, is very commonly of one size. There is, however, no epithelium over the point at which ova are escaping, or have escaped, and it is also absent in aged specimens. In the simple striated form there are a few larger cells, to which Waldeyer has applied the name of primitive ova; as to the *stomata* of the same author, it is said that they are mere spaces due to the incompleteness of the fusion of the cells.

Cortical Layer.—The author points out that the arteries in this region are not of a large size, as some have supposed, and that their muscular layer can only be said to be strongly developed in proportion to the calibre of the vessels. As to the vexed question of the muscular character of the spindle-cells which so largely compose it,

* 'Arch. Anat. und Entw.' (His and Braune), (1879) p. 175.

the author states that he has observed a faint striation, and the regular arrangement of isotropic and anisotropic substances.

With regard to the ovarian follicle, we shall only observe that the abortion of the ovum is connected with the following phenomena :— The germinal spot disappears, and its place is taken by a small collection of angular and glistening waste products, or a radially striated sphere formed of crystalline carbonates ; the same fate awaits the germinal vesicle, and the whole of the yolk, but the *zona pellucida* may remain.

Corpus luteum.—The author, in examining a bitch, twenty-four hours after impregnation, found three large follicles in one ovary ; from these, when opened, there escaped a small sphere of gelatinous matter, in which two ova were found. The walls of the follicle were seen to be very richly provided with vessels, and were thick ; fourteen days after impregnation the vessels were found to be greatly increased in number and in size, and after twenty-one days the *corpus luteum* was found to be completely developed, and a number of " giant cells " were found in close proximity to the vessels ; these accompany the vessels and gradually surround the cells of the *corpus luteum*, giving rise in time to fibrillæ, which convert the body into a *corpus albicans* or *nigricans ;* they are, in fact, the rudiments of the fibrillæ of the connective tissue, and as they increase the cells of the yellow body undergo atrophy. Changes now occur in the contents of the blood-vessels which give rise to rusty brown aggregations, and the blood-vessels themselves die down. The surrounding tissues also suffer, and the wall of the follicle ceases to be apparent, while a whitish spot is at last all that is left to tell the tale of the changes that have taken place.

Natural Science Prizes, *Danish Academy.*—(Before 31st October, 1880. English allowed.)—(1) A series of comparative researches on the formation and development of the embryo sac and of the cells which it encloses before fecundation, made on a sufficiently large number of different angiosperms, so as to really increase the extent of our knowledge, bearing either on the law of development itself or on the general systematic importance of the differences which are presented, and to enable us at the same time to establish on a more solid basis than formerly the morphological value of the parts of the ovule.* (Gold medal of the Academy, value 320 crowns.)

2. Recent researches seeming to make it doubtful whether the salts of soda, so widely spread in the soil and in vegetable ashes, are really as necessary to the normal development of plants as the salts of potash, lime, magnesia, and iron, a research is required, which shall solve this question in regard to any wild and cultivated plants of Denmark.† (Thott prize, value 400 crowns.)

3. Original researches and experiments, which shall contribute to the elucidation of the development of the *Distoma* of the sheep, and that of their migrations until they arrive at the liver, as well as the

* Cf. 'Oversigt Danske Vidensk. Selsk. Forhand.' (1879) p. 28. ('Résumé du Bulletin,' p. 5.)   † Ibid., p. 6.

circumstances which may favour or hinder the introduction of the parasite into the sheep.* (Classen prize, value 600 crowns.)

Klein and Smith's Atlas of Histology.—This work (in 4to) is intended to be a pictorial and literal representation of the structure of the tissues of man and other Vertebrates ; its chief aim being to teach, not so much the history of histology as histology itself in its modern aspect.

The plates are the work of Mr. Noble Smith and the text is by Dr. Klein. Both are excellent—the plates accurate and effective, the text clear and judiciously concise, and comprising besides the explanations of the illustrations a good deal of other matter.

The subject-matter will be treated in this order ; first, the elementary tissues—blood, epithelium and endothelium, connective tissues, muscular tissue, the nervous, vascular and lymphatic systems ; then a short chapter on "cells in general," after which the compound tissues will be considered seriatim ; the alimentary canal and its glands, the respiratory organs, the urinary and genital organs, the skin and special sense organs. The concluding chapter will treat of organs, the nature of which is not sufficiently well known, as the suprarenal capsule, the thyroid and coccygeal gland.

B. INVERTEBRATA.

Fauna of Kerguelen's Land.†—The following are the chief conclusions to which Studer is led by his elaborate study of the fauna of Kerguelen's Land.

The fauna is similar to that of the other antarctic regions ; it has numerous analogies with the arctic region ; its most striking peculiarities belong to the terrestrial fauna, for of the marine genera only four are peculiar to it, while the other genera are found in New Zealand and Tierra del Fuego. It seems, indeed, that the southern point of America, the Falkland Islands, South Georgia, Prince Edward's Island, the Crozets, and Kerguelen must have been connected in earlier geological periods, and the great age of Kerguelen is spoken of by the characters of its geological formation.

Deep-water Fauna of the Lake of Geneva.‡—The fifth series of these interesting observations by Professor du Plessis commences with a note on the chemical characters of the mud of the lake, which, taken from three different stations, present some slight differences, but not such as to give any importance to the variations. As to the water, it is shown that there is no sensible difference in the amount of the solid matters dissolved in it at different levels ; as to the gases, there is no great difference in their absolute amount, but, just as in the waters of the ocean, oxygen is greatly deficient and carbonic acid greatly in excess at great depths.

Professor du Plessis describes four *Turbellaria*, all of which are new to the fauna, and one of which is the representative of a new species—*Vortex intermedius.* Turning to the *Infusoria heterotricha*,

* Cf. loc. cit., p. 30 (p. 6.) † 'Arch. Naturg.,' xlv. (1879) p. 140.
‡ 'Bull. Soc. Vaud.,' xvi. (1879) p. 149.

the author draws attention to the scarcity of deep-water *Ciliata*. To get an exact idea of the *Heterotricha* found at great depths it is necessary to see how far they are represented in the fauna of the canton. The group of *Heterotricha*, which is characterized by the possession, in addition to short and regularly arranged cilia, of a spiral peristomial circlet of larger and stronger, setiform, cilia, may be divided into three groups—Spirostomida, Stentorida, and Bursarida. Of the first family, all the species have been found in the canton, with the exception of the marine genus *Condylostomum;* of the second, one genus, *Freia*, is marine, but the other, *Stentor*, is represented by all its species; while of the third group only two genera are free-living, and of these one only has been observed, and that in the person of its sole good species, *Bursaria truncatella*. The author states that of all these forms only five have been found on the shores of the lake, all of which, with the exception of *B. truncatella*, pass, without modifications, to the bottom of the lake, where therefore *Spirostomum ambiguum, Stentor cœruleus, S. polymorphus,* and *S. Rösellii* have now been found. Of the *Rhizopoda*, for a long time not a single example was found. A dredging off Ouchy in the winter of 1877–78 revealed the presence of *Amœba princeps, A. terricola,* covered with its chitinous envelope, and *Difflugia proteiformis,* which by the production of gas in its interior is enabled also to live on the surface.

It is of interest to observe that specimens taken from the depths of the lake were found to be more transparent than those from the pools on the shore.

This instalment of the results of the explorations concludes with a list of the parasites and intestinal worms found in the fishes of the Lake of Geneva, prepared by M. Lunel.

"**Liver**" **of the Invertebrata.**[*]—M. Cadiat regards the Malpighian tubes of insects as belonging to the hepatic series, and points out that the large cells of which their walls are made up are separated from one another by spaces very similar to those which limit the cells of the hepatic lobule in the Mammalia; the green colouring matter which they contain exhibits with nitric acid the characteristic reactions of biliverdin. The liver of the Gasteropoda is stated to be broken up into lobules, which present an irregular central cavity connected with intracellular passages; the blood-vessels pass from the periphery to the hepatic lobule, and the biliary ducts take their origin from the central cavities of the lobules; the secretion is decolorized and dissolved by nitric acid and is regarded as a derivate of hæmatoidin in a different stage.

Mollusca.

Chromatophores of the Cephalopoda.[†]—The play of colour in the Cephalopoda was observed in the embryo, as well as in the adult, by Aristotle; later observers, such as Carus, delle Chiaje, and Wagner, have shown that this phænomenon is dependent on the possession and on the movements of the so-called chromatophores or pigment spots,

[*] 'CR. Soc. Biol.' for 1877 (1879), p. 217.
[†] 'SB. Akad. Wien,' lxxviii. (1879) p. 7.

which are scattered through the integument. It is to Kölliker, however, that we owe our first instalment of definite knowledge as to the structure of these bodies, inasmuch as it was he who directed attention to the presence of the radial contractile fibres, by the contraction of which the pigment spots are extended. A number of other observers have held similar views, and of these we need only refer to Brücke who pointed out the curious difference which obtains in the Cephalopod as compared with the chameleon; in the former the active state of the pigment spots finds its optical expression in their darker, while in the reptile it is in the brighter coloration. Other observers, such as Harting and Waldeyer, regard the play of colour as due to the protoplasmic substance of the chromatophore, and to that only. The question is now treated by Dr. Klemensiewicz, whose essay may be divided into two portions:—

Structure of the Chromatophore.—In this body we may make out the following parts: (1) A central pigment spot; (2) Its cellular envelope; (3) Radial fibres, set in a plane parallel to the surface of the integument and attached by their broadened conical ends to the pigment body; (4) The cavity of the chromatophore, which is separated from the dermal tissue by a thick layer of connective tissue. The examination of fresh specimens and of embryonic stages, together with specimens prepared by the aid of alcohol and gold chloride, has led the author to agree with Kölliker in regarding the pigment body as being a naked cell, for on no occasion has he been able to observe the structureless membrane described by Boll. As already stated, there is, however, a covering to the cell, which is partly formed by the *cellular* envelope described by Boll, and partly by the insertions of the radial fibres; in the contracted state this investment forms a hollow sphere with outwardly projecting processes; it consists of several layers of cells, between the elements of which there pass the insertions of the radial fibres. No very definite results were attained to with regard to the disposition of the nerve-fibres, as the author was not able to make out any direct connection between them and the pigment body or the radial fibres; the question is however one of very great difficulty from a histological point of view, but we shall see directly how great is the connection which can be made out by the physiological method of investigation. As to the coloration of the chromatophore it is now known that this does not only differ in different species, but even at different stages in development; thus in *Loligo vulgaris* it is reddish in the embryo, but violet in the adult. Of course, also, it differs in different stages of contraction, and thus while it is violet when expanded, it is dark brown or black when contracted; the form too is different, for the thin plate seen in the expanded stage is brought into a more or less rounded form in the contracted condition of the chromatophore. The radial fibres similarly differ in form, being thin and lamellar when the chromatophore is contracted, but broader when it is expanded; they are enclosed in a fine structureless membrane. The cavity (4) is chiefly filled with fluid. The histological differentiation of the body may be shortly summed up in saying that the pigment-spot is formed of a single cell,

and that the protoplasmic mass in which it is imbedded goes to form the cellular investment and the radial fibres.

Physiological Experiments.—These leave no doubt as to the influence of the nervous system on the chromatophores, and are of great interest. Using chiefly *Eledone moschata*, the author shows that there are fibres in the nerves of the arms, mouth, and funnel; which, when stimulated, bring about a darkening of the integument; these nerves are connected with the pedal and visceral ganglia and with the median portion of the lower half ring, which is known to be in connection with the optic ganglion, and there is in this region, it is believed, a special centre for the stimulation of the chromatophores; the results of section of the optic nerve and observation on the changes which obtain when the animal is in the presence of different colours, leads to the view that the chromatophores may be stimulated, after a reflex mode, by the influence of light on the eye. It is also probable that changes may occur at the will of the animal, and support is afforded to this view by the statements of Colosanti with regard to the "nervous axis" of the arms of the cephalopod, which appears to have the structure of a central organ; finally, changes occur when the integument is stimulated, whether mechanically, chemically, or electrically.

The author concludes with some remarks on the "mechanics" of the movements of the chromatophores; here the cardinal point is that when *active* the structures in question are *expanded*, and when *passive* are *contracted*. The opposite condition in the chameleon and certain fishes is to be correlated with the absence, in them, of the system of radial fibres; but this is not the whole difference, for in the Vertebrates just mentioned the changes in colour may take even hours to be effected, while in the fresh cephalopod they occur with extraordinary rapidity. A further proof of the value of the radial fibres is afforded by the fact that in the embryonic condition of the chromatophore the separate fibres may be seen to move; and it may well be concluded that the extension of the chromatophore is due to the contraction of all the radial fibres, which moreover always move in *straight* lines and never exhibit the looped arrangement which they necessarily would, if they were as some have supposed, nerve-fibres passing to the contained protoplasmic mass. The subsequent contraction of the chromatophore appears to be principally, though not altogether, due to the elasticity of the cellular investment, and the rapidity with which it is effected is well explained by the supposition that we have to do with what is practically a weighted muscular fibre; fixed at one end to the skin, there is attached to its other end the movable mass of the chromatophore, where the elastic force of the investment and the contractility of the pigment body represents the weight. The author expresses his belief that nerves pass to the separate radial fibres, although the presence of these has not yet been demonstrated.

There is an account of a few experiments with poisons; no effect was observed with curare.

Shells of the Cephalopoda in relation to the Body of their Constructor.*—Professor Owen returns with new arguments and fresh

* 'Proc. Zool. Soc. London' (1878) p. 955.

vigour to the defence of the position which he took up a number of
years ago, as to the difference in the characters of the coil of the shell
in *Spirula* on the one hand, and *Nautilus*, with the Ammonites, on the
other; the latter are regarded as revolutely spiral or coiled over the
back of the animal, whereas those of *Spirula* are involute.

It has long and well been known that the "fossil shells of Cephalo-
pods exhibit a progressive uncoiling from *Nautilus* to *Orthoceras*, and from
Ammonites to *Baculites*," but, as Professor Owen well remarks, anato-
mical evidence was required to demonstrate that there had been coiling
in the reverse direction; that has been supplied by his dissections of
Spirula and of *Nautilus*, and the author now demonstrates that it is
not always necessary to have seen an animal before we are able, with
proper insight, to tell a very great deal about its organization. Apply-
ing this to the Ammonite, we find evidence in support of Owen's
long-held view as to the shells of these animals having been external;
while specimens in which injury and repair have been effected point
to the mantle of these forms having had just the same structure as in
the living *Nautilus*, and as having been applied to the shell, and not
to have been "muscular and inapplicable to the last chamber as in
Spirula." Another point of similarity between the first two of these
forms is that the shell is porcellano-nacreous in structure, and not
simply nacreous as in *Spirula*. Between *Spirula* and *Ammonites* there
is, however, a very remarkable similarity; in both, the siphons in the
shell are *ventral*, or *ventro-marginal*, but in relation to the curves of
the shell, the siphon of *Spirula* is "internal" or "ento-marginal,"
whereas in the Ammonitidæ it is "external" or "ecto-marginal." To
turn to the Nautilidæ, where the siphon is central or subcentral in
most cases; in others (rare) it is ecto-marginal, and still more rarely
it is ento-marginal. It is here of interest to observe that it may
change its position as it passes through the different chambers of the
shell, so that the position, which is a sign of immaturity in the
existing *Nautilus*, was longer retained in the old Tertiary species.

Professor Owen deals also with the history of those curious
structures, which under the names of *Trigonellites*, or *Aptychus*, have
been referred to the Cirripeds, or have been regarded as parts of the
Ammonite's gizzard, or as protective plates of the nidamental glands
in the female; a careful discussion of the question leads the author
to accept and support the view held by Van der Hoeven, that the
shells in question formed two shelly supports for the hood of *Am-
monites*.

Turning to the chambers of the shell, Professor Owen next describes
what obtains in *Vermetus gigas* and in *Spondylus varius*, as well as
what is seen in *Spirula* and *Nautilus*. As to the "final cause" or
function of the chambers, the author holds to his original opinion that
they enable the *Nautilus* to rise, and the *Spirula* to sink. As to the
modes by which the shell may become complicated, it will be of
interest to note that the septa may be (1) simple and distinct, attached
only by their circumference, or (2) attached subcentrally to each other
as well as by their circumference to the shell-wall; or (3) attached
marginally to the shell-wall and having an organized vascular mem-

branous canal contained in a testaceous tube which unites the partitions; or (4) the tube may be replaced by a number of superimposed funnel-shaped tubes; or, lastly, the tube may be interrupted and the septa and chambers be traversed by a lime-coated membranous canal. With regard to the last arrangement, which is that which is found in the *Nautilus*, it is to be noted that the " calcareous incrustation is apt to be dissolved by the acetous change of the alcohol," and it is this which gives especial value to the observation of Professor Vrolik, inasmuch as it had been previously supposed by some that the siphon of the *Nautilus* might have a dilating and contracting action. The paper concludes with some remarks on the vascular supply of the siphon, and with some suggestions to the student who shall be fortunate enough to be able to examine these forms in their living state.

Eye of the Cephalopoda.*—Dr. Schobl, in an article on this subject, deals more especially with the vascular supply, in addition to which he gives an account of what has been done by earlier authors; as will be gathered from the few words we can say, the arrangements are difficult to make out in their completeness. Around the cornea there is a pair of greatly coiled arteries, and of veins; outside these there is a fringe, in which are small veins and arteries, and outside this is the *circulus arteriosus iridis*; this last is bounded by a fairly broad *corona ciliaris*, made up of about 160 closely applied ciliary processes. Then there is a ring of well-developed vessels formed by a median artery with a vein on either side; then the ciliary plexus, and the well-developed posterior ciliary vein and artery. External to the circular vessels we find the *zona ciliaris*, in which are a number of *venulæ* and of " recurrent arteries."

Action of Strychnine on Gasteropodous Molluscs.†— Mr. E. Heckel has presented to the Academy of Sciences an account of the action of the salts of strychnine upon these Molluscs.

Noting the fact that the alkaloids occur more frequently, and possess a more powerful physiological activity, the higher we ascend in the scale of vegetable life, he asks whether their special task may not be to defend the plant against animal enemies, especially as the more important an organ the more generally it is possessed of poisonous properties. He therefore finds it important to ascertain the action of the best-known alkaloids upon certain selected terms in the animal series. For this purpose he has experimented with strychnine sulphate and oxalate upon *Helix pomatia* and *aspersa*, and *Zonites algirus*. He observed that whilst *Helix aspersa* of the mean weight of 6 to 6·70 grms. succumbed to a dose of strychnine sulphate of ·025 grm., *Zonites algirus* of 8 grms. and *Helix pomatia* of 9·70 grms. perfectly resisted doses of ·045 grm. He concludes that the Gasteropods enjoy a remarkable immunity from the effects of strychnine; that with them, as in the case of the Vertebrata, the degree of

* 'Arch. Mikr. Anat.,' xv. (1878) p. 215.
† 'Comptes Rendus,' lxxxviii. (1879) p. 918; 'M. Journ. Sci.,' i. (1879) p. 514.

hurtfulness of the poison is inversely as the weight of the animal, and that upon them, as in higher animals, strychnine is tetanizing.

Animal of Voluta musica.*—M. P. Fischer, having examined a specimen from Guadeloupe, preserved (imperfectly) in alcohol, finds that it differs from all the other species of this great genus, by its operculum much more elongated than that of *Lyria* and by its multicuspid lingual plate, and considers that it would be better to abandon the name of *Voluta* and substitute *Musica*. It approaches *Vespertilio*, *Amoria*, &c. (of the Volutidæ without operculum) by the greater part of its exterior characters, *Lyria* by the existence of an operculum, and *Marginella* by its lingual plate. It constitutes therefore a well-defined group, which should remain with the Volutidæ, of which it is one of the most aberrant forms.

Neomenia (Solenopus).†—The Rev. A. M. Norman says that the type species has long been known to him as an inhabitant of the British Seas (Shetland). The genus and species must he thinks in justice bear the name (*Neomenia*) bestowed by Tullberg, who published an accurate description, with two plates of figures of the animal and its anatomy, in 1875, at a time when M. Sars had only given the MS. name.

Two Collections of Pteropoda.‡—Dr. G. Pfeffer contributes an account of the Pteropoda collected by the German corvette ' Gazelle,' and by Herr Jagor in the Philippines ; one new genus, four new species, and a well marked variety are here described for the first time. More attention is paid in the descriptions to the characters of the shell and of the larval shell, as seen by a hand-glass, than was given to the subject by Rang and Souleyet. The paper, which is purely technical and quite beyond any abstract, is illustrated by one plate.

Respiratory Apparatus of Ampullaria.§—M. Jourdain describes the results of his examination of four of these interesting Mollusca from Mexico. The respiratory apparatus, which is placed as usual in the pallial chamber, has the gill on one (the left) side largely atrophied. Between it and the normally developed gill there is the pulmonary pouch, which is formed, apparently, by a fold of the mantle, and is separated by a groove from the right gill ; on the floor of the chamber there are developed two siphon-like folds, one of which is large and connected with the pulmonary sac, and the other small and related to the well-developed gill. The renal gland is placed behind this latter structure. In describing the relations of the vessels the author points out that a large number of veins ramify in the walls of the pulmonary pouch, while the blood from the atrophied gill returns to the pallial vessels, to pass to the proper respiratory apparatus.

* ' Journ. de Conchy.,' xix. (1879) p. 97.
† ' Ann. and Mag. Nat. Hist.,' iv. (1879) p. 164.
‡ ' MB. K. Preuss. Akad. Wiss.' (1879) p. 230.
§ ' Comptes Rendus,' lxxxviii. (1879) p. 981.

Molluscoida.

New Genus of Polyzoa.*—The Rev. J. E. Tenison-Woods describes *Euktimenaria ducalis* (εὐκτίμενος, well-built) as a very interesting and curious genus dredged at a depth of 10 or 20 fathoms on coral mud off Darnley Island. It differs so completely from any of the described families of the Cheilostomata that its affinities and relations must remain problematical until others are discovered. The nearest family is the Selenariadæ which have the polyzoary more or less orbicular, convex on one side. Its singular beauty both as regards design and ornament renders it a remarkable addition to an order where beauty and variety are the rule.

The genus is characterized thus:—Polyzoary free, upper surface convex covered with cells, lower surface divided into five portions, each containing large pores; in the centre of the base a vermiculate quinque-partite body.

The species is convex with pentagonal outline; the edge circumscribed by a raised margin of five arches, whence it descends to a broad pentagonal pedicel by five arched concave surfaces, which are horizontally divided in the centre by a straight raised double ridge, above and below the centre of which there is a large conspicuous pore; the pore above is semicircular, that below is perfectly round; both seem deep. The margin of each of the arched spaces curves round into a loop at each side below the lower pore, and is curved again in a contrary direction at each side so as to form another small loop in which there is another small pore. Beneath the lower of the two large central pores there are one or two conspicuous grooves to the base. Upper convex surface covered with concave cells, with a distinct raised margin; mouth in the centre, semicircular, a raised margin. Shape of cells from oval to circular, a few almost pentagonal; the centre of the convex surface seems covered with cells but they are worn almost smooth on both the specimens. The base is vermiculate, but with a radiate tendency, and forming a quinque-partite pattern. Between the margin of the five sides there are upper and lower angular spaces, giving great elegance to the design.

Dimensions: alt. 6, diam. of summit 8, of base 4½, lat. of five lateral spaces 4½, alt. 3½ mm.

The author is unable to suggest any explanation of the pores on the sides or the organs which form the margins, transverse bands, &c. It is quite evident that there must be some individuality in these zoothomes apart from what we call the animal which dwells in the cells, or the symmetrical arrangements of the species could not be explained.

Embryology of Tendra zostericola.†—In continuation of his researches into the history of this form Herr Repiachoff now gives some few details as to the stages subsequent to the blastula; in which there is to be observed a slight thickening of the ectoderm, on the ventral surface; this becomes gradually more marked and is evidently

* 'Proc. Linn. Soc., N.S.W.,' iii. (1878) p. 126.
† 'Zool. Anzeiger,' ii. (1879) p. 67.

the rudiment of the sucker, the cavity in which is formed by a process of invagination ; the apparatus is purely ectodermal in origin.

The upper part of the body, or that which, in the larva, contains the oral groove is, at first, relatively very small ; increasing in length later on, it becomes connected with the endoderm and comes into contact with the fore-gut ; still later the portion of the endoderm which lies superiorly to the fore-gut separates from the rest of the endoderm, and becomes fused with the gut, and now forms a collection of cells which becomes closely applied to the oral grove.   The author refrains from entering at present into a full discussion of theoretical considerations.

Arthropoda.

Metamorphoses of the Blister Beetle (*Lytta vesicatoria* Fab.).* —M. J. Lichtenstein has succeeded at last in following the complete development of the blister-beetle from the egg to the perfect insect, which had already been done for *Meloe*,† *Sitaris*,‡ and *Epicanta*,§ but had never been accomplished with the blister-beetles.   The author reserving to himself the publication of his entire memoir in the special entomological journals, communicates a *résumé* of his work to the French Academy.

He placed females which had copulated towards the end of May and the beginning of June, under a bell-glass with some earth, in which the female laid its rather elongated, whitish, and transparent eggs.   In a fortnight the larva long known under the name of *Triungulinus*, issued from the eggs.   It was scaly, and dark brown, with the meso- and metathorax and the first abdominal segment white. It had very acute jaws, black prominent eyes, and two long caudal setæ.

The author, after several fruitless trials, fed the larva on the stomachs of honey bees, and then on the eggs and young larvæ of bees—*Osmia* and *Ceratina chalcites*.   Honey must be added to the eggs or young larvæ, as animal food is only fitted for this first larval form, and the little *Triungulinus* has an instinctive knowledge that it must not touch the eggs or larvæ unless there is enough honey to feed the form which is to follow it.

On the fifth to the sixth day it changed its skin, lost its caudal setæ and brown colour, and became a small white hexapod worm ; its sharp jaws became obtuse, its eyes less brilliant, and it left the eggs and young larvæ and ate honey.   Five days later it again changed its skin, it jaws became still broader, and its eyes further obliterated.

Five days later there was a fresh moult.   The eyes now disappeared entirely, the feet and jaws became brown and horny at the extremity, the insect presenting the appearance of a small larva of a *Scarabæus*, and it is seen that it is destined to burrow in the earth.

* 'Comptes Rendus,' lxxxviii. (1879) p. 1089.
† Newport, "On the Natural History of the Oil-Beetle (Meloe)," in 'Trans. Linn. Soc. Lond,' 1861.
‡ Fabre, "On *Sitaris humeralis*," in 'Ann. Sc. Nat.,' 1857 ; Valéry-Mayet, "On *Sitaris collatis*," in 'Ann. Soc. Entom.,' 1875.
§ Riley, in 'Trans. Ac. Sci. St. Louis,' 1877.

So far the author had reared them in small glass thimble-shaped tubes, corked and placed upside down, the observations being followed on the surface of the cork. In order to supply the necessary earth in a sufficiently damp state for the larvæ, he now used a glass tube ·10 m. in length by ·025 in diameter, stopped at the bottom by a piece of sponge, and filled with earth, on which he placed the "scarabæoid" larva (this word has already been used by Riley for *Epicanta*). It immediately buried itself, and formed, a little above the sponge, a small chamber or cavity against the wall of the tube, which enabled even its subterranean movements to be followed. In five days more there was a fresh moult; but this time it was no longer a larva that appeared, but a pupa, like that of a Muscide, having four small mamillæ at the apex, and three pairs of small ones in the place where the legs were. It was horny-white in colour, and motionless, having the appearance of a chrysalis. This condition lasted all the winter, and one would have thought life was quite extinct, if from time to time it had not squeezed out of its pores small drops of a transparent hyaline fluid, which remained for several days on the surface of its body.

On 15th April this pupa burst its envelope, and gave issue to a white grub very similar to the *scarabæoid*, but without the strong claws and jaws; only showing rudimentary feet, each composed of three short, thick pieces. This grub moved slowly in its cell; it did not quit it and did not eat. On 30th April there was a fresh moult, giving at last a nympha, returning to the regular coleopterous type, with all its limbs quite visible. This nympha, at first white, soon became coloured. On 17th May it was already of a dark hue, and on 19th the beetle was seen in the tube with its brilliant covering.

The complete evolution of the insect thus lasts for about a year.

The author strongly suspects that those bees which make nests in the earth, like *Halictus* and *Andrena*, are the usual prey of these insects, but has not yet made exact observations on the subject.

New Genus of Cochineals of the Elm.* — M. Lichtenstein has also discovered a new and very strongly-marked genus of cochineal living on the elm, forming the transition between the Coccidæ and Phylloxerians, which he has named *Ritsemia*, after M. C. Ritsema, the Curator of the Leyden Museum.

The animals, first observed in August, were red, ·45 mm. long, of an elongate-oval form, with six-jointed antennæ. Attaching themselves in the crevices of the bark of *Ulmus campestris*, they lost their aphis-like form and took that of a small, flattened, reniform gall or vesicle, as in many Coccidæ. At this period they approached the genera *Nidularia* and *Gossyparia* as they exuded a cottony mass underneath, in which they deposited ovoid bodies of different sizes, which are not true ova, but analogous to what the author has called *pupæ* in the Phylloxerians. In March these bodies acquired traces of segmentation, and in April the males issued from the cottony mass. Their antennæ, moniliform and of nine joints, resemble those of the Coccidæ,

* 'Comptes Rendus,' lxxxviii. (1879) p. 870.

but in other respects the form is not that of the male Coccidæ, but of the Phylloxerians. The head, thorax, and abdomen are united and not separated, as in the former. They are ·4 mm. long, completely apterous, without a rostrum, and with a projecting penis.

A few days after the appearance of the males the pupæ remaining in the cottony mass developed and furnished the female, ·45 mm. long, very similar to the form that appears in August, except that it has eight joints in the antennæ instead of six, and is therefore a different phase. Copulation takes place at the time.

M. Lichtenstein has not yet been able to follow what takes place between May and August, and calls attention to the fact that while these insects exist "in millions" on every elm, the problem of the complete cycle of their life-history, which was set by Réaumur, is still unsolved.

The specific name of *pupifera* is given to call to mind the mode of reproduction (*Anthogenesis*) in which there intervenes a form furnishing male and female pupæ from which the sexual individuals issue and immediately copulate.

Notes on the Phryganida.*—Fritz Müller draws attention to the fact that the pupæ of the *Helicopsyche*, which are found in the brooks around him (Blumenau, Brazil) have the first four appendages long and more or less richly ciliated; in those, however, which are found by the waterfalls, and live on damp stones, the hairs are absent. These examples appear to be of importance as they show in a very striking way the fact that the reduction of parts which have become useless must not be looked upon as being in all cases the simple and direct result of disuse. These swimming hairs are connected with the membrane of the pupa, which covers in the mature insect, so that their being or not being used seems to be a point which would have but slight, if any, effect on the descendants of the insect; why, then, do they disappear so suddenly when the animal changes its locality to one in which it does not swim, and yet why are such useless parts as the incisors in the upper jaw of the ruminant, which are never cut, continued on generation after generation? The answer seems to lie in the difference of time that these separate structures have been in the possession of the animal; where they have been lately acquired, they are, on disuse, easily lost; but where, as in the case of the ruminant's upper incisors, transmission has been acting for long ages, disuse does not so easily or so rapidly effect complete loss of the now useless structures.

Anatomy and Physiology of the Digestive Organs of the Myriapoda.†—M. Felix Plateau, in continuation of his researches into the digestive apparatus of the Insecta, now presents a memoir on the Myriapoda, concerning which group the remark of Newport, made more than thirty years ago, "The Myriapoda have been more neglected by naturalists than almost any other division of the Articulata," still remains true.

* 'Zool. Anzeiger,' ii. (1879) p. 180.
† 'Mém. Acad. Roy. Sci. Belg.,' xlii. (1878), Art. ii.

The digestive tube in this group is more like that of the Insecta (Hexapoda), than to that of any other Arthropod; it consists of a buccal, a median, and a terminal portion, and is provided with a pair of salivary glands, and with one or two pairs of Malpighian tubes; the buccal intestine may be short and broad (*Julus*), or very long and capacious (*Cryptops*), or very long and excessively narrow (*Geophilus*); the epithelium may be absent from its walls, and the chitinous cuticle is in a few cases (*Lithobius*) provided with short chitinous projections which are directed backwards; in *Cryptops* there is a false gizzard intercalated between the fore and the median intestine, which is very muscular, and is provided with a number of setæ or chitinous spinules. The terminal portion of the intestinal tract is ordinarily short, but is elongated in the Chilognatha (herbivorous forms), and is longest in *Glomeris*; the following table will indicate the variations in its disposition, concerning which it was stated by the late and lamented Gervais, that it was only coiled in *Glomeris* and its allies :—

Greatly coiled { Coils occupying a large extent of the cavity .. {	*Glomeris.* *Zephronia.* *Sphærotherium.*
Greatly coiled { Coils occupying a small extent.. .. .. .. {	*Cryptops.* *Himantarium.* *Geophilus.*
Simple terminal curvature	*Julus.*
No convolution or curvature	*Lithobius.*

This terminal portion is always richly supplied by tracheæ.

The salivary glands may be racemose (*Lithobius, Cryptops*) or tubular (*Julus, Glomeris*); in *Geophilus* the excretory canal (efferent duct) is very long, but in *Julus* and *Glomeris* it is short. The Malpighian tubes, which are inserted into the point at which the median passes into the terminal intestine, are ordinarily two in number, but *Julus* has four; they may be of the same diameter along their whole length, or be dilated into reservoirs (*Lithobius, Geophilus*). By transparent light they are seen to be of a yellow colour, and their secreting cells are much smaller than in most insects.

Examined physiologically, we find that the *Myriapoda* may be carnivorous or herbivorous; the former, or Chilopoda, live on flies, earthworms, spiders, larvæ, and so on, which they seize between their forcep-like foot-jaws, and poison; the effect of the poison of *Lithobius* on the house-fly is reported to be as rapid as the bite of the spider; the victim, so soon as it is killed, is devoured rapidly, everything being swallowed, either in large (*Lithobius*) or in minuter (*Geophilus*) mouthfuls. The herbivorous forms (Chilognatha), live on decomposing vegetables (*Julus*), decayed wood (*Polyxenus*), or moss (*Glomeris*), which they gnaw; and in swallowing their food they, like the Chilopoda, take in some, though not so much, earth or sand. In *Cryptops* the gizzard already mentioned delays the food, which is, in it, subjected to the action of a digesting fluid of neutral reaction. In most cases digestion proper is effected in the median portion of the intestine, where the food is acted upon by a yellowish or brownish liquid secreted from its walls; this is ordinarily neutral, but in *Lithobius*,

Cryptops, and others it is faintly alkaline; while the Julidæ are remarkable for having an acid secretion. After this, digestion seems to be at an end in the carnivorous forms, as is shown not only by the extreme shortness of the remainder of the digestive tract, but by the fact that the excreta are enclosed in a fine membranous envelope, which is formed in the median intestine, and which is capable of very effectively resisting the action of chemical agencies; this fæcal membrane is absent in the herbivorous forms, who have, as we now know, a somewhat coiled terminal portion.

Julus and *Himantarium* are shown to resemble a number of insects in resisting for a long period the effects of starvation. The secretion of the buccal glands is colourless, and is neutral or slightly alkaline in reaction; it is never venomous, nor is it similar to the true saliva of Vertebrates or Insects inasmuch as it is incapable of converting starch into glucose. The Malpighian tubes seem to be exactly similar to those of the allied Insecta, and to have the same function of depuratory urinary organs; they produce uric acid, urates of sodium, &c., and oxalate of calcium. This important memoir is illustrated by three plates.

New Scolopendra.[*]—Professor Giebel gave an account to the Naturw. Verein in Halle of a new Scolopendra, discovered in Ecuador, for which the specific name of *respublicana* is proposed; most nearly allied to the *S. insignis* from Columbia of Gervais it differs in its smaller size, the coloration of the upper surface, which is olive-green in the new species, and the armature and number of spines on the legs, of which it has twenty-one pairs; there are nine pairs of stigmata.

Pentastoma tænioides in the Ear of a Dog.[†]—Dr. Gillé presented a specimen of this organism which he had taken from the middle ear of a dog; he observed that the mucous membrane was greatly thickened and inflamed; the "worm" (Linguatulid—one of the Arachnida, as ordinarily regarded) must have entered by the Eustachian tube, and indeed another and smaller specimen was observed in the nostrils. The creature is ordinarily reported as inhabiting the nasal fossæ, the frontal and ethmoidal sinuses, and the region now recorded is one in which it has not been hitherto found.

Genera of Acari.[‡]—Dr. Kramer gives a careful history and critical account of the genera *Rhapignathus* of Dugès, *Leptognathus* of Hodge, and *Caligonus* of Koch. *R. ruber* of Koch has not the slightest resemblance to *R. ruberrimus,* while the genus *Caligonus* which this latter author subsequently founded for the species, is too slightly described for accurate or certain recognition. After referring to the work of Canestrini and Fauzago, who appear to have put the forms in question in a more natural position in the system than any they had before occupied, the author goes on to refer to the work of Mr. Hodge who formed the new genus *Leptognathus.* The author in proceeding to

[*] ' Zeitschr. Ges. Naturw.,' lii. (1879) p. 326.
[†] ' CR. Soc. Biol.' for 1877 (1879), p. 394.
[‡] ' Archiv Naturg.,' xlv. (1879) p. 142.

give an account of the genera states that he has not seen the works of Hodge, and does not know whether he gives any diagnosis of the genus. The writer of this notice has made it his business to refer to the 'Trans. of the Tyneside Nat. Field Club,' in which Mr. Hodge's paper appeared, and finds that, after the notice of the species, the writer says that from the " peculiar character of the rostrum, absence of true palpi, and number of eyes, it would appear to form the type of a new genus," without any more definite diagnosis. The paper concludes with a short account of a new genus *Cryptognathus*, and of the species *lagena ;* it is illustrated by a plate of fifteen figures.*

The Nebaliad Crustacea as Types of a New Order.*—The *Nebaliadæ*, represented by the existing genus *Nebalia*, have generally been considered to form a family of Phyllopod Crustacea. Metschnikoff, who studied the embryology of *Nebalia*, considered it to be a " Phyllopodiform Decapod." Besides the resemblance to the Decapods, there is also a combination of Copepod and Phyllopod characteristics. The type is an instance of a generalized one, and is of high antiquity, having been ushered in during the earliest Silurian period, when there were, when we regard the relative size of most Crustacea, and especially of living *Nebaliæ*, gigantic forms. Such were *Dithyrocaris*, which must have been over a foot long, the carapace being seven inches long. The modern *Nebalia* is small, about half an inch in length, with the body compressed, the carapace bivalved as in Limnadia, one of the genuine Phyllopods. There is a large rostrum overhanging the head, stalked eyes, and besides two pairs of antennæ and mouth parts, eight parts of leaf-like, short, respiratory feet, which are succeeded by swimming feet. There is no metamorphosis, development being direct.

Of the fossil forms, *Hymenocaris* was regarded by Salter as " the more generalized type." The genera *Peltocaris* and *Discinocaris* characterize the lower Silurian period, *Ceratiocaris* the upper, *Dictyocaris* the upper Silurian and the lowest Devonian strata, *Dithyrocaris* and *Argus* the Carboniferous period. Our existing northeastern species is *Nebalia bipes* (Fabricius) which occurs from Maine to Greenland.

The Nebaliads were the forerunners of the Decapoda, and form, we believe, the type of a distinct order of Crustacea, for which the name *Phyllocarida* is proposed.

Physiology of the Nervous System of the Crayfish.†—Mr. James Ward, M.A., gives a brief account of experiments, consisting mainly in severing (1) one or (2) both of the supra-œsophageal commissures, (3) both the sub œsophageal commissures, or (4) in dividing the supra-œsophageal ganglia longitudinally.

From these experiments it may perhaps, with more or less probability, be inferred that :—

(*a*) There is no decussation of the longitudinal fibres in the nervous system of the crayfish.

(*b*) On the presence of the supra-œsophageal ganglion depend (1) the spontaneous activity of the animal as a whole, or what might be called its volitional activity ; (2) the power to inhibit the aimless and wasteful mechanical activity of the lower centres ; (3) the power to maintain equilibrium ; and (4) the use of the abdomen in swimming.

(*c*) The sub œsophageal ganglia are the centres for coordinating (1) the locomotive, and (2) the feeding movements, and (3) for a peculiar rhythmic swim of the limbs seen as soon as the supra-œsophageal ganglia are removed (the sub œsophageal ganglion is apparently the source of a considerable amount of motor energy).

(*d*) There is much less solidarity, a much less perfect *consensus*, among the nervous centres in the crayfish than in animals higher in the scale. The brainless frog, e. g., is motionless, except when stimulated, and even then does nothing to suggest that its members have a life on their own account ; whereas the limbs of a crayfish deprived of its first two ganglia, are almost incessantly preening, and when feeding movements are started, the chelate legs rob, and play at cross-purposes with, each other as well as four distinct individuals could do.

(*e*) Some stimulus from other centres is more or less necessary to the activity of any given centre.

(*f*) The "natural" discharge of a ganglionic centre (not exhibiting "volition") appears to be of a rhythmic kind; the rhythmic movements becoming converted into varied movements by temporary augmentation or inhibition.

Influence of Heat on the Nervous Centres of the Crayfish.*—

M. Richet commences by describing an experiment, by which he says the state of the nervous centres which preside over the power of movement may be well tested. If a healthy crayfish is held by the back between two fingers, it attempts to seize objects between the two branches of its pincers, and if the edge of the inner one be lightly touched the two parts are immediately brought together. Regular as this action is, it is not purely reflex, for in the water the crayfish does not act in the same manner; instead of trying to seize its aggressor, the animal may attempt to escape. Of the true reflex acts three are taken as examples. When the antennæ are cut or pinched, the animal withdraws them ; when the eyes are touched, their supporting pedicels are retracted. Section of one of the large pincers produces swimming movements, to the number of five or six, of the caudal appendage.

Now in submitting a crayfish to high temperatures, the different functions of the nervous system are seen to disappear, one by one, as the temperature is raised :—

1. 23°–24° : The pincer is most feebly moved ; or the voluntary nervous system is affected.

2. 24°–26° : No movement of the pincer under the conditions of the experiment above detailed ; or complete loss of voluntary nervous activity.

* 'Comptes Rendus,' lxxxviii. (1879) p. 977.

3. 27°–29° : Reflex action disappears, although the muscles and nerves still react on electrical excitation.

4. 32°–34° : Motor nerves become inactive.

5. 33°–36° : Muscular tissue ceases to display its properties.

6. 37° : Muscular tissue altogether dead, in a state of contraction.

Temperatures higher than 32° were found to be mortal. The nerves which govern the respiratory movements lose their powers when subjected to a heat of from 28° to 30°.

Blood of the Lobster.*—Dr. Léon Fredericq agrees with MM. Jolyet and Regnard in finding two colouring matters in the plasma of the lobster's blood ; one, of a rosy hue, is with difficulty diffusible, and is not coagulated by boiling or by alcohol, nor does it contain any metallic salt. It does not change colour in vacuo, or under the action of oxygen, nor is it invariably present. The other appears to be identical with the blue colouring matter hæmocyanin,† which the author has already found in the *Octopus*. The blood of the lobster, when these two constituents are present, is rosy on reduction, while when exposed to oxygen it is blue by reflected, and brown by transmitted light ; it coagulates rapidly after removal from the body. The colour of the blood of *Limulus*, as lately described by Professor Ray Lankester, seems to Dr. Fredericq to point to the presence therein of hæmocyanin, which has been distinctly found in some Gasteropods.

Observations on the Amphipoda.‡—Professor Wrześniowski describes four new species of the genus Hyale from Peru, and points out that the genus may be divided into two subgenera, *Allorchestes*, in which the telson is simple and has a complete margin ; and *Hyale* proper, in which the margin of the telson is more or less cleft.

Contributions to the Natural History of the Caprellidæ.§—Herr Gamroth deals with this "cosmopolitan" group of the *Amphipoda* ; the specimens for his examination were obtained at Trieste, where he found them seeking quiet in the branches of a bryozoon (*Bugula neritina*) to which they adhere by their hinder thoracic appendages.

That which has been least studied is the internal organization.

Their muscular system is exceedingly well-developed, and consists of longitudinal muscles, which effect the movements of the body and of the well-developed antennæ, and of transverse muscles which move the appendages and the digestive apparatus in its more anterior region. As in all allied forms the muscles are transversely striated.

The nervous system consists of a cerebral ganglion and a ventral chain connected with it by two commissures ; the lower part of the former is continued into four conical processes, each of which gives off a large nerve-trunk ; the upper and larger portion is divided into two rounded lobes, which are continued backwards into two broad commissures ; then succeed five ganglia, of which the first four are similar in form and size ; the last ganglion is larger, and this is

* 'Bull. Acad. Roy. Sci. Belg.,' xlvii. (1879) p. 409.

† This Journal, ii. p. 164.

‡ 'Zool. Anzeiger,' ii. (1879) pp. 175 and 199.

§ 'Zeitschr. wiss. Zool.,' xxxi. (1878) p. 101.

apparently due to the fact that it supplies the sixth and seventh segments and the rudimentary abdomen. The eyes, which are without stalks, lie at the sides of the head and have a few pear-shaped crystalline cones imbedded in a brownish-red pigment; the tactile organs are represented by setæ, which are especially well-developed on the flagellum of the superior pair of antennæ; as in most *Amphipoda* there is no distinct auditory organ; on the same flagella are found delicate white bodies, which are evidently olfactory in function. The *frontal organs*, which seem to be found in all other *Amphipoda*, are here also found; paired and lying just behind the root of the superior antennæ, they are goblet-shaped in form, but their function remains unknown.

The œsophagus is simple in structure, and the gastric skeleton, though very similar to that of *Gammarus*, is more simple; an inferior prolongation, apparently homologous with the *appendix campaniformis* described by Sars in *Gammarus* and *Mysis*, is present; the structures taken by Goodsir, on account of their long cylindrical form, to be ovaries, are shown to be hepatic tubes; they contain a yellowish-brown oily fluid. The elongated tubular heart, which lies above the intestine, is connected with the integument by bands of connective tissue; it opens to the vascular system by five clefts; a large part of the vascular system is lacunar, and the yellowish blood-corpuscles are, though not strikingly, spindle-shaped. So far as the author has been able to make them out there is but one, and not as in the allied forms described by Dohrn, two pairs of testes; in *Caprella æquilibra* each consists of a tube, which commences in a rounded process at the hinder end of the fifth segment, and rapidly becomes excessively narrow; the external appendages of the male consist of two small curved structures, which are placed on the ventral surface of the abdomen. The ovaries are likewise tubular, and are elongated structures, which extend as far forward as the second, and open in the fifth segment. The ovum, as found in the brood-pouch, is ellipse-shaped, and is completely filled with dark granules and fat-drops; cleavage seems to be complete; the larger rounded cells of the yolk appear to form the head and its appendages, with the anterior thoracic segments, while the smaller elongated parts form the hinder segments and the abdomen. The young form is exactly similar to the adult, but as a rule it remains in the pouch until its muscles are well developed, although it is quite capable, if compelled, of taking to the water.

Caprellidæ of the Mediterranean.[*]—Dr. Haller describes sixteen species, belonging to the genera Rota, Protella, Caprella, and Podalirius; of these, eight appear to be new. He observes that the species of the genus Caprella may be divided into two groups, in one of which the inferior pair of antennæ are provided with simple sensory hairs, while in the other the same structures are closely beset with more complicated setæ. In *C. antennata*, n. sp., of which only a female was found, the anterior pair of antennæ are nearly as long as the body.

[*] 'Zool. Anzeiger,' ii. (1879) p. 230.

Organization of the Phronimida.[*]—After some remarks on the systematic position and the more important characters of this somewhat abnormal group of the *Amphipoda*, together with a diagnosis of the new genera *Phronimopsis* and *Paraphronima*, Professor Claus enters into the discussion of the structure and organization of the group:—

Appendages.—The antennæ are particularly interesting, inasmuch as it is ordinarily stated that *Phronima* is provided with only one pair. Starting, as an examination of the earlier stages allows us to do, with the simple appendage of two joints, we find, in a very early stage of development, that the cylindrical antenna contains in its terminal joint an aggregation of cells, which become differentiated into a small ganglion, and that a seta and an olfactory filament appear at its tip; later on there appears a second filament, and, as the terminal joint increases in length, there appear a third and fourth; next we see that in the young female of *Phronima* the terminal joint increases considerably, and there appear, in pairs, a number of new olfactory filaments, while in many other Hyperida there are differentiated one or two short intermediate joints and a terminal rudimentary flagellum. In the young male the terminal joint becomes much thicker, and the olfactory filaments lose their terminal position; two joints become intercalated, and the terminal piece commences to form an appended flagellum; in the adult of all the male Phronimida there is a many-jointed long flagellum, the anterior surface of which is provided with a thick tuft of long hair-like olfactory filaments.

The second antenna is not altogether absent in the female, inasmuch as its basal joint is always present, although indeed it is so closely fused with the integument as merely to form an elevation provided with a feebly developed seta, or a more strongly developed spine. The antennary character of the elevation is spoken to by the presence on it of the orifice of the duct of the antennary gland, which corresponds to the " green gland " of the crayfish.

The mouth organs agree generally with those found in other Hyperida; the mandibles and paragnathi form a distinct oral atrium, and groups of glands, which probably have a salivary function, are developed in the maxillæ and maxillary appendages. On the thoracic appendages the joints appeared to be reduced to the coxa, but other pieces can be made out; in the fifth pair the arrangement becomes more complicated, and an elaborate glandular system may be seen in the appendages.

Alimentary Canal.—The salivary glands already mentioned are found to be complexes of four glandular cells with long efferent ducts, which are partly placed around the œsophagus, and partly in the jaws; they secrete ferments which act on starch and albumen. The enteric canal contains no glandular cells; its muscular and complicated œsophagus leads into a stomach which is provided with two secondary pouches; there are two hepatic tubes, and the narrow intestine ends, in the sixth abdominal segment, by a short rectum. The short tubes attached to this last portion, which have been ob-

* ' Arb. Zool. Inst. Wien ' (Claus), ii. (1879) art. 2.

served in the Gammaridæ, and may possibly have the same function as the Malpighian vessels of the Tracheata, have not yet been observed by Claus in any of the Hyperida; it is possible, although we have no certain proof of it, that their function is performed by the epithelium of the small intestine.

Circulatory System.—The heart extends from just behind the cephalic region to as far as the middle of the sixth thoracic segment, and is provided with three pairs of ostia; the muscular bands of the heart are formed from two lateral rows of cells, between which there is a dorsal and ventral median suture; there are two arteries which arise from an elongated fissure, and have at their base two obliquely-set ostia; they are placed in the third and fourth segments of the thoracic region, and there is, in addition, in some genera a third pair of arteries in the fifth thoracic segment; the vessels pass into the perienteric canal system of the body-cavity, and their walls are formed by a transparent membrane of connective tissue, in which are contained, just as in the aorta of the Copepoda, oval nuclei. The just mentioned perienteric canal system is thus formed: there is attached to the ventral wall of the heart a septum, formed of large cells, which extends transversely across the body-cavity; a second septum holds a similar relation to the enteron, and the body-cavity is thus divided into three hæmal canals, which are separated by connective tissue, and communicate with one another by definite orifices. These primary canals extend into the cephalic region, and are supplemented by a number of peripheral secondary canals along which the blood courses in a very regular manner; as in all Arthropoda, the fluid starts from the heart in two directions, going forwards by the cephalic aorta and gastric artery, and backwards by the aorta abdominalis and the hinder gastric vessels.

Nervous System.—Exclusive of the sub-œsophageal ganglionic mass, the ventral cord consists of five thoracic and four abdominal ganglia; the last of these is formed by the concrescence of three ganglia, which are separate in the embryo, and supplies the fourth, fifth, and sixth abdominal segments. The sub-œsophageal mass corresponds to six ganglia, or, with the ganglionic centre for the antennæ, which is placed in the commissures, to seven. The peripheral nerves do not take their origin from the "dotted substance," but from the ganglionic cells of their own ganglion, from the preceding ganglion, and from the cerebroid mass. This last contains a well-developed system of commissures, part of which extends into the large optic ganglia. Turning to the eye itself, we find that this is surrounded by an investing sheath of considerable strength, which is formed by a continuation of the outer nervous covering of the brain; the cornea is formed by a special investment of the hypodermis, while the eye continues to grow with the body, by the continuous formation of new peripheral elements; this organ is, as is well known, remarkable in the Hyperida for its division into two completely separated optic areas; in correspondence with this the optic fibres are found to be arranged in two bundles, which arise from different portions of the ganglion.

Generative Organs.—Unlike what obtains in the Gammarida, the ovaries of *Phronima* and its allies are placed very far forwards in the body; flattened in form, and pointed at either end, they are provided with a thick structureless wall, supporting a well-nucleated epithelium. The ova form a single layer. The bent terminal portion of the oviduct widens out into a seminal pouch. In the young males the sperm-producing gland, and the duct which contains the spermatophores, are not distinctly separated, but this is the case also in the adult, between which and the young the chief difference is that the seminal duct of the former is longer, and contains two mature spermatophores. The paper is illustrated by eight plates, containing seventy figures.

Glands found in the Appendages of the Phronimida.*—Paul Mayer, in dealing with these glands, of which, so far as he knows, Professor Claus has alone made mention, points out that the sixth and seventh pairs of thoracic appendages are distinguished by their form and size from those in front of them; this is due to the presence, in their basal joints, of large glandular masses, which, if present in the more anterior legs, are but feebly developed. Placed in the wall of partition formed by the membrane which separates the arterial from the venous stream of blood, the glands appear to be formed by the predominant growth of some of the cells in this region, and to form groups of three or five. As to their function, it is impossible to offer anything more than supposition; at first the author supposed that they might be phosphorescent, but further observation did not confirm this view; their relation to the blood-stream suggests that they are excretory in function; or, again, they may be poison-glands. It is pointed out that in the Hyperida these glands are better developed than in the Phronimida, but they are not so regularly arranged.

" House " of the Phronimida.†—In his next " Carcinological Study " Mayer confirms the view of Claus that *Phronima* very generally makes a home for itself in *Pyrosoma*. On November 27th, 1877, the author took a fairly well-developed female from a house, which, on account of its thin, soft walls and peculiar appendage, he can only regard as being one of the Salpidæ. On the 25th of December he took a breeding female from its *Pyrosoma* habitation, and placed it in a glass with a specimen of *Abyla pentagona ;* this was shortly seized on, and in some ten minutes its velum was eaten up ; in a short quarter of an hour the crustacean entered on its new home. On the morning of the 26th the polyps had disappeared (? were eaten), and the home took on the characteristic shape, with orifices at either end. On the morning of the 27th the *Phronima* was removed from the Hydroid, and placed under the same conditions with a specimen of *Salpa fusiformis ;* this was in like manner attacked, and on the morning of the 28th the nucleus itself of the *Salpa* had disappeared. Some hours later the invader was removed from its new home and replaced in its

first habitation, which had been preserved in spirit; in a few minutes the calm crustacean was quite at ease.

Observations with *Pterotrachea* only led to negative results; as to the males, the greater number were found not to inhabit such " houses," and in the case of *Phronimella*, no male was observed in one; while as to those of the female, not only were they excessively thin, but as chemical observation never revealed the presence in them of the cellulose, which is so characteristic of the integument of the Tunicata, it may be concluded that whatever the houses of species of this genus are formed from, they are not made at the expense of any of these animals.

Some young Stages of Penæus Caramote.*—Mayer's next note deals with some forms which he found in the central canal of *Pyrosoma elegans*. The points said by Heller to be characteristic of the species are:—(1) The deep longitudinal rostral groove; (2) The shortness of the terminal filaments of the superior antennæ; and (3) The projections on the lateral surfaces of the sixth abdominal segment. As to the third point, the projections were not visible in the young, inhabiting *Pyrosoma*, or in the smaller free-living forms. The first was only visible when the animal left its home, and in the youngest stages the antennary filaments are as long as the lamellar appendages of the inferior antennæ. In the earliest stages it is impossible to distinguish the sexes by any differences in the characters of their appendages, but in specimens 60 mm. long the internal branches of the first abdominal foot are closely applied to one another, although it is not till later that they fuse into an unpaired organ.

Hermaphroditism of the Isopoda.†—To English readers this is an especially interesting subject, as the results of Mr. Bullar of Cambridge, were, when published, traversed by Mr. Moseley, who had at the same time to deal with Captain Hutton of New Zealand, who had asserted that *Peripatus*, which, on account of his very notable discoveries, might be almost called Mr. Moseley's especial property, was likewise hermaphrodite.‡ Paul Mayer now states that the results of his predecessor (Bullar) were quite correct, and that therefore there really does exist a group of hermaphrodite parasitic Isopoda. The basis for these results are the observations which he has been able to make at Naples on *Cymothoa*, *Anilocra*, and *Nerocila*.

The free-living Isopoda are provided with three pairs of testes, which are placed one behind the other, and open to the exterior by a common vas deferens placed in the seventh thoracic segment; in addition to this there are two or (Oniscidæ) one penis. The female is provided with an elongated ovary and short oviduct, which opens on the fifth thoracic segment. Now in the adult *Cymothoa* what we find is this: the ovaries, which are attached posteriorly and anteriorly to the dorsal wall, take a longitudinal direction; the

* 'Mitth. Zool. Stat. Neapel,' i. (1878) p. 49.
† Ibid., i. (1879) p. 165.
‡ Captain Hutton has since allowed the existence of male specimens of *Peripatus* (cf. s. v. *Peripatus*, 'Zool. Record' for 1877).

oviduct is given off from it at right angles, and just behind the central portion ; it opens on to the fifth pair of legs. On taking a *Cymothoa* 13 mm. long we find, in addition to the ovaries, testes, the vasa deferentia of which can be easily followed into the penes. So that the hermaphrodite arrangement seems tolerably certain ; tracing the matter still further, we may observe animals when they are taken from the brood-pouch of their mother, as Bullar does not seem to have done ; in such, the external genitalia are not developed, and the tissues of the internal organs are still in an altogether embryonic condition ; four regions may, however, be made out, of which three go to form the testes, and one the ovary ; two efferent ducts, oviduct and vas deferens, may also be made out, though they are as yet very short. In the next stage the testes were enormous as compared with the ovary, and the two penes were developed ; in the succeeding stages, the male organs were observed to be in functional activity, and ova were developed in the peripheral portion of the ovary. As affecting the supposition that the " testes " observed by Mr. Bullar were " spermatophores," it is of interest to note that Mayer expressly states that he was able to make out the different stages in the development of the sperm ; in the anterior portion of each vesicle there were small cells, not to be distinguished from epithelium, which were connected with a number of larger vesicular cells, and succeeded by sperm-cells, with very short tails, and then by bundles of still riper sperm, exactly similar to those found in the terminal portion of the vas deferens. Notwithstanding the presence of the tail, Mayer, no more than Bullar, was able to observe any movement of the sperm ; and this is especially remarkable, inasmuch as the parasitic Cirripedia are the only members of the great group of the Crustacea in which mobile sperm-cells have as yet been observed (always excepting *Limulus*, which has so many points of affinity to the Arachnida).

From what has been said, it will be seen that the young individuals appear to be males, and the older forms females.

The view of Bullar that the ancestors of the parasitic species were diœcious is supported by the investigations of Mayer, who remarks further that in other Isopods he has observed indications of hermaphroditism, inasmuch as in some females of the genera *Cirolana* and *Conilera*, he has observed a filament passing just like a vas deferens, to the seventh segment, together with rudiments of the testes. Interesting as this observation undoubtedly is, the questions which it raises must for the present remain unexplained.

Asellus cavaticus.*—Dr. Max Weber, having had an opportunity of examining this remarkable form at Bonn, takes the occasion to point out certain characters which distinguish it from *A. aquaticus*, and which have hitherto escaped observation. In correlation, probably, with the absence of eyes, the olfactory organs are much larger in *A. cavaticus ;* in the female the superior antennæ are nine-jointed, and the last three joints are each provided with an olfactory process,

* 'Zool. Anzeiger,' ii. (1879) p. 233.

while in the male the same appendages are twelve-jointed, and six of
the joints have an olfactory function; in *A. aquaticus* the number of
joints in the antennæ is large, but still only three are olfactory, while
in the largest of the males the number of "olfactory joints" is only
four. The increase in the number of these appendages in the male,
which even in *A. aquaticus* has one more than the female, is due
probably to sexual selection, and to the necessity of the blind male
seeking the female in the dark cave. The first pair of swimming legs
in the female of *A. aquaticus* are rounded, thin, and thickly covered
with fine hairs, while in *A. cavaticus* they are semilunar, with a broad
basis and continued to a sharp point, while the hairs are either com-
pletely absent or sparse and short. An arrangement obtains in the
liver of *A. cavaticus*, which is only temporary in *A. aquaticus;* the
superior pair of hepatic tubes are scarcely a quarter of the length of
the inferior pair, while in the other form they gradually attain to the
same length, and extend along the whole of the body; but, as if in
compensation for this, the constituent hepatic cells are of a much
larger size.

New Peltidia.*—Dr. G. Haller, in describing some new Peltidia,
states that he preserved these small Copepods in Farrant's medium,
which retained the colour and external form admirably. The new
Zausoscidia is so called from its having the general structure of
Oniscidium with the characters of *Zaus* in the two rami of the first pair
of feet. The single species is called *Folii*. A *Porcellidium* smaller than
any yet known (♀ ·55 mm., and the ♂ ·71 mm.) is described under
the name of *parvulum*. Three new species of *Oniscidium* are also
described briefly.

Vermes.

New Species of Tænia.†—Professor Perroncito describes a form
which he has known for several years, and of which he has obtained
a large number of specimens; hitherto confounded with *T. expansa*
or *T. denticulata*, it is always characterized by its constantly white
colour, hence the name *alba* now proposed for it. A technical descrip-
tion and a plate follow.

M. Moniez describes‡ *T. Giardi*, which is frequently found in
the sheep, and which differs from *T. denticulata* in the position occu-
pied by the male products, and by the arrangement of its ova; as to
the development of these latter, it is pointed out that the elements
of the "fundamental tissue" are not converted into a reticulum, but
form a continuous band; this band takes on an undulating direction,
in which it is followed by a narrow canal, into which the ova pass
after fecundation; the ova gradually pass into the interior band, and
it and the outer wall of the canal form a capsule for them. The
receptaculum seminis gives rise to three "currents" of ova, two of
which pass into the adjacent ovary, while the other passes over to the
other side.

In *T. pectinata* a number of irregular and communicating clefts

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* 'Zool. Anzeiger,' ii. (1879) p. 178.
† 'Arch. Naturg.,' xlv. (1879) p. 235.
‡ 'Comptes Rendus,' lxxxviii. (1879) p. 1094.

are formed in the tissues of the animal; into these the ova fall, and there undergo further development.

Notes on the Turbellaria.*—Dr. Ludwig Graff commences some observations on this subject, with a not unfounded complaint as to the confusion which he finds to obtain in the systematic zoology of this group, of which he promises a revision; he then gives some account of the urticating organs of these animals, as to which there are at present but few authentic reports; in a new *Stenostomum*, which he found at Trieste, and which he dedicates to that veteran zoologist, Siebold, he found urticating capsules, which were of interest as being developed in just the same way as the rod-shaped bodies found in the cells of the parenchyma, and so affording support to the doctrine that the rods and the urticating capsules of the Turbellaria are homologous structures; in another new form—*Stylochus tardus*—which was also found at Trieste, the rod-shaped bodies were completely absent, and the urticating capsules were in consequence very richly developed.

Drawing attention to the fact that Graff has observed *chitinous* structures, in the form of spines, in the integument of the Turbellaria, we have to note that there are interspaces between the longitudinal bands of the dermo-muscular tube, which have hitherto been regarded as being in all cases continuous, and that the observations now under notice confirm the view of the Russian naturalist, Uljanin, that some forms among the Turbellaria have no cœlom; in such forms the nutriment passes by a narrow cleft into a soft medullary substance, rich in vacuoles and fat-drops, which is very similar to what is seen in the Infusoria, with which they seem, *pro tanto*, to have closer relations than is now ordinarily supposed. In the great majority of forms, however, there are distinct walls to the enteric tract, and the cœlom is then filled with a lacunar connective substance, the parts of which may be thick and inclined to form broad plates, or thin and feebly developed; the contained fat-drops usually include a coloured watery fluid, which has some influence on the external coloration of the animal in those cases in which there are no other pigments present; as a rule, however, there are such, which are found imbedded in the connective substance, while the epithelium itself is always colourless. The observation of Oersted, that the spermatozoa vary greatly in character, is shown to be true of the rhabdocœlous, but not of the dendrocœlous forms. Graff's further investigations will be awaited with interest.

Studies on the Nemertinea.†—Herr V. Kennel, in an elaborate paper, deals with two very interesting forms, *Malacobdella* and *Geonemertes*. Of these two, the former has long been regarded as a Leech, but Semper and Hoffmann have shown that it rather belongs to the *Nemertinea* than to the *Hirudinea*. The specimens examined by Von Kennel were found in *Cyprina islandica*, and he notes that they were never found in *Mya arenaria*; the former molluscs, at the station at which he observed—Kiel—were taken from a region which

* 'Zeitschr. wiss. Zool.,' xxx. (Suppl.).
† 'Arbeit. Zool. Zoot. Inst. Würzburg,' iv. (1878) p. 305

was often dry for a long period every day; as a rule, the larger examples were found in older, and the smaller and younger specimens in younger animals, but this was not always the case. As their name implies, the *Malacobdellidæ* have a body of extreme softness; when young they are, except in the region of the sucker, of very much the same breadth all along their whole extent. The oral aperture is placed at the anterior end, and is in the form of a transverse cleft; the pharynx is intensely white, and may be seen through the transparent integument; the intestine is much narrower than it, and is of a brownish or reddish-yellow colour; the proboscis is of an opaque white, and on either side of the pharynx there are cerebral ganglia, which are small, and white or yellowish in colour.

The form in question seems to have been known to O. F. Müller ('Zoologia Danica,' 1779), and has since been examined by De Blainville (1827), Blanchard (1845), and Van Beneden. The result of Von Kennel's inquiries is the confirmation of the Nemertine character of the form; the surface of the body is completely ciliated, the proboscis is of the typical form, the vascular and excretory organs are of just the same type as in the other Nemertinea, and the nervous and muscular systems point to the same conclusion; the anal nervous commissure has been already found in *Pelagonemertes*. When, however, we come to inquire as to the position which it should take in this group, we find it necessary to form a new family; the Nemertinea, hitherto divided into three families, contain one, the Enopla (Tremocephalida), in which the proboscis is armed with spines, the dermal musculature confined to two layers, and the nervous system inferior to it; and two, Rhoemocephalida and Gymnocephalida, in which there are three dermal muscular layers; between the two innermost lies the nervous system; and in these—*Anopla*—the proboscis has no armature of spines: the fourth, and new family, may be thus defined:—

Malacobdellidæ.—No armature of spines to the proboscis, the dermo-muscular layer arranged in an external, circular, or an internal, longitudinal layer; no cephalic grooves or lateral organs; enteric canal simple, and forming several coils; nerve-trunks free from the muscular system, and united posteriorly by an anal commissure; a broad sucker at the hinder end.

Genus: *Malacobdella*. Characters of the family.

Species: *M. grossa* O. F. M. Body flat and broad, mouth anterior, pharynx broad; transparent and white (male), or yellowish—greygreen posteriorly—(female). Semi-parasitic in the mantle-cavity of various Lamellibranchs.

Geonemertes palænsis, Semper.—This interesting terrestrial Nemertine, which was found by Professor Semper in the Pelew Islands, has as yet been very incompletely observed. This animal, which is from four to five centimetres long, is rounded and somewhat truncated anteriorly, and of a reddish colour; the head is provided with two groups of eye-spots, of which there are three eyes in each, one larger than the other two. The mouth is placed at the most anterior end of the body; the anus is dorsal, and the enteric tract is, as in most

Nemertines, provided with a number of lateral diverticula. The body is invested by a well-ciliated simple epithelium, in which there are dark pigment granules, but the rod-like structures, so commonly found in the integument of allied forms, are here completely absent. The dermo-muscular tube is formed of an external circular, and an internal longitudinal layer; the whole of the cœlom is filled with connective tissue. The testes and ovaries are found, as they are in some other rare cases among the Nemertinea, in the same individual. The proboscis has exactly the same structure as in the other Enopla, but, as in Malacobdella, it opens *into* the pharyngeal cavity, and not in front of it or above it, as in most of these forms. The nervous system is of the ordinary and typical form.

All the points already regarded point to the general similarity of *Geonemertes* with the rest of the Nemertinea, but there remains to be noted a special organ of very curious character. At the anterior end of the body, and dorsally to the oral aperture, there is a fine pore, which leads by a short canal into a cavity which has its long axis set transversely to the longitudinal axis of the body; the canal and the cavity are lined by a simple epithelium, which passes without any distinct demarcation into the investing cell-layer of the body; the cilia in the hinder portion of the enlargement being only larger than in the anterior portion, and in the canal. Connected with it there is another cœcal sac, which is elongated in form and circular in transverse section; its only contents was a fine coagulum. This organ has apparently some connection with the terrestrial habit of the animal, but whether it is or is not sensory in function is still an open question.

The circulatory organs are of the ordinary Nemertine type, and excretory pores still require to be observed; they would be best seen in fresh specimens.

Histology of Convoluta Schulzii.* — This green Rhabdocœle Planarian was the subject of the observations on chlorophyll in the green Planaria by Mr. P. Geddes, referred to at p. 161 (from ' Comptes Rendus '), which now appears in the ' Proceedings of the Royal Society ' with additional remarks on the histology of the animal, the general characters of which have been already given by Schmidt.

Mr. Geddes first notices an interesting point in the histology of the ciliated ectoderm. In teased preparations, kept cold, the ciliated cells often become amœboid, some of the cilia changing into slender finger-like or stout fusiform pseudopodia. These often retain their curvature parallel to the unaltered cilia, and he has even seen the finer pseudopodia contracting gently in time with the cilia of the same cell, thus establishing a complete gradation between the rhythmically contractile cilium and the amœboid pseudopodium through what is really a rhythmically contractile pseudopodium. Haeckel and others have accumulated many instances of the transformation of ciliary movement into amœboid and *vice versâ*, but only by Professor Lankester † has the passage-form, the cilium-like pseudopodium, been actually observed.

* ' Proc. Roy. Soc.,' xxviii. (1879) p. 449.
† ' Quart. Journ. Micr. Sci.' (1870), p. 292.

It is important that Lankester's passage-form occurred during the transformation of amœboid movement into ciliary, while the author finds it exactly the same thing during the reverse change.

Two distinct kinds of organ exist in *Convoluta* and other Rhabdo-cœles, and have been confused under the same name. First, the heap of coloured rod-shaped bodies, the original "Stäbchen" of Max Schultze,[*] which furnish in *Convoluta* when treated in alcohol a yellow solution; and, secondly, large and long spindle-shaped bodies, gene-rally arranged singly, each containing a sharp brittle needle, of which the point lies close under the apex of the spindle. In a teased prepa-ration they are generally empty, showing the tube in which the arrow lay, and with a little granular protoplasm hanging round the mouth like the smoke of the explosion. The dart is generally propelled for some little distance, but sometimes sticks in the mouth of the tube. Graff's view that these are offensive weapons is certainly the right one, but they are constructed on so distinct a plan from those of Cœlenterates that they might better be called sagittocysts than nemato-cysts.

Below the epidermis lie the circular and longitudinal muscles, and beneath them comes the layer of chlorophyll-containing cells. The chlorophyll is not collected into granules as in the higher plants, nor into drops as in the green cells of *Vortex viridis*, but is diffused throughout the whole protoplasm of the cell, which is thus very in-tensely coloured. One, or sometimes two, nuclei are present, besides an irregular heap of granules. It was very difficult to break up the cell completely, and so liberate the granules, but in one or two fortu-nate preparations treated with iodine the blue coloration assumed by many of these granules proved that we have here an actual deposit of starch quite like that which Sachs has shown to take place within the chlorophyll granules of the plant.

Deeper than the green layer lie colourless granular nucleated cells, which may be spherical or branched. These yield with iodine the red-brown reaction of glycogen very conspicuously indeed. All the internal tissues are bathed in that abundant slimy protoplasm so often adduced in evidence of the infusorian affinities of the lower Turbel-laria, which may well serve instead of a special circulatory fluid as well as for digestion, any distinct alimentary canal being absent.

The development of the generative products is of interest. An apparently ordinary mesoderm cell enlarges and divides into an oval mass of about twelve to sixteen segments. The granular protoplasm of these is gradually drawn out into the very long spermatozoa, and thus each testicular mass is transformed bodily into a bundle of neatly-folded spermatic filaments. The ova are also developed by the division of a mesoderm cell. There are no separate vitellaria, but the yolk of granules seems to arise in the finely granular amœboid protoplasm of the developing ovum.

Everywhere imbedded in the mesoderm are numerous small colour-less cells scarcely so big as a frog's red blood-corpuscle. These are more or less pear-shaped, with a large central cavity; and lining one

* 'Zeitschr. wiss. Zool.,' xxv. p. 421.

side of the interior of this cavity, and parallel to the long axis of the cell, are a number of distinct transparent homogeneous filaments inserted above and below into the ordinary granular protoplasm which constitutes the remainder of the cell.   In a teased preparation some of these cells are easily found in a state of rapid rhythmical contraction, giving as many as 100 to 180 energetic beats per minute.   The form of the cell alters with every pulsation, shortening and broadening like a contracting muscle.   This change of form is simply impressed upon the cell-body by the contraction of the internal fibres, and does not therefore truly correspond to that observed in a muscle.   Some cells also of extreme curvature (for hardly any two are quite alike) bend sharply and return with a spring.   The movements soon become slow and incoordinate, and waves can be seen passing along the separate fibres independently of each other.   The movement stops altogether, and the cell bursts, but the fibres resist for some time longer the destructive action of the water.

Mr. Geddes was never able to observe any rhythmical contraction, but at most a feeble quivering within the cell while in the body of the animal, nor to make out any trace of definite arrangement.   Max Schultze has described how the alimentary canal of the higher Planarians swarms with *Opalinæ*, and it is possible that these so singular structures may be excessively modified parasitic Infusoria.   In any case, the main histological interest lies in the fact that these pulsatile cells cannot be classified either with ciliary or amœboid, with plain or striated muscular cells, but present a distinct type of contractile structure.

Planaria Limuli.*—Dr. Graff points out that the Planarian parasitic on Limulus (the American king-crab), and so well entertained as to be present in large numbers (" more than one hundred ") on it, is not the same as *Planaria angulata*.   Somewhat similar in appearance to *P. lactœa*, it differs from it by its pointed anterior end, and by the possession of a large posterior sucker.   The bilobed cerebral mass has an eye, on either side, supported by a pyriform swelling ; the eye is covered by black pigment, and the lens is expressly stated (in opposition to Minot) to be made up of a number of cells, as it is in all fresh-water Planarians and in all Rhabdocœla which Dr. Graff has examined.   The longitudinal nerve-trunks are well developed in this new species, and are united at the posterior end, above the sucker, *without any diminution* in size; from their point of union delicate nerve-branches are given off to the sucker; the longitudinal trunks give off lateral branches at regular intervals, and, corresponding to these, there are transverse anastomoses, so that a complicated meshwork of nerves is to be observed in these creatures.   Development is effected without any metamorphosis, and within the cocoon ; in embryos ½ mm. long the enteric tract is not differentiated, and the cerebrum has the form of two transversely-set, oval masses of cells.   The eyes first appear when the embryo is 1 mm. long.   Each cocoon contains from two to nine embryos, and forms a yellowish-brown oval capsule, about 3 mm. long and 1½ mm. broad, while it has a

* 'Zool. Anzeiger,' ii. (1879) p. 202.

stalk of about ½ mm. in length, and is attached to the gill-lamella of the abdominal appendages of the king-crab.

Classification of the Monogenetic Trematoda.*—It is to Dujardin that zoology owes the first classification of the Trematoda, which name was first used by Rudolphi (1808–1810). The French naturalist recognized three families, and his work has been subjected to changes at the hands of his successors; it was not, however, till 1861 that a really natural classification of these forms was put forth by M. P. van Beneden, who recognizing and giving the proper weight to the striking differences to be observed in their modes of generation, divided the Trematoda into the Monogenea and Digenea. In addition to the five families formed by Van Beneden and Hesse, Dr. Taschenberg now proposes two new ones, Monocotylidæ and Microcotylidæ; and divides the Monogenea into two families of Tristomeæ and Polystomeæ, which differ in the following points: in the former the anterior end of the body is not narrowed, there is no terminal sucker, and the ova are only provided with a filamentous appendage at one pole, while in the latter there is a large posterior sucking disk, the body is elongated and narrower anteriorly, while the ova frequently have two filamentous appendages.

Entoparasitic Marine Trematodes.†—An account of the morphology of several species is given by A. Villot.

The author recommends hardening the specimens in absolute alcohol, imbedding in glycerine soap, staining the sections with picrocarmine or hæmatoxylin, clarifying with oil of cloves or creosote, and mounting in balsam.

He describes three species of *Distomum*, one of *Monostomum*, one of *Holostomum*, and six of *Cercaria*, for the details of structure of which we must refer to the paper itself, confining ourselves to the point of chief morphological interest, namely, the account of the vascular system as observed in *Distomum insigne*, a large species, found in the digestive canal of the elasmobranch *Echinorhinus spinosus*.

The vascular system in this species consists firstly of a Y-shaped contractile vessel, opening posteriorly by a terminal pore, and secondly, of a capillary network, permeating the tissues and anastomosing at intervals, forming true sinuses. These dilatations are especially abundant just beneath the integuments in the outer layer of parenchyma, where they form a distinct layer, presenting the appearance in cross section of a multitude of cells, for which, indeed, they have often been mistaken.

Villot considers that this apparatus is both excretory and circulatory in function, the office of excretion being assigned to the contractile vessel, while the extensive system of capillaries and sinuses serves for the transport of nutrient matter from the alimentary canal to the various parts of the system; and he remarks that we have here "a fresh example of the tendency to the *accumulation of functions*, which always accompanies the degradation of the organism," and

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* 'Zeitschr. ges. Naturw.,' lii. (1879) p. 232.
† 'Ann. Sci. Nat. (Zool.),' viii. (1879) Nos. (2–3).

which is, of course, the precise converse of the principle of division of labour.

Helmintholological Studies.[*]—It is quite impossible to do more than draw attention to the energy of Professor von Linstow, from whom a further contribution of " Helminthological Studies " appears in the 2nd part of the 'Archiv für Naturgeschichte' for 1879. Of forty-two forms described, and mostly figured, nineteen are regarded as new. A useful table is given of the characters of the eight species of the genus *Distomum*, which are known to be found in German reptiles, in the course of the description of a ninth species (from *Anguis fragilis*).

Ascaris parasitic in the Lion.[†]—M. Chatin describes immature, male, and female forms of this worm, and shows that in the absence of the membranous expansions (" winged at its head ") and in the characters of its mouth it differs from *A. mystax* which inhabits the domestic cat ; in addition to this there are differences in the digestive tube and generative organs which speak to *A. leptodera*, as defined by Rudolphi, being a distinct species.

Ascaris of the Orang-Outang.[‡]—The same author enters into the details of the structure of this parasite, which has ordinarily been regarded as *A. lumbricoides ;* the new species *A. satyri* differs, however, in its smaller size, while the body is more closely striated, the " buccal valves " (or labial lobes) are much smaller, the œsophagus is provided with a well-marked enlargement, the uterus is more highly developed, and the ova are smaller than in the ordinary parasite of the human subject.

Filaria Otariæ.[§] — M. Chatin describes this new species of Nematoid parasite from the muscles of *Otaria Stelleri*, of which his bibliographical researches have revealed no previous indication. A short technical description is given.

Muscle-cells of the Nematoids.[‖]—In a new genus, not yet named, parasitic in *Callichthys*, M. Chatin has observed some " true " muscle-cells, which were short and ovoid, and narrower in their terminal region ; easily separated by potash, they were seen to consist of a mass of protoplasm with a refractive and excentrically placed nucleus ; no distinct envelope could be observed, and the cortical layer was merely differentiated.

Further Studies on the Oligochæta.[¶]—Dr. Franz Vejdovsky, in describing a new species—*bohemica*—of the genus *Anachæta*, points out that in it he has observed that what D'Udekem called the " cap- sulogenous," and he has called the " dissepimental glands," open by two glandular efferent ducts into the pharynx, and that their secretion appears to have some function in the ingestion of nutriment, so that the *Enchytræidæ*, like most of the *Arthropoda*, possess two pairs of

* 'Arch. Naturg.,' xlv. (1879) p. 165.
† 'CR. Soc. Biol.' for 1877 (1879) p. 266.
‡ Ibid., p. 384.　　§ Ibid., p. 204.　　‖ Ibid., p. 278.
¶ 'Zool. Anzeiger,' ii. (1879) p. 183.

secreting glands, of which one (septal glands) open into the protrusible pharynx, and the other (salivary glands) at the base of this organ and into the œsophagus.

The pharynx of these worms forms a protrusible prehensile apparatus provided with a complex system of muscles; the buccal lobes in connection with it appear to be *gustatory organs.*

In describing their "lateral line" or "lateral cords," the author points out that in the terminal segment there are a number of unipolar or multipolar cells, which extend along the sides of the body between the glands of the setæ and the ventral cord, giving off, in their course, lateral branches to the setal glands, the dissepiments, and the generative organs; the greatest number of ramifications is to be found in the genital and cephalic segments. The author comes to the conclusion that these cords are to be regarded as true sympathetic nerves, and he would apply the name of "N. vagus" to the branches which are given off from the œsophageal commissures.

The "jaws" found in the buccal cavity of *Branchiobdella* are regarded as the homologues of the gustatory organs of *Anachæta*, while the "follicular" structure of the nervous system of the former may be made out also in the latter. The anatomical characters of *Branchiobdella* lead the author to form for it a special family of the *Oligochæta*, under the name of *Discodrilida*, most nearly allied to the *Chætogastrida*.

Spermatophores of the Earth-worm.*—Dr. Paul Fraisse makes some observations on the small conical appendages which at the period of reproduction are to be noticed on the neural aspect of most of the Lumbricina; called "penes," or "appendiculæ generatrices," by the earliest observers, they were regarded (in 1849) by Fritz Müller as spermatophores; but this view has been either neglected or, as by Hering, expressly rejected.

In *Lumbricus agricola* Fraisse describes these bodies as forming flattened and somewhat spirally-coiled structures, from 1½ to 2 mm. in length, and from 0·5 to 0·7 mm. in breadth; at their "superior" end, in a small cavity, there was found a drop of sperm; the cavity was so arranged as to allow the contents easily to pass out on pressure; and the bodies, which were ordinarily arranged in pairs, were attached to the twenty-third to twenty-seventh segments of the worm. It is unnecessary for us to follow the author through his descriptions of similar structures in *L. communis, L. riparius,* or *L. olidus:* in all cases they were, just after copulation, found to be soft, and they only gradually hardened when exposed to the air; they are always attached to the cuticle in the neighbourhood of the generative organs, and it is not difficult to get them off. *They were not found before copulation;* the spermatozoa, when expressed, exhibited lively movements.

The question now arises, where are these spermatophores developed? Great difficulties stand in the way of framing an answer; not only are the generative organs greatly complicated, but

in copulation the worms become covered with a thick opaque mucous layer, which very effectually prevents observation; an examination of the efferent ducts and seminal vesicles did not reveal the presence in them of anything like the spermatophores, which, it may be observed, are attached to ridge-like projections somewhere between the twenty-fourth and twenty-ninth rings; the ridges were found to be connected with internal follicles, which were apparently setigerous, and about three times as large as the other setigerous follicles of the neural aspect of the worm. The setæ in question differed from the rest, not only by their greater size, but by the fact that they did not project beyond the surface. They are surrounded by a capsule of connective tissue, in the walls of which there are, in addition to the matrix of the setæ, some small glandular structures, very similar to those found in the "capsulogenous glands." Varying somewhat in number, these glandular tubes always lie between the hypodermis and the circular layer of muscles; they have not a wide lumen, and are generally found to be filled with a firm coagulated secretion; a branch from this follicle passes into the sheath of the seta, where it ceases to be glandular, and the epithelial cells become flattened; the spermatophores are generally found between the orifices of the two glands, and sometimes project into their ducts; before copulation the spermatophoral tubes are soft, and contain no semen; and finally, if they are found on the twenty-sixth ring (in *L. agricola*) they would in copulation be exactly opposite the male orifice of the other worm.

The paper, which is illustrated by one plate, concludes with a detailed list of the observations which were made.

Body-cavity of the Sedentary Annelids and their Segmental Organs.[*]—M. Cosmovici communicates the following to 'Comptes Rendus':—

The general body-cavity of the sedentary Annelids is divided into several compartments by diaphragms, which sometimes exist only in a portion of the cephalothoracic region (*Arenicolæ, Terebellæ, Clymeniæ*), sometimes throughout the length of the body (*Serpulidæ*); and then each segment has a cavity more or less independent of its neighbours. There are also divisions in the opposite direction. In sections there are seen a central cavity filled by the digestive tube, and two lateral ones separated from the former by muscular bands in the form of oblique diaphragms. A communication exists between all the cavities through the interstices of the fibres of the partitions. The lateral cavities contain the feet with their retractor muscles and the segmental organs; these are the *pedal cavities*.

In *Chætopterus pergamentaceus* the arrangement of the cavities in the three vesicular segments is interesting. The median cavity, containing the digestive tube and the genital glands, does not communicate with the lateral cavities, which are occupied by the reno-segmental organs, except by the segmental pavilion which opens in the wall of separation.

In the *Clymeniæ* the *corpora Bojani* are very long; and at their anterior extremity the segmental organs are attached. After the eleventh segment there are no longer any renal bodies, and in their place there is a plexus of blood-vessels of remarkable abundance. The position of these networks is such that we may say that they represent *so many* corpora Bojani *formed solely by their vascular framework.*

The ovum of these animals is remarkable for the separation into two parts of the vitelline mass; one of these, the larger one, is formed of large granules, the other of very small ones. In the latter is situated the germinal vesicle and the spot, which becomes strongly coloured by picro-carminate.

Pectinaria belgica exhibits first a pair of very large *corpora Bojani*, and then two pairs furnished with segmental organs. The genital gland is on the median line, on each side of the supranervous vessel. The animal is as transparent as glass; and notwithstanding this the segmental organs cannot be perceived. It is curious that in less transparent animals these organs have nevertheless been observed by translucence and figured.

With regard to the segmental organs in the errant Annelides, we find a pair of them in each segment, with a contorted tube having an internal pavilion and an opening outwards. In the Serpulidæ (a family very rich in genera), among the sedentary forms, the same thing is met with. Lastly, in all the other Sedentaria we find the segmental organs sometimes free, sometimes annexed to the *corpora Bojani*, and in the majority of cases we may say that the segmental organs are independent of those bodies.

Hitherto we have been acquainted with three species of *hermaphrodite Spirorbis*; a fourth must be added, namely, *Spirorbis communis*, which abounds at Roscoff.

In the group Gephyrea, in *Phascolosoma vulgare*, we find on the anterior part of the two long blackish sacs, a tube furnished with a pavilion with two broad ciliated lips. The structure of the sacs shows them to be renal bodies, to which the segmental organs are annexed. The genital gland, male or female, is situate at the base of the posterior pair of the retractor muscles of the proboscis. The racemose gland is attached to an elastic thread, which is probably a blood-vessel. The ovum is remarkable for the presence of cilia at the surface of the vitelline membrane, which, when observed in front, appears finely striated.

In the subintestinal blood-vessel, in the midst of the elliptical blood-globules, we find encysted trematodes, which are carried along even into the papillæ of the proboscis, by the cilia with which the vessel is furnished. The above-mentioned papillæ appear to play a great part in respiration; in fact the whole circlet is in communication with the circulatory apparatus. The globules ascend along the walls, and descend by the centre of the papilla. Processes of the wall in the interior of the papillary cavity cause the globules to remain a certain time in contact with the delicate wall of these organs, and thus facilitate an exchange of gases. This may explain

why the animal, when quiet in a trough filled with sea water, exerts its proboscis every moment.

Segmental Organs of the Capitellidæ.*—Dr. Hugo Eisig had intended to make a general revision of the segmental organs of the Annelides, but various circumstances, and, more especially, the conviction that his object would be best attained by making a careful examination of these organs in a particular group, have led to the publication of the present essay, which is of interest and of value as bearing on those structures, which the labours of Professor Semper and of Mr. Balfour have led them to regard as homologous in the Annelides and in the Vertebrata.

In describing the organs of *Notomastus lineatus,* the author says that they are typically formed of two processes, of which the longer and broader one leads to the internal, and the shorter and more delicate to the external orifice; the two orifices are connected by a canal, the cilia of which work outwards; the internal orifice does not, as in most Annelids, float freely in the cœlom, but is closely applied to the peritoneal membrane, and is difficult to perceive; the outer one is, on the contrary, very evident, as it is placed on an elevated infundibular process. The segmental organs are also remarkable for being confined to one segment, where they lie in the groove which separates the dorsal from the longitudinal muscles; the long axis is ordinarily set parallel to the long axis of the body, and the external orifice is anterior, the looped portion posterior, and the internal orifice median in position. In the adult these organs are confined to the hinder setigerous portion of the body —to the abdomen; in the younger forms they are found, more or less distinctly, in a number of the more anterior segments, and are arranged in regular pairs, whereas in the adult they may be absent from one or the other side of a segment, or from both sides; what is more remarkable is that occasionally more than one pair of organs is to be found in one segment; but this is still more strikingly seen in *Capitella capitata,* where the "segmental organs" are confined to the anterior portion of the abdomen; in the adults examined they were found in the tenth to the twentieth or twenty-third segments of the body, and *each of these segments contained several pairs of segmental organs;* two to three in the more anterior, four to five in the median, and five to six in the most posterior segments; the organs are here firmly attached to the peritoneal membrane, with the exception of their internal orifices, and so close is this connection that in section the organs appear to be mere thickenings of the membrane; as to the internal orifices, the number is not always limited to one for each organ. The external orifices are not so easy to find as in *Notomastus,* inasmuch as they do not open to the exterior, but pass their secretion into the space between the cuticle and the integument proper; this observation was best confirmed by feeding the annelid with carmine. As a rule, the organs of each segment are distinct from one another,

* 'Mitth. Zool. Stat. Neapel,' i. (1878) p. 93.

but in some cases these were connected by a branch, the cilia of which work from the more anterior to the more posteriorly set organ. In the larval and young *Capitella* the segmental organs extend further forward, but do not extend so far back in the body. The larval organs are strictly segmental, or in other words, there is never more than one pair in each segment, and, as in most Annelids, each organ is placed in two segments, and their connection with the peritoneum is not so intimate as in *Notomastus ;* the author was not able to observe any definite external orifice. As the permanent segmental organs appear the larval ones undergo degeneration.

It is impossible to avoid seeing the great importance of these observations, as bearing on the fact that, in the Urodela, Max Fürbringer has observed, and has insisted on the observation, that the " segmental organs " are not metameric, but " dysmetameric "; that observation is, as we now see, just as true of adult *Capitella* as of *Salamandra.* Let us note some other points of resemblance.

The Vertebrata were regarded as distinguished by having the segmental organs connected ; this is occasionally true of *Capitella ;* in some Vertebrates (Selachii, Acipenser) the primary archinephric cord remains connected with the peritoneum—just as in *Capitella,* while in others (Amphibia, Amniota) the cord becomes separated from the peritoneum as in *Notomastus.* The more anterior of the segmental organs of the Vertebrata have a tendency to become aborted ; this, too, is true of the Capitellidæ. The larval Cœciliæ have one segmental organ in each segment, while the adult has a number ; in *Salamandra* the organs increase in each myocomma as we proceed backwards ; all this is true of *Capitella.*

The author concludes with a few words on the *receptacula seminis ;* the pores observed by Claparède lead into tubes, placed between the seventh and eighth segments, which seem to have the further function of a penis or of a vulva, according to the sex.

Lateral and other Goblet-shaped Organs of the Capitellidæ.[*]—In continuation of his researches into the anatomy of these Annelids, Dr. Eisig now deals with the somewhat difficult matter of their sensory organs. The observations of Keferstein and Claparède had led to the knowledge of certain protuberances in the abdominal region, which were said to be provided with narrow orifices (lateral organs of the abdomen), and of thoracic pores (lateral organs of the thorax). The former, which are set along the whole of the abdomen and on each segment between the neuropodia and the notopodia, are provided with stiff hairs, sensory in function, but they are not provided with pores and do not provide for the cœlom of the animal any means of communication with the outer world ; or, in other words, they are not, as Claparède thought, the external orifices of the segmental organs. Dealing with the structure of the sensory hairs, Dr. Eisig points out that there are several hundreds of them on each protuberance, from ·04 to ·06 mm. long. They are about ·001 mm. broad at their base and become infinitesimally small at their tip ;

immovable and stiff, they appear to consist of a pale homogeneous substance. Having pointed out in detail the structure of the hairs and of the protuberances upon which they rest, Dr. Eisig comes to the conclusion that they are undoubtedly sensory organs: but how are they innervated? the sensory hairs are connected with rods, the rods with spindle-shaped bodies, and these with granular ones; between these last and the ganglionic cells of the central cord there are many points of resemblance, although the granules are without a neurilemma and without those unipolar peripheral cells which are found in the cord. As to the nerve, it is curious to observe that there passes into the protuberance a band of matter which, at first sight, is easily taken for the innervator, but which is really a muscle, for which we can easily find a function when we note that the sensory hairs are capable of being protruded and retracted. The true nerves arise from the ventral cord; three, or rarely four, being given off to either side from the ganglia; passing through the musculature of the trunk they ramify in the integument, or, reaching as far as the gill, divide into two strong branches, of which one goes to the gill and one towards the sensory protuberance; the observations, however, of our author do not allow him to speak definitely as to the innervation of the protuberances.

The remark just made will be found to apply also to the nerves of the lateral organs of the thorax; as to the pores of these organs, which are elliptical or rounded, and quite evident, no passage could be discovered by which they were connected with the perivisceral cavity of the animal; carefully examining them, Dr. Eisig one day saw a rounded protuberance project from one of the clefts; this was provided with stiff hairs altogether similar to those already observed in the abdominal region. The whole matter was henceforward clear; here as in the abdomen there were sensory organs, but here they were ordinarily hidden in cavities formed for their reception; the protective apparatus was carried a step further in the thorax than in the abdomen. The rounded protuberances are of the same form, though somewhat smaller, and the sensory hairs are exactly similar.

Leaving these, which are truly segmental organs, we deal with the goblet-shaped organs, which are irregularly scattered over the cephalic lobes, the thorax, and the proboscis; those on the first-named structure are set around its whole circumference, and in great numbers; rounded or conical in form, they are only of about one-tenth the size of the organs already described as existing on the proboscis; the sensory hairs are not so numerous and do not diminish in size towards their free end, as do those already noted, which are also about ten times as long; no observations could be made as to their structure or as to the supply of nerves to them. The goblet-shaped organs of the thorax, which are very difficult to make out, are placed in greatest number around the mouth; very similar to those of the cephalic lobes, they appear to be innervated from the ventral cord as well as from the œsophageal ring. Similar organs are found in some hundreds on the proboscis.

Bearing in mind the metameric arrangement of the lateral organs

3 c 2

of the Capitellidæ, we are now led to ask what is their relation to the organs of the same name among the Vertebrata? Discussing in detail the opinions of those who have busied themselves with the morphology and embryology of the lower Vertebrata, Eisig finds that the abdominal protuberances of *Notomastus* are comparable to what is found permanently in Gobius and others, and temporarily in the larvæ of other Vertebrata, while the hyaline tubes of the latter group are in Notomastus replaced by the defended position of the organs; so, too, the thoracic organs of the worm correspond to the canals covered in by integument in the Vertebrates. The author is of opinion that the "lateral lines of the *Naiades*" are not, as Semper thinks, homologous with the system of lateral organs in the Vertebrata. Turning to the goblet-shaped organs, Eisig points out that in the Capitellidæ and in the Teleostei there are goblet-shaped organs on the head, in the buccal cavity, and on the trunk of both; that in both cases they have no relation in their arrangement to the segmentation of the body, and that they are more richly supplied to the buccal cavity and lips than to the trunk, while their structure is exceedingly similar in both cases. Comparing the goblet-shaped organs with the lateral organs we observe the following points of difference:—

(1) The former are not, and the latter are, segmental in arrangement.

(2) The latter are chiefly confined to the trunk, and are found only in animals of aquatic habitat.

(3) The sensory cells of the (Vertebrate) lateral organs are short and pyriform, of the goblet-shaped organs long and filamentous.

(4) The lateral organs have long hairs, seemingly auditory, and appear to be adapted to a mechanical mode of perception, while the goblet-shaped organs have short hairs, seemingly olfactory, and appear to be adapted to chemical changes.

There are, however, strikingly similar arrangements in both; they are both epidermal structures, both form rounded solid protuberances protected by the surrounding epidermal tissue, and both contain centrally a bundle of special "sensory cells." The author appears to incline to the view that the two sets of organs have arisen independently of one another from the epidermis.

We come now to the interesting question of the function of these organs. It has been suggested by Leydig that the system of lateral organs in the Vertebrata forms an apparatus specially adapted to an aquatic habitat, and an organ of a "sixth sense"; F. E. Schultze inclines to a somewhat similar view, regarding the organs in question as being sensitive to movements in mass of the water, or of solid bodies in the water; Eisig, however, would look upon the arrangements in the way of protection and so on, which are found in the Capitellidæ, as being means for preventing the contact of solid bodies with the sensory organs.

As to the goblet-shaped organs, there seems to be but little difficulty in regarding them as having a gustatory function; strange as it may seem to us that these organs should not be distinctly limited to the buccal cavity, it may be pointed out that Schultze regards the similar

organs of the Teleostei as having a similar function, while there appears to be a general consensus of opinion that the similarly shaped (goblet-shaped) organs, which are found again on the tongue of the Mammalia, are entrusted with the duty of tasting organs.

Echinodermata.

Anatomy of the Ophiurida.[*]—Dr. Ludwig deals in this paper chiefly with the skeleton and with the generative organs of the Brittle-stars; pointing out the extreme difficulty offered by them, he says that he has busied himself chiefly with the, in all respects, largest form known to him—*Ophiarachna incrassata* Müller and Troschel, which came to him from Cape York.

Before considering their relations to the Asterida, he deals with the leading characters of their own skeleton. In an arm, four different kinds of skeletal structures may be made out—the jointed plates, the lateral, the ventral, and the dorsal shields. The last are almost completely rectangular, are three times as broad as they are long, at the base of the arms, and they occupy nearly the whole of the dorsal side; the lateral plates carry the four rows of spines and the tentacular scales, while the ventral plates are quadrangular, and have a somewhat convex aboral edge; on their adoral edge there is a process with a depression on either side. The joints, which are formed by the fusion of two lateral pieces, are, with the exception of the first pair, intimately connected; in form they are discoid and present four surfaces; in the centre of the adoral and of the aboral surface there are protuberances and depressions by which the several joints are connected together. On the adoral side we find superiorly two lateral cavities, and, inferiorly, a median one, while superiorly there is a median protuberance, and inferiorly two lateral ones: on the aboral side the conditions are reversed. In addition to these there are other cavities which are less evident, and which go to make up four for either side of each joint. The arrangement is, on the whole, of such a kind that movement is possible in a horizontal as well as in a vertical plane. Running along the median ventral line of the arm there is a groove, at the base of which are small orifices, which lead into five canals that traverse the joints. The adoral one serves for the entrance of a nerve, and the aboral ones for a branch of the ventral water-vessel; and it is of interest to note that the arrangements of this last-named system point, in the opinion of Dr. Ludwig, to the complete homology of the joints of the Ophiurid and of the Asterid arm. This view, which was held by Meckel and by Johannes Müller, has been lately opposed by Gaudry and by Lyman; but it is impossible to enter into a detailed description of the question here, and we can only say that the lateral shields of the Ophiurida are regarded by Dr. Ludwig as being homologous with the adambulacral plates of the Asterida, while the ventral shields of the former should be regarded as subambulacral plates, which are absent in the Asterida.

As to the skeleton of the oral region, it is thought that the ambulacral covering-pieces are parts of the ambulacra, the lateral oral

[*] ' Zeitschr. wiss. Zool.,' xxxi. (1878) p. 348.

shields adambulacral pieces, and the second ventral shields subambulacral; and it is concluded that the whole of the oral skeleton is formed by the conversion of the first two joints of all the five rays, together with the adambulacral and subambulacral pieces which belong to these parts.

As to the generative organs, of which so little is exactly known, it is generally stated that, in the Ophiurida, the generative products are passed into the cœlom, and thence escape by the so-called genital clefts, but it is here shown that the generative products do not take this course, and that the genital clefts do not open into the cœlom. After a review of what has been stated by earlier writers, Dr. Ludwig draws attention to the description he gave when treating of the Asterida, when he showed that the genital clefts open into depressions of the body-wall, for which he proposed the name of *bursæ genitales*, while the clefts were named "bursal clefts." An examination of *Ophioglypha* shows that in it the bursa is a comparatively wide, but very thin sac, which commences at the edge of the bursal cleft, and passes dorsally into the cœlom; at its aboral end it is continued into a narrower portion which passes over the edges of the stomachal sac towards its dorsal aspect; it is a mere invagination of the integument. The genital tubes are placed on that surface of the bursa which faces the cœlom, and the large number of fifty has been counted on each bursa; in youth they are rounded, but they gradually take on a cylindrical form; internally they are invested by a spermigenous or ovigerous epithelium, and the outer lamella of their walls is provided with muscular fibres, somewhat irregularly arranged; in general structure they resemble the similar organs of the Crinoida, Asteroida, and Holothuroida. The generative pores may be seen to form a number of small orifices, surrounded by epithelium, separated by regular distances, and leading directly into the cavity of the genital tubes, which are connected with them by very short efferent ducts; the contents are thus passed, *not into the cœlom*, but into the bursa. Having compared the arrangements in various Ophiurids, the author points out that in them, just as in the case of the branchial vessels of the Asterida, there is reason for supposing that the bursæ serve also as respiratory organs, and suggests that they may also serve as marsupial pouches. That many Ophiurids are viviparous is certain, and the suggestion is one which would free us from numerous difficulties. The paper, which is of great value, concludes with pointing out the likenesses that subsist between these bursæ found, among extant Echinoderms, in the Ophiurida only, and the "genital tubes" or "hydrospira" of the Blastoidea.

Aspidura.*—Dr. Ludwig has some interesting remarks on Dr. Pohlig's late paper on this Triassic Ophiurid,† in which it was stated that the oral shields were divided into two equal lateral parts. Striking as this relation is, it was explained by the apparently justifiable supposition that the oral shields ("buccal plates") are primitively paired, owing to their origin from the lateral plates of the

skeleton of the arms. Dr. Ludwig now insists on the view which he has lately put out,* that the oral shields do not belong to the series of parts which make up the skeleton of the arms, but to the interambulacral series. Evidence as to the correctness of this view is, in Ludwig's opinion, to be found in Pohlig's own paper; thus, what Pohlig calls oral shields in *Hemiglypha*, are really lateral shields, as is shown by the statement that they resemble the lateral shields, that the oral "lateral shields" are indistinct (this, of course, is due to the true oral "lateral shields" being regarded as proper oral shields, while other small plates which are mentioned in the description are seen to be the true oral shields). A somewhat similar criticism is brought to bear on the description of the characters of *Amphiglypha*.

Comatulæ of the 'Challenger' Expedition.†— Mr. P. Herbert Carpenter, M.A. has made a preliminary report on the collection of *Comatulæ* made by the staff of the 'Challenger,' which includes specimens from 45 different localities, but few of which are deep-water stations.

Comatulæ were only obtained seven times from depths exceeding 1000 fathoms. At lesser depths, 200–1000 fathoms, they were met with at 13 stations; but by far the greatest number both of species and of individuals were dredged at depths much less than 200 fathoms, and often less than 20 fathoms, at 26 widely distant stations.

The collection contains 111 species, mostly new; but as the work of examination and description progresses, it is not unlikely that forms now considered different, may turn out to be merely local varieties of one and the same species, so that the number given above may be subject to alteration.

Of these 111 species, 59 belong to the genus *Antedon*, 48 to *Actinometra*, 1 to *Ophiocrinus*, and 3, which are peculiar in having ten rays to the calyx instead of only five, to a new genus for which is proposed the name *Promachocrinus* (πρόμαχος, "challenger").

The distribution of *Promachocrinus* is as follows :—

P. *Kerguelensis* (20 arms).	Balfour Bay, Kerguelen, 20–60 fathoms.				
	Royal Sound,	,,		28	,,
	Cape Maclear,	,,		30	,,
	Heard Island	..	..	75	,,
P. *abyssorum* (10 arms).	Station 147	..	..	..	1,600	,,
	,, 158	..	..	..	1,800	,,
P. *Naresii* (10 arms).	,, 214	..	..	..	500	,,

Ophiocrinus was obtained at four localities at depths varying from 565 to 1070 fathoms, two in the South Pacific off South Australia and New Zealand respectively, and two in the North Pacific, one off Japan, and one just north of the Philippine Islands. All the specimens belong to one species, which is by no means so slender and graceful as Semper's Philippine species from shallower water, but has a much more massive arm skeleton.

The comparative distribution of the other *Comatulæ* is very striking. Relatively speaking, *Actinometra* is extremely limited in

its range, both geographical and bathymetrical. It is almost exclusively a tropical genus, its northern limit being about 30° N. lat. and its southern 40° S. lat. Isolated species are known from the Cape of Good Hope, Natal, South Australia, and Port Jackson, but its chief home is Oceania, especially the Philippines. A few *Actinometra* species are also known from the west coast of the Atlantic, as South Carolina, the West Indies, Bahia, and St. Paul's Rocks.

The bathymetrical limit of *Actinometra* is likewise very slight. Nearly all the 'Challenger' species are from depths less than 20 fathoms, while only three come from a greater depth than 100 fathoms. The individual species of *Actinometra*, like the genus itself, are very local in their distribution. Each of the forty-eight species of the 'Challenger' collection has its own locality.

With *Antedon*, however, the case is different. Not only do nearly all the deep-sea *Comatulæ* belong to this genus, but some species of it have a fairly wide range. *Ant. rosacea* ranges from the north of Scotland to the Mediterranean, while *Ant. Eschrichtii* is found over a much wider area. It is well known on the American coast, and was dredged by the 'Challenger' off Halifax, while the 'Porcupine' met with it in the " cold area " of the North Atlantic.

Some *Antedon* species occur in duplicate from different localities. Two species from near the Kermadec Islands (S. 170), also occur in the neighbourhood of the Fijis (S. 174, 175). A third species was dredged at Stations 147 and 160, two localities in the Southern Sea, in nearly the same latitude, but separated by almost 90° of longitude. A fourth species came up from 1070 and 775 fathoms, off the Admiralty Islands and Japan respectively.

The above facts would seem to show that, with few exceptions, the geographical range of the individual members of the family *Comatulidæ* is exceedingly limited, nearly every species having its own locality, and that not a very extensive one.

The voyage of the 'Challenger' has settled a curious question in connection with the Crinoids, the origin of which is due to Loven. It refers to *Hyponome Sarsii*, a so-called recent Cystid, which turns out to be nothing more than the disk of a *Comatula*, minus its skeleton. The antambulacral plating may be very extensive, forming a complete pavement over the ventral surface of the disk as in many *Pentacrini*; and the ambulacra are not wide and open as is usual in most *Comatulæ*, but almost entirely closed by the approximation of the marginal leaflets at their sides, so that the food-grooves radiating from the mouth are converted into tunnels.

The plates in the marginal leaflets are probably movable as unplated leaflets are in *Antedon rosacea;* so that they can be erected when the arms are spread out, leaving the grooves open for food particles to travel towards the mouth. On the other hand, when the arms are all contracted over the disk, the marginal plates fold over the grooves and cover them in. This is the condition of most spirit-specimens, but it is not in any way comparable to that of the Palæozoic Crinoids, in which the mouth is truly subtegminal while the ambulacra become real tunnels beneath the upper surface of the vault.

Sections through one of these plated *Hyponome*-disks show that all the various structures which underlie the grooves of ordinary *Comatulæ* are present and exhibit their usual characters.

The examination of the 'Challenger' *Comatulæ* has entirely confirmed the opinions held by Dr. Lütken and the author respecting the distinguishing characters of *Antedon* and *Actinometra*. Both agree in referring forms with a (sub) central mouth, five equal ambulacra, and no terminal comb on the oral pinnules, to *Antedon*. On the other hand, species with an eccentric mouth, a variable number of unequal ambulacra, and a terminal comb to the oral pinnules, belong to *Actinometra*.

It will be seen at once that these characters are of no use in distinguishing the genera of fossil *Comatulæ*. But there are very considerable differences in the shape of the radials and centrodorsal piece in *Antedon* and *Actinometra* respectively, and as these are exactly the parts which are most met with as fossils, the generic determination of a fossil form is almost as easy as that of a recent one, which has given up its disk to produce a *Hyponome*. The author has shown elsewhere that in *Act. polymorpha* and *Act. solaris*, half, or even more than half, of the arms may have neither ventral groove, tentacles, ambulacral epithelium, nor ambulacral nerve. No less than twenty-three out of the forty-eight species of 'Challenger' *Actinometræ* may have more or fewer of such ungrooved arms, in which the ambulacral nerve is entirely absent. These arms are usually those which come off from the hinder part of the disk, but in one gigantic Philippine species with over 100 arms there are several ungrooved arms upon each radius. Evidence of this negative character appears to the author to be a serious objection to the German view, that the ventral bands constitute the sole nervous apparatus of the Crinoids; and on the other hand, to strengthen the opinions held by Dr. Carpenter and by the author, that the axial cords of the skeleton are also nervous in character.

Cœlenterata.

New Genera and Species of Corals.[*]—The Rev. J. E. Tenison-Woods describes three new genera and one new species of Madreporaria corals; the genera being *Vasillum* (*tuberculatum*), *Diechorœa* (*boletiformis*), and *Phyllopora* (*spinosa*) and the new species *Balano-phyllia dentata*.

In *Vasillum* (one of the Turbinolidæ) the corallum generally represents *Sphenotrochus*, but in place of a columella the septa of opposite sides of the calice unite to form separate compartments.

Diechorœa (one of the Poritidæ) is a very remarkable instance of the appearance in the present epoch of characters which belong to long-extinct forms of life united to others which are our commonest forms of zoophytic life. *Microsolena* is a fossil coral of the upper Jura of France and great oolite of England, and is distinguished by having all the individuals enclosed in a strong or compact epitheca, and the septal apparatus confluent. The zoothome thus resulting is massive,

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[*] 'Proc. Linn. Soc. N.S.W.,' iii. (1878) p. 92.

turbinate, gibbous, digitiform, dendroid, or spread out in plates. There are about twenty fossil species known, and they appear as late as the later Mesozoic rocks. *Diechorœa* is a *Microsolena* in which the septa are not confluent. It would belong to the turbinate division, but must be placed in a genus by itself, for the septa are not only trabecular, irregular and distinct, but the gemmation is most peculiar, being intracalicular and in congeries of individuals, rising one above another. The walls are also entire above, and form more or less complete partitions above with none of that open, spongy tissue which occurs in *Alveopora*, neither are there any of those horizontal partitions across the cells, which give that genus the tabulate character of the ancient *Favosites*. From these peculiarities of the walls, septa, and mode of gemmation, the name of *Diechorœa* is given (from διέχω, to stand apart, in allusion to the non-confluent septa). The genus is thus characterized :—Poritinæ with the individuals enclosed in a common and conspicuous epitheca, like *Microsolena*, but with the septa not confluent, apart and trabecular; gemmation intracalicular.

We may suppose that the real septa upon which the animal rests are the granular points on the summit of the wall, and that the spiculæ or pseudosepta in the fossa are the supports for the base of the animal. The calices themselves are quite microscopic, three or four of them occupying no more than the space of a millimetre.

Phyllopora is one of the Seriatoporidæ. Cœnenchyma hispid, compact; tabulæ rarely visible; calices distant; septa exsert, distinct, and in cycles.

Balanophyllia dentata (Madreporidæ) was parasitic upon a Polyzoon (*Eschara*) from the south coast of Australia, and was so completely imbedded in the foliations that they had to be broken away to extract it.

The author is not aware whether any other instances are known of corals growing on tufts of Polyzoa, but as this has been found, collectors will probably make a more diligent search, as the specimen of *Eschara* had been a long time in the Macleayan Museum, and had been many times handled before the existence of the *Balanophyllia* was observed.

In other papers [*] six other new species of corals are described, viz.:—(from Darnley Island) *Symphyllia hemispherica, Mussa solida, M. laciniata* (from Wellington, New Zealand), *Cylicia Huttoni, C. vacua*, and (from north-east coast of Australia) *Placotrochus pedicellatus*.

Ctenophora of the Gulf of Naples. [†]—Dr. Carl Chun's arrangement of these forms is as follows :—

<div align="center">

TENTACULATA.

With " grappling-lines."

</div>

Two long tentacles, simple or beset with lateral filaments. All the vessels end blindly. 1. *Cydippidæ.*

Tufts of grappling-lines which are set on either side of the

* 'Proc. Linn. Soc. N.S.W.,' iii. (1878), pp. 128 and 131.
† 'Mitth. Zool. Stat. Neapel,' i. (1879) p. 180.

margins of the mouth. Primary tentacles present or absent, vessels communicating. The young forms are Cydippoid.

<p style="text-align:center">With oral lobes.   2. <i>Lobatæ</i>.
Body band-shaped.   3. <i>Cestidæ</i>.
NUDA.
No "grappling-lines."
Vessels ramify largely.   4. <i>Beroidæ</i>.</p>

It will be seen that by this arrangement we get two distinct groups, or subclasses; the four suborders have been long recognized, but in addition to the presence or absence of the grappling-lines, Chun points out that, as McCrady first saw for the *Lobatæ*, both these and the *Cestidæ* have clearly diverged from the *Cydippidæ* more lately than the *Beroidæ*, inasmuch as they still retain in their life-history an indication of their parentage. Leuckart recognized two subdivisions equivalent to the Nuda and Tentaculata, which he named respectively Eurystomata and Stenostomata; it is now pointed out that the difference in the size of the mouth, or of the stomach, is not a character on which any reliance can be placed. Taking then the tentacles as his guide, Dr. Chun shows that where they have been stated to be absent in any one of the Tentaculata, it is on account of the insufficiency of the observations, or of some confusion of these with other organs. The large mouth of the Beroidæ, with their large sabre-like cilia, the great development of the musculature and the branching of the vessels, are points by which these forms make up for the absence of the " grappling-lines," which are not present even in the larval stages.

The filaments are two in number in the Cydippidæ, and are provided with a number of secondary lateral filaments; in the Cestidæ and Lobatæ they are present in greater numbers, as simple filaments, even where the larger tentacles are also present; these simple filaments are set in a groove, formed by a fold of the integument, which extends from the base of the tentacles, along the margins of the mouth, as far as the lobes.

A further point, which appears to be of value in the classification of the Ctenophora, is to be found in the arrangement of the water-vascular system, which is in all cases really arranged along two radii; the variations in the arrangement are indicated in the foregoing table.

With regard to the systematic portion of the paper, of the Cydippidæ, four species of the Pleurobrachiadæ, and four of the Mertensidæ, were found in the Gulf of Naples; of these *Pleurobrachia rhodopis, Euplokamus stationis, Lampetia pancerina,* and *Thoë paradoxa* were discovered by Chun.

The author is of opinion that the five families formed by Agassiz in the Lobatæ cannot stand, as there are not presented any characters which should be regarded as family ones; two new species are described.

With regard to the Cestidæ the author points out in a note that there is no Latin and no Greek word *cestum*, but that in both

languages we find the masculine form, so that the well-known
" *Cestum Veneris* " should be " *Cestus Veneris.*"

Of the Beroidæ forty-five species and some eight genera have
been described by various zoologists; this number is apparently due
to the great difference in characters which may be found to obtain
between forms at various stages of development, while some exhibit
a great tendency towards variation, and it seems to the author that
quite a third of the species have been formed on differences in pigmen-
tation. To take an example: from the common *Beroë ovata* of the
Mediterranean, *Idyia roseola* (western coast of North America), *B.
cucumis* (Greenland, Norway, and Baffin's Bay), *B. capensis* and *B.
punctata* (Cape of Good Hope and Azores) and *B. macrostomus*
(Pacific and Indian Oceans) differ too slightly to form other species.
In the Gulf of Naples Chun finds *Beroë ovata* and *B. Forskälii.*
The paper is illustrated by one plate.

Protozoa.

Eozoon Canadense.—An excellent abstract of the chief points of
Dr. K. Möbius's recent monograph on " The Structure of *Eozoon
Canadense* compared with that of the Foraminifera," appears in
' Nature,' * copiously illustrated with nineteen woodcuts.

Dr. Carpenter also announces † that he has in preparation (in
conjunction with Professor Dawson) a full and complete memoir on
Eozoon, based upon investigations far more comprehensive (he
considers) than those of Professor Möbius. It will necessarily
occupy considerable time in consequence of the elaborate illustrations
it will require. And in the meantime Dr. Carpenter makes some
brief remarks on that part of the discussion which relates to the so-
called " canal-system."

Among the numerous figures given by Möbius of *sections* of the
" canal-system," there is not one which represents what Dr. Carpenter
described and figured, when he last wrote on the subject,‡ as " what
appears to be the typical mode of its distribution." Nor is this
brought out in any of the small number of figures given of the *internal
casts* obtained by decalcification, though, in fact, it is only when the
sections are interpreted by such solid models, that the real forms and
relations of these " canal systems " can be made out.

Having been furnished by Professor Dawson with numerous
specimens obtained from different localities and in different states of
mineralization, he is now able to assert with confidence that the
peculiar distribution described and figured by him from the actual
specimens five years ago, is the *regular and characteristic* " canal
system " of *Eozoon.* His cabinet now contains hundreds of ex-
amples of it, both in transparent sections and in the solid models ob-
tained by decalcification; and these last, in partially " dolomitized "
specimens, show the following singular peculiarities, which do not
seem to have fallen under Professor Möbius's observation. When a
band of dolomite runs through the calcite layers, (1) the " canal

* ' Nature,' xx. (1879) pp. 272, 297.   † Ibid., p. 328.
‡ ' Ann. and Mag. Nat. Hist.,' June 1874, pl. xix.

systems" in its neighbourhood are very commonly filled with *dolomite*, instead of with serpentine; (2) in one and the same canal-system, some of the branches are often filled with dolomite, and others with serpentine; while (3) individual branches are often partly filled with one mineral and partly with the other.

How these facts can be explained, except by the *pre-existence of a system of canals in the calcareous layers* into which these minerals have penetrated, he is unable to conceive; and that they thus afford demonstrative evidence of a structure which cannot be otherwise than *organic* is not merely his own opinion, but that of Professor Geikie, who has been for some years engaged in the microscopic study of the metamorphic rocks of Scotland, and Professor Bonney, who has been similarly studying the Cornish serpentines.

Whether, when taken in connection with the general structure of the organism, these "canal-systems" indicate its Foraminiferal affinities is, of course, an altogether different matter. To Professor Möbius the difference seems greater than the resemblance; but it is note-worthy that his comparisons are limited to types examined by himself, and do not extend to *Calcarina*, in whose "canal-system" Dr. Dawson and the writer recognize the nearest approach to that of *Eozoon*. He cannot regard it as a valid argument against its Foraminiferal affinities that its canal-system has a plan of its own.

That in its *general plan of growth* (to which the distribution of the canal-system is intimately related) *Eozoon* differs from all recent Foraminifera at present known cannot be regarded as a proof of its non-foraminiferal character by any who have fully studied the very wide range of forms which that group comprehends, including the numerous indefinite "arenaceous" types, whose import is only now beginning to be understood by those who have the best opportunities of studying them. He finds in the chambered structure of *Eozoon*, and in its general relations to the canal-system traversing its calcareous layers, points of essential conformity to the Foraminifera, which far outweigh the differences of detail by which Professor Möbius has been led to the opposite conclusion.

Hereafter he proposes to show that the "cumulative" argument in favour of the organic character of *Eozoon* is as strong as that of the human origin of the "flint instruments." Any one of the fractures that has given to these their characteristic forms, *might* have been accidental; and yet it is impossible to conceive that any number of such flints can have been so shaped "by accident."

Peridinium and Gymnodinium.[*]—Dr. G. Joseph, in describing the "Grotten-Infusorien," gives a valuable account of the history of the cilio-flagellate forms which have been known under these two generic names.

The Peridinia of fresh water are distinguished by a differentia-tion of the outer layer of their body-substance, which takes on the form of a smooth or a plated carapace. The oval body is convex on its dorsal, and more or less flat on its ventral surface. The

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[*] 'Zool. Anzeiger,' ii. (1879) p. 114.

body is divided into two halves by a groove, and the hinder half is provided with a flagellum; the anterior edge of the groove carries fine, short, and closely approximated cilia, and the groove is, on the ventral surface, crossed by a non-ciliated longitudinal groove, which extends along the more posterior region, and the flagellum, when at rest, lies in this groove. These and other details were distinctly made out in small transparent forms, which have hitherto been regarded as *Gymnodinium*. Examined during growth, the carapace was observed to lose its simple character and to become plated, forming at last some five-and-twenty pentagonal pieces, which were connected together by the new cuticle, which could be seen between them; this is the form of *Peridinium*, and in this stage the creature was observed to be sexually mature. The double contour of the covering plates, which may be sometimes observed, is shown to be due to one plate underlying another, and as having been formed into a plate by a bursting of the cortical portion subsequent to that by which the first set of pentagonal plates was formed.

BOTANY.

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

Division of the Pollen-grain in Angiosperms.[*]—Botanists have hitherto generally believed that the processes which take place within the pollen-grain before pollination are essentially different in Angiosperms and Gymnosperms. In Gymnosperms it has long been known that a division takes place of the contents of the pollen-grain into one large cell from which the pollen-tube is produced, and several smaller cells which take no part in any further process, and have hence been called vegetative cells. An analogy is thus traced with the development of the microspore of *Isoetes* and *Selaginella*, the large fertile cell being regarded as homologous with the antheridium, the vegetative cells with the male prothallium. In Angiosperms, on the contrary, it was believed that the pollen-grain remained perfectly unicellular up to the time of pollination. It is true that Reichenbach and Hartig detected and figured pollen-grains with two nuclei, a structure which was confirmed by Strasburger. But it has been reserved for F. Elfving, of Helsingfors, in a most careful and admirable series of experiments carried on in Strasburger's laboratory at Jena, to demonstrate for the first time that a cell-division takes place normally within the pollen-grain in Angiosperms corresponding to that of Gymnosperms. The following are the main results arrived at:—

At a certain stage of development, before pollination, the pollen-grain of Angiosperms divides into two cells, a larger and a smaller one; the latter, or "vegetative" cell, may again divide into a two- or three-celled body.

This latter vegetative cell (or cells) is separated from the large cell only by a protoplasmic membrane, though in a few cases a distinct wall (of cellulose?) is formed.

* 'Jenaische Zeitschr. Naturwiss.,' xiii. (1879) p. 1.

The pollen-tube is developed from the larger cell. In certain cases the vegetative cell (or cells) takes no part in this process, the nucleus and other contents of the larger cell only passing into the tube. But usually the separating wall is resorbed. It may disappear almost immediately after the division, but in most cases endures for a certain time; the entire vegetative cell (or cells) separates itself from the inner wall of the pollen-grain, and is thus surrounded by the larger cell, assuming a peculiar spindle or crescent shape. The vegetative cell may remain for a longer or shorter period in this condition; or its nucleus divides, and fresh cells are thus formed by free cell-formation. In both cases the protoplasmic membrane is finally resorbed, either in the pollen-grain itself, or after the vegetative cell has passed into the pollen-tube. After the disappearance of this membrane, a further division of the naked nucleus may take place, either in the grain or in the tube. The nuclei often have a peculiar form.

Except in the case of the Cyperaceæ, no division of the nucleus of the larger cell was observed.

No definite order is usually maintained in the passage of the contents of the pollen-grain into the pollen-tube. The nuclei are absorbed sooner or later, but always before fertilization. The larger cell and its nucleus appear to be of greater importance in impregnation than the others. This may be inferred from the facts that it is the larger cell that develops into the tube, and that there are circumstances in which the nucleus of the larger cell always takes precedence in the movement, while the opposite case was never observed; and even in those plants in which this precedence is not constant, it is still most usual; as also from certain cases where the vegetative cells remain in their original position within the pollen-grain, and do not enter the pollen-tube.

The observations were made mostly on monocotyledonous plants belonging to the orders Orchideæ, Liliaceæ, Irideæ, Cyperaceæ, &c.; but some also on dicotyledonous plants, as *Lathyrus sylvestris*, *Plantago media*, *Hypericum calycinum*, &c. The preparations were made almost entirely with a one per cent. solution of osmic acid. The author found it, however, almost indispensable to use some pigment after fixing the preparation with osmic acid; and for this purpose he found the best to be a solution of carmine to which some glycerine was added. By this means, after about twenty-four hours, preparations were obtained which left scarcely anything to be desired as to clearness.

In order to see the growth of the pollen-tube, recourse must be had to artificial culture; and for this purpose many sorts of solutions were used, and of very different degrees of condensation; but in the end the author came back to a simple solution of sugar. In some cases weak solutions were required, and in others strong ones. The culture was generally made in the dark, and at a summer temperature, but some grown in daylight succeeded admirably.

On three plates the different forms to be met with in some twenty-three species of plants are represented.

Anatomical and Physiological Study of Nectaries.[*]—*Critical Considerations.*—Messrs. Darwin, Müller, Lubbock, &c., consider that the nectariferous tissues accumulate sugar in order to attract insects and effect cross-fertilization. They moreover describe all floral arrangements as being contrived to produce this result in a definite manner. M. G. Bonnier concludes, on the contrary, from his numerous observations, carried on since 1871 in the Alps, France, Pyrenees, Sweden and Norway, &c., that the size of the corolla, the development of colour in the floral organs, the perfume, and the spots and striæ on the corolla, are not correlated to the formation of nectar, and that they are independent of the frequent visit of insects.

In diœcious nectariferous plants the insects do not go to the male flowers first, though they are more visible than the female flowers.

The same flower may be visited in many ways by the same insect.

The form of the flower may be altered without any sensible modication in the visit of the insects; they very often gather nectar without fertilizing the flowers. The insects that visit the same flower vary according to the quantity of nectar it produces, and those of the same species differ greatly in different countries.

We cannot conclude from the facts observed that the colour, perfume, and corolla of flowers are disposed so as to exclude insects not adapted for cross-fertilization.

In short, there is no ground for admitting a definite reciprocal adaptation between insects and flowers.

Moreover, nectaries frequently exist without any *external nectar.* Numerous nectariferous tissues are also found unconnected with flowers. The rôle of these nectaries is unknown.

The preceding remarks show that the modern theory on the rôle of the nectaries is insufficient.

Anatomical Considerations.—By *nectariferous tissue* M. Bonnier means all tissue in contact with the exterior, in which the different kinds of sugar accumulate in considerable proportion.

He examined the sacchariferous tissues by means of cupro-potassic tartrate, polarized light, and fermentation, as well as with absolute alcohol, and microscopically, in more than three hundred genera, and came to the following conclusions.

There is always an accumulation of saccharine substances, particularly saccharose, near the ovary, and often a localization of it in certain parts of the appendicular organs.

The structure of the nectaries is very variable.

Physiological Considerations.—When the epidermis of the nectariferous tissue is furnished with stomata (which is most commonly the case), it is chiefly by these openings that the liquid is emitted; in other cases it may pass through the non-cuticularized membranes, or by raising the cuticle.

We may conclude, all conditions being equal, 1st, that the quantity of liquid emitted by the nectariferous tissues increases with the quantity of water absorbed by the roots; 2nd, that it increases with the hygrometric state of the air. By combining the two influences,

M. Bonnier made plants (hyacinths, tulips, &c.) artificially nectari-
ferous. Other experiments showed that the osmotic impetus of the
roots, and the capillary force of the vessels, are not necessary to, though
they accelerate, the emission of the saccharine liquid.

In settled fine weather the quantity of nectar emitted is at a
minimum in the afternoon; it is the same with the proportion of
water which it contains. In fact, the production of nectar is in direct
relation to the transpiration of the plant.

The floral nectaries examined at different ages show that the
maximum production of nectar is at the epoch in which the ovary
finishes, and the fruit has not yet begun, its development. The pro-
portion of saccharose contained in the tissue varies in the same way,
whether emitted or not. There exists near to the saccharine tissues
an inverting ferment, which transforms the saccharose into glucose,
and abounds at the time when the fruit is about to develop.
Finally, the whole or greater part of the accumulated sugars return
to the plant; the floral nectaries contribute to the nourishment of the
young fruit and the fertilized ovules, and the extra-floral nectaries to
that of the neighbouring organ about to develop; at the same time
the saccharose diminishes relatively.

*The nectariferous tissues, whether floral or extra-floral, whether emit-
ting liquid or not, constitute special nutritive reserves, in direct relation
to the life of the plant.*

Causes of the Change in Form of Etiolated Plants.[*]—In 1873
Professor Godlewski published in 'Flora' an account of his investiga-
tions respecting the formation of starch in chlorophyll-grains. In
that memoir he stated that the changes in form which plants undergo
in darkness are not due to the suspension of the assimilative process.
In 1875 and 1877, he published in the Polish language two short
notices of his further observations upon this subject, which he now
fully recounts in the present paper.

Only the first series of his later experiments will be referred
to now, namely, those bearing upon the question as to the relation
of the assimilative process to the change of form in growing plants
deprived of light. It is a general rule, to which there are some
exceptions, that internodes grown in the dark are longer, and leaves
are smaller, than those which develop in sunlight. In Prings-
heim's 'Jahrbuch f. wiss. Botanik,' vol. vii. p. 213, Dr. G. Kraus
has sought to explain the latter fact by the hypothesis that it is chiefly
out of assimilated matter freshly formed in growing green leaves
themselves that they expand to their full size, and hence the diminutive
size of etiolated leaves is thought by him to be directly dependent
upon the absence of the assimilative process.

In Professor Godlewski's experiments germinating plants were
cultivated in an atmosphere deprived of its carbonic acid, some of them
in light, others in perfect darkness, but under similar conditions of
temperature and moisture. It was found that when the plants had
exhausted the food stored in the seed and had ceased to grow, the total

[*] ' Bot. Zeit.,' xxxvii. (1879) p. 81.

weight of dry organic matter was the same in the green and in the etiolated plants. The plants which had grown in the light, but in air free from carbonic acid, and where assimilation could not take place, did not bear the slightest resemblance in form to etiolated plants. They were of perfectly normal habit.

Effects of Submersion on Aerial Leaves, and of Water on Floating Leaves.*—Previous experiments by E. Mer on the ivy, haricot, and Tropæolum, had led to the following conclusions, viz.:—

1. Throughout the whole submersion the leaves have no power of producing starch, and they rapidly lose that which they contained.

2. Their development is greatly retarded, and they never acquire their normal dimensions.

3. They die more or less rapidly, according to the species. This is generally preceded by the infiltration of the lamina.

Further investigations by the same authority show that the cause of the death of submerged leaves is not so much asphyxia as starvation, from the failure of the power to assimilate consequent on the diminished supply of oxygen. The perishing is also greatly accelerated by the infiltration of the tissues, which, however, does not usually take place until the starch has completely disappeared. Leaves of plants with bulbous roots suffer much less than others by immersion, because of the constant supply of assimilated food-material from the reservoirs. The infiltration is perceptible chiefly in the intercellular spaces, but, in order to reach these, water has first to penetrate the epidermis.

In the case of aquatic plants with floating leaves, M. Mer shows that these leaves are also killed, like aerial leaves, by submersion, and that the starch which they contain is produced entirely on the upper surface, and not from the carbonic acid dissolved in the water.

Absorption of Water by the Lamina of Leaves.†—The following results have been arrived at by E. Mer, in continuation of his researches on the effects of submersion on the leaves of plants:—

1. The lamina of leaves can absorb water, both when they are entirely submerged after having lost their turgidity, and when placed in contact with the liquid only by a portion of their surface, the other part remaining exposed to transpiration.

2. Absorption is more active by the lower than the upper surface, and more so in those leaves which have a thin than in those with a thick cuticle. In the former it is sufficient to suspend desiccation in the internodes and the remaining leaves which are not submerged, when these organs do not receive water from any other source ; it is, however, not sufficient to preserve the turgidity of the roots. In the latter the absorption of water is not sufficient to recover the weight which they possessed before fading.

3. The absorption is not merely local, since it restores turgidity in the neighbouring organs. All the tissues of a plant are more or less capable of absorbing water. This can be proved in a variety of cases.

4. The lamina of leaves does not absorb water when (1) they have retained their turgidity; at least it does not take place in the vicinity of organs which are actively transpiring; (2) when they have within their reach tissues containing abundance of water; when slightly withered they appear to prefer imbibing water from this source.

Movements of Growing Leaves and Petals.*—Dr. Carl Kraus has an elaborate and important paper on this subject in 'Flora.' The author mentions in the first place that these periodic movements are of two kinds:—those caused by unequally accelerated or retarded growth of different masses of cells; and those which are not dependent on growth, but on a transitory alternate elongation and shortening of certain masses of cells. The first kind are *movements of nutation;* to the second kind, which Pfeffer has made specially his study, he has applied the term *movements of variation.* His investigations have shown that every sensitive movement caused by decrease of light is followed by changes in position of the part affected, the extent of the oscillations depending on the degree of change in the amount of light. Alterations in the amount of light are, therefore, the chief cause of these movements. A secondary cause is a change in the amount of moisture in the air. On these two causes depend mainly the opening and closing of flowers. It is obvious that the "bifacial" structure of the flat, horizontal leaves of most dicotyledonous plants, combined with the fact that, as the leaf unfolds, the under surface is more completely exposed to the light than the upper surface, must bring about different conditions in these respects between the two surfaces of the leaf. The following are some of the special phenomena thus exhibited:—

1. Changes of position from decrease of turgidity. This is the ordinary familiar phenomenon of the withering of leaves or petals when the supply of moisture is cut off. In many plants, such as *Chenopodium album, Stellaria media, Nicotiana latissima,* &c., the loss of water is spread so rapidly from cell to cell that no perceptible difference is manifested between the upper and lower surfaces, and the leaves simply hang down; and the same is the case with the petals of *Solanum tuberosum* and *Convolvulus arvensis;* while those of *Silene noctiflora* roll themselves up inwards.

2. Changes in position from increased turgidity. For the changes under this condition the original paper must be consulted. Observations were made on the leaves of *Chenopodium album, Solanum tuberosum, Nicotiana latissima, Stellaria media,* and *Polygonum Convolvulus,* and the petals of *Convolvulus arvensis, Solanum tuberosum, Silene noctiflora,* and *Calendula pluvialis* and *officinalis.*

The cases of those Papilionaceæ of which the leaflets raise themselves erect in the evening, like *Trifolium pratense* and *incarnatum* and *Lupinus luteus,* and of those which are depressed in the evening, like *Lupinus albus* and *Phaseolus,* were subjected to careful investigation; and the mechanical causes of the various phenomena described are minutely discussed in the paper.

* 'Flora,' lxii. (1879) p. 11.

Disengagement of Heat which accompanies the Expansion of the Male Inflorescence of Dioon edule.*—This cycad has recently flowered abundantly in the hot-houses of the Botanic Gardens at Paris. The opening of the male inflorescence was attended by a strong and nauseous odour, coinciding apparently with the dehiscence of the anthers. M. Poisson has observed that this was accompanied by an elevation of temperature of at least 10° C.; and that the disengagement of heat is promoted by light, and is consequently more marked on the side exposed to light than on the shady side.

Spiral Cells in the Root of Nuphar advenum.†—M. Pihier notes in the root of this plant a single superficial layer of these cells, analogous, in their appearance and their situation, to those described by M. Chatin in the aerial roots of epidendral orchids. This structure, all the more exceptional in its character from its occurrence here in submerged roots, may be held to establish a new point of similarity between the Nymphæaceæ and the order placed by many botanists at the head of Monocotyledons as respects complexity of structure.

Structure of the Fruit of Conium maculatum.‡—M. Moynier de Villepoix has made a more careful examination of the structure of the fruit of the hemlock than has hitherto been conceded to it. He finds in the seed an abundant endosperm, as is usual in Umbelliferæ, formed of polygonal cells with thin walls, and containing grains of aleurone. This is bounded on the outside by two zones of brown cells which have long been known as especially characteristic of the mericarp of the hemlock. Thirdly, there is the pericarp, properly so called, in the parenchymatous tissue of which are the organs of secretion or vittæ, although the fruit of Conium is frequently described as being destitute of these.

Modifications which Starch undergoes from a Physical Point of View.§—F. Musculus thus sums up the results of a series of experiments :—

Starch can be obtained in the colloid or crystalloid state.

In the colloid state it is soluble in water, is coloured blue by iodine, is not diffusible, is easily converted into sugar by ferments and dilute acids, and readily passes over into a condition insoluble even in boiling water, and is then scarcely acted on by ferments or acids, and assumes a red or yellow colour under the subsequent iodine reaction. After treatment with concentrated sulphuric acid or soda-ley, the blue colour is again obtained by iodine, and ferments or dilute acids have a powerful action.

Crystalline starch consists of separate crystals which readily unite into plates, and then become gradually less soluble in water, so that crystalline starch behaves in this respect like colloid; on the other hand, it remains soluble in water of 50°–60° C., is diffusible, though with difficulty, and is readily acted on by ferments or dilute acids.

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* 'Bull. Soc. Bot. France,' xxv. (1878) p. 253.
† Ibid., p. 163.   ‡ Ibid., p. 166.
§ 'Bot. Zeit.,' xxxvii. (1879) p. 345.

The separate crystals are not coloured by iodine-solution, but such a solution assumes a red colour, which turns to violet and finally blue on evaporation.

A similar difference in the degree of molecular cohesion occurs also in the case of cellulose. On the one hand, the cellulose in certain cotyledons is a delicate tissue, coloured blue by iodine and acted on by diastase; on the other hand, it is a hard solid mass, as in cotton, the pith of the elder, &c., which undergoes change only after long-continued action of concentrated acids or alkalies.

Cellulose and starch present therefore many analogies, not only in their chemical, but also in their physical properties.

Rain of Sap.*—On the 22nd August, 1878, at 4 P.M., in calm weather, with a clear sky, and a temperature of 24° C. in the shade, M. C. Musset was struck by the evolutions of the gnats under the outspread branches of two trees, varieties of *Abies excelsa*. Round some yew trees (*Taxus baccata*), a lime tree (*Tilia platyphylla*), and two very old stumps of *Althæa frutex*, he noticed similar swarms of insects, but less numerous; under other trees there was not a single gnat. He then noticed an immense quantity of very limpid little drops falling in the form of fine rain, which became visible against the rays of the sun.

The phenomenon was observable for a fortnight, at any hour of the day, and often, by the light of a lamp, in the night.

If, on hot days, with a misty sky, the falling of the drops is not to be seen, it is easy to prove the reality of the fact by spreading a piece of dark-coloured silk material.

The following are briefly, in his opinion, the approximate causes of this phenomenon. At the end of summer and the commencement of autumn, vegetation gradually suspends its activity, the tissues become cuticularized, and consequently the transpiration decreases; but the sap continues to rise in the vascular bundles, and, being no longer utilized for the work of assimilation, its excess is poured out by the stomatic openings and the bordered pits, so peculiar to the cells and vascular fibres of the Coniferæ.

This aqueous sap is nearly insipid, perhaps slightly purgative, and colourless, but in a few days it assumes a pale amber tint.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Prothallium of Salvinia natans.†—Bauke has investigated the development of the unfertilized prothallium of Salvinia, a point left undetermined in Pringsheim's investigations. Sachs has already shown that of the two families of Rhizocarpeæ, the Salviniaceæ exhibit an intermediate stage between the other family, Marsileaceæ, and ferns, especially in reference to the structure of the fructification. The development of the unfertilized prothallium of *Salvinia natans* was thus followed out by Bauke. The power of division of the cells

* 'Comptes Rendus,' lxxxviii. (1879) p. 306.
† 'Flora,' lxii. (1879) p. 209.

of the apical ridge is limited. In the whole of its anterior portion cell-division has completely ceased when about four rows of archegonia have been formed. The conclusion of growth is always indicated by the pushing forwards of the archegonia close up to the cells of the apical ridge; they therefore appear to be directed towards the margin. Archegonia were never seen to originate from the cells of the marginal ridge. Since no further growth takes place in the anterior direction, the posterior cells on both sides of the ridge which are nearest the macrospore retain their power of division. There remains therefore on each side a zone of growth, increasing downwards, by the activity of which a relatively broad wing-like appendage is produced. In this zone of growth archegonia are continually being produced, and especially on the prolongation of the ridge of the prothallium; and since at the same time growth ceases gradually downwards in the marginal cells, new archegonia are also produced laterally towards the margin. Since the new archegonia are produced in acropetal succession, a further resemblance of the Salviniaceæ to ferns is here indicated.

Bauke has also made an additional observation on the formation of the ventral canal-cell of the archegonium. While the canal of the neck is at first filled with granular protoplasm, there is finally only a very small granular string left within the mucilage, the loss of mass being very striking. The formation of the mucilage is therefore a process of excretion or growth rather than simply of swelling. This indicates a similar origin of the mucilage to that in the case of ferns. No rhizoids were ever observed on the prothallium of Salvinia, such as occur in Marsilea.

Fungi.

Contribution to the Germ Theory.[*]—Dr. Robert Koch has published an important monograph on the ætiology of infectious traumatic diseases (Wundinfectionskrankheiten). The paper opens with a definition of the diseases treated of, and a review of the present state of our knowledge with regard to *contagium vivum*, and of the arguments for and against the doctrine. Then follows a description of the author's method of research, and then the most important part of the work, a detailed description of his exact and laborious experiments on artificial traumatic diseases.

1. *Septicæmia in Mice.*—Putrid blood or infusion of meat was injected under the skin of the back. Characteristic symptoms showed themselves, and the animals died in four to eight hours. No bacteria were found beyond those injected, so that in this case the disease was evidently due to a soluble poison (sepsin), and not to the agency of microphytes. In correspondence with this no effect was produced by very small injections (1 to 2 drops), except in about one-third of the cases. In these, different but equally characteristic symptoms supervened, death took place in about fifty hours, and a post mortem examination showed the blood to be crowded with small bacilli about 1μ in length, which occurred in the vessels of all organs of the

[*] 'Untersuchungen über die Aetiologie der Wundinfectionskrankheiten,' Leipzig, 1878.

body, surrounding the red corpuscles and absolutely filling the white. Even $\frac{1}{10}$ drop of the blood thus affected was able to communicate the disease to another mouse, and the disease was, in fact, carried through seventeen generations. There seems little doubt that the bacilli are the actual contagium of this form of traumatic septicæmia. It is a curious circumstance that field-mice and rabbits were not susceptible to the disease.

2. *Progressive Tissue-necrosis (Gangrene) in Mice.*—In mice injected with decomposing blood there were sometimes found at the place of injection (in the subcutaneous tissue) micrococci, as well as the regular bacilli of septicæmia. These micrococci had a diameter of $0 \cdot 5 \mu$, multiplied rapidly, and showed a great tendency to the formation of " chains." Lymph from the subcutaneous tissue infested with these was injected into a mouse's ear. The micrococcus-chains soon multiplied so fast as to interpenetrate the whole ear, the tissue of which became so changed as to be hardly recognizable; cartilage cells looked pale, as if treated with potash, and blood and connective-tissue corpuscles were no longer to be seen. It seems clear that the septicæmia-bacillus is a necessary forerunner of the gangrene-micrococcus. An interesting pure-culture experiment was tried. Field-mice, which, as stated above, are not susceptible to septicæmia, were injected with fluid containing both bacilli and micrococci. The former had no effect, the latter multiplied and caused death, and from the animals so affected both field and house mice could now be inoculated, the result being always gangrene and never septicæmia.

3. *Progressive Abscess-formation in Rabbits.*—Rabbits were injected with putrid blood. A flat, hard, lenticular infiltration was gradually formed at the place of injection, producing at last a fatal abscess in the subcutaneous tissue. The abscess was covered by a thin layer of micrococcus-zoogloea; its cheesy contents were finely granular, and contained no bacteria, but were probably derived from the zoogloea and from the enclosed dead tissues. The individual micrococci were $0 \cdot 15 \mu$ in diameter. The blood of rabbits dying from this disease produced no infection, but the disease was communicated by injecting a little of the interior of the abscess rubbed up in water.

4. *Pyæmia in Rabbits.*—A rabbit was injected with fluid obtained by macerating mouse-skin in water. A purulent infiltration of the subcutaneous tissue resulted, accompanied by swelling of the spleen, morbid changes in lungs and liver, and peritonitis. Micrococci abounded in the affected places, occurring in the blood-vessels surrounding the corpuscles, and forming accumulations which sometimes quite obstructed the lumen. These micrococci are distinguished from those of gangrene and abscesses by not forming chains or zoogloea, and by their size ($0 \cdot 25 \mu$). For inoculation, $\frac{1}{10}$ of a drop was sufficient, but not $\frac{1}{1000}$.

5. *Septicæmia in Rabbits.*—The animals were injected with a putrid infusion of meat. A purulent accumulation (jauchige Vereiterung) took place, and the subcutaneous tissue in the neighbourhood became filled with a watery fluid, containing large oval micrococci (diameter $0 \cdot 8$ to 1μ), which also occurred in the kidney and spleen.

Injection of 5 to 10 drops of the œdema fluid communicated the fatal symptoms.

6. *Erysipelatous Process in Rabbits.*—The ear was injected with mouse's dung, softened in distilled water. The organ became red, swollen, and flabby, and was found to contain large numbers of bacilli 3 μ in length and 0·3 μ in diameter. The author failed to communicate the disease to other animals.

After the description of these experiments, Koch devotes a few pages to splenic fever, and then sums up his results, and discusses their importance. For the first five cases there is complete, for the sixth partial evidence of parasitic nature. Infection is produced by so small a quantity of fluid, that toxic effects are quite excluded. For each disease the bacterium-form is distinct and unchangeable ; this is the most important result of all. The living body is the best possible pure-culture apparatus.

Some former writers have stated that the virulence of the poison in these diseases increases constantly in successive generations ; Koch considers that it increases up to the second, or latest the third generation, and then remains constant.

Nature of the Fur on the Tongue.*—The fur on the tongue is generally stated to consist chiefly of epithelial cells usually sodden and granular, though Robin, Kölliker, Billroth, and others have described fungi as existing in it or in the buccal mucus.

According to Mr. H. T. Butlin, Schizomycetes form the essential constituent of the fur.

On 68 healthy tongues examined, fur was found on all except one ; and on 178 tongues of persons suffering from disease or accident, on all except two.

Microscopical examination of the results of scraping gave in nearly every instance the same results : (1) *Débris* of food and bubbles of mucus and saliva ; (2) Epithelium ; (3) Masses which appeared at first to consist of granular matter, but which are the glœa of certain forms of Schizomycetes.

That the last-named of these three is the essential constituent is proved by the fact that the quantity of the glœa depends roughly upon the quantity of fur, and that its position upon the tongue corresponds with that of the fur, both covering the tops of the filiform papillæ, but not usually lying between them.

In order to ascertain the true nature of the glœa, and to obtain it in a purer form, it was cultivated upon a warm stage (30°–33° C.). Several fungi were discovered, but only two of these were present in every instance, *Micrococcus* and *Bacillus subtilis ;* and, as the glœa produced artificially was similar to that existing naturally in the tongue-fur, it is believed that fur is composed essentially of these two fungi. *Micrococcus* developed abundantly and rapidly, forming large masses of yellow or brownish-yellow colour. *Bacillus* did not develop, but existed in greater or less abundance in all the cases examined. Its development was probably prevented by the presence of other

* ' Proc. Roy. Soc.,' xxviii. p. 484.

developing organisms, from which it was found impossible to separate it. It appeared to be identical with the *Leptothrix buccalis* of Robin. Although it did not develop under artificial conditions, it is probable that development takes place freely upon the surface of the tongue. Its habitual occurrence there, and the presence of spore-bearing filaments, favour this view.

Besides these fungi, there were present, more or less constantly, *Bacterium termo*, *Sarcina ventriculi*, *Spirochæta plicatilis*, and a larger form of *Spirillum*. *Sarcina ventriculi* was frequently present, and generally developed quickly, forming large masses of a yellow or brownish-yellow colour. *Spirochæta plicatilis* occurred only in two or three of the specimens examined. *Bacterium termo* existed in some of the furs, and twice developed with such rapidity that the whole of the fluid was crowded with these organisms.

The slime between and around the teeth was found to consist of the same fungi as the tongue-fur, but the rods of bacillus were longer, probably owing to the disturbing causes being fewer.

When thin the fur can only be scraped off with difficulty, and always brings with it numerous fragments of the hair-like processes which form the terminations of the filiform papillæ. But when thicker, soft and moist, it can be removed in considerable quantity with ease.

Supposed Amylaceous Substance in Fungi.*—The entire group of Fungi are generally stated to be altogether destitute of both chlorophyll and starch. In his investigations of the Pyrenomycetes, M. Crié believes that he has detected an amylaceous substance in the asci of *Sphæria Desmazieri*. The young asci, having a length of from $0 \cdot 005$ to $0 \cdot 007$ mm., proceed from the hymenium of a perfectly closed perithecium, and have hard and very dark walls; they are simple cylindrical cells, formed from a homogeneous or finely granular protoplasm, enveloped by a single membrane. The existence at this period of an amylaceous globule is very perceptible, presenting the appearance of a simple point occupying the summit of the ascus. This globule, which is distinctly organized, increases gradually in size by intussusception, as can be proved by the iodine reaction, which shows also that it is composed of granulose. The globule appears to take no part in the formation or nutrition of the spores, but is expelled from the summit of the ascus immediately before their dissemination. It appears to consist of true starch, but is formed in perfect darkness, from a protoplasm destitute of chlorophyll, and insoluble in the cell-sap. He proposes for it the term *amylomycine*.

M. de Seynes, however, contests the view of this structure taken by M. Crié.† He points out that in many of the Sphæriaceæ the asci are composed of two utricles or membranes, one enclosed within the other. The inner membrane is sometimes permanent and bears the spores on its outside when it bursts the outer membrane. Sometimes it is transitory, and disappears as the spores are being formed, when it is difficult of detection. Berkeley and Broome, the first describers

* 'Comptes Rendus,' lxxxviii. (1879) p. 759.
† Ibid., p. 820.

of the *Sphæria Desmazieri*, describe this inner membrane as being furnished with an oblong process at the tip; and it is this "oblong process" which M. Crié has mistaken for an amylaceous substance. When first formed it is in intimate connection with the membrane of the ascus, and remains attached to it after the formation of the spores; the narrow neck which unites them becomes thicker, so that the corpuscle, at first spherical, becomes pear-shaped. The same structure, with slight variation, was observed in two allied species, *Rosellinia Aquila* and *R. Thelena*.

Cellules en boucle.*—The peculiar cells found in some fungi and known as "cellules en boucle" or "Schnallenzellen," already described by Hoffmann and de Bary, have received further attention from M. de Seynes.

They are distinguished by the presence of a rounded appendage placed here and there on their external wall. This is a cylindrical cellular formation, very short and of small diameter, proceeding from the cell below a septum, and united with it either in its entire length or only by its summit. The cavity of this small cellular excrescence usually remains in communication with that of the cell from which it emanates, but is sometimes separated by a septum. The writer believes these structures to be simply an arrested condition of cells in the act of multiplication. They are well shown in the pseudo-parenchyma of the receptacle of Fistulina.

Anthracnose of the Vine.†—M. Cornu gives a full description of the disease of the vine known as "anthracnose," from the neighbourhood of Narbonne, where it is committing great ravages. The cause of the disease is a fungus considerably smaller than the oidium, but committing even greater devastation. It appears to be strictly annual, and makes its appearance on the green organs during the season of fine weather.

Aschotricha.‡—M. Bainier describes two species of Aschotricha grown on damp linen.

The first is very abundant and of an elegant appearance. In the centre are the naked asci; at first elongated, subsequently round, and so small as to be difficult to distinguish. Each contains eight smooth ascospores, oblong and yellow when mature. Dispersed among the asci are paraphyses, black filaments, the extremities of which are finally transformed into a segmented club-shape. The paraphyses branch and anastomose. The conidia have no special supports.

The second species, less common and often much smaller, is distinguished at first sight by the absence of the club-shaped extremities of the paraphyses, which also do not anastomose. The conidia are not round, but have somewhat the form of little corkscrews.

Development of Sclerotia.§—M. Cornu has followed out the researches of Tulasne and Leveillé as to the part played by the "sclerotium" in the development of certain fungi, confirming on the whole the previous observations.

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* 'Bull. Soc. Bot. France,' xxv. (1878) p. 95.
† Ibid., p. 227.   ‡ Ibid., p. 245.
§ Ibid., p. 176.

The fungus which gives rise to the "sclerotium complanatum," not uncommon in the neighbourhood of Paris, is *Clavaria juncea*, while the species which grows from the development of the sclerotium is a very delicate one, placed in an allied genus, and known as *Typhula phacorrhiza*, which was, however, described by Desmazières as a variety of *Clavaria juncea* parasitic on the sclerotium. The "sclerotium varium" was found to develop into a Peziza allied to *P. tuberosa*. The sclerotium which gives rise to *Agaricus cirratus* is "s. subterraneum var. truncorum." The "sclerotium varium" causes a destructive disease in Jerusalem artichokes.

New Genus of Sphæriaceæ.*—Some years ago M. de Seynes gathered in a garden in the neighbourhood of Montpellier a twig of wood, on which were black elevations caused by the attacks of a fungus belonging to a genus new to science, to which he gave the name *Eurytheca monspeliensis*. While belonging to the Sphæriaceæ it appears to present some characters intermediate between that family and the Tuberaceæ. The asci are placed in considerable numbers side by side in the tissue of the stroma; they are of an elliptical form, with transparent walls, and measure about 0·04 to 0·055 m. The spores are large, 0·025 to 0·03 m. in length, the number in each ascus varying between four and eight, as is frequently the case in the Tuberaceæ. There are no paraphyses.

Specific Differences among the Uredineæ.†—The *Juniperus Oxycedri* of the Mediterranean region is often attacked by a Podisoma, which has generally been regarded as identical with the *P. Juniperi* so abundant on the common juniper. M. Cornu has succeeded in studying this fungus by cultivating it, in its form of *Rœstelia lacerata*, on the leaves of the hawthorn, and has fully established its identity.

The spermogonia appeared abundantly at the end of fifteen days or less. It is probable, however, that many Æcidia which appear identical are not so in reality. De Bary has shown that the species parasitic on the haricot and the common bean, so alike externally, are not identical, but differ from one another as greatly as the *Uromyces Phaseolorum* and *U. Fabæ* from which they proceed. It is much more difficult to distinguish from one another the æcidial than the teleutospore forms; and it is no doubt for this reason that the number of species of Puccinia is much greater than that of Æcidium, even when from the former are excluded those which, like *P. Dianthi* and *P. Malvacearum*, reproduce themselves directly without any alternation of generations. Of two hawthorn-bushes on which the spores of the Podisoma were sown, one perished entirely, the other appeared to die all except a single bough, which, when the plant was placed in a greenhouse, gave birth to a branch of very peculiar structure, with short sessile leaves and axillary branches, the whole of which was strongly infested with the Rœstelia, appearing in February, far from its normal time of year. The parasite was feeble, and pro-

duced but a small number of spermogonia. This shows that although the Rœstelia is strictly annual, the mycelium may retain its vitality for a time in the tissue of the host.

Neovossia, a New Genus of Ustilagineæ.*—Von Thümen has detected in the ovary of *Molinia cærulea*—a grass on which no parasite of the kind has hitherto been observed—an ustilagineous fungus, which he makes the type of a new genus nearly allied to *Tilletia*, and describes under the name *Vossia Moliniæ* (subsequently altered to *Neovossia*, the former name having been already appropriated).

The mycelium consists of slender hyaline hyphæ, 4 to 5 mm. thick, not distinct at the apex, but forming a pseudascus or gelatinous follicle subpersistent around the mature spore, with a rather long cormoid process; the spores are dusky, and ellipsoidal or ovate. The origin of the spores at the ends of the hyphæ, and their formation in the gelatinous sac, are very characteristic, as well as the remaining of the spores within this sac even when ripe; while those of *Tilletia* present at the same age no trace of the gelatinous layer which previously enveloped them, but are perfectly free.

Injection of Bacteria into the Blood without any Toxic Effects.† —Professor Livon states that he has injected into the femoral or jugular veins of various dogs different liquids in a state of putrefaction— bile, urine, &c.—and containing a large quantity of *Bacteria*, without any other result than a certain amount of lassitude; the only change in the blood was an augmentation in the number of the white corpuscles; autopsy revealed no lesions. We draw attention to these statements chiefly because it does not seem to be as generally understood as it should be, that ordinary atmospheric bacteria do not set up fermentative changes in the *healthy living* organism; *Bacillus* will produce splenic fever in healthy organisms, but these forms require for their perfect development free exposure to oxygen, which is very far from being the case with *Bacterium termo*.

Anthrax and its Cause.‡—M. Paul Bert states that the blood of animals suffering from anthrax ("charbon"), when submitted to great pressure of oxygen, retains its mortal capabilities for ninety-nine hours, but no "bacteria" were seen; similar blood, treated with three to four times its volume of strong alcohol, gave just the same results; and he concludes that the bacteria are neither the cause nor the "necessary effect" of the disease, but that its virus is of the same nature as that of cow-pox or of glanders. He further states that the blood of the dog suffering from the disease is not poisonous to another dog or to the guinea-pig.

M. Leflaive, speaking at the same "séance," stated that he believed he had shown that in the Herbivora the poison resulted in a general affection of the whole system, while in man it only gave rise to a local affection, the blood not containing the virus, and being therefore incapable of propagating the disease. What obtains in man appears also to M. Leflaive to obtain in the Carnivora; in which case we get

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* 'Oesterr. Bot. Zeitsch.,' xxix. (1879) p. 18.
† 'CR. Soc. Biol.' for 1877 (1879), p. 355.   ‡ Ibid., pp. 19, 20.

an explanation of Professor Bert's results.   At a later meeting *
M. Bert stated that the results of some experiments on a guinea-pig,
which had been poisoned with the morphological element ("bac-
terium") of anthrax poisoning, and whose blood lost completely its
toxic effects after a week's treatment with compressed oxygen or con-
centrated alcohol, had led him to believe that there were two maladies
confounded under the name of the "charbon"; that one is *virulent* and
owes its origin to the matter precipitated by alcohol, while the other
is merely *micro-parasitic*; it is possible that the two states may co-
exist in the same animal, but, where the poisoning has been of the
virulent type, Bert found but few bacteria; in the guinea-pig it was
noticed that the "virulent blood" killed in ten to twelve hours, and
the blood-corpuscles were crenulated, while with the "bacterian
blood" death occurred after thirty to thirty-six hours, and the corpuscles
retained their original character.

The volume already cited also contains (p. 442) an account of a
pathological investigation on the human subject; the patient was a
carrier of meat who had cut his chin with a razor; during life a drop
of blood revealed the presence of long "bacteridia" ($\frac{1}{56}$ mm. in length).
The patient exhibiting a very low temperature (33° C.), the respiratory
gases were examined, and it was found that he, a man weighing 80
kilogrammes, absorbed 7·924 litres of oxygen, and gave off 6·300 litres
of carbonic acid in an hour; in other words, only about one-third of
the healthy quantity of oxygen was inspired. In pursuance of the
subject (p. 465), M. Regnard gives an account of the investigations
which, with the aid of another colleague, he had made on a dog; here
again the results of anthrax poisoning were a diminution in the amount
of oxygen absorbed and of carbonic acid exhaled, together with a
great fall in temperature, and the presence of a quantity of bacteria
in the blood. Previous to inoculation with the anthrax poison, the
blood of the dog absorbed 20·4 c.c. of oxygen per 100 grammes,
while after poisoning the same quantity of blood absorbed 26 c.c.

Lichenes.

Lichenological Review.—The 'Revue Mycologique' is in future
to deal with Lichens as well as Fungi, the editor being of opinion
that the change is justified on account of "the points of con-
tact which in certain genera so intimately unite the Lichens to the
Fungi, and which are so evident even to observers the most disposed
to defend the autonomy of Lichens as a distinct family, that they have
not hesitated to declare in their writings that it was difficult to say
where the Lichens ended and the Fungi began."

Algæ.

Power of Algæ to resist Cold.†—At a recent meeting of the
Botanical Society of France, M. Cornu stated that he had seen
several Chlorophyceæ, and especially Hydrodictyon, growing beneath
ice. *Palmella hyalina* produced myriads of zoospores in a vase filled

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* 'CR. Soc. Biol.' for 1877 (1879), p. 317.
† 'Bull. Soc. Bot. France,' xxv. (1878) p. 79.

with melting ice.   Hæmatococcus vegetates at very low temperatures, even beneath ice.

Marine Algæ of the Gulf of Naples.*—P. Falkenberg gives a list of the marine algæ found at Naples, which will be exceedingly useful to the student of these forms who visits that region : the most complete work on the subject is very old, inasmuch as it was published in 1823—the ' Hydrophytologia Regni Neapolitani' of the famous Delle Chiaje.

The systematic portion of the essay is based upon Agardh's work on these forms ; but there is also given in addition, notes on the times at which the algæ were found and of their times of fructification, while the localities of the rarer forms are also indicated.   The list contains the enumeration of six algæ from Messina, which are not mentioned in Langenbach's list; some of these are new to the flora of the Mediterranean.

New Diatoms.†—P. Richter records two new fresh-water species of Diatomaceæ belonging to the genus *Homæocladia*, hitherto known as an almost entirely marine genus, which he calls *H. germanica* and *H. conferta*.   They were found in a mill-stream near Leipzig, growing amongst Cladophora, within reach of the spray of the mill-wheel.   The ground in the neighbourhood is strongly impregnated with salt.

Terrestrial Diatoms.‡ — M. J. Deby recalls the inquiry of Ehrenberg § as to how it was that amongst the 400 species of diatoms found in the environs of Berlin, the two species which were most common in the atmospheric " dust " of all parts of the world, and at all elevations above the level of the sea, *Eunotia* (*Nitzschia*) *amphyoxis* and *Pinnularia borealis*, and which were also those met with most frequently in dust deposits at Berlin, were of the greatest rarity in a living state on the ground.   He points out that few naturalists have occupied themselves with the search for diatoms outside their usual habitat in the sea or fresh water, with the exception of the late Mr. Walker Arnott, in whose collection are two gatherings obtained from moss growing on elms at Ulverston and in Perthshire.   Mr. C. Johnson, of Lancaster, and the Rev. — Cresswell, of Teignmouth, have also made similar collections.

The following were the species obtained :—*Orthosira mirabilis, O. spinosa, Navicula mutica, N. pusilla, Pinnularia borealis, Nitzschia amphyoxis, Amphora affinis, Achnantidium coarctatum.*

These species, and probably many others, M. Deby considers to be essentially *muscicole*, living habitually on trees and in other places exposed to atmospheric vicissitudes ; and he recommends the methodical washing of mosses wherever found, with a view of forming a list of Bacillaria which they contain in a *living state*.   The presence of these species in the mosses of trees explains the fact of their presence

* ' Mitt. Zool. Stat. Neapel,' i. (1879) p. 217.
† ' Hedwigia,' xviii. (1879) p. 64.
‡ ' Bull. Soc. Belge Micr.,' v. (1879).
§ ' Uebersicht der seit 1847 fortgesetzten Untersuchungen, &c.' (1871) p. 102.

in the atmospheric dust without being found in a living state in adjoining water; and thus Ehrenberg's question is answered.

It is very possible that these diatoms belong to those in which the phenomena of deduplication, conjugation, and formation of spores are the most active, rapid, and easy to follow, and it is on this account that the study of *terrestrial* diatoms deserves attention.

The Rev. George Davidson, of Scotland, told M. Deby that for several years he has searched mosses for diatoms, and has found that the mosses growing at the foot of elms on the side exposed to the north furnish the greatest number.

MICROSCOPY, &c.

Method of preserving Infusoria, &c.*—M. Certes repeats in the 'Journal de Micrographie' the account of his observations, which have already appeared in the 'Comptes Rendus,' † to which he adds the following remarks :—

To obtain good preparations the following conditions must be fulfilled.

1. The absence of any movement of the cover-glass which could crush the Infusoria.

2. *Rapid* action of the osmic acid and *complete elimination* of the reagent as soon as the desired action is obtained.

3. *Slow and progressive* action of the colouring reagent, whatever it is, and elimination of it by glycerine.

4. *Very slow* substitution of the pure glycerine for the diluted and coloured glycerine.

5. *Hermetical* sealing, which cannot be obtained either with paraffin or with sealing wax dissolved in alcohol, or with Canada balsam if the margins of the preparation are not perfectly dry.

Hæmatoxylic Eosin and its employment in Histology.‡—It is known that eosin, soluble in water, colours the protoplasm of the cell elements, without having any selective action for the nuclei, so that when we wish to bring out these latter in a preparation coloured with eosin, recourse must be had to the method of double colouring proposed in 1876 by Wissotsky, a method which is long and requires several successive washings, which easily leads to the deterioration of the sections. Moreover, alcoholic or aqueous solutions of eosin precipitate that of hæmatoxylin prepared after Boehmer's classic formula.

M. J. Renaut, having remarked that eosin in an aqueous or alcoholic solution does not precipitate the hæmatoxylin of Boehmer's liquid, when the mixing is effected in the presence of neutral glycerine, conceived the idea of employing a liquid prepared in this manner. He mixes one part, by volume, of neutral glycerine and one part of a saturated solution of eosin in alcohol or water (according as pure eosin or eosin à la potasse is used). There is then added drop by drop hæmatoxylin prepared according to Boehmer's formula until the

* 'Journ. de Micr.,' iii. (1879) p. 242.
† See this Journal, ii. (1879) p. 331.
‡ 'Comptes Rendus,' lxxxviii. (1879) p. 1039.

green fluorescence of the mixture is scarcely visible. The filtered liquid gives a violet solution, which he calls *hæmatoxylic eosin*, and is employed in the same way as picro-carminate of ammonia in mounting preparations in glycerine or in Canada balsam. In the latter case the dehydrating is effected with alcohol charged with eosin and clarified with oil of cloves similarly charged.

Preparations made after the action of osmic acid or chromic solutions colour very well with this reagent, showing very regular differentiations. The nuclei are tinted violet, the connective tissue pearl-grey, the elastic fibres and the blood-corpuscles dark red, the protoplasm of the cells and the axis cylinders of the nerve-tubes a very intense light rose, &c.

In treating sections of the salivary glands of *Helix Pomatia*, the author discovered two kinds of cells—the one secreting mucus and colouring an intense blue, the other secreting a special matter distinct from mucus and colouring rose; this distinction is not observable when other colouring matters are employed.

In sections of the salivary glands of mammals, and particularly of the Solipedes, the same fact is, remarkable to say, presented. In each acinus (from an ass) *the clear cells which secrete the mucus were coloured pale blue;* the nucleus buried at the base was coloured violet. The *crescent* cells of Gianuzzi, that is, *the cells which secrete the salivary ferment, were coloured a deep rose* and showed a violet nucleus contained in the centre of the protoplasmic mass.

Brösicke's Staining Method.[*]—Dr. G. Brösicke, of Berlin, recommends a combination of osmic acid and oxalic acid for staining the tissues, instead of osmic acid alone.

Small pieces of the tissue, or prepared sections, are placed for an hour in one per cent. osmic acid solution, and then carefully washed to remove all superfluous acid. They are then immersed for twenty-four hours or longer in a cold saturated aqueous solution of oxalic acid (one to fifteen), and are ready for examination in water or glycerine.

The result is that while certain substances, such as mucin, cellulose, starch, bacteria, the outer coat of certain fungi, &c., are scarcely at all coloured, other tissues, such as the vitreous humour, the substratum of the cornea, the walls of the capillaries, and various intercellular connective tissues, appear of a bright carmine; and muscular fibres, tendon, hyaline cartilage, the outer fibrillary substance of decalcified bone, and most of the tissues rich in albumen are stained a darker carmine. The grey substance of the central nervous system, most nuclei, and many cells, assume a dark Burgundy red tint. In all these cases, however, each particular tissue is stained a slightly different shade, so that it can be readily distinguished from its neighbours.

None of the objects treated by this method swell up or exhibit signs of internal coagulation. The oxalic acid produces darker or lighter shades in proportion to the length of time the specimen had

[*] 'Sci.-Gossip,' No. 175 (1879) p. 160.

previously been immersed in osmic acid, and if the latter has once completely blackened the tissue, the oxalic acid is powerless afterwards to redden it. Mixed solutions of osmic acid and oxalic acid stain proportionally to the relative strength of each. The chief drawback to this method is the small penetrating power of osmic acid, which prevents the whole thickness of a specimen from being equally stained.

Method of examining Living Cells of Larva of Newt, see p. 692.

Undescribed Microscopes.—We believe that the following Microscopes have never yet been described in any English treatise or journal. We propose to add from time to time the descriptions of any other extant forms which present any specialty, and have not hitherto been described in this country.

Fig. 1 represents the " *Microscope nouveau grand modèle renversé avec miroir argenté* " of Messrs. Nachet.

If the eye-piece of a Microscope is removed considerably from the objective, the image is of course largely increased, but to obtain the full advantage, it is necessary that the eye-piece should be of increased diameter. The weight of this and the long tube presents, however, a practical difficulty in addition to the fact that the observer is so far from the stage that it is impossible for him to manipulate properly.

To avoid these difficulties, M. Nachet conceived the idea of the Microscope represented in Fig. 1.

A strong tripod base supports a hollow brass column, the upper end of which is closed by a plate with a central hole, and to which is fixed a socket in which the tube carrying the objective A is moved by the milled head B forming the coarse adjustment. A fine adjustment is obtained by means of a second tube moved by the milled head V.

To the side of the column is soldered another tube (placed obliquely as shown in the figure), the interior of which is in communication with that of the column by an elliptic opening and having the eye-piece at the upper end. At the bottom of the column is placed a plane mirror silvered on its upper surface, and inclined at such an angle as to be perpendicular to the line bisecting the angle formed by the two tubes, so that all the rays from the objective pass to the eye-piece. The mirror does not appreciably deteriorate the image, the loss of light being insignificant. The distance of the eye-piece from the objective is 90 cm., and very large amplification can be obtained.

The stage is supported above the objective on three supports, and is supplied with movements by G and D. Above the stage is a "superstage" C (which can be turned aside from the Microscope) for illuminating apparatus, and over that the mirror with universal movements, supported on an upright rod, which can be moved round the summit of the column.*

One of these instruments (from Mr. Crisp's collection) was exhibited at a recent soirée of the Quekett Microscopical Club. It was first exhibited at the Vienna Exhibition.

* Cf. Robin's ' Traité du Microscope,' 2nd ed. (1877) p. 62.

Fig. 2 represents the *Portable Demonstration Microscope* of Messrs. Nachet, which is very handy and convenient for class demonstration.*

It consists of a tube carrying the objective and eye-piece, which

FIG. 1.
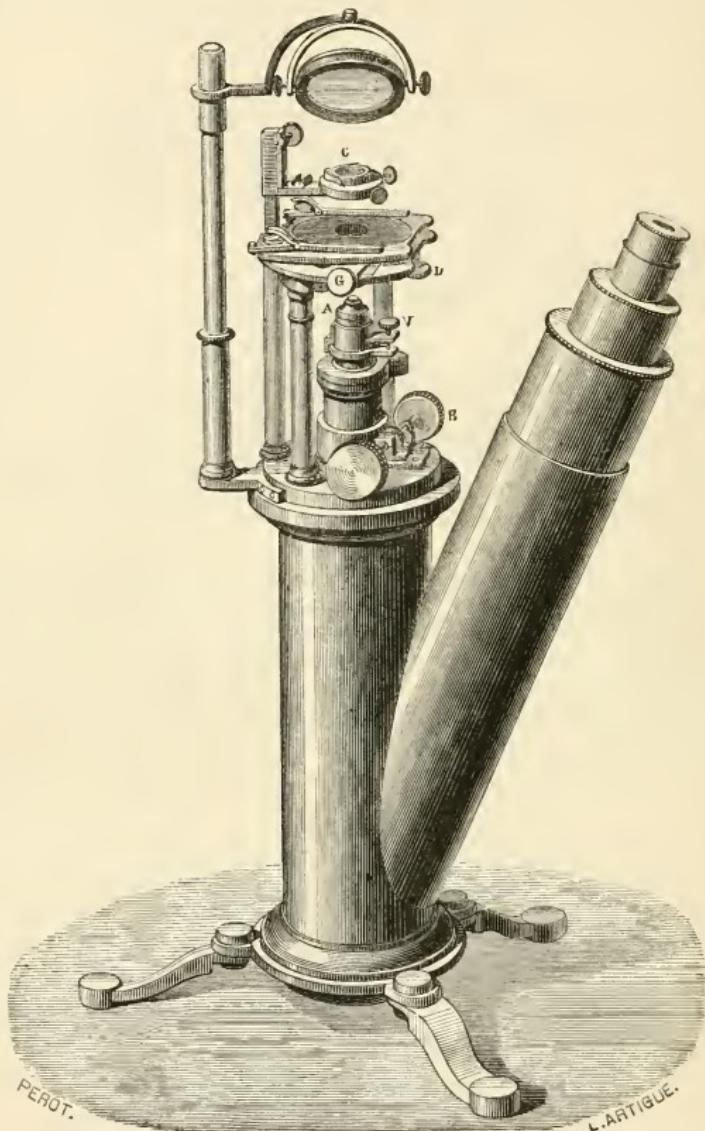
slides within another attached to a handle by means of which the Microscope is held by the observer and directed to the light. To the handle is fixed a rod which carries the stage and illuminating apparatus.

* Cf. loc. cit., p. 81.

A speciality of the stage is that the object is fixed to its *under* side, so that no change of focussing is required with preparations mounted on slides of varying thickness. The coarse adjustment is made by sliding the tube carrying the objective through the outer one, and there is in addition a special fine adjustment moved by a screw close to the objective.

By means of the handle and the fork at the end of the rod which carries the stage, the instrument can be rested on the table without any danger of injuring the slide.
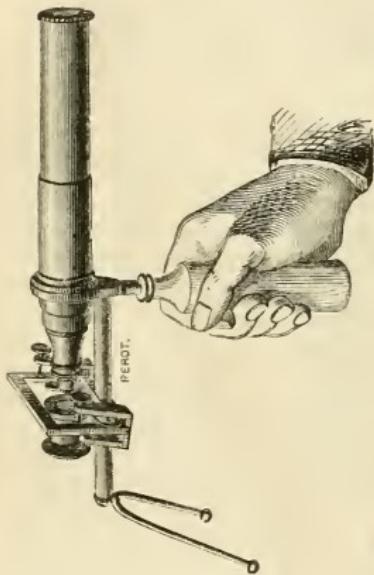
FIG. 2.   FIG. 3.
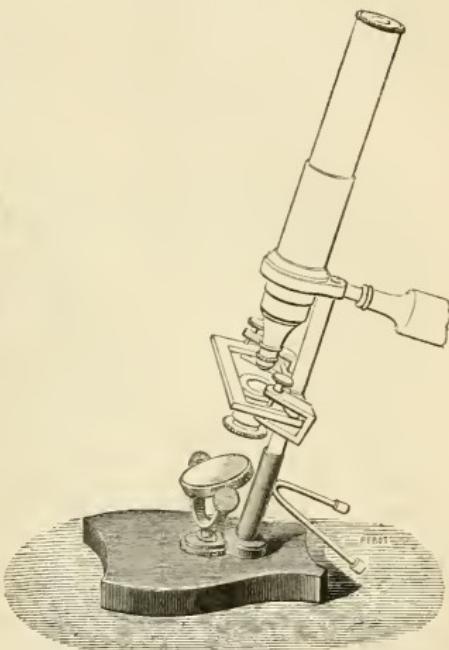
If in a preparation any point difficult to find is required to be shown, the Microscope can be fixed in the base which carries a mirror (shown in Fig. 3), and the preparation examined in the ordinary way.

This instrument will be shown at the next meeting of the Society.

Novel Method for Focussing.*—The Société de Biologie of Paris devote a page of their 'Comptes Rendus,' just issued, to a description by M. d'Arsonval of an arrangement which he has devised for focussing, " without touching either the object or the Microscope." The inventor states that he discovered the method several years ago, but neglected to communicate it, though at the same time he wishes it to be understood that he makes no claim for priority.

The idea was suggested to him by the observation that if an object is viewed through a parallel plate of glass, it will appear the nearer

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* 'CR. Soc. Biol.,' xxix. (1877, pub. 1879) pp. 124–5.

3 E 2

as the plate is thicker. He accordingly arranges a layer of liquid between the objective and the eye-piece, the tube which carries the eye-piece being closed by a piece of glass, above which is a small tube communicating with a syringe full of water. On pushing the piston, water is injected between the objective and the eye-piece, and it is thus possible to vary the thickness of the layer of water to the extent of the whole distance which separates the two.

The method enables thicker cover-glasses to be used, and is available with the most powerful immersion objective, in which it differs from the arrangement of M. Govi (who placed a horizontal glass vessel of water between the object and the objective, and varied the thickness of the layer of water), that being only applicable to Microscopes which have a focal distance of at least $1 \cdot 01$.

The method may also be very conveniently used, according to the inventor, for photography, as coloured solutions may be employed to give monochromatic light.

Roy Microtome.*—The woodcut (Fig. 4) represents this instrument in natural size, the design of Dr. C. S. Roy. The object aimed at is simply to combine the accuracy gained by the use of a good microtome with the simplicity and convenience with which sections can be cut with the unsupported razor, not a few of the best histologists having abandoned microtomes on account of the trouble and waste of time occasioned, more especially in pathological work when a few sections are required from each of several different specimens, or from different parts of the same specimen.

The horse-shoe shaped piece of glass rod a is intended to support and guide the knife or razor which is used for cutting, and which glides on the surface turned in the figure towards the observer. This glass rod is firmly fixed by its two extremities in the brass plate b. The smaller brass plate c, on the upper surface of which a thin layer of cork is cemented, can be moved forward or backward by the fine-threaded screw d, movement in any direction being prevented by the form of the bed which has been cut in the larger plate for its reception. The small thumb-screw e serves to connect the movable plate with the end of the larger screw d, and admits of the plate being removed when desired.

Fastened underneath the larger plate in such a way that it can be readily removed and replaced is the bent brass tube f, which is intended to admit of a few drops or of a constant flow of spirit being projected on the knife and specimen while sections are being cut. This tube is connected with a test-tube arranged after the principle of a Wolff's bottle, and which can conveniently be suspended by a thread from the button-hole. A caoutchouc tube, with a mouthpiece of glass attached to it, permits of air being blown into the test-tube, forcing out a part of the contained spirit or water by the tube f.

The method of using the instrument is exceedingly simple. The portion of tissue to be cut is imbedded in an appropriate imbedding mass, and is then placed upon the movable plate c. Upon this it is held fixed by the thumb of the left hand, the index and middle fingers

of which pass under the plate *b*, and exert a counter pressure.   Both the specimen and the microtome are thus held in the same manner as one holds the specimen when no section-cutter is employed.   The plate and imbedded specimen are pushed gradually forward by turning the milled head of the screw *d*.

FIG. 4.
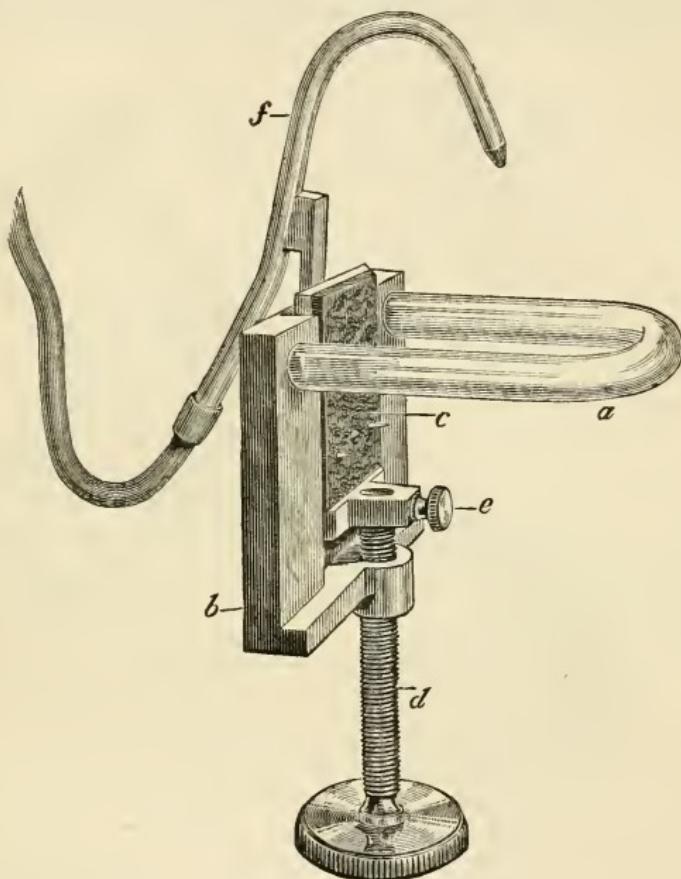
The imbedding mass employed by Dr. Roy is the well-known mixture of white wax and olive oil (equal parts by weight for warm, with a larger proportion of oil for cold weather) used with small oblong moulds of zinc without bottoms (instead of the usual paper boxes).   They have the convenience of giving a cast suited to the size of the plate on which it is to rest.   If the specimen is not imbedded, a pallet of wax or of wax and oil is placed between the tissue and the cork plate so that the edge of the razor may not come in contact with the latter.

Woodward's Oblique Illuminator.*—Colonel Woodward has devised an apparatus, to which he gives the above name, intended to

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 268.

obtain with certainty illumination at definite angles with Microscope stands which are not fitted with a swinging substage. The inventor describes it as follows:—

" A perspective view of the apparatus (slightly reduced in size) is shown in Fig. 5. It consists of a transverse bar of brass (1), at one end of which, attached by a hinge (2), is a square brass plate (3), which can be inclined at any desired angle. This plate is transfixed

FIG. 5.
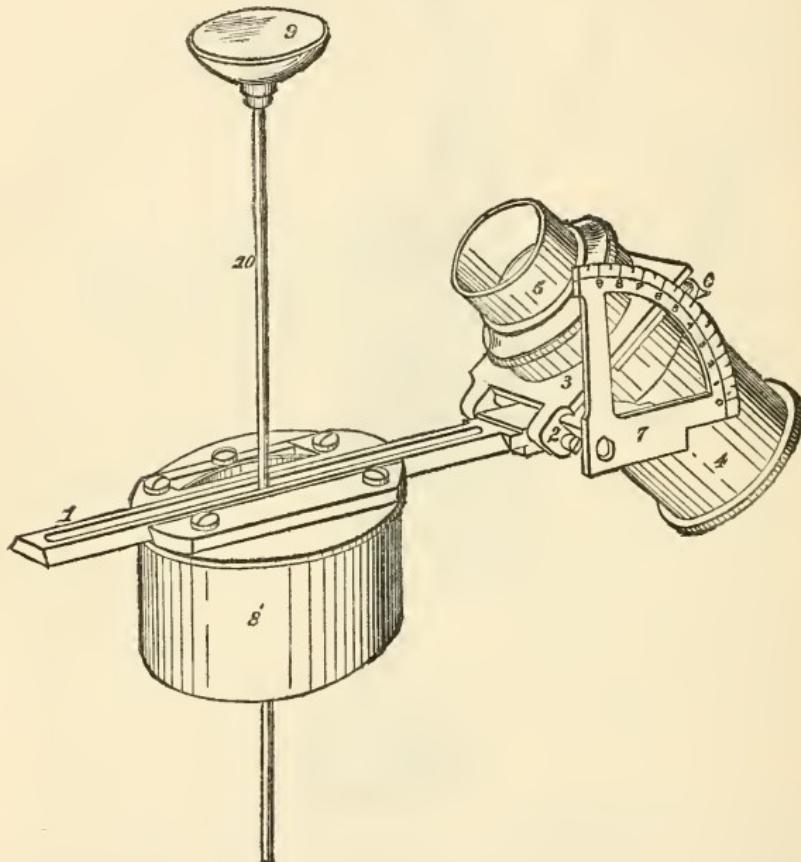
centrally by a brass tube half an inch long, in which a second tube (4) an inch and a half long slips easily. The slip-tube (4) is provided at one end with the Society's screw, by which a 3-inch objective (5) or any other preferred for the purpose, can be attached. The movable square plate is provided with a spring catch (6) which fits into any one of a series of notches in the edge of a brass quadrant (7), and thus serves both to hold the plate in position and to register the angle of obliquity. The transverse bar (1) slips in a groove on the upper surface of a strong brass tube (8), fitted to the substage of the Micro-scope. The bar itself has a longitudinal slot running nearly its whole

length, so that it can be pushed to any desired position without disturbing the position of the central steel rod (10), at the upper end of which a lens (9) is fastened. The lens (9) is such a segment of a hemisphere of crown glass, that when brought into optical contact (by oil of cloves) with the under surface of an ordinary glass object-slip, the object to be studied will be as nearly as possible at its centre of curvature, and the rod (10) slips freely in the top of the substage tube (8), so that the lens may be pushed into position or withdrawn at pleasure.

In using this apparatus with monochromatic sunlight, I first set the square brass plate)3) at the desired angle as read on the quadrant, and then slip the transverse bar (1) backwards or forwards as may be necessary, until the pencil of monochromatic sunlight (to which the desired degree of obliquity has been previously given by means of a prism) falls centrally through the slip-tube (4) and illuminating objective (5) upon the face of the lens with which the object is viewed. By means of the slip-tube, the illuminating objective (5) is then brought to the proper focal position. Ordinary illumination is thus obtained of any desired obliquity, from about 30° to the limit of the thickness of the stage. When I desire still greater obliquity I use Powell and Lealand's extra stage, and slip the transverse bar into the groove at the upper end of the holder which those makers provide with it to carry the small bull's-eyes they furnish for the examination of *Amphipleura pellucida*. In this manner I can get more oblique illumination up to 80° or even 85°, but of course the oblique pencils thus obtained are refracted at the under surface of the glass slip that carries the object, and cannot possibly reach the object itself at an obliquity greater than 41°. To obtain greater obliquity than this, I make use of the hemispherical lens (9). The illuminating objective is set at the desired angle, say 45°, and the object illuminated as described above. When this is satisfactorily done a drop of oil of cloves is placed on the flat surface of the hemispherical lens, which is then pushed up into contact with the under surface of the slide on which the object is mounted. The light now enters in the line of a radius of the hemisphere, at the angle registered on the quadrant (7). Fig. 6 represents a section of the apparatus when thus in use (also slightly reduced in size). The numbers in the two figures correspond. In addition, on Fig. 6, A is the objective, B the slide carrying the object, and C the immersion fluid.

I have found this apparatus exceedingly convenient for the purposes of photo-micrography and sunlight work generally ; for when I have once obtained any particular result by means of a certain obliquity, I am able to reproduce the effect at pleasure without any loss of time. It has also proved useful, for the same reason, by ordinary lamplight. When, however, the object of the microscopist is merely to resolve *Amphipleura pellucida* or similar tests mounted in balsam, by lamplight, with suitable objectives, I still give preference to the simple substage prism I described last year,* through which I can throw the light at once at an angle of 45° by means of the concave

* See this Journal (1878), p. 246.

mirror or a small bull's-eye, and thus obtain for this particular pur-
pose equally good effects, with less expenditure of time in making the
adjustments."

Fig. 6.
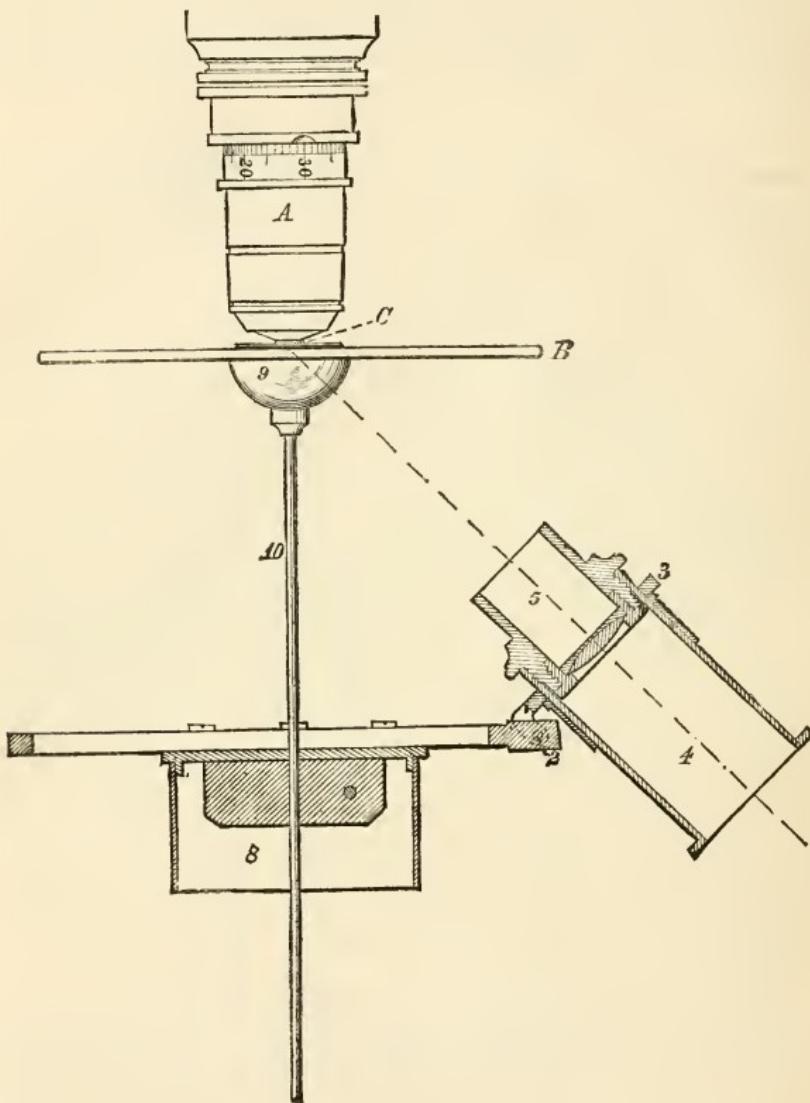
Improvements in Microphotography.*—Dr. E. Cutler describes
the apparatus he adopted for photographing with Tolles' $\frac{1}{75}$ objective,
the special features in which the apparatus differs from Colonel
Woodward's plan (besides portability) being (1) in the size of the

condenser, and (2) the absence of the ammonio-sulphate of copper or alum cells, which are troublesome.

The condenser consists of an 18-inch Voigtlander photographic objective, about 3 inches in diameter, and is probably the largest ever employed in microphotography. The reason of its selection was simply to avoid heat. It is easy to see that if a 2-inch condenser is regarded as sufficient, the same amount of light could be obtained with a 3-inch, away from the heat focus and thus avoid the effect of focussing the sun's rays on the object and the objective. This practical point has been of great value, and explains the absence of contrivances to prevent the passage of destructive heat.

Modern Applications of the Microscope to Geology.*—An interesting article on this subject is contributed by M. L. Fouqué to the 'Revue des Deux Mondes.' The progress of human knowledge, he says, is not accomplished in a regular and continuous manner, but by starts. Sometimes a man of genius gives a new impulse to science by the power of the divine reflex which animates him, but more often, particularly in experimental researches, each clearly marked impulse of the scientific movement is signalized by the employment of a new method of investigation. Thus the invention of the Microscope was the point of departure of brilliant discoveries in natural history, and each of its improvements corresponded to a period of progress in the development of the science to which it was applied. To-day the manufacture of the instrument has arrived at a remarkable degree of perfection, its magnifying power is enormous, its images are of an extreme clearness, and ingenious arrangements have rendered the instrument more manageable without having lessened precision, and its constructors have known how to adapt it to the special requirements of each class of research.

The consequences of these innovations were soon manifest. The study of organized beings took an unexpected turn, anatomy and vegetable physiology were entirely transformed, the domain of the zoological sciences was enlarged beyond conception, and the secrets of life have been explored in their most mysterious functions.

The application of the Microscope to the examination of the inorganic world took place more tardily in consequence of special obstacles. These difficulties are now happily surmounted. A harvest of new results is being reaped, so rich that it dazzles the imagination of those who gather it.

In the first part of the article is traced the historical development of modern "Microscopical Petrology," commencing with 1858, when Dr. Sorby's memorable researches first appeared, and on whom is passed a warm eulogium as "the real initiator and propagator of the new method," and after dealing with the labours of Zirkel, Vogelsang, and Rosenbusch the author regrets as a "curious matter and one difficult to explain that though in Germany microscopical petrography is now studied with unequalled ardour, in England, the country of its origin, it seems to make but slow progress."

* 'Revue des Deux Mondes,' xxxiv. (1879) pp. 406–31.

The second part explains the results obtained by the application of the Microscope to the study of minerals and rocks, and particularly the light thereby thrown on the actual constitution of the latter, and on the complex structure of a great number of crystals supposed to be simple, their mode of formation and the changes in the temperature, chemical composition, and stability of the media during the process. The Microscope is thus able to give an account of the conditions which prevailed when the minerals were being formed, as well as doubling the field to which geology can extend its conquests.

The third part gives a summary account of the methods of examination by polarized light, and the modern improvements which have been made in the examination of minerals by its means.

Adams' Measuring Polariscope.—This consists of three principal parts. The lower section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of lenses and Nicol's prism arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope.

Besides these there is a middle piece, consisting of two lenses (nearly hemispheres) forming a box to enclose the crystal immersed in oil, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned about the optical axis of the instrument. The vertical graduated circle carrying the central lens and crystal may be turned through an angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle, with its centre at the centre of curvature of the central lens, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystals and the central lenses can be turned about each by three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rims of the central lenses, the central and crystal lenses may be turned separately about the optical axis of the instrument, so as to bring the planes of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.

Homogeneous Immersion.—From conversations which we had with microscopists at the time of Professor Abbe's recent visit, it appears that the difference between the modern "Homogeneous Immersion" and the "Oil-Immersion" of Amici and Hartnack has not been appreciated.

One of the leading points of Professor Abbe's theory of 1874 was his explanation of the important bearing which the *diffraction pencils* have on the formation of the microscopic image so that the resolving power of an object-glass is dependent upon the diffraction pencils that are taken up by it.

This fact was not previously known, and in the absence of that knowledge it is not surprising that those who suggested the use of oil instead of water abandoned it in practice, not thinking it worth while

to follow it up. The use of oil as an immersion fluid would obviously have seemed at that time to be a *disadvantage* so far as aperture was concerned, in consequence of the diminution of *angle* which was necessarily caused.

When, however, the bearing of Professor Abbe's theory was appreciated, it was seen that an object-glass acting in oil might take up diffraction pencils which one of larger angle acting in air could not reach, and hence, although the *angle* was reduced by the use of oil, yet the diffraction pencils belonging to an *aperture* of more than 180° in air would be compressed (so to say) within the lesser angle, and greatly increased *apertures* could be utilized.

"Homogeneous immersion" is thus seen to be essentially dependent upon the principles enunciated by Professor Abbe in 1874, and the reason why it was not previously discovered, even by those whose minds were directed to the subject, is explained.*

Hamilton Smith's "Universal Apertometer."†—Prof. Hamilton L. Smith describes this apparatus devised by him (Fig. 7), which he uses for measuring the true angle in all cases, the old system being, he considers, all wrong, telling a false story in either case, dry or immersion. For angles in glass, or for immersions, the new apparatus may be used precisely like Dr. Abbe's apertometer, and indeed, as it seems to him, has some advantages over that instrument, which will not give the direct air angle, but deduces it from the angle

FIG. 7.
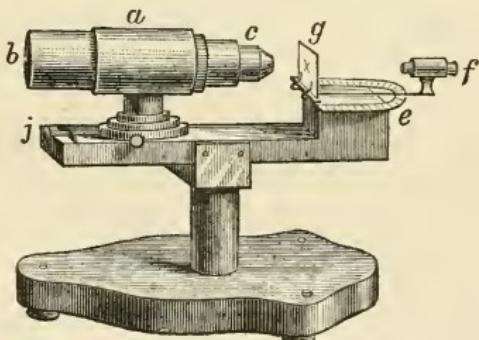
in glass; a separate graduation being required when it is to be read off directly. The 180° are compressed into an arc of 82°, and the whole space on that arc between 60° and 80° is not more than that between 0° and 10°, i. e. the graduations are necessarily unequal, and the instrument is only graduated to every fifth degree. The cylindrical surface, though it may show a sliding edge with sufficient clearness, is not so good as the more easily made spherical surface

* Mr. Stephenson draws our attention to an error in his note on p. 490, in which he says that the present homogeneous system "gives an *angle* greatly in excess of even the ideal maximum of a dry lens (180°)"—for "*angle*" should be read "*aperture*."

† 'Am. Quart. Micr. Journ.,' i. (1879) p. 194.

which forms a part of the new instrument, and by means of which one may bisect a minute white circle with the greatest accuracy. Moreover, few would be able to graduate the "apertometer" correctly, and the process of computation, though easy enough, is not necessary.

A brass tube a (Fig. 7), say 2 inches long, is supported on a pillar, into which another tube b slides easily, carrying at one end the objective c; the other end b is open except when a cap with a small hole is put on for purposes of centring, and when it is used after the manner of Abbe's apertometer; e is an arc (a good protractor answers very well) graduated to degrees (any higher refinement is quite useless, as in the larger angles there will always be an uncertainty of at least a quarter of a degree, a space readily estimated). An arm moving freely on a pin at the centre of the arc, carries at its end an eye-lens in a small sliding tube, and having a small eye-hole f, the lens having its focus over the central pin; g is an ordinary glass slide (3 by 1), which can be slipped in or out of place at will, and is held at right angles to the plane of the graduated arc by two springs, which press it against two uprights, so that the front surface of the glass is exactly over the centre of the arc, and therefore of the pin on which the movable arm turns. The glass slide is held by a separate brass holder, which can be pushed forward when the focal point of the objective is just over the pin until the slide touches the front lens, and a black bar with a straight edge painted on the glass can be made to cut off just half of the surface of the front lens, by putting in the perforated cap at b, and looking through f, which is supposed to be standing over the middle of the arc. This is for using Mr. Wenham's method, and it gives very nearly the same results as his (Prof. Smith's) own. The apparent aperture of the uncovered half is measured (twice this will give an extravagant angle), the whole aperture is then measured, but in the usual way, i. e. until the light disappears; the angle of the half is now subtracted from that of the whole, and twice the remainder is the true angle; this method is only available when the front lens is flush with the surface.

The mode in which he prefers to use the instrument, however, and which gives the true air angle, is as follows:—The front surface of the slide g is brought accurately over the centre of the arc by slipping the brass holder quite home; two fine cross lines ruled with a diamond on the glass, are, by sliding the glass laterally, brought directly over the centre of the arc or pin on which the arm carrying f moves; their intersection is thus placed directly over the centre of motion; the objective is focussed on these lines: it is not necessary to use an eye-piece unless the focal length be very long. Yet for true angle, independent of definite length of tube, it would be sufficient simply to focus upon the lines without an eye-piece; the screw j may be used for this purpose, or it may be effected by simply sliding the tube b in a. Suppose now the eye-lens f to be over the middle of the arc; on looking through towards the objective one will see something like Fig. 8, where the outer circle is the periphery of

the front lens, the middle one is the image of the diaphragm at the back of the objective; or, if this diaphragm is sufficiently large, the margin of the posterior system; the inner circle is the image of the end of the tube b, and within the area of this will be an inverted picture of external objects crossed at the centre by the lines on the glass; the objective c and the eye-lens f forming a sort of miniature telescope, and having the lines as a common focal point: the smaller circle would disappear if the end of the tube b was large enough, and there would be but these two—the periphery of the front lens, and the image of the diaphragm or posterior system—and it is with this last we are to deal.   A piece of tissue paper, or cap with

FIG. 8.   FIG. 9.   FIG. 10.   FIG. 11.
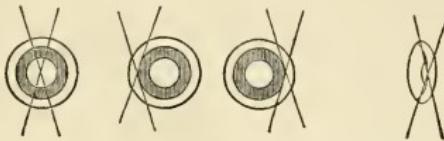
ground glass, is now put on at b, and immediately a soft light fills the field, and the lines appear like cobwebs stretching across it. The sector arm carrying the lens f is now swung round until the intersection of the lines is tangent to the image of the margin of the posterior system or diaphragm, as in Figs. 9 and 10, which represent the circles as they would appear with very small angles; with wide angles they are foreshortened as in Fig. 11, where the larger circle is,

FIG. 13.

FIG. 12.

FIG. 14.
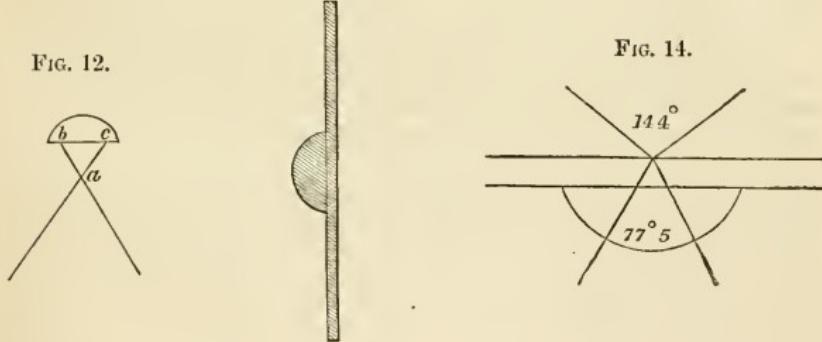
as before, the margin of the front lens; the next inner one is the image of the diaphragm, and the smaller (partly obscure) is the bright field still visible, and which gives the exaggerated angle to measurements made in the old way.   The sector arm may be swung many degrees farther on each side before this will disappear.   When the fine lines are thus projected on the face of the front lens, they will, as in Fig. 12, mark the extremities of a diameter of the circle which, if stopped out, would exclude all light from passing through

the objective when used to form an image in the field of the eye-piece of the Microscope.

So much for the air angle; for balsam, or what we will here consider as the same thing, angle in glass, the slide g is replaced by another (Fig. 13) of the same thickness, but with a small bull's-eye—say 0·25 inch radius—cemented to it, and of such thickness that its centre of curvature is in the front surface of the slide; fine lines are also ruled on this slide passing through the centre of curvature of the lens. When the bull's-eye is properly adjusted, it will make no difference in the distinctness with which the images of external objects are exhibited when using the objective and eye-lens f as a little telescope, whether the glass slide and bull's-eye are in position, or whether they are removed, the rays pass through the slide and bull's-eye, emerging without refraction at the convex surface; they will emerge indeed at a much smaller angle, as shown in Fig. 14, from the refraction at the front surface; and in this refraction nearly all the rays which give the exaggerated angle disappear, and the angle of the emergent rays is the true angle in glass, from which the true air angle may be computed. To avoid this computation, Zeiss constructs the apertometer with another scale, upon which an arc of 82° corresponds to 180°, and one of 77·5° to 144°, &c.

A Spencer $\frac{1}{8}$ inch, when the systems were closed, and it was adjusted on the cross lines in the centre of curvature of the hemispherical lens, transmitted rays making an angle of 77·5°. The natural sine of half this angle is ·6259, and this, multiplied by 1·52, assumed as the index of refraction of glass, gives ·9513, the natural sine of 72·05°, twice which, or 144·1°, is the air angle. Measured directly, using the glass slide g, and the lines as before described, 144° was obtained. Measured on the sector in the old way, there was no difficulty in getting 179° before the light disappeared.

It will be understood that for immersion angle, or, as it is generally called, "balsam angle," all that is necessary is to introduce a drop of fluid (theoretically, this should have the same refractive index as the glass) between the objective front and the glass slide, and to re-focus on the lines. The $\frac{1}{8}$ inch, at the same closed point which gave only 77·5° from air into glass, will give 87° with glycerine interposed. There is very little difficulty in observing the true angle here; the proper point is when the circle of light, which is beautifully shown when the tissue paper covers the open end of the tube b, is dichotomized, and the slightest movement will cause it to disappear. This action is even more prompt with the fluid interposed than when air intervenes.

To convert the instrument substantially into Abbe's apertometer, it is only necessary to keep the slide and the bull's eye in place, focus on the lines, and then, putting on the cap with the small eye-hole at b, look in there instead of at f. Placing a sheet of paper in front of the graduated sector, and allowing the light to shine through it, we shall get a distinct picture of the end of the tube f, and see a little spot of light (the eye-hole) in the centre. The lines ruled on the glass may interfere with perfect definition in the middle of the field,

but when the sector arm is swung round, the little circle of light can be neatly bisected on each side of the field, as shown in Figs. 15 and 16. A long focus lens may be applied at the eye-hole if necessary, or the supplemental tube recommended for Abbe's apertometer, but the Professor finds all that is required is his ordinary reading-glasses, and he can make the bisection of the little bright circle as accurately as when using a compound Microscope to view it even with a $\frac{1}{12}$ objective.
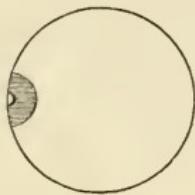
FIG. 15.   FIG. 16.
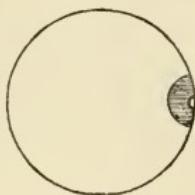
If we remove the bull's-eye slide, and focus on the lines on the plain slide, we may obtain the air angle with great accuracy by simply looking through the eye-hole in the cap applied at the end of the tube b (Fig. 7), and observing, by aid of a long focus lens, when the image of the hole in f is neatly bisected on either side, as shown in Figs. 15 and 16. If, instead of a single lens, a short compound Microscope with an objective of 4 inches focus is used, the eye-hole will not be necessary. Except for higher amplification, this supplemental part is not needed. The highest air angle objective measured by Professor Smith is an old $\frac{1}{16}$ by Spencer, 163°. He has no doubt that some of the first-class modern dry objectives of recent date may reach 170° or more; but even with an angle of 163° the extreme rays strike with such obliquity, that more than half the light is reflected from the front surface, without entering the lens at all, and yet more at higher obliquities. Professor Smith does not mean to say that there is not a gain worth striving for in passing from, say, 160° to 170°, but an objective whose real air angle is more than that last named will have an inconveniently short working distance.

To compute rigidly the balsam or glass angle from the observed air angle, or *vice versâ*, the objective must not only be accurately focussed, but the intersecting lines *must* be used; otherwise an exaggerated angle (varying very much in different objectives, to the extent of 2° to 12°) may be obtained as the glass angle; and if from this we should compute the air angle, it might be 10° or 20° too much.

Carefully used, the instrument will give entirely concordant results. Moving to the right, the point of intersection will travel in the same direction as from Fig. 8 to Fig. 10, and to the left the change will be from Fig. 8 to Fig. 9. This is contrary to what one might at first suppose; a little reflection will show the reason for this.

As it seems to have been supposed that Professor Smith intended in his paper to cast doubts on the accuracy of Professor Abbe's instrument, we may point that the Professor himself says in his

original article that "with high powers and wide angles, *the agree-ment between his own instrument and that of Professor Abbe is as close as could be desired*," while Colonel Woodward shows * the source of the erroneous readings which Professor Smith obtained when he attempted to use his apparatus after the Abbe method with low-power objectives.

Mr. Wenham, writing on this paper,† calls attention to the following experiments, not as indicating any defect in Professor Smith's principle, but in the mode of use which he considers may be the cause of error in the measurement :—

In order to well define the transmitting diameter or boundary of the light spot on the front of the glass, Professor Smith applies a piece of tissue paper or ground glass to the open end of the object-glass tube. This gives results in excess of truth, which may be attributed to the diameter of the screen. Instead of following this course, set a lamp a few feet away exactly in the axis of the object-glass, and focus the Microscope on the index line ; the flame of the lamp will be beauti-fully in focus at the same time, showing that the examining Microscope does not in the least alter the focal distance of the object-glass under test. On traversing the lower Microscope sideways, the flame appears curiously projected, as if it were actually strung on to the lines ruled on the glass. At an obliquity greater or less according to the aperture of the objective, the flame shows a tendency to leave the line before it vanishes. Now, with the flame, this limit gives a result less than when the ground glass is used. The former is, therefore, the limit of aperture. The ground glass does not increase the transmitting diameter of the front, which remains the same under all circum-stances ; but it allows oblique rays from a screen or field of view to pass through. The lamp flame is distant, and in one fixed, axial, focal point. As the image of the flame and the ruled line are kept in the direction of the axis of the examining Microscope, the angular traverse of the line of this axis must indicate the true aperture.

Mr. Wenham also thus summarizes the facts upon which Pro-fessor Smith's conclusions are based :—

" 1. That the front lenses of Microscope object-glasses only admit incident rays through a central area, far within their actual diameter.

" 2. That angle of aperture strictly means the angle measured by a triangle taken from the extremities of the diameter of this light spot as a base line up to the focal distance in the axis, whether that distance is in air, water, or glass, with the difference of angle due to the refraction of each.

" 3. That rays extending laterally from places without the central focal point do not constitute a proper angle of aperture, but cover an area known as field of view.

" 4. That rays from every part of the field of view pass through every portion of the transmitting diameter of the front lens, and, together, enter the pupil of the eye from the eye-piece.

" 5. That in the optical methods of measuring angles of aperture

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 278. See infra, p. 784.
† Ibid., p. 280.

heretofore in use, rays from the light or index points have traversed and intersected all these exterior rays or oblique angles in succession to the limit of the field of view, which has been erroneously assigned as angle of aperture."

Measuring Aperture.—Professor Hamilton Smith in his paper above referred to describes an experiment with a Spencer $\frac{1}{8}$, made when the systems were closed and a small dot of ink put on the flat surface of the front lens, just large enough to cut off the little circle of light that appears when one looks into the objective with the front system toward the eye. Under these circumstances when the objective was attached to the Microscope, not a ray of light could be obtained except what came through the instrument, yet on the sector he was still able to see light when the arm was swung up to 179°. He further says, "The true air angle at the same closed point . . . . is only 144°."

Mr. J. Mayall, jun., properly points out * that this experiment is fallacious. "It being admitted that no aperture, properly speaking, can be measured unless the image of a point be rendered, approximately at least, as a point; does Professor Smith mean to say that when the system of lenses is closed he can measure the true air angle? My experience with immersion lenses of high angle is that when the system is closed, so as to get definition through the thickest cover-glass and the immersion medium, at that adjustment no true air angle can be obtained. The true air angle can only be actually measured when the objective is adjusted so as to give true focus in air, a focus sensibly free from aberration."

So far as Professor Smith's apertometer is applicable to immersion lenses, Mr. Mayall considers it is practically the same as Mr. Tolles's traverse lens which yields results equivalent to those obtained with Abbe's apertometer.

Woodward's Apertometer.†—Colonel Woodward describes an apertometer which he has been using for some time, which is a combination of the Abbe apertometer with the well-known sector, and which he thinks has advantages over both that and the Universal apertometer of Professor Smith.

Colonel Woodward objects to the Abbe apertometer (1) in regard to the cutting away of the surface that corresponds to the diameter of the semicylinder at an angle of 45°, rendering necessary the silvered cover-glass with circular central spot, which should correspond to a path of the rays to the oblique surface, and thence by reflection upwards, just equal to the radius of curvature, an error in selecting this point rendering the reading inaccurate; and (2) in regard to the graduation into divisions corresponding to an arbitrary scale. The modified instrument is shown in Fig. 17.

A is a circular disk of brass of about 10 inches radius, inlaid near its circumference with a silver circle divided to sixths of a degree. It is mounted for convenience on a heavy three-legged stool of wood.

* 'Am. Quart. Micr. Journ.,' i. (1879) p. 284.
† Ibid., p. 272.

It was made a full circle, in order to use it for another purpose also ; but a semicircle of the same size would answer equally well.   Into a hole in the centre a pin is fitted, on which swings the radial arm B, which carries on one side of the centre of rotation the body of a Microscope E, while its extremity is provided with a vernier clamp D and
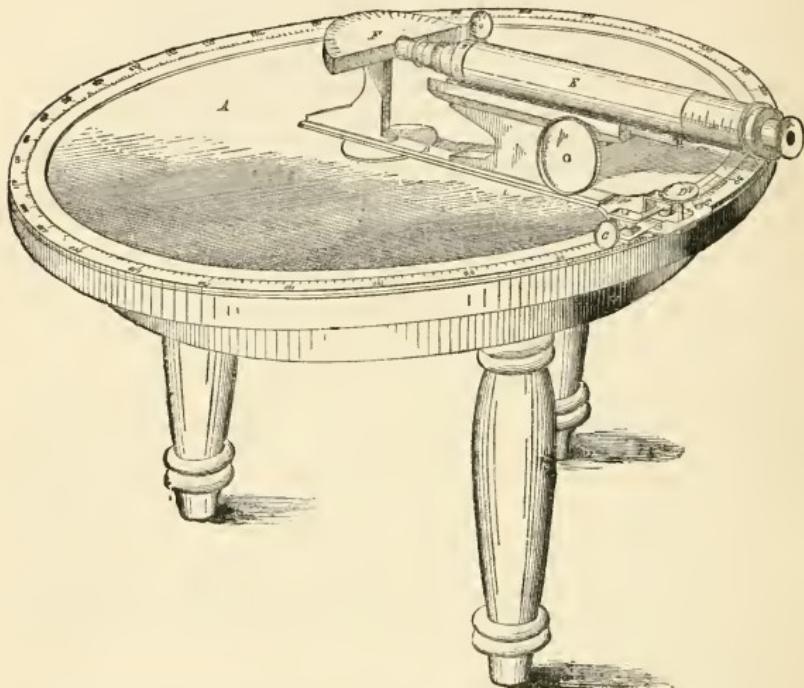
tangent screw C. On the other side of the central pin the radial arm carries a table, on which is mounted a semicircle of crown glass F of about two inches radius and half an inch thick. This is so mounted that the edge, which corresponds to the diameter of the semicircle, is directly over the centre of rotation, and the Microscope objective can be focussed exactly upon the centre of the semicircle. At this spot a thin glass cover, silvered except at a central circular hole (or vertical slit) about $\frac{1}{20}$ of an inch in diameter, is cemented with Canada balsam, the central hole (or slit) being fitted precisely over the centre of the semicircle. A suitable achromatic convex lens (a 4-inch objective answers very well) is screwed at the end of the draw-tube of the Microscope body, and serves to convert it into a telescope, precisely as in the apparatus of Abbe.*

The particular method for which the apparatus was constructed and by which exact measurements can be made, is as follows. Using

* This apparatus can be used precisely like his, if the semicircle is engraved to degrees, and two shutters or indices provided.

the Microscope as a telescope, some distant object is viewed so small that it only occupies an extremely minute portion of the field, and so bright that it can easily be discerned as the slit of a spectroscope placed at about 10 feet and illuminated by monochromatic (blue) sunlight. This appears when the adjustments are rightly made as an extremely minute blue star in the centre of the field. The radial arm is then swung until the star comes to the extreme margin of the field, the adjustment is made as exact as possible with the tangent screw, and the vernier read. The radial arm is then swung till the star comes to the opposite margin of the field where the same process is repeated. The difference between the two readings is the aperture of the objective for any medium of the same index of refraction as the crown glass semicircle. The apparatus reads to half minutes, which is closer than the observations can be accurately made. In fact, after the star comes to the edge of the field, it usually begins to fade just before it entirely disappears, and a motion of several minutes is necessary to effect the change. The best plan is to adjust the instrument as exactly as possible at the point at which the star begins to fade and then read to the next lowest sixth of a degree, neglecting the small fractional remainder. The same instrument answers very well to measure the glass angle corresponding to the actual air angle of dry objectives of any power, or the semicircle of glass being removed and the Microscope still used as a telescope to view the blue illuminated slit as before, air angles may be directly read with a degree of precision not attainable when the sector is used in the ordinary way.

From the angles of aperture measured in the semicircle of crown glass, it is quite as easy to compute air angles, water angles, glycerine angles, balsam angles, &c., as from the numerical scale of Abbe. It is only necessary to subtract the logarithm of the index of refraction of the rarer medium in which the aperture is to be expressed from that of the index of the glass semicircle, and to preserve the difference as a constant for use whenever the aperture in the selected medium is to be computed from the angle observed with the semicircle. Then to perform the computation, it will only be necessary to add this constant to the logarithmic sine of half the observed angle, and take from the table of logarithmic sines the angle corresponding to the sum, which will be half the angle required.

It will readily be understood that if the crown glass semicircle of the apparatus is of precisely the same index of refraction as the crown glass front of the objective, the rays of light passing into the objective from the semicircle will, after more or less refraction as they enter and leave the immersion fluid, resume in the crown glass front, precisely the same course they had in the semicircle. In this case the angle measured in the semicircle would be precisely equal to the aperture of the pencil passing through the crown glass front, and might be called the *first interior angle of aperture,* or briefly, the *interior aperture* of the objective. As this is the angle which after all determines the resolving power of the objective (provided its aberrations are properly corrected), Colonel Woodward thinks it would be better

hereafter to express the angle of objectives in degrees of interior aperture instead of speaking of air, water, or balsam angles, or using the numerical scale of Abbe. This end will be obtained with sufficient exactness if the crown glass semicircle has an index of refraction of 1·525. In this case the angles read by the apparatus with each objective will be its interior aperture, and no computation will be necessary. But equally exact results can be obtained from a glass semicircle of higher or lower index, provided only its index of refraction is known. In this case it is simply necessary to compute the corresponding angle in a medium of 1·525 from the observed angle by the method already explained.

The index of refraction of the glass semicircle may be exactly determined in the ordinary way by measuring the angular deviation produced by a prism cut from the same piece of glass. But in the absence of conveniences for this determination it is one of the advantages of this apertometer that it affords the means of measuring the index of the glass semicircle with sufficient accuracy, for if the angle of any immersion objective that exceeds 90° of interior aperture be measured by it, and then the immersion fluid wiped away, and the angle measured with a very thin film of air between the front of the objective and the semicircle, the observed angle will be reduced to a figure which is constant for all objectives of the same or greater aperture, and which is independent of variations in the angles of such objectives, representing in fact double the angle of total reflection from the glass of the semicircle to air. If the sine of half this constant angle be divided into unity the quotient will be of course the index of refraction of the glass semicircle.

Provided the glass semicircle is nicely centred, the silvering of the glass cover which prevents vision from taking place except through the small hole or slit directly over the centre of the semicircle, would be unnecessary with the highest powers; for the diameter of the circular spot through which rays can pass into the objective is so small, as compared with the diameter of the semicircle, that the greatest possible chance of error from this source will be very small indeed. But with dry lenses of low power this is not the case; the greater the transverse diameter of the objective, the more readily would those rays enter it, which having passed through the semicircle but not through its centre, would indicate a greater aperture than the objective actually possessed. This is, Colonel Woodward supposes, the source of the erroneous readings which Professor Smith obtained[*] when he attempted to use his apparatus after the method of Abbe with low-power objectives. He did not use the opaque cover with a small central hole which is indispensable in this case.

Microscopical Researches in High-power Definition.[†]—Dr. G. W. Royston-Pigott presented a paper on this subject to the Royal Society in their last session (not yet printed *in extenso*), but of which the following is an abstract by the author.

[*] 'Am. Quart. Micr. Journ.,' i. (1879) p. 203.
[†] 'Proc. Roy. Soc.,' xxix. (1879) p. 164.

In its general scope the paper is intended to deal with difficulties in microscopic research, usually found insuperable, such, for instance, as the invisibility of minute *closely packed* refracting spherules, existing in double rouleaux, or promiscuously aggregated; when their individual diameter varies between the $\frac{1}{80000}$ to the $\frac{1}{200000}$ of an inch.

These difficulties are principally created by overlapping images, due partly to residuary aberration both spherical and chromatic, partly to the effects of diffraction, caused by brilliant illuminations of spurious disks of light, partly to the constant development of Eidola or false images, which vary the loci of their development according to the nature of underlying structures, and according to the object-glasses being over- or under-corrected, and partly, and indeed very considerably, created by the use of excessively large angular apertures.

The paper discusses also the relative effects on visibility, of large and small angular apertures in objectives.

It shows that the black margins or black marginal annuli of refracting spherules, constantly displayed by low aperture glasses, are attenuated gradually to invisibility, as the glasses employed are endowed with the largest apertures; that the black margins also of cylinders, tubules, or semi-tubules suffer similar obliterations; and that, in consequence, innumerable minute details are concealed or destroyed till the aperture is sufficiently reduced; that minute refracting bodies obey the laws of their refrangibilities, and display beautiful phenomena, discoverable by transcendent powers of definition, but totally unseen by inferior compensations; and that, in consequence, the so-called achromatism of modern glasses is an illusory approximation to correct vision.

Examples are given of molecular structures, varying in form, translucency, and refrangibility, in which natural pencils are caught and displayed in the order in which, as in a rain-drop, iridescent rays are emitted by the decomposed light. Several examples are also introduced, in which a high order of lenticular correction beautifully discovers structure, hidden, according to Dr. Carpenter, from the great bulk of observers.

As the paper deals so often with magnitudes very much less than the $\frac{1}{100000}$ of an inch, a method is introduced of readily estimating roughly such magnitudes between the $\frac{1}{80000}$ and the $\frac{1}{500000}$ of an inch, by means of a micrometer gauge. The writer has been emboldened to grapple with these difficult minutiæ, in consequence of the sharp and clear definition he has attained of spider lines miniatured down to the fourteenth part of the $\frac{1}{100000}$ of an inch. The eye, accustomed to contemplate this subtlety of form, readily appreciates the one-fourth or one-sixth of this size, i. e. $\frac{1}{400000}$ or $\frac{1}{600000}$.

A new test for the Microscope is also described displaying bright lines of uniform thickness less than $\frac{1}{100000}$, and sharp black lines of much less tenuity than those given by Nobert's celebrated lines ruled on glass, and incomparably more easy of illustration.

The employment of various fluids for immersion lenses is care-

fully considered ; and the singular property of castor oil, discovered by the writer, is referred to.

As the author's paper on "A Searcher for Aplanatic Images," was inserted in the 'Transactions,' he now introduces a new form which offers some advantages, by its extended traverse, by its simplicity and economy of light with increase of magnifying power.

Finally, some examples are given of producing transcendent definition in cases found hopeless by a numerous body of observers. The means also of its attainment are minutely described.

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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

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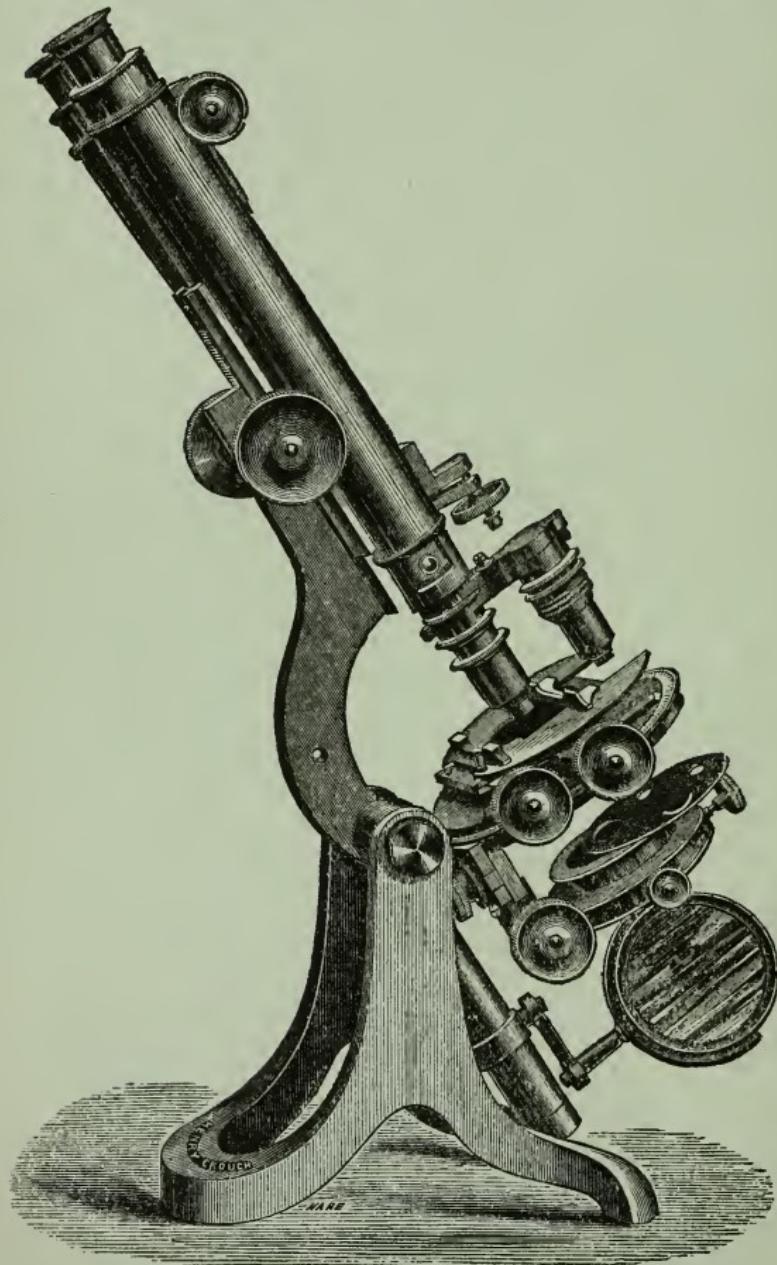
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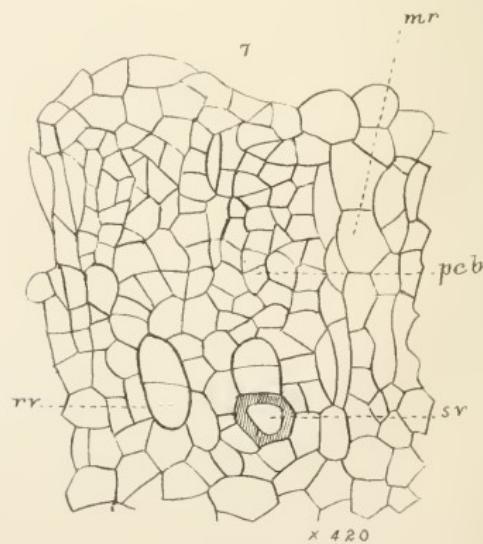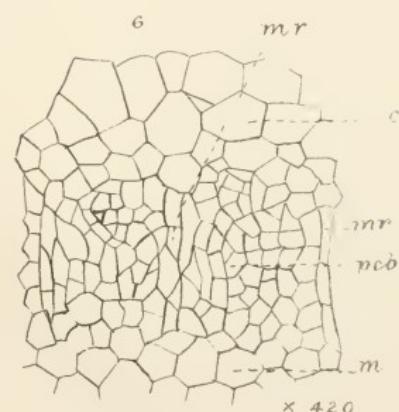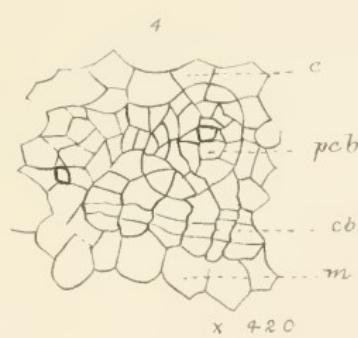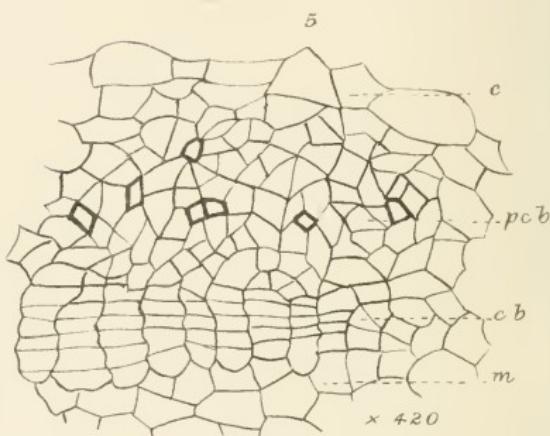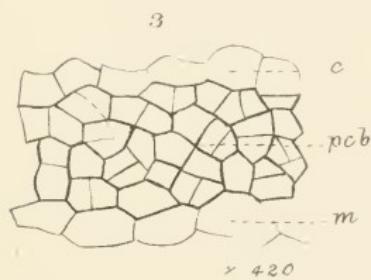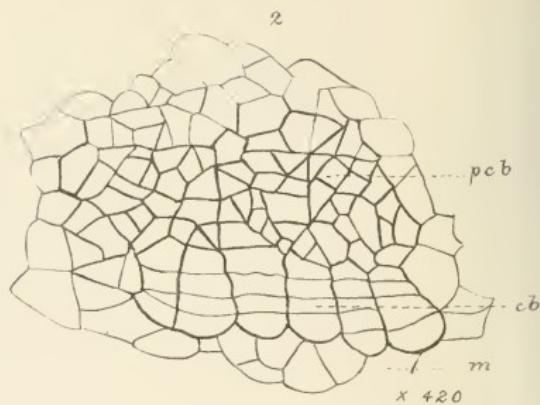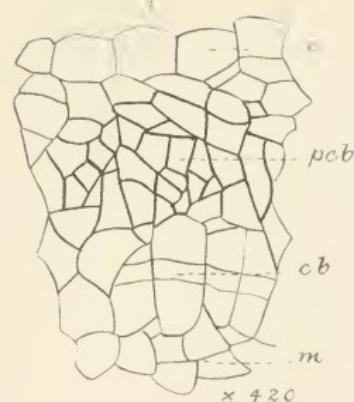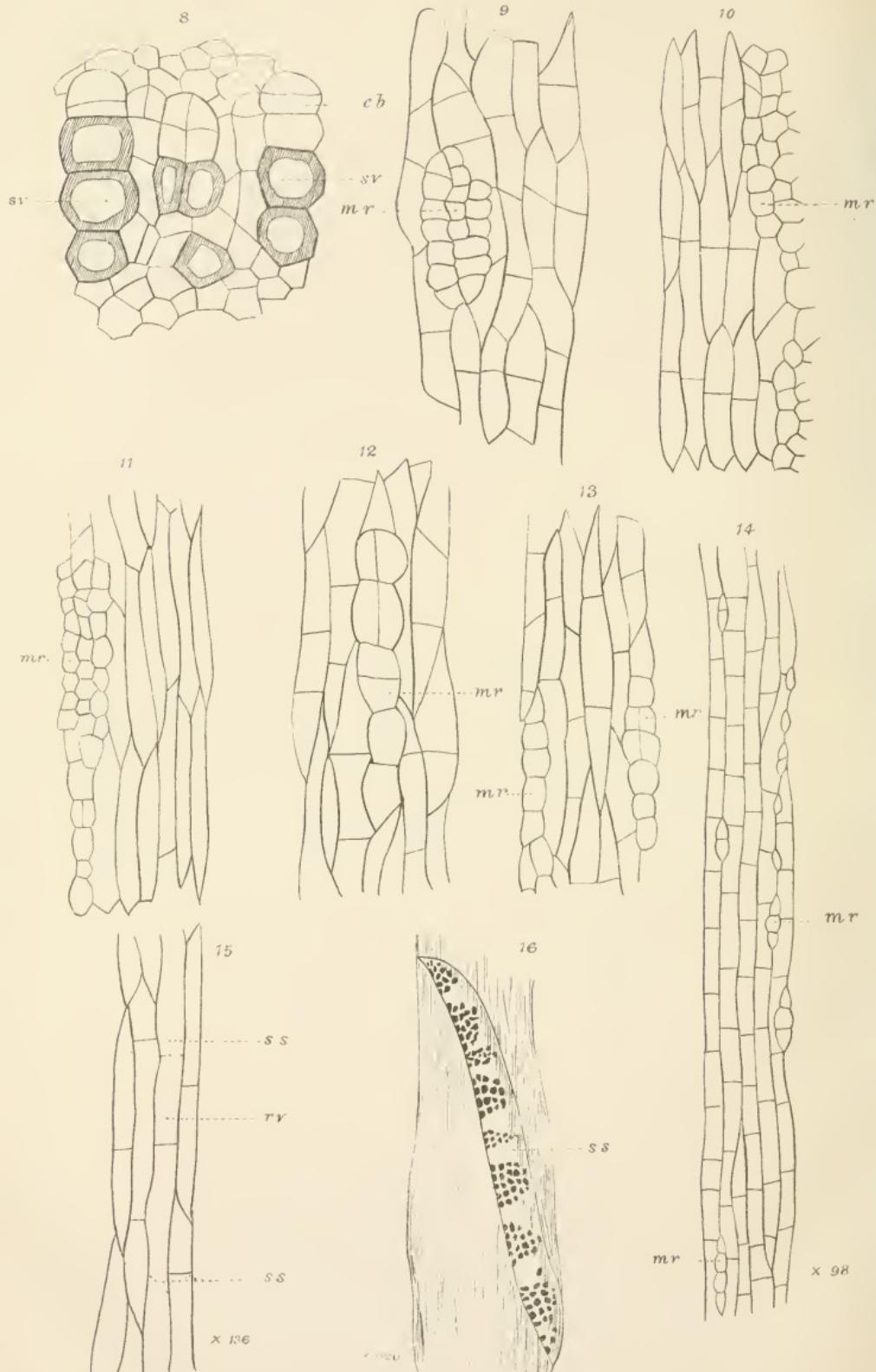
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Morphology of Vegetable Tissues.

Morphology of Vegetable Tissues.

TRANSACTIONS OF THE SOCIETY.

XXXV.—*On the Morphology of Vegetable Tissues.*
By W. H. GILBURT, F.R.M.S.

(*Read 8th October,* 1879.)

(PLATES XXII. AND XXIII.)

IN the early autumn of last year, while examining some preparations I had been making of the leaf-buds of various trees, certain appearances were observed, which seemed scarcely to agree with the views now held, concerning the origin of the cambium layer in the stems of the woody dicotyledons; and suggested the desirability of a further study of the subject.

During the twelvemonth which has since elapsed I have followed up the inquiry, with results of at least considerable interest.

EXPLANATION OF PLATES XXII. AND XXIII.

All figures drawn with Camera Lucida.

pcb, procambium; *cb,* cambium; *mr,* medullary rays; *m,* medulla; *c,* cortex; *sv,* spiral vessel; *ss,* sieve septa; *rv,* rudimentary vessels.

FIGS. 1, 2.—Sections through procambium of *Cytisus laburnum,* showing earliest observed appearance of cambium. Fig. 1. Very oblique, radial diameter of cells much exaggerated.

FIGS. 3–5.—Sections through procambium of Lombardy poplar. Fig. 3. Showing first division of procambium cells. Figs. 4, 5. Two stages in development of cambium.

FIGS. 6–8.—Sections of *Ficus carica.* Fig. 6. Before division of generating cells on xylem side. Fig. 7. Enlargement, division, and thickening of cells, producing first vessels of medullary sheath. Fig 8. Appearance of cambium septa in cells dividing thickened cell-forms.

FIGS. 9–11.—Tangential sections through cambium of *Cytisus laburnum.*
FIGS. 12, 13.—   „   „   *Syringa vulgaris.* (Figs. 9, 10, 12, 13. Showing cambium cell-groups. Fig. 11. Same after absorption of transverse septa. Medullary rays in transverse section.)

FIG. 14.—Section through cambium of *Salisburia adiantifolia.*

FIG. 15.—Development of vessels in *Sambucus nigra;* sieve septa indicated by dotted lines; transverse septa still remaining.

FIG. 16.—Sieve septa in rudimentary vessels of *Ailanthus glandulosus;* very oblique, and cut through.

The doctrine generally held concerning the origin of the cambium may be briefly stated as follows:—

That after the development from the primary meristem of the primary cortex and pith, a zone remains between them, which preserves its merismatic character, and is called the pro-cambium; the cells of which are similar to each other, and are combined without intercellular spaces; that on either side of this procambium the cells are differentiated into permanent tissue, on the outer side bast and parenchyma, on the inner side prosen-chyma and vessels; and that in open bundles a certain portion remains over between these two tissue systems; this portion con-stituting the cambium layer.

Now in the sections through the apices of the stems and terminal buds of certain trees referred to above, I observed that on the inner side of the procambium ring or bundles, there were a greater or less number of cells which appeared in every respect to agree with those which in older stems separate the xylem from the phloem; being thin-walled, regular in disposition, without intercellular spaces, and arranged radially with regard to the axis of the stem. Examining a section somewhat farther from the apex, I found that a few of the cells adjoining the pith were thickened; while in a section nearer to the apex, the procambium zone was thinner, and the cambium-like series absent.

The thought naturally suggested by these observations was, that possibly the cambium was not in itself a portion of the pro-cambium, but a special tissue developed from it. In order to determine this, I have made many preparations of the terminal buds of some sixteen species, but owing to the sharply curved course taken by the procambium at or near the apex, and conse-quently the line of section being at a more or less acute angle with its length, the inquiry proved one of considerable difficulty. Nevertheless, in all cases at a suitable distance from the apex, this cambium-like tissue was to be found either with or without one or two thickened cells on its inner surface, while the remainder of the procambium was undergoing differentiation into hard and soft bast.

A few species, however, were most instructive, especially the Laburnum (*Cytisus laburnum*), Lombardy poplar (*Populus nigra*), and the Fig (*Ficus carica*); and after a careful and prolonged study of them, there seems but one conclusion possible; viz. that the whole of the procambium is differentiated into hard and soft bast, with the exception of its innermost layer, the cells of which by means of successive tangential divisions, produce a cambium tissue; this new generating tissue preceding in order of develop-ment the appearance of any thickened cell-forms on the xylem side.

In its earliest condition the procambium can only be distinguished from the surrounding tissue, when examined in transverse section, by the comparatively small size of the cells composing it. This similarity, however, speedily disappears, as most of its cells divide into two, three, or four; the cell-plates being laid down indifferently as to order or relative position. This is well shown in Fig. 3, which represents a portion of the procambium of the Lombardy poplar. This division of the cells does not take place simultaneously throughout the whole of the tissue, but commences at certain spots which correspond with the position to be occupied by the vascular bundles, whether primary, secondary, or of a higher order.

In some species the next step in development consists in certain cells at more or less definite distances, growing most rapidly, and dividing in a radial direction, that is, with regard to the axis of the stem; this being the commencement of the primary medullary rays. In others, however, these are not to be distinguished till much later.

In Figs. 6 and 7, which are from a section of *Ficus carica*, the primary medullary rays are present, and it will be seen that by them the procambium is separated into well-marked bundles, and while on their inner side there is no distinct line separating them from the medulla, yet that on the outside their limits are well defined.

The next stage is, that the layer of procambium-cells next the medulla, which have remained unaltered, and which I would call the generating layer, becomes divided by septa which are invariably tangential to the circumference of the stem. As the differentiation of the phloem elements commenced at certain points which agree with the position and order of the future vascular bundles, so with the septation of these cells; commencing at certain definite points the process continues till we have a closed cambium ring or a series of bundles separated from each other by the primary medullary rays. In Fig. 1, which represents a portion of the procambium of the laburnum, it will be seen that there are three cells, which show this septation at the earliest stage in which I have observed it. In each cell there are two septa, the outermost one of which is the thinnest, and therefore the last laid down. In Fig. 2 is shown part of a bundle from the same section, of rather earlier origin, in which we have a radial series of four or five cambium-cells; the fact of their origin being from a single cell is still plainly indicated by the greater thickness of the mother-cell wall which still seems to surround them.

The same process in every important particular holds good in the Lombardy poplar, three stages in the development of which are represented in Figs. 3–5. I have, however, occasionally

found on the inner side of the cambium in this species, a few cells of small calibre, which do not appear to have been developed from it; although I have not been able to trace their origin with certainty, the probability being that they result from the division of the outer cells of the medulla. These cells may remain permanently thin-walled, or some of them may become thickened—a differentiation, however, which is not observed until the cambium is some three or four cells in thickness.

With regard to the order of development of the cells forming the cambium, it was just stated that in the earliest stage observed in the laburnum, there were two tangential septa thrown across the mother-cell, and that the one nearest the phloem being the thinnest, was the youngest. In the consideration of this part of the question we are greatly helped by a study of what takes place in *Ficus carica*. In this species the process of development is somewhat modified, as a reference to the figures will at once render apparent. Fig. 6 is a section through the procambium immediately after its differentiation into phloem elements, and no indication of either xylem or cambium is seen. In Fig. 7 at *a* we find a cell adjoining the medulla, which has enlarged and divided tangentially into two daughter-cells. At *b, b* we notice that in two cells in which this same process commenced earlier the daughter-cell next the pith has become spirally thickened, while its sister-cell has grown and divided again in the same direction. Growth in the two daughter-cells at first takes place equally, so that we find them both of one size; but there is this difference in them, that while one passes over into a permanent form, the other preserves its generating character; so that by the time the one has become fully developed the other is again ready for further division.

It will be observed that the cells we have just been dealing with are separated from each other by one or two cells of smaller dimensions. In these, growth takes place equally with those already described, but the divisions arise irregularly, sometimes being tangential, at others radial.

This order of development continues till the condition shown in Fig. 8 is reached. Here we have, proceeding from the centre of the stem, a series composed of two or three spiral cells or vessels preceded by two or three thin-walled cells, the whole of them being produced in regular succession by division of the cell immediately adjoining the phloem. Thus far, then, development has taken place in regular progression, proceeding from the centre outward. At this stage we notice that tangential septa arise in the cells which separate these series of thickened cell-forms the one from the other, and thus a continuous band of cambium is produced in the bundle.

At first sight it would appear that in this species we have an

example which differs in most important particulars from the conclusion stated early in this paper. But it must be borne in mind that the development of these xylem elements commenced by the enlargement and division of a single cell, and not simply by the thickening of a cell already existing in the procambium, and that the tissue intervening between the several series of thickened cell-forms, is at first produced from the same layer of cells, viz. those immediately adjoining the pith. This statement is supported by the fact, that, although the bundle as a whole has increased greatly in radial diameter, yet the phloem portion of it remains about the same as at first; the small amount of apparent growth resulting probably from the greater size of the individual cells, and not from their increased number. We must therefore regard the xylem elements and the cambium, the development of which we have been tracing, as new tissues resulting from the activity of the generating layer of cells, that in the other species produces the cambium at the first.

The progressive development of the cambium-cells described above appears to hold till the tissue consists of some six or eight cells in thickness, after which division takes place frequently in the cells which form its three or four outermost layers, as I have found thin cell plates between thicker ones, the cells thus cut off being about half the size of those immediately contiguous.

The species which I have studied, in addition to the three already referred to, are *Ribes nigrum, Æsculus hippocastanea, Betulus alba, Quercus robur, Quercus ilex, Acer pseudo-platanus, Fagus sylvatica, Ulmus campestris, Syringa vulgaris, Castanea* sp., *Nerium oleander;* and, while I have not been able in all cases to carry back the investigations to the earliest divisions of the generating cells, yet they all agree in this: the cambium tissue is always to be seen next the medulla before the appearance of any thickened cell-forms, and that the farther you can carry the inquiry back, the smaller is the number of cells of which the cambium is composed.

In one species only, viz. *Tilia europæa,* have I failed to see the cambium as just described, and that simply from the very sharply curved course taken by the vascular bundles at the apex, and the extreme difficulty of getting a section at all favourable for observation of the earliest stages of development. There is no doubt, however, judging from what I have seen, that it agrees closely with the other species examined.

Turning now to a consideration of the structure of the cambium-layer, I find that it differs in certain important particulars from what it is generally understood to be.

In studying this tissue, the plan followed has been to make a series of tangential sections of the region existing between the bast

fibres and the true wood, keeping each section separate and numbered in its proper order.

Now, the only statement made, concerning the structure of the cambium, is, that its cells are thin-walled, close-fitting, filled with protoplasm, and generally prosenchymatous in form.

In this part of my investigations, serial preparations of the following species have been made :—

Fraxinus excelsior	..	..	2, 3	Larix europæus	.. .. ..	8–10
Prunus lusitanicus	..	..	4–6	Taxus baccata	.. ..	6–8
Tilia europæa	..	..	4	Ficus carica ..	.. .. ..	4
Syringa vulgaris ..	..	..	3, 4	Cytisus laburnum	.. ..	2
Acer pseudo-platanus ..		..	4	Corylus avellana ..	.. ..	6–8
Sambucus nigra ..	..	..	2, 3	Salix sp.	.. .. ..	6–8
Cratægus oxyacantha	..	..	4, 5	Eucalyptus sp.	.. .. ..	4
Ilex aquifolia	..	..	8, 7*	Juniperus communis ..	..	8
Cornel sp. ..	..	..	4	Wellingtonia gigantea	..	?*
Ailanthus glandulosus		..	4	Cedrus sp. ..	.. ..	?*
Salisburia adiantifolia	..	..	12, 13			

In all of them I find the cambium composed not of prosenchymatous cells, but of prosenchymatous cell-groups, i. e. of cells so grouped, that the terminal ones of each group being more or less pointed at one end, the group is, as a whole, more or less prosenchymatous in form.

The number of cells so grouped varies with the species, and also in some species it varies within certain narrow limits. It may, however, be taken as true, that the longer the prosenchymatous elements of the mature wood are, the greater the number of cells composing the cambium cell-groups will be. Thus the figures placed to each name in the foregoing list of species, indicate the number of cells grouped together in the cambium; and it will be seen that in the Coniferæ, which possess the longest prosenchymatous wood-cells, there are from six to eight in Taxus, and twelve to thirteen in Salisburia; while in Cytisus, which has the shortest wood-elements I have seen, there are but two.†

That this is the true character of the cambium is proved from

* In these species, owing to the line of section being somewhat oblique to the course of the tissue, the numbers could not be counted satisfactorily, as frequently, owing to the comparatively great length of the group, the whole of it was not present.

† Each member of these groups is a complete cell, i. e. possesses a distinct nucleus, in which one or more nucleoli are to be seen. After the absorption of the transverse septa referred to in the next paragraph, the nuclei approach each other, and are frequently to be seen in a group near the centre of the young wood-cell. Coalescence of the nuclei appears now to take place. In Laburnum I have seen, first, a nucleus in each cell; after absorption, two nuclei partly overlying each other; and in wood-cells in which thickening is taking place, only one nucleus about twice the size of the original ones. The same remarks apply to one or two other species examined in this regard. In *Salisburia* fusion of the nuclei takes place undoubtedly so far as reducing the original number to half, while in size they are double. These remarks are founded on observations made on tissues in a state of rest, and since the date of the paper.

the fact, that in cutting a series of sections of the whole region referred to, it will be found, after leaving the parenchyma and soft bast, we find nothing but groups of cells as described, until the true wood is reached. Moreover, on the side next the phloem we find the cambium passing over to parenchyma by the rounding off or further division of the individual cells, and on the xylem side we find the transverse septa absorbed, not always wholly or at once, for traces of them are often to be seen on the cell-walls even after thickening has commenced.

Thus in *Cytisus laburnum,* a species well adapted for study, it will be seen in Fig. 9, which is taken from a section adjoining the parenchyma of the bast, the cells are comparatively broad; that in Fig. 10, which is from about the centre of the cambium, they are narrower and proportionately longer, while the two combined cells are more decidedly spindle-like in form; and in Fig. 11, they have been still further modified in the same direction, the dividing transverse septa having disappeared—this figure being taken from a section next the xylem.

The same process in every respect is illustrated in Figs. 12 and 13, drawn from sections of *Syringa vulgaris.* Here the groups are composed of three and occasionally four cells. The modifications take place in exactly the same order; decrease in diameter, increase in length, and absorption of septa.

If we look at the development of the cambium in the other direction, or on the phloem side, we should observe in Cytisus that as a rule each cell divides into two; and so we sometimes see on the outside of the tissue, groups with spindle-like ends composed of four cells; but growth very speedily obliterates the form, and intercellular spaces arising, we have a true parenchymatous tissue.*

Such then being the character of the cambium, it follows, that we can no longer regard prosenchyma as being composed of differentiated original elementary cells, for we find that they are like the vessels, but in a much more limited sense, cell-fusions.

This view of the structure of the cambium also involves of necessity a modification in the account given of the origin of other elements of the xylem, viz. the wood-parenchyma.

Sachs says † "They arise (i. e. the parenchymatous cell-forms of the xylem) according to Sanio by transverse division of the cambium-cells before their thickening commences." From this it would appear that Sanio saw these cell-groups in the cambium, but from some cause failed to observe that the whole of the cambium was composed of them. Sachs also figures these paren-

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* With regard to the origin of the fibrous elements of bast, they appear to arise in two ways, viz. the combination and fusion of the cambium cell-groups, and also by the fusion of vertical series of parenchymatous cells. This point, however, has not been satisfactorily made out, and is reserved for further observation.

† Sachs' 'Text-Book of Botany,' p. 100, Oxford, 1875.

chymatous cell-forms, in the wood of Ailanthus,* the details of which correspond in every particular with my own observations, and the special elements under consideration also agree in form, dimensions, and number of cells in combination, with the cell-groups of the cambium. It is therefore naturally suggested that wood-parenchyma results simply from the non-absorption of the transverse dividing septa, and that while spiral or other thickening has taken place, yet their outward form is the same as it was when the group occupied its place in the cambium.

In the development of the vessels also there are one or two points of interest. In the mature vessel, the remains of what has hitherto been regarded as the original transverse septa, are always inclined more or less to the course of the vessel. That this should be so is apparent, if we take into consideration the fact that the cells from which they are developed are combined in the form now described; the septa, the remains of which we see upon the walls of the vessels, being the terminal ones of the cell-group, and therefore originally oblique, the intervening ones, which are at nearly right angles to their length, being wholly absorbed. In Fig. 15 is shown a portion of a section of *Sambucus nigra*, in which is seen a rudimentary vessel, the dotted lines indicating the position of the septa, the outer portion of which will remain upon the wall of the fully developed vessel. The transverse dividing septa are still present.

Another fact worthy of notice, is, that these oblique septa become before absorption in all respects like the septa of sieve tubes, being pierced with minute pores arranged in groups as shown in Fig. 16, drawn from a young vessel in *Ailanthus glandulosus*, the septa being very oblique and cut through. These pores gradually enlarge and coalesce, till either all the central portion is removed, or the bands which separate the sieve-like plates remain, forming the scalariform septum.

It would seem that absorption in cell-walls generally, or at least frequently, commences by this thinning down and piercing of the wall at minute points; for in the Coniferæ I find in the forming wood immediately adjoining the thickened tissue, similar sieve-like plates corresponding to the positions eventually to be occupied by the well-known coniferous bordered pits, whether it be on the radial walls of the tracheides, or on the medullary rays. This is well shown in *Salisburia adiantifolia*, and quite as certainly in all others that I have examined, though not always so readily to be made out.

The results of my observations may now be summed up, and from them it appears that the cambium-layer is not a portion of the procambium remaining over after the differentiation of the

* See London Science Class-Book, Botany, Morphology, &c., p. 40.

primary phlœm and xylem, but a special and new tissue developed from it; that it arises in the layer of procambium which is next adjoining the medulla or pith; the cells composing the cambium being developed by septation, in regular sequence, proceeding outwardly, till a tissue from six to eight cells in thickness is formed, the divisions then taking place in irregular order in those cells which form the three or four outermost layers.

That the cambium is composed of prosenchymatous cell-groups, the combined cells varying in number with the species to which the plant belongs. From the cambium on the phlœm side parenchyma is produced by the rounding-off, and sometimes by the further division of the individual cells, and prosenchyma on the xylem side by the absorption of the transverse septa; wood-parenchyma being simply those cambium cell-groups in which such absorption has not taken place.

That the vessels arise by the fusion of certain cambium cell-groups, which are arranged vertically with regard to each other; the oblique septa separating the groups being partly absorbed, and the transverse ones entirely so.

That absorption of the oblique septa appears to commence with the formation of sieve-plates, the pores of which enlarge and coalesce till either there is one large circular aperture through the centre, or the bands dividing the sieve-plates remain, forming the scalariform septa of some species.

XXXVI.—*Note on the Structure of the Scale of a Species of the Genus Mormo.* By Joseph Beck, F.R.M.S.

(*Read 8th October,* 1879.)

There is no subject which has been more freely discussed, and with such varying conclusions (not even excepting the much-vexed question of the structure of the siliceous valves of the Diatomaceæ), than that of the causes producing the appearance of "notes of exclamation markings" on the scales of several of the Thysanura.

It is not my intention to enter into a *résumé* of the views held by different microscopists, but simply to notice what I regard as a fresh proof that these so-called "markings" are due to a structure very different from what would be assumed were we merely to judge from the appearances that are apparent under the Microscope.

For some years I have maintained that the "notes of exclamation" markings on the scales of *Lepidocyrtis* are due to uneven *corrugations* in the membranes of which they are composed, and I have illustrated this before the Society by running moisture up and down the scale in the furrows between the corrugations or ridges. In the supplement to Sir John Lubbock's treatise on the Thysanura, I have used these words in describing the scale of *Lepidocyrtis curvicollis,* "Irregular striæ or corrugations from pedicle to apex broken up into large, well-defined separate 'notes of exclamation' markings; markings very black, with a light bright ridge down the centre of each; appearance due to irregular corrugations on the outer surface of the under membrane, slight undulations on the outer surface of the upper membrane, and to structure between the superposed membranes." I have produced a similar appearance by rubbing together two scales of *Polyommatus argus,* which scales have straight simple ridges running from pedicle to apex—when placed over one another at an angle [*]— but I have never until now been able to find a moth or butterfly scale which, in its natural condition, gave under the Microscope the appearance of "notes of exclamation" markings.

I now desire to call the attention of the Society to a scale from a specimen of the genus *Mormo* from the East Indies (I have been unable to obtain the exact name, having only the wing), which shows "notes of exclamation" markings very similar to those observed on many of the Thysanura. Under a low power these scales present the same watered-silk appearance seen in *Lepidocyrtis curvicollis*; under a $\frac{1}{5}$ they show the "notes of exclamation" markings; under a $\frac{1}{10}$ they are resolved into distinct ribs from pedicle to apex, *thus showing in one scale how the appearances run from*

[*] See Carpenter's 'The Microscope and its Revelations,' 5th edition (1875), p. 695.

one into the other, and adding another link in the chain of evidence in favour of what I have previously maintained, viz. that scales being expansions of the quill, require something to strengthen them, and that for this purpose they are all, whether amongst the Lepidoptera or Thysanura, supplied with ribs running from pedicle to apex, and that the varied appearances seen under the Microscope are due to the irregularities of the membranes of which the ribs form a part.*

* Since communicating the above I have, at the suggestion of the President, examined a large number of the scales of Lepidoptera, and I have invariably found that the corrugations are on one side only, and that side the under side, or the one nearest the body of the insect. Great care is required lest a mistake should be made by the moisture running between the scale and the slide, and not on the exposed surface only.

XXXVII.—*On New Methods for Improving Spherical Correction,
applied to the Construction of Wide-angled Object-glasses.*
By Professor E. Abbe, of Jena, Hon. F.R.M.S.*

(*Read* 11*th June*, 1879).

The correction of spherical aberration, in *dioptric* systems of all
kinds, is based on the much-applied principle of compensating one
deviation by an opposite deviation of the same kind.   The positive
aberration of the collective (convex) lenses of any system is balanced
by the negative aberration of dispersive (concave) lenses.   Besides
this method there can be no other, as long as practical optics is
confined to spherical surfaces.

Though this principle might be applied in various ways, one
only has hitherto been adopted, which may be called the method of
allied corrections.   Spherical correction is always effected by con-
cave lenses of the higher dispersive material (flint-glass), which
are used for getting rid of the chromatic dispersion of the positive
(crown-glass) lenses.   The combination of a concave flint-lens
with a convex crown-lens (generally cemented together) is the
means of effecting both corrections at the same time, without being
obliged to treat each separately.   But of course it is not at all
necessary that those binary lenses should be corrected, even ap-
proximately, in themselves.   In the case of compound systems, as
microscopic objectives generally are, one part of the system may be
considerably under-corrected in each respect, provided it is balanced
by an opposite deviation in the other part of the system.

The circumstance mentioned here—the possibility of correcting
both aberrations by the same elements, *appears* to be a great advan-
tage in the construction of objectives; and from one point of view
it is in fact so, as it saves the unavoidable complication of separate
concave lenses for spherical correction, in addition to those which
are necessary for achromatism.   But, on the other hand, this com-
bination of the two corrections is the origin of a very serious defect,
which becomes especially obvious in wide-angled systems.   The
amount of spherical aberration which is introduced by a lens of
definite curvatures depends on its refractive index.   Now the re-
fractive index varies with the colour of the rays in both kinds of
lenses, but in the flint the increase of this index, say, from red to
blue, is much greater than in the crown, which is of course necessary
for chromatic correction.   In consequence of this the negative
aberration in any optical system increases more rapidly from red to
blue than the positive, and it is therefore impossible to obtain
simultaneously the correct balance for different colours.   If the
compensation is got for the red rays, the negative spherical aber-

* The original paper is written by Professor Abbe in English.

ration of the flint lenses will be in excess for the blue ; and if it is got for the blue rays, this negative aberration will be in defect for the red. The system, therefore, will be either spherically over-corrected for the blue or under-corrected for the red. Binary lenses especially increase this discrepancy to a great extent, the negative aberration in this case arising from the concave surface in which flint and crown meet together. This negative aberration therefore depends on the small difference of the refractive indices of flint and crown, which difference must of course vary from red to blue to a much greater extent than the refractive indices themselves, relatively.

The residual aberration considered here—" chromatic difference of spherical aberration " would be the correct name—is readily observed in any kind of dioptric system, Telescopes or Microscopes. The visible result of which must be (as may be easily demonstrated), a characteristic discordance of *achromatism* for the various zones of the aperture of any objective ; if the central part of the aperture is well corrected chromatically, the peripheral zone must be over-corrected, and if the marginal rays afford the best possible achroma-tism the central rays must be under-corrected. This derivative defect of colour-correction must rapidly increase with increasing aperture, as it owes its origin to *spherical* aberrations (which vary with the *square* of the angles), and therefore becomes especially visible in such wide-angled systems as are used with the Microscope. Every attentive microscopist and optician will be familiar with its appearance in microscopic objectives, which always reveal a considerable difference of achromatism, in their performance with central and with oblique illumination. If an objective has the best possible colour-correction in the central part of its aperture (direct light yielding the secondary colours only), oblique light will show broad borders of yellow and blue on the outlines of the objects—the indication of chromatic over-correction of the marginal zone ; and if the primary colours have been obliterated for the marginal pencils (rose or violet and green remaining only with oblique light), central illumination will give deep tints of red and blue on sensitive pre-parations such as organic tissues or the thick ribs of diatoms.*

These results of residual spherical aberration are of great prac-tical importance. As they cannot be eliminated by the means hitherto applied, they represent an universal defect in microscopic objectives. Owing to this defect the performance of the best glasses is not equally satisfactory for every kind of work. An objective which has been corrected chromatically for central light will sometimes afford a well-defined and colourless image on

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* This description will hold good for the central part of the field of vision only ; for outside the axis the phenomena in question may be totally concealed by the much coarser chromatic effects arising from difference of *amplification* for different colours, which is never absent in wide-angled objectives.

delicate organic tissues or other similar objects, but it will show far too much colour, and, therefore, a great lack of definition when it is used on diatoms or other preparations requiring oblique illumination ; and on the other hand a lens which has been made for the brilliant exhibition of diatoms may possibly be nearly useless for histological work.

This divergence would not be of much importance if objectives of especial excellence could be constructed for the one or for the other kind of work. But this is not the case, because the operation of the different zones of aperture is not really separated by different modes of illumination. Though the incident pencil may be either central or in the marginal zone, deflected and diffracted pencils will generally engage very different parts of the aperture, except in certain special preparations. Consequently the only rational plan for general work must be so to distribute these deviations as to prevent their accumulation in one part of the aperture. This is done by correcting the spherical aberration of the rays of predominant intensity (the yellow rays for visual performance), and compensating the greater part of the residual aberration of the red and blue by a moderate amount of chromatic under-correction—the plan now adopted, consciously or unconsciously, by the best opticians. But by the best possible distribution of these deviations they cannot be *eliminated*, but must always remain in the image, and to a certain extent debase the general level of the defining power.

In the year 1873 I expressed an opinion that the correction defect in question is the principal objection to the use of objectives of moderate focal length with deep eye-pieces, instead of the deeper lenses now required.[*]

It is now sixty years since C. F. Gauss, the celebrated mathematician of Göttingen, considered the above-mentioned aberration defect. He then discussed the problem of a more perfect correction of objectives, and suggested a plan for getting rid of the residual aberration in binary lenses made of ordinary crown and flint, for telescopic use. Unfortunately, his plan, which is disadvantageous even for telescopes, is utterly inapplicable to systems having the large apertures required in Microscopes. His method of correction, (without considering other difficulties) would need *uncemented* concave lenses of curvature so deep that even moderate apertures would make the angles of incidence approach, or exceed, the limit of total reflection from glass to air.

My own researches upon the subject, beginning from 1870, and having special regard to the Microscope, had for a long time a negative result—as far as the actual conditions of optical work were considered. From various practical difficulties every plan

* ' Beiträge z. Theorie d. Mikroskops.' ' Archiv mikr. Anat.,' Bd. ix. p. 425.

for correcting the residual defects spoken of *appeared* to be impossible, unless the connection between the correction of spherical and chromatic aberration could be removed.

On this supposition, which I afterwards found to be premature, I began to investigate the method of *independent* correction, which had never been considered before. I discussed the conditions for correcting the spherical aberrations of the convex lenses, or at least a part of these aberrations, by such other concave lenses as produce chromatic correction, and for this purpose searched for the appropriate means in systems not restricted to the low aperture of telescopic objectives. The general method could be easily indicated, as everything appeared to depend on one essential condition: viz. concave surfaces which would introduce negative spherical aberration, by difference of the refractive index of consecutive media, as in ordinary binary lenses, but would either exclude chromatic aberration of perceptible amount, or admit chromatic aberration of *opposite* character. The accessory requisites annexed to this would be somewhat different in the two cases, but would be accomplished without difficulty. The principal condition, however, indicated above, would require optical media essentially different from those hitherto applied. It would be necessary to dispose of two media which are to some extent unequal in refractive power, but either approximately equal in dispersion, or varying in opposite directions. Now, the various kinds of crown and flint glass differ widely in refractive index and in dispersive power, but the dispersion always varies with the index, the greater dispersion being associated with the higher index, and *vice versâ*, with very slight deviations. An independent correction of spherical aberration would require at least two kinds of glass, having optical relations different to those now in use—either low refractive index combined with high dispersive power, or high refraction with low dispersion. There is no reason for supposing the production of such a material an impossibility; but the makers of optical glass not having even thought of the problem at the time, any improvement of optical systems in the way proposed appeared to be postponed indefinitely.

Notwithstanding these difficulties, the principle thus indicated of independent correction of both aberrations has been put to a decisive practical trial. In order to obtain a clear view of the direction in which further improvement in the dioptric performance of objectives ought to be made, Mr. C. Zeiss, on my suggestion, undertook a very interesting and important experiment, not hitherto publicly recorded, by constructing some systems with *fluid* lenses, based on the principle of independent correction. For this purpose we availed ourselves of the low refractive indices of certain of the highly dispersive fluids which are to be found among ethereal oils

and artificial chemical preparations, selecting those fluids similar to crown, or light flint, in respect to refraction and equal to heavy flint in respect to dispersive power. Substituting a *collective* (convex) lens of such a fluid for one of ordinary crown (not a dispersive one for flint, as has been done for quite another purpose) and combining it with a concave lens of suitable flint of greater refraction and less dispersion, the dispersive power of the flint may be balanced by the dispersion of the fluid and from the difference of the refractive indices a sufficient amount of negative spherical aberration may be obtained, the chromatic variation of which is just opposite to that of ordinary binary lenses. At the same time the rapid increase of dispersion from red to blue in some of these fluids, if properly selected, will afford a simple and effective expedient for an almost perfect compensation of the secondary chromatic defects arising from the ordinary flint and crown lenses. The fluid uniting with the crown will make up the deficiency in the relative dispersion of the blue part of the spectrum of the crown in comparison with flint. Owing to this peculiar fact the plan indicated a degree of refinement of *both* corrections which, without taking into consideration the practical difficulties, could not be obtained, by ordinary means, at the time.*

In 1873 Mr. Zeiss made an objective on the plan in question; a dry $\frac{1}{4}$ (6·0 mm. focal-length) with a numerical aperture of 0·83, and another one in 1876, an immersion $\frac{1}{8}$ (3·0 mm.) of 1·15 aperture, a mixture of oil of cassia and of aniseed being used in the former, and pure Cinnamyle-hydrogen ($C^{18}H^8O^2$) in the latter. The refractive indices and the partial dispersions of all the materials having been measured very accurately, the formulæ were computed on the condition of perfect collection of spherical aberration for the two colours, D and F, and of very approximate correction of the axial rays for the three colours, B, E, and G. Both objectives were planned as quadruple systems, the latter with duplex front. The three anterior lenses are not essentially different from the ordinary construction; the back lens was made in each case of two glass lenses, flint and crown, including between them a fluid meniscus of collective character. Both objectives—which are still preserved at Mr. Zeiss' workshop—perform exceedingly well when their fluid contents are kept in good order. They yield images almost perfectly colourless on every kind of preparation and with every kind of illumination, with very superior definition — demonstrating the great improvement in

* Objectives have several times been announced as being free from secondary colours, owing to the application of three different kinds of glass. Anybody who has a clear notion of the conditions of achromatism will see at once, that such an assertion must have been either illusion or deception. For no kind of glass hitherto produced would admit of the collection of *three* different colours in one focus, even in a small telescopic objective.

dioptric performance which is attainable by a really perfect correction of spherical and chromatical aberration.

In consequence of the numerous grave drawbacks which attended objectives of such construction, the result of this troublesome and expensive experiment was considered by Mr. Zeiss and by myself as a matter of theoretical interest only—a glance at the Microscope of the future. But, as some of the principal difficulties would be considerably diminished in objectives for homogeneous immersion, owing to the omission of the correction setting, I am of opinion, that this method of independent correction under the new conditions is still capable of successful application in the improvement of high-power objectives.

In the meantime, however, another way of eliminating the chromatic difference of spherical aberration has suggested itself to me, reverting to the long-established system of *allied* correction.

In a recent investigation suggested by the introduction of the homogeneous-immersion system and during the attempts at still further increase of aperture, I touched once more upon the old problem, and observed that a device, which I had discussed in theory eight years ago, had not been then pursued to its legitimate conclusion, and that the residual defect of spherical aberration—though not simultaneously the secondary chromatic difference—could be got rid of by the ordinary means within reach of practical optics.

The general idea of the plan in question is shown by the diagram.

M N is an objective, O and O* the two conjugate foci of object and image ; M (represented, for sake of simplicity, by a single lens in the diagram) the anterior part of the system considerably *under*-corrected spherically and chromatically ; and N the posterior part, *over*-corrected in both respects, just sufficient for balancing both aberrations of the anterior part ; N being separated from M by a relatively considerable distance. The continuous lines in the figure indicate the path of an oblique *red* ray, the dotted lines the path of the corresponding *blue* ray, both derived from the same incident ray O P.

The chromatic correction of the entire system being assumed to be perfect for the axis, red and blue rays of small obliquity starting from O will meet the axis at the same point O* ; and supposing the system to be corrected spherically for the *red*, the *red* oblique ray will be collected to the same point O*. These two conditions can obviously be fulfilled in every system ; but then in the ordinary
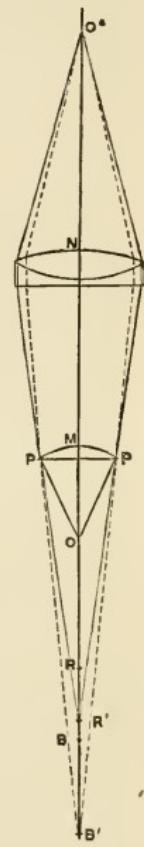
case the *blue* oblique ray would not meet the axis at O* but in a more distant point (not indicated in the diagram), owing to the spherical over-correction of the more refractive rays.

Consider now the action of the under-corrected anterior part of the system and the effect arising from the supposed distance between M and N. Owing to *chromatic* under-correction, the axial pencil emanating from O will have two different virtual foci R and B for red and blue after its passage through M ; and owing to *spherical* under-correction of the anterior system, the oblique pencils O P after their passage will yield two *other* virtual foci R' and B' at a greater distance from O and from each other than R and B. The intervals R R' and B B' will indicate the linear amount of spherical aberration for the extreme colours, introduced by the front system M.

Owing to the positions of these four points the pencil of blue rays emanating from M will be confined to a smaller divergence than the red, and the sectional diameter of this pencil will be diminished, in comparison with the other, more and more from M to N. If now both pencils reach the concave surface of the correcting flint lens in the posterior system N, every blue ray will meet this surface at a smaller distance from the axis than the *corresponding* red ray, and therefore with a smaller angle of incidence ; the difference increasing as the distance from M to N is increased. Owing to this difference the negative spherical aberration arising from the concave surface will be of less amount in the blue pencil than in the red, the action of this surface on the blue rays being somewhat similar to the action of a surface of less curvature ; and thus the increase of negative aberration for the blue which at the same time arises from the greater difference of the refractive indices between flint and crown, may be exactly balanced. The whole pencil of blue rays will then be gathered to the same point O* where the red rays are collected.

As will be understood, this demonstration does not pretend to prove that the method here considered will attain the object in view *within practicable limits* in respect to the necessary amount of under- and over-correction, and the necessary distance between both parts of the system. This could only be done after an exhaustive mathematical analysis of the problem. The foregoing discussion is intended only to afford a clear idea of the *method* in general and to establish the principal *direction* in which the computations must be made in devising an objective according to this plan. This direction is readily expressed by the rule : combine a strongly under-corrected anterior system with an over-corrected posterior at such a distance that the chromatic difference of spherical aberration may be overcome—all other conditions of optical performance being taken in the ordinary way.

As is obvious from a glance at the diagram, this plan is connected with a peculiar difference of the image-forming pencils. Owing to the effect of the distance M N, the blue pencil must pass to the image with less angular convergence than the red one. According to the general theorem, established by Lagrange, this difference indicates a different *amplification* of the blue and the red image (the blue *larger* than the red), notwithstanding their identical position on the axis, or, expressed in another way, a chromatic difference of focal length, coexisting with identical position of the conjugate foci for different colours. The practical result of this deviation must be a defect of achromatism *outside* the axis. The images of different colours coinciding on the axis, the centre of the field will appear perfectly achromatic; but the blue image overlapping more and more the red one, coloured outlines will appear outside the centre, increasing with the distance from the axis.

Achromatic defects of this kind are of subordinate importance, as they do not injure the definition in the central part of the field, They are to be found in all objectives of somewhat considerable aperture, and are generally overlooked by microscopists, though the difference of amplification in such object-glasses exceeds 1 per cent. (the more brilliant rays of the red and blue considered only), and much more still in systems with duplex front. But such defects of amplification, if they become too obvious, may be easily corrected either by specially constructed eye-pieces or by a separate correcting lens added to the ordinary eye-piece. Hence the fact above noticed, though not of course advantageous, is no serious objection to the plan here considered.

On the other hand this mode of construction much facilitates the correction of another kind of amplificatory defect of still greater importance, which cannot be overcome by the eye-pieces or similar means, but must always be corrected in the objective. What is generally called by microscopists "curvature of field," is in fact in its principal part the result of different amplification by different zones of the aperture,—the axial pencil yielding a different linear amplification of the image to those of the various oblique pencils; and for correcting these anomalies, which are a grave difficulty in the construction of wide-angled systems, the elements of a separated posterior lens can be readily made available.

Respecting the practical application of this plan of correction, it can be used in both telescopic and microscopic objectives. But in telescopes of small and moderate focal length the residual spherical aberration is not of any practical importance; and in large objectives, where it has an injurious influence, there are much greater aberrations arising from the disproportional dispersive powers of crown and flint (secondary colours). As long as these exist the

advantages of a more perfect spherical correction are inappreciable, and the subject in question will have no practical interest for telescopes, unless the manufacturer of optical glass makes considerable progress towards a better conformity in the dispersive powers of crown and flint.

In microscopic object-glasses the secondary dispersion, though also perceptible, and the removal of which would be a considerable improvement, is not nearly so injurious as residual spherical aberration, because the latter increases so rapidly with increase of aperture. There can be no doubt therefore that objectives, even of moderate aperture, would, by the correction of the chromatic difference of spherical aberration, attain a much higher standard of defining power than has been hitherto obtained; and if there be microscopists who appreciate a luxurious exhibition of optical art, they will, I hope, be gratified by seeing opticians apply this plan of correction to objectives of various powers. But the practical advantages of more complicated and more expensive constructions will remain somewhat questionable in the case of those moderate apertures, the full performance of which can be obtained (without inconvenience from too short a focal length), with good ordinary objectives. For a moderate aperture needs only a moderate amplification for the full exhibition of the minutest details accessible to the aperture. Such an amplification may be obtained by an objective of relatively long focal length, if the dioptric refinement admits of a large increase of amplification by means of deep eye-pieces; in the other case it must be got by an objective of shorter focal length, requiring low eye-pieces only for the same amplification. Though from the purely optical point of view the former is the more perfect instrument, the latter will be practically the same, as long as a moderately short focal length is still sufficient for the aperture. Now even the largest aperture attainable by dry lenses will need no higher amplification for perfect exhaustion of the microscopic image than may readily be obtained by a good $\frac{1}{8}$ of the ordinary construction combined with rather low eye-pieces; at all events no observation of any scientific value has ever been made by any dry lens, which could not have been made just as well with an $\frac{1}{8}$; and there is no practical inconvenience in the case of such a glass, if it be properly made, which would not occur to the same extent with a more accomplished $\frac{1}{4}$, fit for replacing it by means of deeper eye-pieces. The more substantial advantages will, therefore, be derived from the removal of residuary aberrations for the higher apertures alone, which are obtained by the immersion system, and especially in the case of homogeneous immersion; for in these cases higher amplification is needed than can be effectively obtained by an $\frac{1}{8}$ with the ordinary mode of correction. Raising the level of dioptric performance in those objectives will remove

the very short focal lengths, which are so inconvenient in use and scarcely less difficult in workmanship.

According to this consideration, the plan in question has been applied practically to the production of an objective of very large aperture on the homogeneous immersion system. The formula has been computed on the condition of equal spherical correction for two different colours (D and F) for a focal length of $3 \cdot 0$ mm. ($\frac{1}{8}$), and an aperture of $1 \cdot 40$ numerical $= 138°$ balsam angle—the widest angle, probably, which has been hitherto attained, as it already exceeds by several per cent. the utmost aperture for water immersion, and approaches within 7 per cent. the possible maximum, which is consistent with balsam-embedding and crown-glass covers. The system is planned on the duplex-front construction. In order to use a moderate curvature (shortest radius $1 \cdot 30$ mm.) the front has been tasked in an unusual way: it has been made active up to $6°$ beyond the equator of the sphere, a surface exceeding the hemisphere by about $\frac{1}{10}$ of the radius thus being applied as a clear lens.* The angles of incidence of the rays increase up to $44°$ on the air side of the front lens, but do not exceed this amount at the anterior surface of the second lens. The anterior part of the system (corresponding to the lens M of the diagram) is made as a quadruple system, two binary lenses above the duplex front; the over-corrected posterior part (N) of relatively great focal length is a triple lens, the flint cemented between two crown lenses, and the distance between the opposite surfaces of both parts is approximately three times the focal length of the entire system. Though it would have been possible in this case to make shift with three separate lenses in the front part, I preferred to take four, in order to deal with lower curvatures; the good success of the quadruple systems having practically proved that the slight loss of light and the slight increase of diffused light by one lens were more than counterbalanced by the advantage of surfaces of lower curvature. The computation of the formula was based on the supposition of an immersion fluid of a refraction exactly identical with that of the covering glass, $1 \cdot 518$ to $1 \cdot 520$ for the D ray.

* As a hyper-hemispherical lens cannot be set into the brasswork in the ordinary way, it was necessary to fix it by means of a parallel plate cemented on, fixing the slightly prominent edge of this plate—a device applied already by Mr. R. B. Tolles, as I am told. Avoiding the difficulties connected with this unusual shape of the front lens, would have needed a much stronger curvature of this front for obtaining a focal length of 3 mm. But then its focal length would have been considerably less than the focal length of the entire system, and the objective would have been similar to a much stronger one in all practical respects. The advantage of a lower power depending only on the greater focal length of the front lens, the aim must be to keep this focal length as great as possible. By the construction considered above it is obtained only slightly less than the focal length of the entire objective.

The lenses having been ground and set in the brasswork with all possible care, according to the formula, the two made at the workshop of Mr. Zeiss were perfectly corrected by a very slight alteration (some hundredths of a millimetre) of the distance between the second and the third lens of the front part. The apertures of both objectives, observed with the light of a soda flame, was found 1·40 to 1·41 by means of an apertometer with flint-glass disk and the same by an independent micrometric method. Notwithstanding the various delicate and novel manipulations which were necessary for exact polishing and setting of a front lens of this peculiar kind, the performance of the two objectives was perfectly satisfactory. The resolving power gave evidence of the increased aperture. Ordinary specimens of *Amphipleura pellucida* are rather coarse test-objects with an aperture of this amount, as they are resolvable by a moderately oblique pencil. There is no doubt that on balsam-mounted preparations, striations up to 5000 lines per millimetre (125,000 per inch) would be readily resolved by an incident pencil of the utmost obliquity, and still finer photographically. The difference of chromatic correction between the central and the marginal zone of the aperture is in fact imperceptible; the middle of the field yields nearly white images, with central light, and secondary colours only, with light of extreme obliquity. The definition with the deeper eye-pieces proves decidedly superior to the objectives of similar focal length, made for homogeneous immersion on the ordinary plan of correction; and as the other circumstances connected with this construction are somewhat less favourable, there can be no doubt that the improvement is due solely to the removal of the residuary spherical aberration.

As was anticipated from the formula, the chromatic difference of amplification appeared much more perceptible than with other objectives. I added therefore a correcting lens below the eye-piece—a convex flint- and a concave crown-lens cemented together, calculated for neutralizing one another in respect to the middle rays of the spectrum, but with exceeding chromatism of the flint. This lens therefore performs like a plane parallel plate for the middle rays, as a collective lens for the blue, and as a dispersive lens for the red rays. Inserted at the end of the tube by a suitable adapter at a short distance from the field-glass of the ocular, it introduces—owing to its position—no perceptible aberration, neither chromatic nor spherical; but it corrects the path of the coloured pencils *outside* the axis by continuously increasing prismatic deflections. This device performs quite satisfactorily with all eye-pieces, except very low ones.

For photographic performance an objective of this construction

would not need a separate correcting lens, as this could be combined with the concave " amplifier " introduced by Dr. Woodward for preserving the right position of the conjugate foci, while the image is projected to a considerable distance. This amplifier may be readily made use of for correcting every difference of amplification, provided it be not made achromatic, but rather over-corrected chromatically to a proper degree.

Some difficulties, arising from the nature of the immersion fluid, which at first occasionally interfered with the satisfactory performance of the objectives in a rather vexatious manner may now be considered as overcome. As the difference in the refractive index between oil of cedar-wood and the covering glass seemed to me too great for the increased aperture and as the stronger oils or mixtures of oils are of too great dispersive power, I was obliged to abandon these liquids. The solution of anhydrous chloride of zinc, which can be easily concentrated up to the refraction of covering glass, by using a refractometer or a test-bottle with a crown-glass prism of 1·518, at first appeared to be the best substitute. But it was found that in the high concentration needed here the solution is subject to sudden changes unless it is perfectly free from the ordinary hydrous salt. This may be obtained by very careful preparation, and the liquid then performs very well—provided it be preserved in a tight bottle and prolonged observation with the same drop be avoided, but I prefer now a solution of chloride of cadmium, or of sulpho-carbolate of zinc, in strong glycerine, which can be brought to the right refraction. They are rather sticky it is true, and in this respect less convenient for use ; but as they are not nearly so hygroscopic as the chloride of zinc, they can be applied with much more ease. With sufficient cleanliness none of these liquids, not even the chloride of zinc, will do any injury to the lenses or to the stands. The application of *strictly* homogeneous immersion has, therefore, no serious drawback, even if a more convenient liquid should not be hereafter discovered, as may still be hoped.*

As the result of the practical trial here recorded, I consider the three following facts as sufficiently established :—

1. The chromatic difference of spherical aberration may be overcome even in wide-angled systems by means of the ordinary methods hitherto applied in optical construction.

2. By the removal of this defect of spherical correction in

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* Microscopists who are connected with chemical matters are kindly requested to promote the homogeneous immersion method by looking out for such less known liquids as afford some hope of being useful for the purpose, and I shall be glad to investigate every sample which may be sent to me for trial. A few drops only, is quite sufficient for exact measurement, by means of the refractometer, of the refractive and dispersive indices.

microscopic objectives a useful improvement of the dioptric performance (definition) is obtained even when the defect of secondary chromatism cannot be removed.

3. The homogeneous immersion system admits of a useful increase of aperture closely approaching the ultimate limit which is imposed by the optical qualities of the materials hitherto available for microscopic preparations.

Anatomy of Leptodora hyalina.
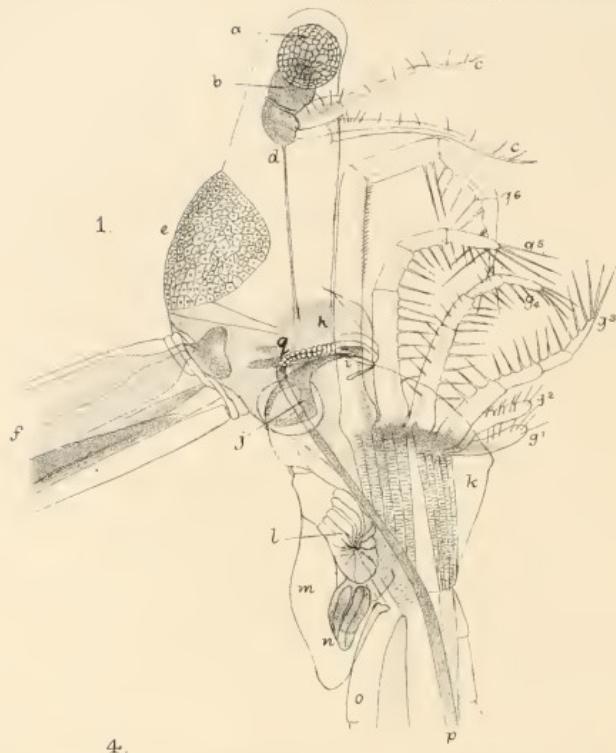
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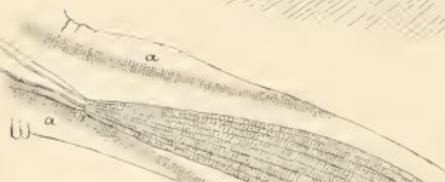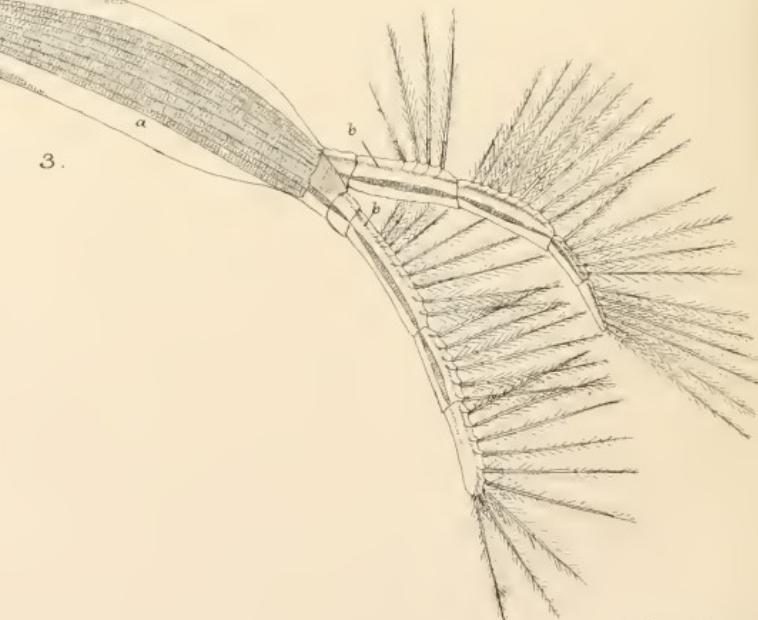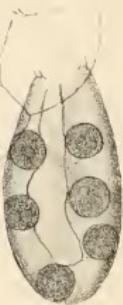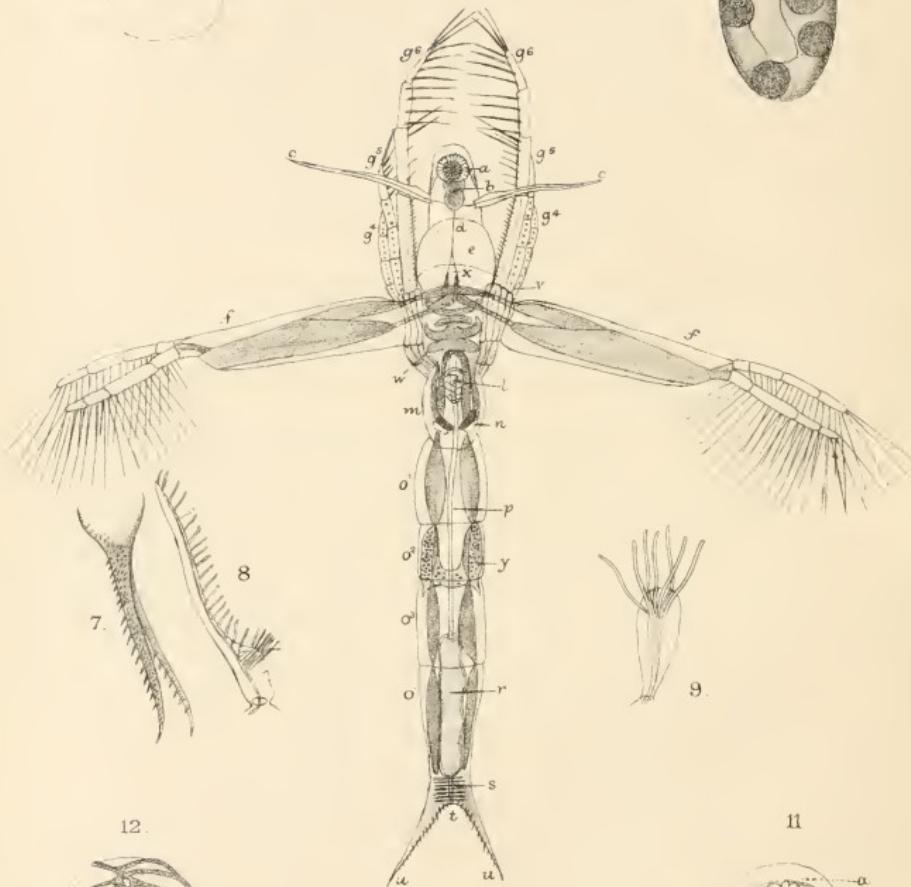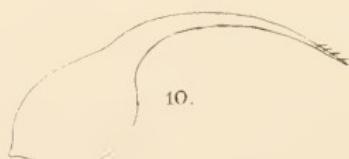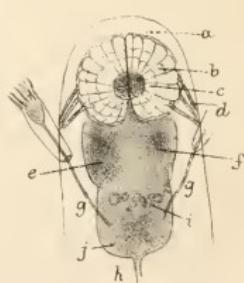
XXXVIII.—On the Anatomy of Leptodora hyalina.
By H. E. Forrest.

Plates XXIV. and XXV.

Leptodora hyalina is a very interesting Entomostracon, which has only recently been added to the British fauna. It was discovered in this country on the 19th July, 1879, in Olton reservoir, near Birmingham, by Mr. J. Levick, who with several fellow-members was on an excursion of the Birmingham Natural History and Microscopical Society. Sir John Lubbock read a paper on it at the meeting of the British Association at Sheffield, and a short description of it is given in the 'Midland Naturalist' for September, by Mr. W. Graham. Up to the present time, however, nothing has been published in England upon the anatomy of the animal, and it is hoped that the following remarks may be useful both to those who have seen it, and those who have not had an opportunity of doing so.

I will describe first its external structure, next the digestive apparatus, then the nervous or sensory organs, and lastly the reproductive organs, and differences between the sexes.

EXPLANATION OF PLATES XXIV. AND XXV.

Fig. 1.—Lateral view of male *Leptodora hyalina*, to the first abdominal somite.
„ 2.—Dorsal view of the entire male animal. *a*, eye. *b*, cerebrum, or brain ganglia. *c*, antennules. *d*, commissure. *e*, cephalostegite, or head shield. *f*, antennæ. *g*, 1 to 6, legs. *h*, upper lip. *i*, lower lip. *j*, mandible. *k*, thorax. *l*, heart. *m*, omostegite, thoracic shield, or carapace. *n*, kidneys. *o*, 1 to 4, abdomen. *p*, œsophagus. *q*, pharynx surrounded by salivary glands. *r*, stomach. *s*, rectum. *t*, anus. *u*, terminal hooks of the abdomen. *v*, ligaments, to the ends of which the muscles of the antennæ are attached. *w*, ditto for muscles of the six pair of legs. *x*, œsophageal collar. *y*, testis.
Fig. 3.—Antenna viewed from beneath. *a*, muscles. *b*, nerves.
„ 4.—Seta from branch of antenna. *a*, nerve entering from below, and terminating on diaphragm between the joints.
Fig. 5.—Carapace (omostegite) of female, with ova arranged round it, and showing the opening which fits over the abdomen.
Fig. 6.—Ideal section of ditto, showing the incurved edges and ovum *in situ*, one on each side.
Fig. 7.—Side view of terminal abdominal hooks.
„ 8.—Antennule of male, showing the nerve entering from below and traversing the whole length, giving off branches to each of the truncated setæ.
Fig. 9.—Ditto of female.
„ 10.—Mandible, showing teeth on point.
„ 11.—Head of female. *a*, outer membrane of eye. *b*, crystalline tubes. *c*, pigment mass. *d*, muscles of the eye. *e*, *f*, right and left ganglia of brain. *g*, nerves of the antennules. *h*, commissure connecting the brain with the thoracic ganglia. *i*, dark oval bodies. *j*, basal ganglion.
Fig. 12.—Dorsal view of the heart, showing only the surface muscles.

I. *External Structure.*

The general appearance of Leptodora is shown in Fig. 2. The body, which is long and straight, is of nearly the same width throughout. It measures from ¼ inch to ½ inch in length and about $\frac{1}{20}$ inch in greatest breadth. The division into head, thorax, and abdomen is well marked. The head (Fig. 1, *a–h*) is apparently of one piece, having no traces of segmentation. In shape it is a rounded column, gradually expanding towards the base, and slightly flattened on the ventral side. On each side of the eye there is an antennule (= the superior antennæ of Baird), which is long and tapering in the male (Fig. 8), but short and claviform in the female (Fig. 9). Just above its junction with the thorax the head is covered, dorsally, by a saddle-shaped shield (= cephalostegite of Huxley), beautifully constructed of flat polygonal cells, each with a raised dot in the centre of it (Fig. 1, *e*). Almost opposite this, on the ventral surface, is the mouth, one of the most extraordinary I have ever seen. In the Crustacea we are accustomed to find a complicated arrangement of maxillæ, palpi, and other hard structures. In Leptodora we find, however, simply an upper and lower lip, soft and mobile, the upper fitting over the lower like the two halves of a duck's beak. When the animal requires to open its mouth it calls into play a set of muscles which cause the upper lip to wrinkle and curl upward in a manner which cannot fail to strike the observer as comical. The lower lip, which is the same shape as the upper, possesses little or no mobility; it almost rests on a kind of platform, formed by the top of the thorax (Fig. 1, *h*, upper lip; *i*, lower lip).

On each side of the body, between the cephalostegite and the thorax, are attached the antennæ (= inferior antennæ of Baird), joined to the body by several wrinkled folds of the integument (Figs. 1 and 2, *f*). Each antenna consists of a large, broad, and slightly flattened arm, divided at the end into two branches (see Fig. 3) of four joints each. The arm is not setose, but the three distal joints of the one branch bear nine, six, and nine setæ respectively, and the four joints of the other branch bear four, nine, five, and six setæ respectively. These are the usual numbers, but they vary slightly in different individuals. Each seta (Fig. 4) is divided into two, and occasionally three joints, and tapers off to a very fine point. The sides are delicately fringed with hairs of extreme tenuity, so closely set that the whole forms a kind of oar almost impervious to water; presenting, perhaps, the largest possible surface, at the smallest expenditure of material. The antennæ are used solely as organs of locomotion, i.e. as swimming organs. Their motion is chiefly perpendicularly up and down. Though

at the same time the animal progresses *forward*. This forward motion is no doubt due in part to a slightly backward direction of the down stroke, but I think that it is also largely due to the structure of the antenna.

As I have pointed out, the flattened oar-like end of this organ is jointed, and therefore flexile. At each downward stroke it bends upwards, at each upward stroke it bends downwards. The setæ all taper to the point, so that the base is stronger than the point, and the weakness increases gradually upwards: consequently although the normal position is straight, the force of the impact of the water causes it to yield and bend, and this yielding is greater towards the point than at the base, and since they are all united so to speak, into a compact plate by the fringes on each side, and are all acted upon at once, the whole surface of the oar assumes a curved form, and strikes the water obliquely, instead of flatly, and the animal is in consequence driven forward. My meaning will probably be clearer, if I say that the principle which causes the oar of Leptodora to glide *forward*, is exactly the same as that which causes a rower's oar to glide *downwards* when he dips it into the water obliquely and " catches a crab." At each stroke of the antennæ the direction of the slope is reversed, so that both the upward and downward stroke drive it forward. The direction of the hairs which fringe the setæ (Fig. 4), is also such that it is easier for the water to pass over than between them.

The thorax (Fig. 1, *k*) is that part of the body which bears the legs. It consists of seven somites which have anastomosed so thoroughly as to leave no traces of the original segments, and indeed we can only guess their number from the number of pairs of appendages. Six pairs of these (Fig. 1, g^1–g^6) take the form of legs, and are placed in a semicircle around a kind of platform formed by the top of the thorax. Although they vary immensely in length, they are all constructed exactly alike, each consisting of four rounded joints provided with setæ. The smallest pair (Fig. 1, g^1) is in the middle of the semicircle, and each succeeding pair is longer than the last, the sixth being so long that they meet far above the head (Fig. 4). The three smaller pairs are curved upwards and towards the mouth, the three larger ones in the opposite direction towards the last three.

The flexure of the limbs naturally leads to the supposition that they are used for capturing prey, and their arrangement round the mouth is such that no animal once within their pale could well escape running the gauntlet between those ferocious-looking organs of destruction, the mandibles (Fig. 1, *j*). These last are the seventh pair of thoracic appendages, modified for manducatory purposes. It is remarkable that none of the limbs are converted into branchiæ such as we find in the Daphniadæ. The dorsal side

of the thorax below the limbs is expanded into a hoodlike carapace (= omostegite of Huxley), which is small and attached all round to the body in the male (Fig. 1, *m*), but large and open below in the female (Figs. 5 and 6 in section). The abdomen (Fig. 1, *o*), (Fig. 2, *o* 1–4), consists of four somites of unequal length, but nearly the same width; the terminal one is divided at the end into two long sickle-shaped hooks (Figs. 7 and 4, *u*) covered with short flat spines, a row of larger ones along the inner edge.

II. *The Digestive and Circulatory System.*

The alimentary apparatus of *Leptodora* is very simple. The mouth I have already described. The bases of the mandibles (Fig. 1, *j*) are embedded in a muscular bulb in the thorax, but the points are free and project into the mouth, one on each side, at the junction of the upper and lower lips. Their points are armed with three or four projecting teeth (Fig. 10). Whenever the mouth opens these mandibles begin to work towards each other across the opening of the œsophagus, tearing the food as it passes between them. The food consists chiefly of small water insects and other living things. The pharynx (Fig. 1, *q*) is not always open, and I have seen it opening and shutting as if it were closed by a sphincter muscle. It passes straight backwards as far as the roots of the mandibles, and is surrounded by a number of cells, which are probably salivary glands. It passes between the mandibles and then curves suddenly downwards, and enters the œsophagus, a long tube traversing the centre of the abdomen as far as the last somite but one, where it is expanded into a stomach the walls of which are corrugated interiorly. The anus is situated between the terminal hooks, at the end of a short rectum (Fig. 2, *s*).

On each side of the heart there is a long dark vessel (Figs. 1 and 2, *n*), which is probably a kidney. It is bathed all round with the blood, and would no doubt secrete the urine from it as it passes. It is divided at the end into two lobes, one of which is of a darker colour than the other. A long duct leads from it upwards into the centre of the thorax, where it gets lost in the mass of muscles and nerves which crowd this part, so that I have not been able to trace them any further. I think, however, that the ducts enter the œsophagus, and their contents then find their way out through the same opening as the other fæcal matters.

There is no trace of a liver, but probably the walls of the stomach secrete some fluid analogous to the gastric juice. The circulatory system is also very rudimentary. The heart (Fig. 1, *l*, Fig. 2, *l*, and Fig. 12) is a perfectly transparent sac encircled with numerous muscles, situated in the centre of the thorax, to the sides

of which it is attached by slender ligaments of connective tissue. Fig. 12 is a dorsal view of the heart showing the arrangement of the muscles. It pulsates very rapidly, pumping the blood along just like a pair of bellows. *Leptodora* cannot be said to have any true arteries or veins, the blood merely courses along the interstices between the organs of the body. The corpuscles are amœboid, colourless, nucleated, and remarkably few and far between. At each contraction of the heart the blood is driven forward through an opening at the end nearest the head, where there is a valve which prevents its return when the heart re-expands. The blood then enters at the opposite end, to be in its turn driven forward, and so on *ad libitum*. It is very remarkable that *Leptodora hyalina* has no organs set apart for respiration. In the other Cladocera we always find some of the limbs flattened and otherwise modified so as to serve the purpose of gills, but in *Leptodora* the whole body wall is so thin, and consequently the whole body so thoroughly exposed to the oxygenizing influences of the water, that the specialization of any parts for breathing organs is unnecessary.

III. *Nervous System and Sensory Organs.*

The nervous system is more highly developed than might be expected from the otherwise low organization of the animal. It shows a degree of concentration almost equal to that of the spider crabs (*Maia*). There is a large brain mass or cerebrum in the front part of the head, and the eye rests immediately upon it (Fig. 1, *a* and *b*). The cerebrum is indistinctly divided into three parts. Two upper right and left parts (Fig. 11, *e* and *f*), and one basal part (Fig. 11, *j*), probably the remains of three ganglia which have coalesced. The basal part gives off a large nerve (*g*) to each of the two antennules. Each nerve gives off branches to the setæ with which these organs are studded, and it is remarkable that they differ materially from the setæ found on other parts of the body, being truncate instead of pointed (Fig. 8, male; 9, female). Hence the end of each nerve is exposed almost naked to the water, making the antennules most delicate sensory organs.

What their precise function is, is a moot point, some authors say they are for hearing, others for smelling. Sir John Lubbock in his recent paper read before the British Association fully discusses this question, and concludes that the latter is the most probable, because the antennules are much more developed in the males than in the females. If one sex attracts the other by sound, both sexes would have the ear developed, for the attracted sex must be able to distinguish the sound, and the singing sex must have a good ear

to regulate the sound. In such a case there would not be much difference between the organs of hearing in the male and female. But if one sex attracts the other by smell, it is not necessary that the attractive sex (female in this case) should have well developed organs of smell. If the antennules were hearing organs, I still do not see how they would be available for bringing the sexes together, for the assumption that the male can produce any sound is pure hypothesis, and so soft are the parts of its body that I doubt whether such a thing is possible; indeed the whole evidence is so strongly in its favour that Sir John Lubbock's conclusion is evidently the right one.

The eye is a most beautiful organ. If viewed laterally (Fig 1, *a*) it appears globular, but is not really so. Seen from beneath (Fig. 11) it is found to be reniform, composed of a series of cuneiform crystalline tubes (Fig. 11, *b*) with rounded extremities, but not so closely appressed as to become hexagonal. These are enclosed in a very transparent membrane (Fig. 11, *a*), and radiate from a dark-coloured pigment mass (*c*) in which their inner ends are embedded. This eye is remarkable for exhibiting a distinct tendency to become two eyes as in the higher crustacea. Down the centre of it (Fig. 11) there is drawn a faint line, which in the lower half widens into a considerable gap, where there are no crystalline tubes, the right and left halves thus formed corresponding to the right and left cerebral ganglia (Fig. 11, *e* and *f*). In some specimens this gap is much more distinct than in the one figured. We see the same thing in the larva (Zoea) of the prawn, which has one eye, but later on two eyes. The eye of *Leptodora* too, is much in advance of that of the other Cladocera, in which it consists of a pigment mass with a few irregular crystalline sacs attached to it. Between the upper and lower ganglia of the brain there are several dark oval bodies (Fig. 11, *i*), whose function I cannot guess. The basal ganglion gives off a large commissure (*h*), which bifurcates, in some specimens close to, in others at a considerable distance from its origin; the two halves being very much thickened as they pass one on each side of the œsophagus to form the œsophageal collar (Fig. 2, *x*). They meet on the opposite side, in a large nerve mass formed by the coalescence of all the nerve centres of the thorax and abdomen into one. This mass is situated between the bases of the six pairs of legs and the mandibles, and gives off nerves, one to each leg, one to each side of the abdomen, and one larger than the others to each antenna. These nerves of course give off smaller branches innumerable, but I need not describe them further than to say that every individual seta is provided with one. In the large setæ on the antennary branches (Fig. 4, *a*) the nerve terminates on the diaphragm between the two joints.

IV. *Muscles.*

Probably in no other animal is muscular action and structure displayed more beautifully than in *Leptodora*, for on account of its transparency the muscles may all be seen *in situ* without any dissection. The most powerfully developed are those of the antennæ, which are shown from a dorsal aspect in Fig. 2, *f*, and from beneath in the larger drawing (Fig. 3, *a*). The immense power of these muscles requires that the point of attachment should be very firm, but the body wall of the thorax is much too soft to bear the strain, so instead of being attached to it, they are fastened (Fig. 2, *v*) to the ends of two ligaments which pass right through the thorax, and are only fastened to the body wall by threads of connective tissue. Thus the two opposite antenna-muscles actually pull against one another, and the whole strain is borne by the ligament between them. The six pairs of legs are each provided with a muscle, and their ends too are attached to ligaments between their bases (Fig. 2, *w*), and the right and left sides pull against one another. A large flat muscle runs down each side of the body, and is attached to each somite, the final attachment being to the sides of the terminal somite, almost at the end of the stomach (Fig. 2, *r*). The rectum (*s*) is opened and closed by a set of sphincter muscles, and so is the pharynx, as I have already mentioned. The muscles which move the lips are attached at one end to the lips, at the other to the ventral or dorsal sides of the head (see Fig. 1). The eye has six muscles fastened to it at six different points, about equal distances from one another (Fig. 11, *d*). These are constantly in motion, causing the eye to perform a quarter of a revolution in one direction, then to revolve the same distance in the opposite direction, and this movement does not seem to be under the control of the animal, as it is as incessant, though not so regular as the beating of the heart. The muscles which encircle this last-named organ are distinctly striate (Fig. 12), and distributed over its surface in irregular loops.

V. *Sexual Differences.*

In *Leptodora*, as in most of the Cladocera, the female is larger than the male. In August, when I first began to collect them, the females were much more numerous than the males; but later on the males appeared in goodly numbers, and finally, in October, there were as many males as females, if not more. Now (November) both sexes have entirely disappeared, and I much regret that I am not able to give a drawing of the ovaries, as I neglected to mount a female specimen, supposing I should be able to procure them alive at any time. I have seen them, however, very often, so am not at a loss how to describe them. They are elongated

dark-coloured organs, fastened by one end to the inside of the wall of the abdomen, close to the junction of the first and second somites. The inner ends are free, the right-hand ovary projecting into the abdomen downwards; the left upwards. When much distended with eggs they sometimes nearly fill the abdomen. My friend Mr. W. P. Marshall informs me that he saw one female with a row of eggs the whole length of the abdomen, but I did not see the specimen myself. The oviducts open on to the surface between the second and third somites. The eggs, after extrusion, are carried about in the carapace of the mother until hatched. The way in which they are kept in their places is very remarkable. The carapace (omostegite) is much larger in the female than in the male (Fig. 5, female, and 1, *m*, male), shaped like the bowl of a spoon, with the edges produced and curled over inwards. It is this incurvature of the edges which prevents the eggs from tumbling out of the carapace, as shown in Fig. 6, which is an ideal section of the carapace and abdomen showing two eggs, and the way in which the opening is closed below by the top of the abdomen. The eggs are always arranged round the carapace, never in the middle, and the greatest number I have seen within it at one time is six. I am indebted to Mr. J. Levick for a specimen showing the structure of the female carapace very clearly.

The testes (Fig. 2, *y*) occupy the same position in the male as the ovaries of the female. They each consist of an elongated, transparent sac, pointed above and below, and connected together by a saddle-like band. They are filled with sperm vesicles, most thickly congregated towards the upper end. As my paper only treats of the anatomy of the animal, I cannot enter into the subject of its development, although it is highly interesting.

VI. *Zoological Position.*

Leptodora hyalina was placed by Lilljeborg in the Branchiopoda, Order Cladocera, and Family Daphniadæ, and his placing has since been admitted by other naturalists without demur : but, during the last two months, I have had the animal under close observation, and the more I study it the more the conviction grows upon me, that its departure from the type is so great that one of two things must happen. Either the diagnosis of Cladocera and Daphniadæ must be altered in order to admit the species, or else *Leptodora* must be placed in a separate order and family. The following is Baird's description of the order Cladocera, condensed.

Body, except the head, enclosed in a bivalve carapace hinged at back. Feet four to six pair, articulations chiefly branchiform, not adapted for locomotion. Eye single, large. Antennæ two pairs, inferior branched, large, and adapted for swimming. Mandibles without palpi.

In the 'Micrographic Dictionary,' the first part of the diagnosis which speaks of the body being enclosed in the carapace is omitted, but even in this revised form it will not admit *Leptodora*.

I don't understand why Lilljeborg placed *Leptodora* in the family Daphniadæ, which is defined thus: " Superior antennæ very small, inferior large with two branches. Legs five or six pairs all enclosed within the carapace." As the carapace of *Leptodora* is so small that it does not completely cover one somite of the abdomen, much less any part of the legs.

The probable explanation is that Baird's arrangement was founded only on those British Entomostraca with which he was acquainted, and under these circumstances it will, I suggest, be best to place *Leptodora* in a family by itself, and to modify the Cladocera as defined in the ' Micrographic Dictionary,' by the alteration of a single word.

Order, Cladocera. Legs four to six pairs, *generally* branchial ; eye single, and very large, antennæ two pairs, inferior large, branched, and adapted for swimming.

Family I. Daphniadæ ; Family II. Polyphemidæ ; Family III. Leptodoridæ. Inferior antennæ very large, two branched, both four-jointed. Legs six pairs, none of them branchiform. Carapace very small, not enclosing the body. Young passing through a metamorphosis from the winter egg.

VII. *History.*

Leptodora hyalina was first discovered by Dr. Focke, who found it in the moat of the city of Bremen in 1844, and exhibited it at a meeting of the Natural History Society of that place. It did not however receive any name until 1860, when it was described in the 'Transactions' of the Swedish Academy by Lilljeborg, who had found it in the Swedish lakes. His treatise is written in Swedish, but he gives a long Latin diagnosis. Müller was the first to find the male in the Lakes of Constance, Geneva, and Denmark. Nicolaus Wagner discovered it in 1868 in Russia, in a lake near Kasan, and not knowing that Lilljeborg had already described and named it, he gave a description and four plates of it under the name of *Hyalosoma dux.* In 1873, Sars published some notes on the development of the winter eggs. In 1874, Dr. August Weismann published a very elaborate and careful paper on its anatomy, with six plates, in the 'Zeitschrift für wissenschaftliche Zoologie,' vol. xxiv. Through the kindness of Mr. Crisp, I have been able to examine this paper, which was translated for me by a lady friend, and I find that there are one or two points on which my observations do not agree with his. He draws all the setæ on the branches of the antennæ equal in length, which in my view is not

correct. He does not appear to have noticed the incurved edges of the female carapace by which the eggs are held, as he figures it merely as spoon-shaped, and states that the eggs are held in their places by transparent threads. I have not been able to detect these threads, but would not venture to deny their existence. He also states that the dots on the cephalostegite are the openings of glands; if so, they would open inwards, but they appear to me *raised* spots on the outer surface, and not openings at all. I do not know whether he observed the polygonal markings on this shield, but he does not figure them. He also contradicts Wagner's assertion that bristles occur on this part of the body, and considers that what Wagner took for bristles were parasitic fungi. I have noticed that almost all my specimens had the cephalostegite and sometimes other parts of the body covered with the frustules of a diatom (*Synedra*), which at a casual glance might easily be mistaken for bristles. Probably this was the cause of Wagner's error.

Two things would tend to prevent the earlier discovery of *Leptodora* in Britain: first, its extreme transparency; and second, its habit of frequenting open and deep water, for it is usually found at a depth of three or four feet. A naturalist hunting for Entomostraca, would probably only dip for them in the weedy shallows where they mostly congregate, and would thus come away without procuring a single *Leptodora*, even in a pool where they abounded. Swimming in open water, the animal is of course exposed to the attacks of fishes, and no doubt its transparency is then a great protection to it. It would also serve to conceal it from any prey on which it is stealing.

Since its discovery at Olton reservoir, *Leptodora* has been found in great abundance at Edgbaston Pool, another large sheet of water in the neighbourhood of Birmingham, and in both pools it was associated with *Hyalodaphnia Kahlbergensis*, also a new discovery in this country.

XXXIX.—*On a New Species of the Genus Eucampia.*
By Henry Stolterfoth, M.D.

(*Read 8th October*, 1879.)

THE genus *Eucampia* was defined by Ehrenberg, and placed by him amongst the Desmidiaceæ. In Smith's 'British Diatomaceæ,' vol. ii. p. 25, it is rightly placed amongst the Diatomaceæ. Only two species are recognized by Smith, *E. Zodiacus* and *E. Britannica*, and neither of these had been seen by him in the living state. Both these species I have taken living by means of the tow-net in the estuary of the Dee, Chester. There is another *Eucampia* known, in the Hong Kong gatherings made by Dr. Palmer, as *nodosa*; this latter is, I believe, identical with *E. Zodiacus*, and only represents a stronger growth in a hotter climate.

In the year 1875 my attention was called by A. O. Walker, Esq., Chester, to some circular rings taken in the tow-net. These were, however, very few, and I then took them to be some kind of unknown Confervæ. The rings I have since continually seen, but never in sufficient abundance to make out their silicious covering.
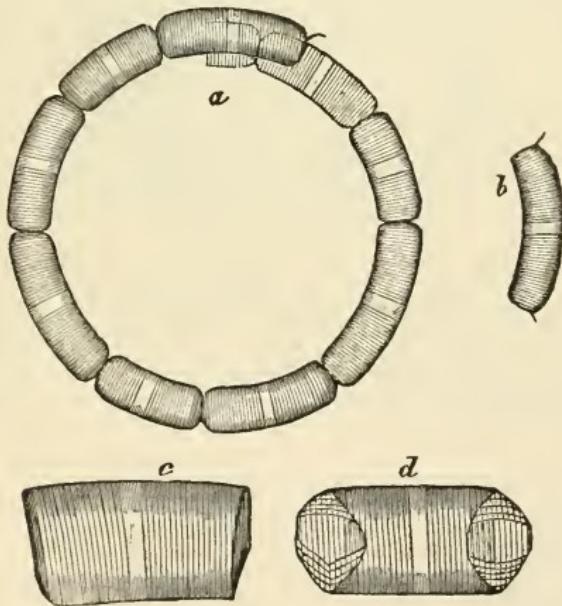
a.—*Eucampia striata* n. sp. × 350.
b.—A single frustule, showing spines.
c.—*Eucampia striata*, n. sp. var. *maxima*.
d.—The common appearance of the frustule when seen on a burnt slide.

On July 14th, 1879, I obtained a nearly pure gathering of this form and was able to make a careful examination of it both living, burnt on the cover glass, and preserved in fluid.

3 K 2

The definition of the genus *Eucampia* Ehr. as given in 'Sm. Brit. Diat.' vol. ii. p. 25, is—

" *Frustules* cuneate, quadrangular or oblong, united into a spiral filament ; valves dotted, elliptical."

This definition slightly extended, so as to include my new form, obviates the necessity of creating a new genus :—

Frustules cuneate, quadrangular or oblong, united into a spiral filament ; valves dotted or costate, elliptical or circular.

Eucampia striata n. sp.   Breadth of the whole plant circle about ·01 of an inch.   Valves hyaline.   Side view, circular, ·002." Front view, trapezoidal, and about four or five times longer than broad.   Marked with fine costæ extending across, 14 to the ·001". A small spine at the angles terminating the convex border, and situated at the edge of the circular side view.   Endochrome green.

Habitat, marine ; estuary of the Dee, Chester, July 14th, 1879, and Hong Kong Harbour (Dr. Palmer).

In the same gathering I found another form, which I take to be a variety—*Eucampia striata* n. sp. var. *maxima*.   I have never seen a complete circle of the whole plant, only five or six frustules together forming a curve.   Valves hyaline.   Side view, circular, ·004".   Front view nearly square, marked with costæ 7 or 8 to the ·001".   No spine.   Endochrome green.   In the dry state the ends of the valves fold over, as seen in *d*.

Habitat, marine ; estuary of the Dee, Chester. July 14th, 1879, and Hong Kong Harbour (Dr. Palmer).

The variety *maxima* may only be a stage of growth, but it is constant in its appearance, and I do not find intermediate states of growth.

I have added the locality Hong Kong on the authority of my friend, Laurence Hardman, Esq., who pointed out to me the exact similarity between my form and that found in the Hong Kong gatherings, and which he believes has never yet been described owing to the want of fresh material.

XL.—*Immersion Stage Illuminator.*
By John Mayall, jun., F.R.M.S.

The illuminating device here described was obviously suggested by Professor Abbe's Apertometer-disk.

It is evident that every apparatus fit for observing the aperture of a high-angled object-glass must likewise be capable of being used for illuminating the marginal zone of such an objective.

The apertometer-disk itself was found to require modifications as to size, shape, &c., to render it more practical as an illuminator, especially for lamp-light. The modifications here detailed have been designed specially with a view to using the illuminator on the Continental stands provided with concentric rotating stage, many of which do not conveniently admit the use of very obliquely incident light from beneath.
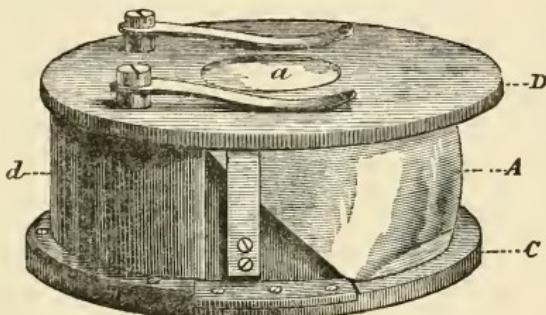
Diagram ⅔ scale.

The plate of glass A is held on to the foot-plate C by means of vertical spring clips from which it can be removed for cleaning; the back edge is cut to an angle of $45°$ as in the apertometer-disk, for total reflection of illuminating rays; the peripheral margin, admitting the rays, is ground spherically instead of cylindrically, which adds to the illumination; it is supported by a brass semi-cylinder *d* which forms part of the foot-plate C. A brass object-plate D, carrying clips for the object-slide, is made to rotate on the upper surface of A round the circular glass plate *a* which is slightly below the surface of D and ground conical and cemented on to A and acts as a pivot to D, smooth rotation being obtained by means of a film of glycerine interposed.

The illuminator is to be secured firmly on the rotating stage by clamps on the projecting edges of the foot-plate after the centre of *a* has been centred with the optical system. The lamp and condensing lens to be suitably adjusted so that the reflected image

of the flame is seen nearly in the plane of the object.   The object-
slide is placed in immersion contact with the plate *a* under the
clips ; the brass plate D will now rotate the object-slide to the
required position with reference to the incident light, while the
rotation of the Microscope stage (carrying the illuminator) will
give every range of obliquity from central light to dark-field with
any objective, the lamp and condenser remaining stationary.

It would doubtless be possible to dispense with a rotatory stage
by inserting the glass plate A into a rotating plate in the foot-
plate C, but there would be difficulty in making the rotation exactly
concentrical to the rotation of the brass object-plate D.

My acknowledgments are due to Professor Abbe for the interest
he has shown in the practical development of the plan : without
his assistance even this experimental device would probably not
have been made.

XLI.—*On a Table of Numerical-Apertures, showing the Equivalent Angles of Aperture of Dry, Water Immersion, and Homogeneous Immersion Objectives, with their respective Resolving Powers, taking the Wave Length of Line E as the Basis;* $a = n \sin w$, $n = refractive index,$ and $w = \frac{1}{2}$ *angle of aperture.*

By J. W. STEPHENSON, F.R.A.S., Treas. R.M.S.

(*Read* 12*th Nov.,* 1879.)

As considerable misapprehension appears to exist, not only in this country but also in the United States, as to the special advantage of the " Numerical-Aperture " of Professor Abbe, I have thought it would be useful to construct the subjoined Table. It cannot be too strongly impressed upon microscopists, that the expression *angle of aperture* of objectives furnishes in itself no intelligible measure of the actual resolving powers, which, as will be seen by the Table, bear no relation whatever to the *angles*.

The resolving powers are, however, exactly proportional (*cæteris paribus*) to the *numerical apertures,* and the expressions for the latter will therefore allow the resolving powers of different objectives to be at once compared, not only if the medium (air, water, oil, &c.) is the same in each case, but also if it is different.

Thus, to say that a dry objective has an angle of 60°, a water-immersion 53°, and a homogeneous immersion 48°, conveys no idea (without calculation) of their relative resolving powers, but when we are told that the three objectives are of 0·50, 0·60, and 0·62 numerical aperture, the comparison is obvious.

The Table shows, moreover, how little increase in resolving power may be gained by a considerable increase in the angle. Thus two dry objectives whose angles are 180° and 157° respectively, differ in resolving power by only 2 per cent.

	Numerical Aperture $= a$.	Angle of Aperture in Air.	Water Angle.	Homogeneous (or Balsam) Angle.	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0\cdot5269\,\mu$ =line E.)
Maximum aperture of homogeneous immersion objectives, with crown-glass cover ..	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
Zeiss' homogeneous ⅛th (1879)	1·40	..	..	134° 10′	134,960
	1·38	..	..	130° 26′	133,032
	1·36	..	..	126° 57′	131,104
	1·34	..	..	123° 40′	129,176

	Numerical Aperture = a.	Angle of Aperture in Air.	Water Angle.	Homogeneous (or Balsam) Angle.	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0.5269\,\mu$ = line E.)
Maximum aperture of water-immersion objectives	1·33	..	180° 0′	122° 6′	128,212
	1·32	..	165° 56′	120° 33′	127,248
Powell and Lealand's homogeneous $\frac{1}{5}$	1·30	..	155° 38′	117° 34′	125,320
	1·28	..	148° 28′	114° 44′	123,392
Zeiss' homogeneous $\frac{1}{8}$, $\frac{1}{12}$, $\frac{1}{18}$ (1878)	1·26	..	142° 39′	111° 59′	121,464
	1·24	..	137° 36′	109° 20′	119,536
Powell and Lealand's ditto $\frac{1}{16}$	1·22	..	133° 4′	106° 45′	117,608
	1·20	..	128° 55′	104° 15′	115,680
Nobert's 19th band = 113,000	1·18	..	125° 3′	101° 50′	113,752
	1·16	..	121° 26′	99° 29′	111,824
	1·14	..	118° 00′	97° 11′	109,896
Powell and Lealand's water immersion $\frac{1}{8}$, $\frac{1}{16}$	1·12	..	114° 44′	94° 56′	107,968
,, ,, $\frac{1}{4}$ ..	1·10	..	111° 36′	92° 24′	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
Maximum aperture of dry objectives	1·0	180° 0′	97° 31′	82° 17′	96,400
	0·98	157° 2′	94° 56′	80° 17′	94,472
Amphipleura pellucida = 92,000 to 95,000 ..	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
Navicula crassinervis = 78,000 to 87,000 ..	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° 76′	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
Surirella gemma = 64,000 to 69,000	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
Pleurosigma fasciola = 55,000 to 58,000 ..	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
Pleurosigma angulatum = 44,000 to 49,000 ..	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′	45,344
	0·44	52° 12′	38° 38′	33° 39′	42,416
	0·42	49° 40′	36° 49′	32° 5′	40,488
	0·40	47° 9′	35° 0′	30 31′	38,560
Pleurosigma Balticum = 33,000 to 37,000	0·38	44° 40′	33° 12′	28° 57′	36,632

Note.—The wave length assumed in the above Table is, as stated, $0.5269\,\mu$, but it is not unimportant to observe, that if the

point taken had been, as nearly as may be, midway between E and F, i. e. $= 0 \cdot 508 \, \mu$, the numerical aperture would *itself* have been the true measure of resolving power, being exactly equal to the number of hundred-thousands of lines in an inch ; thus giving 100,000 lines as the maximum of a dry lens, 133,000 as that of a water-immersion, and 152.000 as the ideal maximum of a homogeneous-immersion objective with crown-glass covers.

As the resolution by the same objective is affected by the intensity of the illuminating beam, by the colour of the object, and other circumstances, it is not possible to assign an absolute measure —using the line D ($= 0 \cdot 5889 \, \mu$), for instance, in the computation, the resolving power would be found to be $10\frac{1}{2}$ PER CENT. *less* than the tabular results : on the contrary, if the line F ($= 0 \cdot 4861 \, \mu$) were selected, the resolving power would be $8 \cdot 4$ PER CENT. *greater*, or taking the line $= 0 \cdot 40 \, \mu$ (near H_1), as probably sufficient for photographic resolution, the maximum number of lines which could be delineated by a dry lens would be 127,000, by a water immersion 168,910, or, by a homogeneous immersion objective (under present conditions) 193,040, although, if flint-glass covers with suitable homogeneous fluid were adopted, the ultimate limit might, on this hypothesis, be extended to, say, 200,000 ; and on the assumption that the space between each of these lines was equal to the lines themselves, it follows that the width of each line would be $\frac{1}{400,000}$ of an inch, but it by no means hence follows that this would be the ultimate photographic limit for a *single* line.

☞ There is *no loss of aperture on objects mounted in balsam*, or any more highly refractive medium (as was formerly supposed by many, myself included), under either of the systems, in fact the *full* resolving power (with transmitted light) can be attained only if the object is mounted in a medium whose refractive index is equal to, or greater than, the *numerical aperture* of the objective, so that if ever homogeneous objectives are constructed for flint-glass covers, some more highly refractive medium than balsam must be used for mounting the objects, such as bisulphide of carbon or oil of cassia.

XLII.—*Aperture Measurements of Immersion Objectives expressed as " Numerical Aperture."*

By John Mayall, jun., F.R.M.S.

(*Read 12th November*, 1879.)

As it is probable that apertures will be expressed, in future scientific discussions, by the nomenclature suggested by Professor E. Abbe, i. e. " Numerical Aperture," the following list of actual measurements may be interesting to microscopists :—

		" Numerical Aperture."
Zeiss's homogeneous immersion (Abbe's formula, 1879)	$\frac{1}{8}$	1·40
Tolles's oil immersion (1879)	$\frac{1}{12}$	1·30 +
„ „ „	$\frac{1}{10}$	1·30 +
„ water immersion (1876)	$\frac{1}{12}$*	1·28 +
Zeiss's homogeneous immersion (1878)	$\frac{1}{18}$	1·25 +
Tolles's water immersion (1877)	$\frac{1}{10}$	1·20 +
Zeiss's homogeneous immersion (1878)	$\frac{1}{18}$	1·20 +
„ „ „ „	$\frac{1}{8}$	1·20 +
„ „ „ „	$\frac{1}{8}$	1·20 +
„ „ „ „	$\frac{1}{8}$	1·20
„ „ „ „	$\frac{1}{8}$	1·20
Tolles's water immersion (1875)	$\frac{1}{10}$	1·20
„ „ „ (1876)	$\frac{1}{8}$	1·20
Powell and Lealand's oil immersion (1879)	$\frac{1}{8}$	1·20
Tolles's water „ (1874)	$\frac{1}{4}$	1·18
Powell and Lealand's „ „ new formula (1875)	$\frac{1}{4}$	1·18
Tolles's „ „ (1874) belonging to Mr. Crisp	$\frac{1}{8}$	1·15 +
Powell and Lealand's „ „ new formula (1875)	$\frac{1}{8}$	1·15 +
„ „ „ „ (1874)	$\frac{1}{10}$	1·15
„ „ „ „ new formula (1876)	$\frac{1}{8}$	1·15
Tolles's „ „ (1876)	$\frac{1}{25}$	1·12
„ „ „ „	$\frac{1}{25}$	1·10
Powell and Lealand's „ „ new formula (1876)	$\frac{1}{8}$	1·10
Prazmowski's „ „ (1874) No. 8 = $\frac{1}{8}$		1·05 +
Zeiss's „ „ (1875)	$\frac{1}{25}$	1·05 +
„ „ „ „	$\frac{1}{25}$	1·05 +
„ „ „ „	$\frac{1}{18}$	1·05 +
„ „ „ „	$\frac{1}{8}$	1·05
Nobert's „ „ (1867)	$\frac{1}{24}$	1·00 +
Hartnack's „ „ „ No. 12 = $\frac{1}{21}$		1·00 +
„ „ „ „ No. 9 = $\frac{1}{13}$		1·00 +
Prazmowski's „ „ (1874)	$\frac{1}{33}$	1·00 +
Gündlach's „ „ „	$\frac{1}{15}$	1·00 +

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* I am indebted to Professor R. Keith (of U.S.A.) for this measurement. He measured the balsam angle to be 115° (the highest aperture attained at that date), which would be about 1·28 of " numerical aperture." The other measurements were made by myself, and several were verified by Professor E. Abbe.

								"Numerical Aperture."
Spencer's	water immersion	(1878)	..	..	$\frac{1}{10}$	..	..	1·00 +
,,	,, ,,	,,	..	..	$\frac{1}{8}$	..	..	1·00 +
Ross's	,, ,,	(1879)	..	..	$\frac{1}{10}$	..	..	1·00 +
Merz's	,, ,,	(1868)	..	..	$\frac{1}{18}$			
,,	,, ,,	(1869)	..	..	$\frac{1}{18}$		slightly less than	
Beck's	,, ,,	(1875?)	..	..	$\frac{1}{20}$		1·00	
Prazmowski's	,, ,,	(1875)	..	..	$\frac{1}{60}$			
Powell and Lealand's water immersion (1879)					$\frac{1}{50}$			

The above list does not include those immersion objectives, by various makers, which yielded measurements of balsam angle notably less than 82° (= 1·00 num. ap.). The signs + indicate in which direction the measurement tended.

RECORD

INVERTEBRATA, CRYPTOGAMIA, MICROSCOPY, &c.,

including Embryology and Histology generally.

ZOOLOGY.

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

Gestation of the Armadillo.[*]—Mr. Milne-Edwards refers to the presence of four fœtal (nine-banded) armadilloes in a common chorion; the phenomenon may, he thinks, be explained either (1) by a number of ovules having been enclosed in the Graafian follicle, inasmuch as these ovules might also be enclosed in a common granular layer, and this layer would, on accompanying them into the oviduct and thence into the uterus, be converted into a common chorion; or (2) the effect may have been produced by the disappearance of the granular layer of each ovule and by the subsequent investment of the four fecundated ovules by a layer formed by the walls of the oviduct or uterus;—but this could not happen unless the secondary (amniotic) chorion had been absorbed, or had never been formed; or, (3) the four amniotic chorions might have fused at their points of contact and have undergone absorption at all but their peripheral portions.

Vitality of the Spermatozoa of the Trout.[†]—The details of M. Henneguy's experiments will be seen by the following table, which shows the number of ova that became developed after they (having been impregnated), were subjected to the following agents:—

(1) Pure water	..	..	..	..	..	62 eggs	.. ..	50 developed.
(2) Water with 5 per cent. alcohol	..	91	,,	.. ..	74	,,
(3) ,, ,, 10 ,, ,,	..	59	,,	.. ..	50	,,
(4) ,, ,, 5 ,, ether	..	51	,,	.. ..	42	,,
(5) ,, saturated with chloroform	32	,,	.. ..	19	,,

The fishes produced exhibited no difference to those developed from ova which had been fecundated in the ordinary manner; and it is concluded that doses of alcohol, &c., which are sufficient to kill Infusoria for instance, have no effect on the spermatozoa.

Experiments on Development.[‡]—MM. Pouchet and Beauregard describe some experiments in which they removed from eggs a small quantity of their liquid albumen and replaced it by a certain quantity (half a gramme) of sugar; and then reclosed the eggs in the manner they have already described. Experiments were made on eighty eggs, and of these twenty-eight were opened during the first thirteen

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[*] 'Comptes Rendus,' lxxxviii. (1879) No. 9.
[†] 'CR. Soc. Biol.' for 1877 (1879), p. 274.　　　[‡] Ibid., p. 338.

days of incubation; fifteen were found to be undergoing the normal processes of development, and thirteen, though partly developed, were found to be dead. No observations were made on eggs more than thirteen days old; in no case did the cane-sugar seem to have been converted into glucose, but the authors are unable to reply to the question they themselves propose: Has the sugar remained unaltered in the albumen or has it been absorbed by the embryo? They draw, however, attention to what they were enabled to observe in those eggs which underwent no development at all; part of the vitellus presented a milky-white colour, the albumen, especially near the yolk, was opaque, and the egg, when opened, had the odour of a substance in which lactic fermentation was going on.

M. Pouchet has also made some experiments on the eggs of birds, with the view of seeing whether the form of the egg has any influence on the direction in which the embryo is developed, and found that if he seized a chalaza and turned it round in the yolk, and then allowed development to proceed, the embryo was itself altered in position.

Granular Bodies found in the Ovum. *—M. Dareste reaffirms the presence of amyloid granules in the yellow of the egg; he shows the presence of starch by the action of chemical reagents, and points out that the fact of these granules not being composed of lecithin is shown by their insolubility in alcohol or ether; he has not, however, been able to isolate these granules from the rest of the mass.

M. Dastre, however, is of opinion that the granulations are phosphates of fatty bodies (of lecithin), and asserts that they contain no starch; he draws attention to the difficulty of finding starch, which gives a blue reaction to the iodine test (as found by Dareste), and points out that it is only vegetable starch which does this, and that animal starch reddens under the action of iodine.

Development of the Ova and the Structure of the Ovary in Man and other Mammalia.†—The history of these structures has been lately dealt with by Mr. Balfour in the 'Quarterly Journal of Microscopical Science,'‡ and to this paper Dr. Foulis refers in one by himself in Humphry's 'Journal of Anatomy and Physiology.'

The principal results arrived at by Dr. Foulis are that all the ova are derived from the germ epithelial cells. In the development of the ovary small and large groups of the germ epithelial cells become gradually embedded in the ever-advancing stroma. Germ epithelial cells do not grow downwards into the substance of the ovary. The ovarian stroma constantly grows outwards, surrounding and embedding certain of the germ epithelial cells. As these latter increase in size, and as the stroma thickens around them, the whole ovary becomes enlarged. Pflüger's tubes in the kitten's ovary have no existence as such, but are appearances produced by long groups

* 'Comptes Rendus,' lxxxviii. (1879) Nos. 11 and 14; see 'Rev. Sci. Nat.,' i. (1879) p. 91.
† 'Journ. Anat. and Phys.' (Humphry), xiii. (1879) p. 353.
‡ 'Quart. Journ. Micr. Sci.,' xviii. (1878).

of embedded germ epithelial cells, many of which groups are not completely cut off from the germ epithelial layer by the young ovarian stroma. Such groups of germ epithelial cells, in various forms, are met with in all ovaries, but have no importance whatever as tubular structures. In the human child's ovary numerous furrows, or clefts between irregularities of the general surface, are met with. Sections through these furrows and clefts produce the appearance of the germ epithelium (pseudo-epithelium, Balfour) having passed downwards into the ovary in the form of tubular open pits, as was described by Waldeyer and his predecessors. No real tubular structures from which Graafian follicles are formed exist in the mammalian ovary at any stage of its development. Graafian follicles are formed only in one way from the beginning of the ovary to the end of its existence.

The youngest connective tissue of the stroma, in the form of offshoots of jelly-like protoplasm, surrounds and embeds large and small groups of germ epithelial cells. A single germ epithelial cell may be completely surrounded by this young connective tissue. When this takes place the germ epithelial cell rapidly grows and becomes a primordial ovum. Each individual cell in a group of epithelial cells, surrounded by the young ovarian stroma, shows a similar tendency to become a primordial ovum. All the groups of developing germ-cells or cell-nests in the ovary are broken up into still smaller cell-nests by the ever advancing young connective tissue, until, at last, individual cells in the cell-nests become completely surrounded by the youngest connective tissue. When an individual germ-cell becomes surrounded by the young connective tissue, at the same time, and as part of the process, the Graafian follicle begins to be formed. Whenever the young jelly-like connective tissue appears, in its substance nuclei, generally fusiform at first, make their appearance. These nuclei may be always seen in contact with the yolk substances of the primordial ova. The follicle cells are derived from the nuclei which lie in contact with the protoplasm or yolk substance of the developing ova. This takes place in all parts of the ovary wherever cell-nests are formed. The follicle cells thus originate from the cells of the ovarian stroma, and not from the germ epithelial cells. In the mammalian ovary at birth the most advanced ova are met with deep in the ovary, and not in passing from without inwards, as described by some observers. In a ripe Graafian follicle the stroma cells outside the membrana propria folliculi become converted into cells exactly similar to the true follicle cells, and it is possible to trace the ordinary stroma cells outside the follicle through all stages of development into cells resembling the follicle cells, the observation affording a most conclusive proof of the origin of the follicle cells from the ordinary cells of the stroma.

With these results it will be interesting to compare those of Mr. Balfour; he, likewise, says "The whole egg-containing part of the ovary is really the thickened germinal epithelium." "Pflüger's egg-tubes are merely trabeculæ of germinal epithelium, and have no such importance as has been attributed to them." So again, as

regards the "cell-nests," Mr. Balfour observes that he noted "the fusion of several ova into a syncytium, the subsequent increase in the number of nuclei in the syncytium, the atrophy and absorption of a portion of the nuclei, and the development of the remainder into the germinal vesicles of ova."

Micro-chemical Researches on Cell-nuclei.[*]—Dr. Brandt has been making some observations, from a micro-chemical point of view, on cytods and cells. The researches of Miescher have shown that the cell-nucleus consists of a special substance, nuclein, which is distinguished by the possession of phosphorus. Brandt treated some *Protamœbœ* with ten per cent. salt solution, and found that they broke up altogether; where nuclein is present a precipitate is left, and this, which was found where Protozoa proper (that is, nucleated forms, and not Protista or cytod forms) were acted on by the reagent, is regarded by Brandt as being a carbo-hydrate allied to cellulose. We have here therefore a valuable method to be applied in all cases where the presence of a nucleus is disputed.

Observations on the Living Cartilage Cell.[†]—W. Schleicher, whose paper on the division of cartilage cells has been already noticed,[‡] now investigates more fully the movements observed in these cells and in their nuclei.

The nucleus moves as a whole, vibrating (*ballotter*) from side to side, either quite irregularly, or, if it is in contact with the edge of the cell, regularly from right to left, and *vice versâ*. The action is caused by the solid elements in the protoplasm of the cell, which are in constant vibration, communicating the movement to the nucleus. The slight changes in form undergone by the surface of the latter are due to the same cause. The solid elements within the nucleus (rods, filaments, &c.), are, like those of the cell itself, in constant motion, by virtue of which they cause slight changes of form in the nucleus, which, from being spherical, may present slight tuberosities. The movements may be augmented in intensity by raising the temperature to 20°–25° C.

Schleicher objects to the term "reticular" as applied to the refractile elements of the nucleus. He says that just as the cell-protoplasm is composed of two different substances, an almost liquid and homogeneous matrix, and solid contractile elements, floating freely in this liquid, so the nucleus consists of a nuclear fluid, and of solid contractile elements like those of the cell-body, but separated from them in the quiescent state of the cell by the nuclear membrane.

Microcytes (very small Red Blood-corpuscles) in the Blood.[§]—MM. Lepine and Germont state that in the blood of a patient suffering from carcinoma of the stomach, they observed a considerable proportion of globules varying in diameter from 2 to 5-1000ths of a mm. These bodies were spherical and by no means biconcave, but their coloration was so slight that it was with some difficulty that they

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[*] 'Zeitschr. gesammt. Naturwiss.' (Giebel), lii. (1879) p. 120.
[†] 'Bull. Acad. Roy. Sci. Belg.,' xlvii. (1879) p. 811.
[‡] This Journal, *ante*, p. 273.
[§] 'C.R. Soc. Biol.' for 1877 (1879), p. 164.

were observed to be red; these globules or microcytes were observed on *only one occasion,* and after their appearance the patient in whom they were found, exhibited a considerable, though unfortunately only temporary, improvement.

Two hypotheses present themselves in explanation of the phenomena: either the microcytes owed their origin to the secondary formation of a number of new red corpuscles, which would require a certain time to attain the normal size, or they were due to the breaking up of a number of red corpuscles. The former hypothesis is supported by the explanation offered by several histologists as to the presence of the small red corpuscles which measure from 6 to 6·5 micromillimetres in diameter; while the second, which seems to be the more satisfactory, would be supported by the cachectic state in which the patient was found previous to their appearance, and by the *à priori* supposition that it is more natural to regard them as fragments of corpuscles, which have only become spherical owing to the action of the fluid blood. The authors point out that the best way to solve the question is to apply the colorimetric test and to discover whether the amount of hæmoglobin is increased, in which case the former hypothesis would be shown to be the correct one, or whether the hæmoglobin is not increased in quantity, in which case the presumption would be in favour of the second, and they promise to perform experiments in this direction.

Terminal Nerve-plexus in the Cornea.[*]—M. Ranvier, in an introduction to an account of some experiments on the function of this plexus, points out that in the rabbit the largest nerves are the deepest, and the smallest the most superficial; that they all divide and subdivide dichotomously; that they take a course towards the surface, where they unite to form a large plexus.

The results of his experiments go to show that (1) The view of Snellen, in which the presence of trophic nerves in the cornea was denied, is correct, inasmuch as nutrition is still regularly effected after all the nerves which supply this region, are cut; (2) The nerve-filaments pass very rapidly into the plexus and always retain their physiological and anatomical individuality—in other words they merely form a *plexus* and not a *network*; (3) This plexiform arrangement of the nerves of the cornea does not seem to have any special physiological duty, but to be due to the necessity of an arrangement which shall not disturb the homogeneous character of the membrane; (4) The nerves have only a general sensibility, and yet their presence is not absolutely necessary; it is "une fonction de luxe," inasmuch as the insensitive cornea may be well protected by the sensitive conjunctiva and eyelids.

Harderian Gland of the Duck.[†]—Dr. Jules MacLeod in a paper on the histology of this gland says that it is a compound tubular gland, being made up of glandular tubules disposed in a verticillate manner around common canals, so as to form secondary tubules.

* 'Comptes Rendus,' lxxxviii. (1879) p. 1087.
† 'Bull. Acad. Roy. Sci. Belgique,' xlvii. (1879) p. 797.

The form of the primary, and the disposition of the secondary tubules, allows of the division of the organ into two parts; a superior, in which the primary tubules are contorted, the secondary few and incompletely separated; and an inferior, in which the primary tubules are straight, the secondary numerous and completely separated by septa.

In the primary tubule, two regions may be distinguished, differing according to the character of the glandular cells.

The Harderian gland of birds resembles in structure that of reptiles, but differs wholly from that of mammals, which is a racemose gland.

There are certain glands which form a transition between the gland in question and the simple tubular gland on the one hand, and the racemose gland on the other.

Structure of the " Eye-spots " of some Osseous Fishes.*—Dr. M. Ussow points out that the structure of these organs, the presence of which has been noted by a number of zoologists, has never been investigated by any anatomist other than Leuckart (1864); the author himself has already published some observations on the subject, in which he has demonstrated the metameric character of these organs, and has shown that they are formed on the type of the so-called compound eye, and are provided with simple corneæ. The structures may be arranged in two series; in one they are accessory eyes, and in the other they form pigmented glands; the genera *Chauliodus, Astronesthes*, and *Stomias* present examples of the former, as do *Scopelus, Gonostoma*, and *Maurolicus* of the latter. The organs in question are found on either side of the ventral median line, where they form one or two parallel rows extending from the caudal fin to the first ray of the thoracic fin; they are placed just below the scales, and they have the form of small pigmented spots, varying in number from sixteen to forty-eight.

After describing in detail their character and position in a number of forms, Dr. Ussow passes to an account of their structure. Most simple in *Astronesthes*, they have the form of a biconvex lens, which projects somewhat beyond the surface of the body, and they exhibit the following points: (1) a thin investment of connective tissue which completely envelopes the eye; (2) a thicker pigment layer, formed by six-sided dark brown cells; (3) in this there is a circular orifice, which is merely covered by the transparent envelope; then (4) there is a lens-shaped body which resembles in structure the lens of many Vertebrata; (5) in the subjacent layer we find transparent hexagonal plates, altogether devoid of pigment, not exhibiting nuclei, but showing a longitudinal striation of their component protoplasm. These cells are arranged concentrically, and the whole of the internal cavity is filled with a transparent watery fluid, which easily coagulates under the influence of reagents. The organs in question appear to be supplied by the rami ventrales, which send fine nerve-filaments to them. We have no space to follow the

* ' Bull. Soc. Imp Nat. Moscou,' liv. (1879) p. 79.

author into his accounts of the eye-spots of *Stomias* and *Chauliodus*, which appear to be formed on the same type.

In *Gonostoma*, *Maurolicus*, and *Argyropelecus*, the structure is altogether different; they have distinctly the character of glandular organs. Taking for description the first-named of these genera, we find that the form of the organs is oval, and that they consist of a number of radially arranged cones, the tips of which point to a central cavity; each constituent cone is ordinarily sharply separated from the rest by a thin investment derived from the general investing capsule; in their more intimate structure they consist of a number of pyriform cells, set concentrically around a central cavity, and there are also two other envelopes, one of which is pigmented, while the other consists of connective tissue; the pigmented layer is of a dark-brown colour, and resembles generally the pigmented layer found in *Chauliodus*; the characters of this form, as well as the general structure and regular disposition of the parts under discussion, point, in Ussow's opinion, to the common origin of these glands and of the eyes found in the other sets of forms. As before, we must refer our readers to the original for a description of the similar organs in the other genera above mentioned.

In dealing with the morphology of these organs, the author commences by pointing out that the arrangements seen in such Invertebrata as *Mysis* and *Polyophthalmus* prevent our associating the special organs of sense with the region of the cerebral ganglia only, and he then insists on the value which the position of the eyes in the Asterida and various Myriapods and Rotatoria has, as compared with the eye-like organs of these fishes; as may be supposed, therefore, the structures just described are regarded by the Russian investigator as proper accessory optic organs; as to the gland-like organs of the second series, he points out that no orifice can be observed in them, and he compares them with those special end-organs which are to be found in so many fishes. In conclusion, it is to be noted that the metameric or segmental arrangement of these parts is a point of considerable importance.

Two tables and four plates illustrate the details of the paper.

Histology of the Cerebellum of Petromyzon fluviatilis.[*]—The cerebellum of *Petromyzon*, which, in most of its morphological characters, resembles that of the frog, has been lately subjected to a histological examination by A. Jeleneff. Forming a vertical interposition between the cerebral hemispheres and the medulla oblongata, it is nothing more than a thin plate, and is only separated from the former by a small pit, while the *corpora geminata* of the frog are not developed in this fish. The necessary process of hardening the cerebellum was effected in the following way; it was first placed for from seven to nine days in a solution of bichromate of potash, and was then exposed for four days to a one or two per cent. solution of chromic acid. After careful washing with distilled water, it was placed in alcohol of 60°; the preparations were stained with carmine,

* 'Bull. Acad. Imp. St. Pétersbourg,' xxv. (1879) p. 334.

eosin, or a weak solution of hæmatoxylin; and, in some cases, with chloride of gold.

The cerebellum of the Vertebrata is ordinarily regarded as consisting of four layers—fibrous, nuclear, cellular, and molecular. In *Petromyzon*, however, only three layers were found, inasmuch as the fibrous layer is not distinctly developed. Lining the fourth ventricle is an investment of epithelial cells, which have the general characters of cylinder-epithelium; their free surface is flattened, while their sides form a cone which projects some way inwards, but does not seem to be connected with the nervous elements; towards the upper surface, these epithelial cells become flattened and altogether lose their characteristic form. Below the epithelium there is a layer of nerve-fibres with small rounded cells, which are so closely packed that the fibres are with difficulty detected; it is in consequence of this arrangement that it is impossible to assert the presence of a fibrous, distinct from the nucleated, layer. The nerve-fibres ordinarily run parallel to the surface, and a few only pass into the mass of the cerebellum to become connected with the processes of the deeper lying cells. The author does not find himself able to support the view of Golgi that the fibres come into connection with the peripheral ganglionic cells. Three sets of fibres were distinguished: (1) medullary nerve-fibres; (2) non-medullated fibres; and (3) fibres, in which the axis-cylinder was only partially covered by medullary substance.

The nuclear-substance is composed of cells, which are rounded in form, and have in the centre a highly refractive portion; the view of V. Baer, that they are arranged in groups rather than, as Denissenko states, in regular rows, is stated to be the more correct; the so-called "nuclei" give off fine processes, which enter into various connections; but much of what follows is concerned with a criticism of Denissenko's statements, into which it is impossible for us to enter. In the midst of the cells there are to be found a number of nerve-fibres, which surround the cells and are partly connected with them by processes, and the connection is so close that the author is inclined to speak of a nucleo-fibrous layer.

As to the cellular layer, the only differences between *Petromyzon* and the frog lie in quantitative characters; there is a series of large pyriform cells—the cells of Purkinje, which are provided with two processes, and have their greater portion occupied by a large nucleus; these cells are invested by a membrane of a character somewhat difficult to distinguish in its continuations on to the processes of the cell; the plasma surrounding the nucleus is traversed by primitive fibrillæ, which are collected together at the process into which they pass.

The "molecular layer" is almost completely made up of the branches of the peripheral processes of the cells of Purkinje, and these cells though they vary greatly in direction never pass into the nerve-fibres.

Spinal Ganglia and Dorsal Medulla of Petromyzon.[*]—An account of his examination of these structures is given by Herr Freud.

The difficulty of the investigation was enhanced by the smallness of the spinal ganglia; making use of fresh specimens, which were separated into small pieces in consequence of the fact that gold chloride does not infiltrate through any great depth of tissue, and choosing especially the caudal end where the muscular layer is thin, and the mass of fatty cells feebly developed, or carefully separating off the muscular portions, or, still better, by removing the nervous portions by dissection of the animal, the author placed them in solutions of gold chloride $\frac{1}{2}$ per cent. or $\frac{1}{4}$ per cent. strong; 1 per cent. solutions were also used, but the best results were obtained with the $\frac{1}{4}$ per cent. solution. Thence the specimens were removed to Pritchard's reducing fluid, formed of one part of formic acid with one of amyl-alcohol and 100 of water, where they remained for twenty-four hours exposed to the light. The preparation, which would be now of a dark purple-red colour, was removed to Königstein's macerating fluid, containing 50 parts fuming hydrochloric acid and 35 parts water and 15 parts glycerine. Twenty-four hours' maceration made the preparation much darker and separated it into small pieces; removed to glycerine to be rendered transparent, these were, after twenty-four hours, fit for inspection.

Dealing with the "essential" characters in the structure of the spinal ganglia, Herr Freud points out that the cells of these structures become arranged in two distinct layers, of which one belongs to the dorsal and one to the ventral branch, and it is in the latter that we find a smaller number of larger cells as a general rule. Varying in arrangement and in compactness as they appear to do at first sight, we soon learn that the spinal ganglia always present certain types, and that these types reappear at definite points, so that the spinal ganglion of a certain segment has the same "physiognomy" in all animals. There are but two essential elements in a spinal ganglion—nerve-cells and nerve-fibres; the former vary in number from eight to twenty-three, but from ten to sixteen is the most common number; they are of three sizes, but the medium forms are the most usual; their form is spherical or ellipsoidal, and their contours are well marked; they are, with scarcely an exception, bipolar, for those which are ordinarily regarded as unipolar are merely modifications of the others. It is interesting to compare this observation with that of Dr. Beale, whose knowledge of this subject is probably unequalled—"There are no apolar cells and no unipolar cells in any part of any nervous system."

The author deals in detail with the fibres of the ganglion, which are found to vary greatly in size, and passes on to "Details of the Structure of the Spinal Ganglia," "Remarks on the Relation of the Spinal Ganglia to the Dorsal Medulla," "On the Origin of the Roots of the Nerves and on the Dorsal Medulla and pia mater." The paper, which is illustrated by four plates, extends over eighty pages.

Amœboid Epithelia.[*] — Professor Graber, of Czernowitz, adds another to the list of cases in which amœboid movements have been

* 'Zool. Anzeiger,' ii. (1879) p. 277.

observed in the cells of the higher animals. He finds that the blastoderm cells in *Chironomus* send out well-marked pseudopodia (some straight, some bent, others branched) into the space between the egg and its membrane. They are best seen at the upper pole of the egg, opposite the polar cells. Their movements are often so rapid as to be with difficulty figured with the camera lucida. Sometimes, too, cells of the blastoderm become detached, and form true wandering cells, but probably these are subsequently reabsorbed.

Effects of Induced Currents on the Nervous System.[*] — The contribution of M. Schiff on this subject opens up quite a new field of physiological research, which promises to be of extreme importance. He was led to undertake his experiments by having observed the results of M. Charcot's researches on hysteric patients. This eminent physician has demonstrated that on the application of metallic plates to the extremities of hysteric persons, in whom one side of the body appeared more or less completely insensible, sensibility was in a few minutes entirely restored, for a time; during the operation the opposite side was completely insensible, so that it is clear that we have not to do with any *general augmentation* of the faculties of the organism; with a magnet similar results can be obtained when it is held at the distance of one or two centimetres from the patient, but in this case the results are more remarkable, inasmuch as it is, of course, possible to affect the patient with the magnet, while he remains totally ignorant of its nearness to him.

Led by these experiments M. Schiff has lately devoted himself to a series of researches on animals by the aid of an induction coil; the object in view has been to see whether these agents can modify the functions of the nervous system, and if they can, by producing hysterical conditions, reveal to us some method by which these phenomena can be analyzed; the following are brief indications of some of the results:—

(1) When the skin of the leg of a frog was touched by the terminations of rheophores connected with a very feeble battery the sensibility of the digits to contact was augmented; this augmentation, which was tested by the reflex movements of a pithed frog, was not exhibited until after a latent period of from eight to twenty-five minutes.

(2) Similar results were obtained with motor nerves.

(3) The modifications in the functions of the nerves were expressed by modifications in their electrical properties; thus, if the lower portion of the extremity of a frog was submitted for twenty minutes to a feeble induced current, no electric current was to be observed in the sciatic nerve itself.

(4) When the sciatic nerve was placed between the two poles of a very powerful electro-magnet, the latent period which always intervenes between the moment of irritating the sciatic plexus and the contraction of the gastrocnemius muscle was slightly increased.

A series of experiments was also made on dogs, with a view to see what were the effects on the *nerve-centres* of magnetic stimulation.

[*] 'Arch. Sci. Phys. et Nat.,' i. (1879) p. 226.

Schiff's late experiments on the so-called motor centres of the brain have led him to believe that it is possible to destroy or to weaken the tactile sensations or the sensations of pressure and of pain by effecting a lesion of the cerebral substance; what happens when, after such an experiment, an extremity has its superior portion brought under the influence of the magnetic coil? When the circuit remains open the effect is *nil*, but when the circuit is closed then there is seen a very evident increase in the sensibility of the parts, without, however, any consciousness; the reflex activity is merely more energetic in some portion of the centre which lies inferiorly to that in which stimulation of nerve-centres leads to consciousness. The paper concludes with the following observation :—In hysterical patients, and in the case of those who are suffering from certain other cerebral affections, there is not, so far as any evidence shows, any organ wanting; at the same time we may admit that there is in them a greater resistance than ordinary to the transmission of stimuli to the centre. When the impulse becomes greater it may overcome the resistance and force a transmission of the stimulus. In the dogs experimented on this " forced transmission " may obtain also, but in them it has no effect, inasmuch as it is stopped by the cicatrix of the previously effected lesion.

M. Schiff promises to continue his observations on the effect of magnetization.

Mollusca.

Habits of the Octopus.[*]—This creature, M. Frédéricq tells us, lives alone under large stones, in a kind of hole, the entrance to which is paved with smaller pieces of rock. Its habit of casting all around its retreat what it has left of its repasts betrays its habitation, so that when we meet with scattered fragments of crustacean carapaces and molluscan shells, still retaining their ligament, we may be almost certain that an octopus is near. When its home has been discovered it must be withdrawn from it by force; at the moment it is seized it often emits an inky stream of water, but there is not much danger of being bitten; M. Frédéricq in all his experience having been only bitten once, and then quite slightly. If they are well supplied with water and placed in a sufficiently large aquarium they retain perfect health ; they do not seem to mind captivity, and do not attempt to escape.

Segmentation of the Ovum in Helix aspersa.[†]—Professor Perez points out that a large number of observers have agreed with Semper in stating that the follicles of the hermaphrodite gland, previous to the period of functional activity, are clothed with a " vibratile epithelium," of which some cells become, later on, converted into ova and others into spermatic cells, and he further shows that Ludwig has correlated the contradictory statements as to the presence or absence of a vitelline membrane, by pointing out that there are in various Pulmonate Gasteropoda all degrees of transition between a superficial

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[*] ' Arch. Zool. Expér.' (Lacaze-Duthiers), vii. (1878) p. 536.
[†] ' Journ. Anat. et Phys.' (Robin), xv. (1879) p. 329.

and merely condensed layer and a distinct membrane. *Helix aspersa* was always observed to be provided with a true membrane by M. Perez; it is seen most easily in the earlier stages, when it is easily distended by water; in the mature egg, however, it is difficult to demonstrate its presence, but observations of different ova will probably satisfy the observer as to its existence.

Turning to the next succeeding phenomena, Perez states that the first sign is a series of changes in the germinal spot, and the subsequent appearance of two small nucleoli; these changes consist in the appearance of pale and indistinctly separated granulations, in the midst of which two small nucleoli may be seen; the germinal vesicle loses its distinct contour and its membrane folds in just like a bladder does when its contents are being expressed; suddenly it disappears and leaves no trace of its existence.

The clear space thus left is rapidly surrounded by yolk-spheres and two "centres of attraction" dominate over the substance; in other words, the two nucleoli are developed at the expense of the substance of the germinal spot. As to the connecting "fusiform body," it is supposed that it has nothing in common with a modified nucleus, but that it is due to purely physical causes, which compel the connecting lines of molecules to form arcs between the two nucleolar centres. Experiments by the aid of pressure led the author to the conclusion that the two nucleoli of the germinal spot, rendered free by the dissolution of the nucleus, become surrounded by rays in consequence of the attraction which they exercise on the surrounding protoplasm.

As to the "polar globule," the author gives the following account, which is of extreme interest. In his view what happens is this: when the nucleoli have attained a certain size, they become provided with a membrane, the presence of which is the cause of the cessation of the movements of molecules around the nucleolus; the fluidity of the substance which has undergone cohesion increases as the attractive power of the nucleoli disappears; and the fusiform system tends towards disaggregation; on the other side there is the vitelline mass, which exerts a certain amount of contraction on the system, which is thereby forced towards the surface of the egg, from which it is finally expressed in a spherical form in consequence of the forces exerted by the molecules of the fluid. The fusiform radiating substance is expressed in two drops.

There now remain the two nucleoli (nuclei) without any fusiform connecting mass. They increase greatly in size, and their proper nucleoli are continually subdivided, until at last they form mere granulations; the succeeding stages the author has not been able to observe, but he is not inclined to think that they become fused, but that, rather, one is totally destroyed while the other, persisting, develops two nucleoli, which become the centres of a new system of radially arranged molecules, and which, by affecting the whole of the vitelline mass, effect its segmentation. He points out that the presence of the two primary nuclei (after the formation of the polar bodies), both of which have had a common origin, is an excellent argument against regarding one of them as being a spermatic nucleus;

and he congratulates himself on having shown the direct descent of the nucleus of segmentation from the germinal spot. Although the germinal vesicle disappears the spot gives rise directly to two new nucleoli; and the theory of Haeckel, which requires the presence of, at some stage, a cytod, or non-nucleated cell (ovum), must be consequently modified. Earlier observers have, however, stated that the ovum is always nucleated; and it is to be hoped therefore that some observer will, as M. Perez suggests, submit his observations to an "infallible criterion"—the examination of ova which are developed parthenogenetically.

Cutaneous Absorption of Helix pomatia.*—M. Mer has made some experiments on the curious faculty possessed by the snail of absorbing a large quantity of water; first noted by Spallanzani, it was cited by the eminent physicist Dutrochet as a remarkable example of the power of osmotic forces.

1. A *Helix pomatia*, entirely immersed in water, absorbed it not only by its integument, but also by the walls of its pulmonary sac and of its digestive tube. If a healthy example is under observation, the experiment may be continued for three days, but the quantity absorbed, though exceeding in weight the snail itself, is not taken in regularly; absorption, very rapid at first, continually decreases, though without altogether ceasing, until the moment of death.

2. So too with regard to the expulsion of the absorbed water; when the animal is removed to air, the water is at first got rid of with great rapidity, and the excretion becomes gradually less.

3. The period of excretion is longer than that of absorption, but even then all that has been absorbed is not excreted, owing to the fact that, previous to the experiment, the tissues of the animal did not contain all the water which they were capable of holding.

4. In correlation with this it is to be observed that if a snail is removed from the water after a period of immersion lasting only for two or three hours, it takes a considerable time to rid itself of the fluid which it has so rapidly absorbed.

5. The amount of water absorbed depends on the state of contraction of the muscles around the blood sinuses.

6. If left in water after death, the tissues free themselves from the liquid.

7. The penetration of water appears to have no effect on the constituent elements of the body, and death appears to be due to the resistance offered by the water to the active circulation of the blood.

8. Although all parts of the body are able to absorb water, the walls of the pulmonary sac appear to be most capable.

Treated with such colouring agents as carmine, aniline blue, or rosaniline, the snail exhibits, with weak solutions, no other phenomena than those observed with water; but it is to be observed that the colouring matters did not, in any appreciable quantity at any rate, pass into the blood. Experiments with stronger solutions are described in detail, and the author comes finally to the consideration of the question, Is the penetration of fluids effected by passages

* 'CR. Soc. Biol.' for 1877 (1879), p. 186.

between the epithelial cells, or does the fluid penetrate the cells themselves? The second method seems to be that adopted, inasmuch as (1) the canals are present in certain aquatic molluscs, e. g. *Cyclas cornea*, which do not swell up in water ; (2) colouring matters have been observed in the cells themselves ; (3) the phenomena appear to be rather those of dialysis than of endosmosis ; and (4) the epithelial cells have a great affinity for water.

Influence of "Cardiac Poisons" on Helix pomatia.* — The experiments of Hæckel on the effects of strychnine on the *Gasteropoda* have led M. Vulpian to repeat some experiments, which he described in his course of lectures of 1864, when he showed that *Upas antiar*, which acts so freely on the heart of the frog, has no such influence on the heart of the mollusc. Dealing with an alcoholic extract of *inée* (*Strophanthus hispidus* DC.), which has, on the frog, the effect of stopping the ventricle in the systole, and the auricles in the diastole, he finds very similar results with the *Helix*. As the effect of the injection of the poison there is a cessation of locomotor movements on the part of the animal, the movements of the heart become irregular, and there appear periods of arrest in its activity ; at the end of two or three minutes the auricle is found to be distended, while the ventricle is very markedly contracted. When the heart has a drop of the solution placed on it, the results are very far less marked. A solution of muscarin was found to be much more feeble, the movements of the heart became much slower, and occasionally ceased, but the arrest never continued for more than five or six minutes ; atropine was found to have an antagonistic effect; and, in fine, with regard to these two poisons, their influence is very much the same on the snail as on the frog ; and from this M. Vulpian infers that there is a certain analogy between the innervation of the hearts of the snail, the frog, and the mammal. Neither muscarin nor *inée* seem to have any influence on the heart of the crayfish.

Respiratory Apparatus of Ampullaria.†—M. A. Sabatier, referring to M. Jourdan's description ‡ of the double respiratory apparatus of the *Ampullariæ*, consisting both of a branchia and a lung, says that he is able to give some new facts which had previously escaped observation.

The venous blood, returning from the different parts of the body, divides into three parts :—one passes to the right into a cavernous sinus, which accompanies the terminal intestine ; this is the *rectal sinus*, which is a diverticulum of the general cavity of the body ; the second comes from the anterior region of the body (head, pharynx, stomach, anterior margin of the palatine arch) and forms on the right the *proper afferent vessel* of the lung, which it circumscribes to the left and in front ; this vessel presents a double series of orifices for the afferent branches of the roof and of the floor of the pulmonary chamber ; the third part, which is far more important, comes together

* 'Comptes Rendus,' lxxxviii. (1879) p. 1293.
† Ibid., p. 1325 ; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 323.
‡ This Journal, *ante*, p. 706.

in a large deep vessel with muscular walls, which soon ramifies on the lower surface and on the thickness of the large gland, already alluded to. From this network the efferent vessels take their origin, the greater part of which reunite in a large trunk with muscular walls which carries the blood to the renal organ : this is the *deep afferent vessel of the renal organ*, peculiar to the *Ampullariæ*. The other vessels which originate from the large gland discharge themselves successively into a superficial vessel of no great size, placed on the posterior margin of the renal organ, and which is its *superficial afferent vessel*, corresponding in all respects to the single afferent vessel of the other Pectinibranchiata. Hence the blood which has traversed the large gland in a true portal system is not, as M. Jourdan thinks, mingled with the blood returning from the organs of respiration, to be immediately poured into the heart, but it does not reach the latter until after it has traversed the renal organ first and the respiratory organs afterwards.

From the anterior margin of the renal organ there originates, by successive roots, an efferent vessel of the renal organ, which, after having anastomosed with the afferent vessel of the same organ, continues forward on the right margin of the principal branchia, of which it constitutes the afferent vessel. This vessel receives, in passing, some affluents from the rectal sinus.

On the left margin of the branchia, between the latter and the lung, is a large trunk which terminates at the auricle, and which is not simply, as M. Jourdan thinks, an efferent vessel of the branchia and of the lung. This vessel contains, in fact, a series of fissure-like orifices, which pour into it the blood from the branchia, and two series of circular orifices, of which the upper part are the *efferent* orifices of the pulmonary arch, and the lower are the *afferent* orifices of the floor of the lung. On this floor, in fact, the vessels which originate from these orifices, ramify in a network of which the efferent branches converge into a large trunk, overlooked by M. Jourdan, and which, collecting the blood of the whole of the floor of the lung, empties itself directly into the auricle.

From this results the fact, entirely exceptional in the Pectinibranchiata, that the auricle receives two totally distinct afferent veins. The one is branchial and pulmonary, the other exclusively pulmonary. This is a remarkable peculiarity of the anatomy of the *Ampullariæ*, which is in connection with the double respiration of these animals, and with the alternations in function of the double respiratory apparatus.

The afferent vessel of the branchia and the proper afferent vessel of the lung meet in front in such a manner as to form an anterior arch. The intermediate trunk meets this arcade very obliquely and under a very sharp angle open to the left. There is thus formed between the two vessels a valvular spur, which plays an important part in several respects. When, during sojourn in the water, the pulmonary respiration and circulation are suspended by the want of air and the collapse of the lung, the blood of the proper afferent vessel of the lung, being unable to traverse the pulmonary network,

arrives in abundance at the level of the mouth of the intermediary trunk, to which it applies the valvule and which it thus stops. It is thus obliged to pass entirely into the afferent vessel of the branchia, and, consequently, into the branchia, of which the activity is thus greatly increased. When, on the contrary, during sojourn in the air, the collapsed branchia does not act, the blood of the afferent vessel of the branchia, arriving *en masse* on the edge of the spur, there divides into two currents, one of which penetrates into the proper afferent vessel of the lung, and the other into the intermediary trunk, of which it augments the tension, and which distributes a part of it to the floor of the lung, and reconducts the rest to the heart. By this means the activity of the pulmonary circulation is increased during the repose of the branchia. Hence results this interesting fact, that the *Ampullariæ*, which are Pectinibranchiata in which pulmonary respiration has made its appearance, have the respiratory vessels disposed in such a manner that, when this newly-introduced function suspends its activity, all the blood which should have traversed the pulmonary network, is constrained to traverse the branchial system, where its hæmatosis is assured. This curious arrangement may suffice to explain the preservation of the branchia in Gasteropoda, in which the lung has attained so remarkable a development, and which might have become purely pulmonary animals.

The distribution of the vessels in the pulmonary walls merits special mention. They form a double system of portal veins; that is to say, the vessels form on their journey two successive networks separated by intermediary trunks. This arrangement, a little less accentuated on the floor than on the roof, added to the presence of a fine vibratile epithelium on the course of the pulmonary vessels, proves the active part of this apparatus as an organ of hæmatosis.

Doridæ of the Northern Seas.[*]—Dr. R. Bergh has a technical paper on this group; in his introduction he points out how few are the species—not more than twenty-two—that are known; he further states that Alder and Hancock, although they have brought into relief a number of anatomical differences, still recognize only three genera, *Doris*, *Lamellidoris*, and *Acanthodoris*. The author considers that there are a larger number of genera, and that these may be divided into two groups—to which he applies the names of Cryptobranchiatæ and Eleutherobranchiatæ, according as the gills are or are not retractile; the former group appears to be somewhat cosmopolitan and contains the genera *Archidoris*, *Diaulula*, *Cadlina*, *Joorunna*, *Aldisa*, and *Rostanga*; the latter is confined, so far as we know, to the colder regions, and contains *Acanthodoris*, *Adalaria*, *Lamellidoris*, *Goniodoris*, and *Doridunculus*.

Glands in the Foot of the Lamellibranchiata.[†]—M. Justus Carrière gives a short sketch of the very different views which have been held as to the characters of the byssus-gland, noting that Réaumur regarded the byssus as being formed by the glutinous

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* 'Arch. für Naturg.,' xlv. (1879) p. 340.
† 'Arbeit. Zool.-Zoot. Inst. Würzburg,' v. (1879) p. 56.

matter secreted by the muscles, while Poli looked upon the muscular "languet" as being quite secondary. Blainville and others have regarded the byssus threads as being dried muscular fibres, and Leydig as being formed of chitinized fibres. The first correct account is due to A. Müller, who described the acinous *glandula byssipara* in the groove of the foot of *Mytilus;* Siebold (1848) agreed in the main with A. Müller, and suggested that the byssus threads were formed at the base of the byssal pit by lamellæ in very much the same fashion as the human nail is developed on the fingers. In 1877, Tycho Tullberg returned to the subject, and investigated the characters of the byssus in *Mytilis edulis;* he observed the presence of two glandular masses, one whitish and one greenish in colour; he found that the latter was placed towards the tip of the foot and opened by ramified tubes into the semilunar cleft, while the whitish gland was placed on either side of the groove and poured its secretion directly into it.

M. Carrière finds that in the anterior portion of the tongue-shaped and comparatively freely movable foot there is a large *byssus-gland*, which opens into a gland more or less semilunar in shape; this groove is directly connected with the cleft which extends along the margin of the foot, but it may, by the closure of its walls, form a somewhat semilunar canal. Behind the gland there is placed the "second characteristic organ," the byssus-cavity, which is occupied by fan-shaped processes, between which are placed the byssal lamellæ, which form the byssus proper.

As to the epithelium which covers these processes, it is to be noted that there is no *ciliated epithelium,* but only cylindrical cells, in those in which—e. g. *Mytilus, Dreissena*—the byssus is best developed; in those in which—e. g. *Pecten, Lithodomus*—the byssus has a less complete function of attachment, the processes are somewhat atrophied, and the non-functional regions *are* covered with ciliated epithelium; while in others—e. g. *Lima*—in which the byssus merely forms, with other substances, a kind of bed, the whole of the byssus-cavity is invested with ciliated epithelium.

It is, of course, impossible to follow the author through his extended observations on some twenty-five species; those of our readers who want his results in short will find on pp. 80–82 a list of the Siphoniate and Asiphoniate Lamellibranchs as to which M. Carrière is able to give any information. The author is of opinion that the byssus-lamellæ are secreted by the byssus "fans" or rather by the epithelium of these processes; while as to a more general result we may add this : the byssus-gland was primitively possessed by all the Lamellibranchiata, some of which have, in the course of time, lost it as a functional organ, but its presence is constantly indicated by the possession of rudimentary byssus-organs in the shape of glands, sacs, or clefts. The author also thinks that the orifices and clefts found in the foot only serve for the exit of the glandular secretions, and that they have no communications with the vessels or with the lacunæ of the body (in consequence of their unbroken investment of epithelium); if this view be cor-

rect it is clear that water cannot enter by them into the organ of Bojanus.*

Land Shells of Californian and Mexican Islands.†—Mr. W. G. Binney gives an important contribution to the geographical distribution of land shells.

The Mexican island of Guadelupe, 220 miles from San Diego, off the west coast of Lower California, has been visited by Dr. E. Palmer, and he found numerous fragments of snail-shells which had been devoured by a species of mouse, the only land mammal on the island. These appeared to belong to *Arionta Rowelli* (Newcomb), found in Lower California. *A. facta* occurred, a variety with open umbilicus, like that found fossil on San Nicolas Island, California. Living specimens of *Binneya notabilis* were brought from Guadelupe, found also on the Californian island of Santa Barbara; it is very nearly allied to if not synonymous with the Mexican genus *Xanthonyx*. Thus it is supposed to have been first distributed from Mexico, then to Guadelupe, thence to Santa Barbara.

Pompeian Conchology. ‡—Dr. N. Tiberi gives a list of forty-four species of shells found at Pompeii, and which had served for food or been used by the Pompeians for ornament and other purposes, with particulars of their relative abundance as well as of their distribution and economy.

Some were of eatable kinds as the oyster and mussel, *Pecten jacobæus*, *Venus chione*, *Tapes decussatus*, and several species of *Helix*. Others adorned fountains, as *Haliotis tuberculata*, *Murex trunculus*, and *M. brandaris*, and were all of species still common in the Bay of Naples. The Oriental pearl-shell (*Meleagrina margaritifera*) was represented by only a single valve. The Pompeian ladies seem to have attached considerable value to the *Cypræa* or Cowry as amulets against sterility, and among these shells were some of species from the Red Sea and Persian Gulf. A single specimen of the exotic shell *Conus textilis* must have been kept for its beauty as an object of curiosity.

Method of Obtaining Minute Mollusca.§—The Marquis de Folin describes the following method:—Specimens of the ooze from various shores, bays, and dredgings having been obtained, they should be washed with fresh water in a fine sieve, and then left to dry; if diatoms are being sought for, the results of the filtrations should be preserved, the water decanted, and the deposit left to dry. When dried, the objects should be placed in a box thus formed: the base should be formed of a piece of glass a decimetre square, provided with walls about one centimetre in height which should be fixed to the glass; it will then be possible, as the Marquis points out, to shake the deposit about with safety, while searching for objects of

* This Journal, *ante*, p. 551.
† 'Proc. Acad. Nat. Sci. Phila.,' 1879, p. 16; see 'Nature,' xx. (1879) p. 535.
‡ 'Tiberi, N., 'Le Conchiglie Pompeiane,' Napoli, 1879; see 'Nature,' xx. p. 624.
§ 'Bull. Soc. Imp. Nat. Moscou,' lv. (1879) p. 202.

interest. Similar means may be applied to the deposits left by streams of fresh water after any considerable increase in their height.

It is also possible to obtain a large number of minute species by carefully removing the mossy earth which is so frequently found near running water; when the water has been washed away and the mass carefully dried, a number of specimens will almost certainly be found. The author reminds his readers that specimens of distant fresh-water Mollusca can by this means be as easily obtained as can those marine specimens which are to be found in the bottom of bays or sea-washed shores.

Molluscoida.

Recent Species of Heteropora.[*]—Mr. Geo. Busk, referring to Mr. Waters's paper [†] on *Heteropora pelliculata* (from Japan), and *H. cervicornis* (from Adelaide), says that the occurrence of these two forms, belonging to a genus of which we had previously no species more recent than the Crag, and extending back to the Cretaceous period, is of particular interest, and he is induced therefore to indicate the existence of what may probably be a third species of the genus—one from New Zealand, which in most respects appears to bear a very strong resemblance to the Japanese form, if not specifically the same; there are one or two points in which they do not quite agree.

In the absence of more complete acquaintance with Mr. Waters's form, Mr. Busk provisionally designates the species,

Heteropora neozelanica, n. sp. ?   Zoarium erect, composed of short divergent branches, springing from a short thick stem, and soon dividing once or twice dichotomously, and terminating in blunt rounded extremities. The diameter of the primary branches is about ·2 inch, and of the terminal ones about ·1 to ·15 inch. The surface presents orifices of two kinds, though scarcely distinguishable in size. The larger ones in the older parts of the growth, have a slightly raised peristome and are quite circular; the others (cancelli) disposed more or less regularly round these, generally to the number of seven or eight, are more or less angular, and the border of the opening is never raised.

In the perfect state the surface, as in most Polyzoa, is covered with a thin chitinous pellicle, by which the cellular openings are more or less closed. This epitheca coat does not seem to become calcified or thickened, as in *H. pelliculata*, but always retains a delicate membranaceous character, and it is easily removed by caustic soda. Nor has he been able consequently to perceive the minute openings in the covering of the cancellar orifices described by Mr. Waters.

In sections the walls of the zoœcia and of the intermediate barren tubes or cancelli are perforated, as figured by Mr. Waters, by numerous infundibular pores, by which, as it would seem, facilities exist for the permeation of fluids throughout the entire zoarium. These pores and

* 'Journ. Linn. Soc. (Zool.),' xiv. (1879) p. 724.
† This Journal, *ante*, p. 390.

pore-canals are lined, like the zoœcia and cancelli, with a thin animal substance, which is readily dyed by any aniline colour, &c., by which means the pore-canals are rendered beautifully distinct in thin sections.

The chief points of difference between the New Zealand and Japanese forms would seem to consist (1) in the difference of habit —the branches in *H. pelliculata* appearing to be longer and more terete and to be occasionally connate, whilst in *H. neozelanica* they are short and not terete, expanding and never joined together; and (2) in the absence in *H. neozelanica* of the calcareous pellicle or epitheca, left after incineration in *H. pelliculata*.

Cyphonautes.*—Herr Repiachoff has some notes on this very interesting Polyzoan larva. He states that, by the aid of reagents, he has been able to show that the œsophagus (Schneider) passes gradually into a "vestibule" which is pretty sharply marked off from the next succeeding portion of the enteric tract. The "foot" (Claparède) or "bud" (Hatschek) is shown to be made up of two portions; a sucker-like thickening of the external epithelium, which is fringed by cilia, and a superiorly lying aggregation of cells, which occupies a similar position to the so-called "endodermal bud" of the larvæ of the allied forms *Pedicellina* and *Tendra*. The creature is, further, stated to be provided with distinctly striated muscular fibres. The retractile foot is regarded as being homologous with the "oral groove" of other Cheilostomatous larvæ, while their so-called "sucker" seems to be completely atrophied.

Arthropoda.

a. Insecta.

Nervous System of Insects.†—The results of M. Brandt's researches on 1032 species taken from most of the families of the *Hymenoptera, Coleoptera, Hemiptera, Lepidoptera, Diptera,* show that:—

i. In some forms, as *Stylops,* the subœsophageal ganglion fuses with the next posterior one. ii. The "convolutions" of the brain occur in all. iii. The convolutions vary in different individuals of the same species, and notably are less developed in males of the social Hymenoptera than in the females and workers. iv. A connection is apparent between the development of the instincts and that of the brain hemispheres,—not of the whole brain. v. The upper lip nerves rise from the œsophageal nerve-ring. vi. Where two thoracic ganglia exist, the first corresponds either to the first larval ganglion or to the first two; the second of the adult corresponds to one or two thoracic and one or two abdominal ganglia. vii. The number of ganglia may vary in different individuals of the same species—e. g. in the bee and in the wasp. viii. The penultimate abdominal ganglion may be complex, instead of the ultimate one. ix. *Bombus* and *Tenthredo* have a thoracic sympathetic system constructed like that of the abdomen. x. Two types of transformation occur in the nervous system; one, the inverse of that usual in insects, being the resolution

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* 'Zool. Anzeiger,' ii. (1879) p. 517.
† 'Comptes Rendus,' lxxxix. (1879) p. 475.

of a single larval ganglion into a number in the adult, as in *Volucella*. xi. In cases of a single thoracic ganglion in Hemiptera, this corresponds to the two last thoracic and all the abdominal ganglia. xii. Lepidoptera have four abdominal, and either two or three thoracic ganglia.

Cephalic Ganglia of the Insecta.*—M. N. Wagner points out the supra-œsophageal ganglia are the seat of almost all the functions which are performed by the cerebral hemispheres of the Vertebrata— they contain the organs of perception, of memory, and of intelligence. In correlation with this they present a more complicated histological structure than the rest of the ganglia of the insect's body, although they are formed on the same general plan. The nerve-cells occupy the periphery, and the bundles of nerve-fibres the central portion; towards the centre of the ganglion there are to be found three groups of small cells, set one above the other, and connected by a large number of fibres. The most peripheral group may be considered as having the most intimate connection with the horse-shoe-shaped convolutions, which are particularly well developed in the social Hymenoptera, which are the most intelligent of all the insects; and it is to be noted that the degree of development of this region is to be correlated with the development of the intellectual powers; for example, if we take the bee, we find these parts to be better developed in the workers than in the queen-mother, while in the males they are quite rudimentary. M. Wagner concludes that the sexual life, and above all the production of ova and sperm, is opposed to the development of these organs.

The crossing of the nerve-fibres which pass to the eyes is not to be compared with the "optic chiasma" of the Vertebrata, as it only applies to the constituent parts of the lateral compound eyes; at the same time this crossing of the fibres probably produces a complete coincidence in each part of the composite eye.

The preparations studied were previously hardened in Betz's liquid, made of equal parts of sulphuric ether and chloroform.

Brain of the Cockroach.†—Mr. E. T. Newton gives an account of his researches on the minute structure of the brain of *Periplaneta orientalis*.

After an abstract of previous work on the subject, Mr. Newton describes the external anatomy of the brain as made out by sections, and the nerves proceeding from it. Of these he gives a very exact and detailed description, many of the nerves having been observed by him for the first time.

The section of the paper treating of the internal structure of the brain cannot readily be abstracted, and we must refer the reader to the original source, where the description is by no means long. Mr. Newton deserves the thanks of comparative anatomists for proposing a consistent nomenclature for the various structures, hitherto only known by Flögel's vernacular terms. That author's "Balken" is

* 'Comptes Rendus,' lxxxix. (1879) p. 378.
† 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 340.

called the *trabecula*, the "Vorderhorn" becomes the *cauliculus*, the "Hinterast" (Pilztheil, Dielt), the *peduncle*, the "mushroom body" of authors the *corpus fungiforme*, its trough-like portions—"Becher" of Flögel—the *inner* and *outer calices*, and the "Centralkörper" the *corpus centrale*.

The most successful sections were prepared from a specimen hardened in osmic acid.

Nerves of the Proboscis of Diptera.*— M. Jules Künckel has examined into the terminations of the nerves in the proboscis of the Diptera. He remarks that the proboscis terminates in two valves, which, in repose, are laid against each other, but during suction are applied to the surface attacked so as to constitute a regular sucking cup. These valves represent the labial palpi. Their internal structure presents a peculiarity well known to microscopists; they contain a large tube, from which issue numerous branches in a digitate form, and all these parts present an appearance like that of tracheæ. The name of *false tracheæ* which has been given to them is perfectly justified, as they have no communication with the true tracheal apparatus, their principal function being to support the integuments of the palpi, whilst a true trachea ramifies in these organs. Parallel to the large trunk of the false tracheæ the labial nerve may be traced, of comparatively large size. It speedily divides into two parts, and emits a multitude of ramifications to the periphery and inner surface of the valves. Those nervous filaments which run to the periphery go to the numerous and greatly developed hairs with which the margin of the valve is furnished; those which go to the inner surface, on the contrary, terminate at rudimentary hairs, reduced to a minute chitinous cylinder.

On examining the nervous terminations which run to the marginal hairs, it will be found that a filament separates from the ganglionic inflation, and goes to the hair, as has been already described and figured by M. Jobert, but that it terminates in the interior of the hair at the point where the latter is joined to the integument by a membranous part. On the other hand, in the case of the terminations which go to the rudimentary hairs, the filament will be seen to traverse the little cylinder and project outside in the form of any fine and delicate rounded point. There are thus in the proboscides of the Diptera (Muscidæ and Syrphidæ) two kinds of nervous terminations —one set connected with well-developed hairs, which are no doubt tactile in function; the other, with rudimentary hairs of peculiar form, which are probably gustative.

Sense-organs of Insects.†—With regard to the results announced by Professor Graber,‡ as to the presence of an otocyst in the antennæ of certain Diptera, Dr. Mayer declares that independent investigations made by himself on the same species show that the organ in question is open to the exterior, and therefore not otocystic. Further, he

* 'CR. Assoc. Franç. Avancem. Sci.,' 1878 (1879) p. 771; see 'Pop. Sci. Rev.,' iii. (1879) p. 444.
† 'Zool. Anzeiger,' ii. (1879) p. 182.
‡ 'Arch. Mikr. Anat.,' xvi. (1878) p. 36; see this Journal, *ante*, p. 45.

states that in *Sicus* and *Eristalis* additional organs of this kind—and in *Musca vomitoria* as many as fifty of them—occur in the same terminal segment of the antenna. From their structure and innervation he would still regard them as sensory, but leaves the question of their exact function to be settled by physiological experiment.

Dr. H. Krauss identifies the fly-larva in which Professor Graber claimed * to find an otocyst, as that of *Tabanus autumnalis* Linn., a species remarkable in its genus for its aquatic habits in its earlier stages. The organ referred to is found also in the perfect insect.

Scales of the Lepidoptera.—In his ‘Physical Description of the Argentine Republic,’† Dr. H. Burmeister devotes a chapter to a special examination of the scales of the Lepidoptera.

After remarking that the whole life of a special observer would not be sufficient to recognize the innumerable variations in the scales of even a single species, and describing the general structure of the scales, Dr. Burmeister comes to the question of the markings on their surface, and states that notwithstanding the trouble that the question has already given to naturalists, he considers himself able to say, as the result of his own researches, that any difficulty is now cleared up.

The scales which he studied were those of different species of the genus *Castnia*, which has the largest of any insect.

According to his observations the scales do not enclose any third membrane, but are empty, the two membranes of which they are composed not touching each other, but leaving a certain space between them, a construction which is plain in the white and transparent scales. Those which are coloured, contain a fluid colouring matter at the commencement of the formation of the scale, which dries little by little by the influence of the air, and leaves a deposit on the inner surface of the two membranes, the fluid being finally replaced by the air entering through the membranes, which remain soft for a short time after the formation of the scale. The colouring matter seems to be principally attached to the upper membrane, rendering it opaque, whilst the lower one receives less of the deposit, and remains, consequently, somewhat more transparent, and even without any deposit in many insects.

Dr. Burmeister’s researches have proved to him that the fine longitudinal striæ belong entirely to the *upper* membrane of the scales, and are wanting in the lower.

The longitudinal striæ are very regularly distributed with equal intervals, though somewhat different in different scales. The breadth of the spaces between the lines is always greater than that of the lines themselves, while the lines are in general of equal breadth, though there are some scales where coarse lines alternate with finer ones. This distinction of coarse and fine lines the author has seen plainly in scales with an indented terminal margin, and found that the coarse lines correspond to the teeth of the margin, whilst the others correspond to the intervals between them.

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* Loc. cit.

† ‘Description Physique de la République Argentine,’ vol. v. “Lépidoptères,” part i. p. 21, 8vo, Buenos-Ayres, Paris, and Halle, 1878.

There is no doubt that these markings are due to filaments which are elevated on the inner side of the upper membrane, and appear from the exterior as fine striæ. In the large scales of *Castnia* it can be seen very clearly that they do not entirely traverse the interior of the scale, but terminate free, leaving an interval between them and the lower membrane.

The latter presents internally a completely different structure. There are a great number of small, irregular, transverse lines (somewhat similar to those on the palm of the hand), showing none of the regular arrangement of those on the upper membrane.

According to M. Deschamps and other observers, the intervals between the longitudinal lines are divided regularly by transverse ones, thus forming small squares, giving the scales a trellised appearance, and originating many errors in regard to their true structure. Exact observations, however, on scales in which the two membranes were dissected apart, have shown that this is a deception, and that the appearance is produced by the lower set of striæ showing through the upper transparent membrane.

Dr. Burmeister's views are, we need hardly say, opposed to those of Mr. Beck,* and would appear to be disproved by his well-known experiment of running moisture up and down in the furrows between the " corrugations " on the under surface of the scales.

Butterflies with Dissimilar Sexes.†—Mr. Meldola has an interesting review of Fritz Müller's paper in ' Kosmos,' on this subject, the phenomena of which have been well described by Mr. S. H. Scudder, under the name of " Antigeny." The principal object of the author is to show that in some cases the male, and not the female, is the selecting partner. Dealing with *Epicalia acontius*, of which the sexes are so separate that they have been placed by some systematic zoologists in even different genera, while Fabricius applied the specific name of *Antiochus* to the male and of *Medea* to the female ; the author shows what is the extent of the difference by describing what obtains in the two sexes ; in both sexes the general ground colour of the wings is black, the male has a broad oblique bar of a bright orange colour extending from about the middle of the inner margin of, to about the middle of the fore-wing in the direction of the apex ; as there is a corresponding blotch near the middle of the hind-wing, the whole forms, when the wings are extended, one oblique orange bar ; now, the female has two oblique rows of pale yellow spots across the fore-wings, which run nearly parallel with the costal margin, and there are two similar rows across the hind-wings, and these, with extended wings, give rise to the appearance of three straight parallel rows (which are continued on to the body by spots of the same colour).

It is to be noted that the hindmost row of spots " have been distorted so as to form a straight bar parallel with the other rows ; this results from the displacement of the spots, each of which, although situated in one wing-cell, does not appear on the *corresponding place* in each cell ; were this the case, the row would be curved instead of straight. That it was the sense of beauty of a critical eye, which

* See *ante*, p. 810.   † ' Nature,' xix. (1879) p. 586.

straightened the original curved row of spots to a straight bar, is strikingly shown by the two foremost spots of the row, which are unsymmetrical with regard to the corresponding row on the front wings, and which really form the commencement of a curved bar — *but these are hidden by the overlapping* of the front wings." It is supposed that the critical eye was the eye of the male.

Adoption of an Ant-queen.*—The Rev. H. C. McCook reports the following case of the adoption of a fertile queen of *Crematogaster lineolata*, a small black ant, by a colony of the same species. The queen was taken on April 16th, and on May 14th was introduced to workers of a nest taken the same day. The queen was alone within an artificial glass formicary, and several workers were introduced. One of these soon found the queen, exhibited much excitement, but no hostility, and immediately ran to her sister workers, all of whom were presently clustered upon the queen. As other workers were gradually introduced they joined their comrades until the body of the queen (who is much larger than the workers) was nearly covered with them. They appeared to be holding on by their mandibles to the delicate hairs upon the female's body, and continually moved their antennæ caressingly. This sort of attention continued until the queen, escorted by workers, disappeared in one of the galleries. She was entirely adopted, and thereafter was often seen moving freely, or attended by guards, about the nest, at times engaged in attending the larvæ and nymphs which had been introduced with the workers of the strange colony. The workers were fresh from their own natural home, and the queen had been in an artificial home for a month. As among ants the workers of different nests are usually hostile to each other, this adoption of an alien queen is an example of the strong instinct which controls for preservation of the species.

Mode of depositing Ant-eggs.†—Mr. McCook also states that a queen of the black carpenter ant, *Camponotus Pennsylvanicus*, which had long been kept in an artificial nest, had once been seen in the act of depositing an egg. The queen was at the time clinging to the side of a hollow in the surface of the earth, almost in a vertical position. The usual body-guard of workers quite surrounded her, continually touching her with their antennæ. The egg was a white cylindrical object, about one-eighth of an inch in length. It was about two minutes in escaping from the body, and as soon as dropped was carried below within the galleries by a worker. The queen was never left by her body-guard, who sought to control her movements by pressing around her, blocking up the path which she wished to take. Frequently more vigorous persuasions were used, an antenna or leg being grasped by a worker, and the queen thus pulled backward. She made no attacks upon her guard, but often stubbornly held her own way; though commonly yielding more or less graciously to her attendants. This colony had been received from the Allegheny Mountains in December, within their formicary in an oak bough, in which they were hibernating, being quite stiff with cold. They immediately revived in the warmth, and were healthy and active during the following

spring. The queen survived until September following, and would doubtless have lived longer had she not been neglected during a prolonged absence in summer. She outlived all her subjects, and was certainly more than a year old.

β. Myriapoda.

New Pauropod.*—Mr. J. A. Ryder describes a new Myriapod, which is nearly allied to the form first described by Sir John Lubbock under the name of *Pauropus*, in reference to the fewness of its feet. The specimens obtained are ten in number, and have but six segments, fewer than any other known member of the group, whilst the number of pairs of legs is nine, the same as in *Pauropus*, which is very strong evidence that the specimens are adults. The following characterization of the genus and species is proposed :—

Eurypauropus spinosus, gen. et sp. nov. Body segments six in number, sixth exceedingly rudimentary ; antennæ five-jointed ; legs in nine pairs, equidistant ; tergal sclerites laterally expanded so as to conceal the legs almost entirely when the animal is viewed from above, and covered with fine tubercles which are joined to each other by raised lines ; appressed curved spines are also scattered over their surface in less number, and also fringe their margins, being disposed at regular intervals ; the spines and lines give the dorsal surface of the little creature a slightly silky lustre when viewed with reflected light. Colour a delicate light brown. Mouth-organs the same as in the first-described genus. No evidence of eyes could be detected. Length $\frac{2}{5}$ of an inch ; width about $\frac{1}{70}$ of an inch. Habitat in Fairmount Park, Philadelphia, east and west of Schuylkill, in moist situations under sticks and decaying vegetable matter.

The tergal sclerites are much thicker than in *Pauropus*, having the characteristic brown colour of chitin when viewed with transmitted light. The antennæ have the terminal globular hyaline body with a long pedicle as in *Pauropus pedunculatus*. The type is the most distinct form discovered since the detection of the first known representatives in England in 1866, and also extends the geographical range of the family, and does much towards fully establishing the Pauropoda as a distinct order of Myriapods.

γ. Arachnida.

New Division of the Tarantulida.†—Dr. Karsch proposes the following division of the *Tarantulida* :—

1. All the six true legs are formed in the same way (**i. e.** the fourth pair has no tibial joint).

　　Phrynichus :—type sp. *P. reniformis* Linn.

2. The legs of the fourth pair have each a single tibial joint.

　　Damon (C. L. Koch) :—type sp. *D. medius* Herbst.

3. The legs of the fourth pair have two tibial joints, and the anterior one is the shorter.

　　Tarantula Fabr. :—type sp. *T. pumilio* (C. L. Koch).

4. There are three tibial joints.

　　Charon :—type sp. *Charon Grayi* Gervais.

* 'Proc. Acad. Nat. Sci. Philad.,' 1879, p. 139, and 'Am. Nat.,' xiii. (1879) p. 60
† 'Arch. Naturg.,' xlv. (1879) p. 189.

Differences between the Young and the Adult Forms of the Gamasidæ.*—Dr. Kramer's paper on this subject deals especially with the criticisms of M. Mégnin, who stated (1) that the absence of the holding lobes from the anterior pair of feet was peculiar to females and nymph-forms, (2) that the dorsal shield was only cleft in nymphs, and (3) that the margin differs in form in nymphs and in the different sexes. Kramer, however, is by no means satisfied as to the accuracy of these views, and he states that he has only observed in a single species the absence of the holding lobes, that he has had under observation adult females of species of *Gamasus* in which the dorsal shield has been divided, while as to the characters of the margin, howsoever they vary, the variation is not such as to render their specific characters obscure.

Pairing of Spiders.†—The Rev. H. C. McCook describes minutely the pairing of a male and female of *Linyphia marginata* which he witnessed in June, 1878. The observation is too long for our space, but it may be mentioned that the pair were in union for 2 hours and 55½ minutes, during which period they were separated nineteen times in consequence of various interruptions, some of which could be accounted for, but others were apparently without any extraneous cause. Twice the male ran to one side of the dome, made a web attachment to a bit of leaf hanging in the snare, drew out a thread about 2¼ inches long, which he overlaid a couple of times, and then made the following motion: First, the body was placed erect, i. e. back upward, and was moved backwards and forwards along the line, rubbing the points or "nippers" of the palps at the same time: then the spider swung over until the body made an angle of about 45° with the line, and while holding on thus the palps were rubbed back and forth alternately along the line as before. The process was repeated during another of the intermissions. It was conjectured that the purpose of this movement might be the distribution of the seminal fluid into the palpal bulbs. This is taken up by the sacs, by the inflation and contraction of whose membranous coats it is forced into the spermathecæ of the female.

Observations on the Pycnogonida.‡—Nearly ten years ago Dr. Dohrn published in the 'Jenaische Zeitschrift' an essay on the structure and development of the Pycnogonida, which he was led to place with the Arachnida, rather than with the Crustacea, on account of the presence of seven pairs of appendages; the three pairs found in the larva were seen to be converted into the maxillary palpi, antennæ, and accessory or ovigerous feet; as to the last it was shown that they were formed at the same time as the first pair of true legs, and that therefore there could be no relation between them, in the way of one being developed from the other.

Professor Semper has lately been investigating the history of the same group, and has come to certain conclusions § with which we will

deal, after having, with Dohrn, directed attention to the fact that the investigations of the Würzburg professor seem to set at rest a question which has been differently answered by different observers. The genus *Phoxichilidium*, which has been lately subjected to examination, is, in its larval stages, parasitic on *Hydractinia*; according to Gegenbaur, the parent lays its eggs in the polyp, whereas Hodge and others state that the larvæ enter the polyp so soon as they leave the egg; among the latter is Claus, and that he was right in his view is shown by Semper's detailed account.

Turning to the points on which Semper and Dohrn are at variance, between *Phoxichilidium*, as described by the former, and *Achelia*, as described by Dohrn, there is this difference, that in the former the ovigerous appendages are a later development and are not represented in the larva, so that the Pycnogonida apparently have not as Dohrn imagines seven, but only six pairs of true appendages. So far as this bears on the relationship of the Pycnogonida with the Arachnida, which as Professor Semper thinks is rendered doubtful by their possession of only six pairs of legs, Dohrn remarks that " the homologies of the appendages will only be proved when the blood-relationship of the separate orders of the Arthropoda has been demonstrated by some other method." In addition to this " theoretical " consideration Dohrn asserts that Semper is wrong in his facts. The great and important point is the character of the nervous system: with regard to the first ventral ganglion, it gives off three pairs of nerves; the first, which is not noticed by Semper, supplies the rostrum and its musculature, its sensory hairs and complicated lips; the second pair supplies the so-called tentacles, or those appendages which are intercalated between the rostrum and the ovigerous appendages: the third pair pass to the ovigerous appendages and present the same morphological relations as the second pair.

In the larva, the first pair of legs are supplied by a nerve given off from the supra-œsophageal ganglion and the two hinder pairs by two distinct nerves, which arise from two incompletely separated *ventral* ganglia; from this it is clear that these two larval extremities are not equivalent to the appendages of one segment, but are two " homodynamous structures." The larva is therefore provided with three pairs of appendages, and as four other pairs are developed later on, Dohrn's original view that there are seven pairs of appendages in the Pycnogonida is true for all cases in which the larval legs persist; and even when the third pair disappear, as Semper has shown them to do in the case of *Phoxichilidium*, the nerve still retains its old morphological relations, and supplies the horseshoe-shaped ridge which is the final remnant of the ovigerous appendages. From the point of view then of development and of nervous relations the " typical " character of the ovigerous legs (the third pair in the larva) as true appendages appears to be well established.

Professor Semper has, however, yet another argument; he asserts that in all Pycnogonida cæcal gastric sacs are " typically " continued into the appendages: of the third of these sacs he states that it

goes to that segment of the body which in the larva bears the third pair of larval legs and in the adult the first pair of true legs. But Dohrn asks how these sacs are made out to be typical rather than the generative cæcal sacs of which only four pairs are developed; in fact they cannot be in any sense regarded as typical, inasmuch as in some genera there are *no* cæcal sacs for the palp or the ovigerous appendages; while in others there are two pairs, and yet again in others only one. Semper asserts that there are only six paired ganglionic masses in the body, while Dohrn states there are eight.

The statement of Cavanna that the egg-pouches are found only on the male is supported; and the blood-corpuscles are stated to be enormously large. Dr. Dohrn announces that he is preparing an account of the *Pycnogonida* of the Gulf of Naples.

δ. Crustacea.

Structure of the Nervous System of the Decapodous Crustacea.* —In the summary of his results M. Yung enters into somewhat greater detail than he did in the ' Comptes Rendus,† and we are able to add one or two points of importance.

The author points out that the absence of a differentiation of myelin and of the axis-cylinder which is to be observed in the central nervous system of Vertebrates, together with the form and composition of the cells, brings the central nervous system of the Crustacea into very close affinity with the sympathetic system of the Vertebrata, the only difference between them being one of size.

The thoracic ganglia of the Macrura have a similar structure to the abdominal ganglia, and the slight differences between them may be seen to be due to the concrescence of several ganglionic masses; this is best and most strikingly seen in the Brachyura, where there is only a single thoracic ganglion. As already stated, the brain seems to be formed of three ganglia, and it is possible, we may add, to distinguish anterior, lateral, and posterior protuberances; these are formed by a compact medullary mass, which is finely dotted, and is divided into a number of more or less cubical portions by fine lamella of connective tissue, and distinguished histologically by being more deeply coloured by osmic acid than is the rest of the nervous substance; the medullary mass is covered by a layer of nuclei, but it is not possible to distinguish any cellular investment; the nerves of special sense have their origin in the superficial cells of the protuberances, but it is not easy to say exactly whence any particular nerve arises.

It is interesting to observe that the studies of M. Yung confirm the theoretical views, long ago propounded by M. Milne-Edwards, as to the presence of three pairs of ganglia in the brain.

Physiology of Muscle and Nerve in the Lobster.‡—MM. Fredericq and Vandevelde have contributed a paper on this subject to the Belgian Academy. Their conclusions are as follows :—

* ' Arch. Zool. Exp.' (Lacaze-Duthiers), vii. (1878) p. 449.
† See this Journal, *ante*, p. 419.
‡ ' Bull. Acad. Roy. Sci. Belgique,' xlvii. (1879) p. 477.

1. There appears to be complete identity of properties between the muscles of the lobster and those of the frog.

2. The motor nerves of the lobster present, from a physiological point of view, strong points of resemblance with those of the frog. The most characteristic difference consists in the slowness with which the motor excitation travels along the lobster's motor nerves (6 metres a second in the lobster, 27 metres in the frog). The propagation of the motor excitation undergoes, in the lobster, a considerable retardation in the muscular terminations of the motor nerve.

Action of Electric Currents on the Pincer of the Crayfish.*— By the aid of the graphic method, and the slowness with which the muscles of the pincer effect their contraction, M. Richet has been able to show that the form of the muscle-wave varies with the intensity of the electric currents which effect it ; it is short when the currents are feeble, although longer than in the muscles of the frog. When the intensity of the current is increased the form alone changes ; the fall of the curve is at first rapid and then gradually slackens. As the current is increased in intensity the second period increases in length, and the former diminishes until at last it may be seen to completely disappear ; and it follows from this that it is not the height but the duration of the muscular contraction which increases with the increased intensity of the exciting currents. That the contraction is due to change in the muscle itself, so far, at any rate, as its second portion (that of gradual relaxation) is concerned, is shown by the fact that this " contracture," as the author calls it, is barely apparent when the motor nerve is itself directly excited. The myographic traces obtained were found to be remarkably similar to those exhibited by muscles poisoned by veratrin. These observations may be taken as supplementary to those previously recorded.†

Atlantic Stalk-eyed Crustaceans.‡—Mr. S. J. Smith, of Yale College, publishes an account of the stalk-eyed crustaceans of the Atlantic coast of North America. It forms part of the report in pre paration for the United States Commission of Fisheries, and embodies the study of the extensive collections made during the past fourteen years by Professor Verrill and himself.

In the present paper only the species inhabiting the coast between Cape Cod and Northern Labrador are given, and although the paper has special reference to the geographical distribution of the species, considerable matter is introduced in regard to specific variation and specific characters, and under some of the species, to the synonymy, especially where it seemed necessary to the proper understanding of the geographical distribution, or to show the propriety of the nomenclature adopted, or where the species is not well known.

* 'Comptes Rendus,' lxxxviii. (1879) p. 1272.
† This Journal, *ante*, p. 562.
‡ 'Trans. Connecticut Acad. Arts and Sci.,' v. (1879) ; ' Nature,' xx. (1879) p. 535.

The total number of species recorded is 73, of which 45 are Decapods, 11 Schizopods, and 17 Cumaceæ, one-half of which are also to be found in Europe, the author concluding that there is not only a close relationship between the marine fauna of Greenland and that of Northern Europe, but a similar close one between that of Greenland and of the coasts of the continent of North America.

Some New Cymothoida.*—Herr Koelbel describes some new species of this group from various localities in a paper which is illustrated by two plates; among these is a representative of a new genus *Emphylia*, which is allied to *Nerocila* of Leach, but is distinguished from it by the approximation of the bases of its internal antennæ. The single species receives the name of *ctenophora*, and the habitat is stated to be Akyab. There are no points in the paper of general interest.

Trilobites and Limuli.†—Professor E. von Martens recapitulates the history of the Trilobites, which, so characteristic of Silurian deposits, are never found in any strata later than those of the Permian epoch. He points out that their relationship to the Isopoda is opposed by the freedom of the head in these latter, and by their constant possession of seven thoracic and seven abdominal segments, while in the Trilobites the cephalic and thoracic portions are always fused and the number of segments is inconstant. With regard to the view of Professor Claus that the Trilobites are allied to the Phyllopoda, it is allowed that in these extant Crustacea numerous points of similarity are to be observed.

Turning to the *Limuli* (American king-crabs) the author points out that they are to be distinguished from all other forms of Crustacea by the fact that there is only one pair of præ-oral appendages; in this point they agree with the Arachnida, and with this class some modern zoologists would place them; when, however, we consider the points by which the Crustacea and Arachnida are distinguished, and then study the characters of *Limulus*, we may see that the view of Professor von Martens is, at any rate, highly probable. The Arachnida are remarkable for the absence of abdominal appendages, the presence of simple eyes only, the straight intestine, and the possession of Malpighian vessels. None of these characters are presented by *Limulus*; it, like all Crustacea, has abdominal appendages, branchial organs, genital orifices situate at the boundary between the thorax and abdomen, compound eyes and a true proventriculus. Observation of living forms has recalled to Professor von Martens the great similarity between *Limulus* and the Phyllopod form *Apus cancriformis*, and he concludes with stating that in his opinion we have both in the case of *Limulus* and of the Trilobites, to do with special and isolated orders of the Crustacea, both of which have taken their origin from the Phyllopoda.

* 'SB. Akad. Wiss. Wien,' lxxviii. (1879) p. 401
† 'Naturforscher,' xii. (1879) p 377.

New Species of **Chirocephalus.**[*]—Mr. John A. Ryder, observing that this genus does not seem to have been noticed in North America, announces the discovery of a hitherto undescribed species in New Jersey, where it was found in abundance in the ditches.

The genus, as characterized by Dr. Baird,[†] has been found in Switzerland, France, England, Russia, and Siberia. The species *C. lacunæ*, most nearly like the one now discovered, is figured and described by Guérin in his 'Iconog. Règne Animal,' as being found at Fontainebleau. The differences between the species are, however, sufficiently striking and constant to characterize a well-marked specific type, for which the following characterization is proposed.

Chirocephalus Holmanii, nov. sp.

Char. specif.—Claspers moderately robust; second joint forked, longest branch longer than first joint, and curved inwards, its tip crossing that of its fellow of the opposite side when in repose; shorter branch, less curved, slightly swollen, and rough on the inner surface of its tip, about half as long as the longer branch. Two long, fleshy, proboscis-like prehensile organs arise from the bases of the claspers and are coiled up between the latter; muscular fibres pass throughout their length; near their origin and for the first third they are expanded inferiorly into a thin margin with about seven papilliform processes; they then gradually contract, becoming cylindrical at their second third, where about seven well-marked digitiform processes are found, the longest of which are about as long as twice the diameter of the proboscis at this point; the remaining third gradually contracts, and is thickly studded with half-rings of small papillæ which seem to mark indistinctly the segments of the organ. Total length of the proboscis, when extended, about three times that of the claspers. Total length 12–14 mm. Habitat, Woodbury, New Jersey.

The specific name is given in honour of Mr. D. S. Holman, in recognition of the services he has rendered in devising methods for studying living objects, both large and small, under the Microscope.

Reproductive Organs of **Non-parasitic Copepoda.**[‡]—A monograph on this subject is published by Dr. August Gruber, of Freiburg.

1. *Testis and Vas deferens.*—The primitively double testis is, in all free forms, a single, usually pear-shaped gland. The vas deferens is always divided into three parts, differing in structure and function. The first portion extends at first backwards from the testis, often has a strong curve forwards at the end of its course, and is provided with a very narrow lumen. The second portion is more or less convoluted, and differs from the first mainly in being considerably distended by the quantities of seminal fluid (Samenmasse) stored up in it;

* 'Proc. Acad. Nat. Sci. Philad.,' 1879, p. 148.
† "Monograph of the Family Branchipodidæ," 'Ann and Mag. Nat. Hist.,' xiv. (1851) p. 216.
‡ 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 407.

the spermatophore takes its origin in this segment. The third portion, the spermatophoral sac or *ductus ejaculatorius*, is usually short and thick-walled; in it the formation of the spermatophore is completed. The author points out that this division into three parts of the male genital duct corresponds with a similar state of things described by Grobben in the *Decapoda*.

The ripe spermatozoa accumulate at the anterior end of the testis, and are carried off along the first segment of the vas deferens, the lumen of which is so small, that often only two can lie side by side. Arrived at the second segment, they accumulate at its hinder end, being prevented from entering the third segment by a pylorus-like constriction between the second and third. The second portion of the duct becomes so swollen out by the accumulation of sperm, that its walls are reduced to a very thin membrane; this accumulation proceeds up to the bend which marks the line of juncture of the first and second portions.

Even in the first portion of the duct there is seen to be a granular secretion of its wall among the spermatozoa, as well as a delicate investment, also a secretion of the wall, around them. In the second segment these two secretions have become much more important, and there can be distinguished, from without inwards, (1) the thin investment; (2) the layers of spermatozoa; and (3) the central mass of granular cement-substance.

The rudiment of the spermatophore thus constituted is partly pushed through the valve into the third segment of the duct, and the greater part of it is constricted off to form the spermatophore, part, however, remaining in the second segment, ready to begin the formation of a new spermatophore.

The author does not believe in the existence of the special secretion (Sprengstoff or Austreibstoff) described by some observers, having for its function the emptying of the spermatophores.

The first section of the paper concludes with a description of the male organs in the *Cyclopidæ*, the *Harpactidæ*, the *Peltidiæ*, the *Corycæidæ*, the *Calamidæ*, and the *Pontellidæ*.

2. *The receptaculum seminis and the formation of the egg-sacs.*— This section treats of the female organs in the *Calamidæ*, the *Cyclopidæ*, and the *Harpactidæ*. The author sums up his results as follows :—" Amongst the *Copepoda* some species are found devoid of a special receptaculum, others with a pair of symmetrically disposed receptacula, and others again in which the organ is unpaired, and lies in the middle line of the abdomen. In the first case, the semen, surrounded by the cement-substance of the spermatophore, is simply inserted into the vulva, in both the other cases the seminal capsules empty themselves, usually through a special pore, into the receptacula, from which the semen makes its way, during the extrusion of the eggs, into the vulva. The receptacula are never also cement-glands, but the secretion which forms the egg-sacs is a product of the oviduct, the terminal portion of which it fills as a clear, delicate mass, which sets in water.

The Notodelphyidæ.*—M. L. Kerschner describes two new genera of the curious Copepod family Notodelphyidæ, each including a single species, which he names *Paryphes longipes* and *Dorsipys uncinata*.

He prefaces his descriptions with some corrections of previous notions as to certain points in the organization of these crustaceans. He shows that the brood-chamber, which is usually regarded as contained within the body-cavity, is formed, in the majority of Notodelphyidæ, by a duplicature of the integument of the body proceeding from the dorsal surface of the fourth and from the sides of the fourth and fifth segments, but that in two genera this duplicature is inserted even upon the second thoracic segment. He further indicates that an unpaired ovary is present, and that the ova pass in strings into the oviducts (formerly " ovaries ").

The author confirms a part of Thorell's observations upon the connection of the female generative organs, and, by the discovery of the hitherto overlooked external genital aperture of the female, brings back these organs to the general type of the whole order.

In all the males observed he describes an unpaired testis, and represents the envelope of the spermatophores as secreted by the wall of the whole of the seminal duct. In the spermatophore itself he recognizes more layers than Thorell. He describes the type on which the nervous system is constructed, and in opposition to Buchholz, asserts the presence of olfactory nodes.

New British Entomostraca.—The very curious translucent Entomostracon *Leptodora hyalina*, which was first found in the deep Swiss lakes, and subsequently in other parts of Europe, has now been found in England, first in the Olton Reservoir, near Birmingham (in the masses of a minute alga, *Clathrocystis*), and subsequently in two other localities, and was described † by Mr. Graham, the President of the Birmingham Natural History and Microscopical Society, with a drawing by Mr. Forrest.‡

In the Olton Reservoir (and subsequently in a second locality) there was also found an Entomostracon, new to Britain, which was at first supposed to be a new species and so described and figured in the 'Midland Naturalist' § (" *Daphnia Bairdii* "), but was subsequently recognized by Professor Lankester as *Hyalodaphnia Kahlbergensis* of Schödler. Only the female was found.

Vermes.

Segmentation in Worms and Pulmonates.‖—Dr. W. Mayzel, of Warsaw, confirms Auerbach's observations as to the changes undergone by the nucleus in the dividing egg of *Ascaris nigrovenosa* and of *Strongylus auricularis*. In both these species, as well as in *Limax variegatus*, he found the now well-known caryolytic figures—the spindle

* 'Anzeig. Akad. Wiss. Wien,' June 13, 1879 ; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 321.
† 'Midl. Nat.,' ii. (1879) p. 225.
‡ See also Mr. Forrest's paper, *ante*, p. 825.
§ 'Midl. Nat.,' ii. (1879) p. 217.
‖ 'Zool. Anzeiger,' ii. (1879) p. 280.

nucleus, nuclear disk, "suns," &c. His observations, therefore, tell strongly against Brandt's amœboid theory of nucleus-division, according to which there is no real differentiation of the nucleus, the fibres described in it being merely folds in its membrane, and the "suns" at its poles, radially arranged nuclear processes or pseudopodia.

Prizes for Life-histories of Entozoa. — The council of the Entomological Society of London are authorized by Lord Walsingham and other gentlemen interested in the diseases of our native game-birds to offer to public competition the following prizes :—

50*l.* for the best and most complete life-history of *Sclerostoma syngamus* Dies., supposed to produce the so-called "gapes" in poultry, game, and other birds; 50*l.* for the best and most complete life-history of *Strongylus pergracilis* Cob., supposed to cause the grouse disease.

No life-history will be considered satisfactory unless the different stages of development are observed and recorded. The competition is open to naturalists of all nationalities. The same observer may compete for both prizes. Essays in English, French, or German to be sent in on or before October 15, 1882, addressed to the Secretary of the Society, Chandos Street, Cavendish Square.

Development and Metamorphoses of Tæniæ.* — M. P. Mégnin now gives a fuller account of his observations than that which appeared in the 'Comptes Rendus.'† He expresses the opinion that the armed *Tæniæ*, or those which are provided with spines, are forms which exhibit a suppressed development; it is, however, to his remarks on the polymorphism of these forms that we now wish to direct especial attention. As he very justly observes, the existence of two adult forms developed from the same cestoid worm appears to be very remarkable ; to remove any difficulty in accepting the correctness of his statements, he directs attention to the polymorphism which obtains [as Ehlers has shown] in *Nereis Dumerilii* and *Heteronereis fucicola*, of which one is small, agile, and free swimming, and the other large, slow, and bottom-dwelling ; similar examples may be taken from among the Arachnida, and it is concluded that polymorphism is the rule in the lower animals, and that this polymorphism is always the result of the influence of the surrounding medium, or is effected by certain special conditions of existence. In the particular case now under investigation, the cause is pretty evident ; when the "vesicular worm" passes into the Carnivore it finds itself in an intestine, the contents of which are in a state of continual movement so that the feeble scolex has need of all its hooks and suckers to fix itself to the wall ; but, in the Herbivora, it can pass into a more retired position, and here the hooks are altogether useless.

Nematodes in the Caves of Carniola.‡ — Dr. Gustav Joseph, of Breslau, gives a brief account of his researches on the hitherto little-

* 'Journ. Anat. et Phys.' (Robin), xv. (1879) p. 228.
† See this Journal, *ante*, p. 162.
‡ 'Zool. Anzeiger,' ii. (1879) p. 275.

known free Nematodes in the caverns of Carniola. The following examples of known genera are found :—*Dorylaimus*, 2 species ; *Tyleuchus*, 2 ; *Apheleuchus*, 1 ; *Tripyla*, 1 ; *Monhystera*, 1 ; *Anguillula*, 1 ; *Mononconchus*, 1 ; *Cephalobus*, 2 ; *Rhabditis*, 3 ; and *Ilectus*. One species of the latter genus was especially interesting, partly because of its size as compared with *P. granulosus*, the species it most resembled (11–13 mm. as against 1·3 mm. in the male, and 9–10 as against 0·8 in the female), and partly because it was found both in the sand of the Recca-grotto and in the sea-sand near the mouth of the grotto ; in other words, an animal probably originally marine is able to adapt itself to a life in fresh water and in darkness. Further observations are necessary to show whether this migration into the dark cave has relation either to wintering or to breeding.

Anuræa longispina.—This rotifer, discovered by Professor Kellicott at Buffalo, N.Y., and described in our April number,* has now been found by Mr. J. Levick † in this country, in the prolific Olton Reservoir near Birmingham.

Mr. Levick was not able to see the pair of well-defined " wheels " described by Professor Kellicott, and thinks them probably a mistake, a view which Professor Kellicott, in a recent letter to ourselves, confirms.

Studies on the Gephyrea.‡—Dr. Spengel in treating of the formation of the ova in *Bonellia*, points out that the organs described in 1852 by Schmarda as being those of the female generative system were very differently regarded by Lacaze-Duthiers in 1858 ; and that, since then, twenty years elapsed before the female generative organs were again carefully examined. Armed with the latest methods of modern histology, Vejdovsky has returned to the subject, while the investigations of Greef have led the latter author to confirm the results of Lacaze-Duthiers as to the uterus and ovary.

Dealing with Spengel's own observations, we find that the ovary of *Bonellia*, discovered by Lacaze-Duthiers, is placed in the ventral aspect of the animal, between the nerve-cord and the coils of the enteron ; extending through the two hinder thirds of the body, the ovary is connected with the ventral blood-vessel, which accompanies the ventral cord ; the anterior part of this vessel consists of a peritoneal investment succeeded by a membrane in which are contained muscular fibres ; the part which takes a share in the formation of the ova is the peritoneal investment, which in its anterior portion, where it is not connected with the ovary, consists of flattened cells with small elongated nuclei ; about its median third the vessel is seen to become provided with cells remarkable for their great size. These are the youngest germ-cells, or, more correctly, " primitive ova," and at the margin of each there are to be made out some flattened cells, which are so arranged as to form a kind of investment. Connected with the primitive ova is a more or less large number of cells which are placed on pedicels, and in groups which are made up

of a set of internal cells, covered by a layer of flatter ones, and both of which owe their origin to the primitive ova and their investing cells.   The two sets continue to be developed equally, but the inner ones undergo a differentiation, which, it may be noted, is very difficult to observe as it is not a morphological one, but is merely dependent, in its earlier stages, on change in position; one cell becomes distinctly central and increases a good deal in size; some of the peripheral cells next increase in size; the largest cell, which results from those changes, is the future ovarian cell.   Into their further history it is impossible for us, in our limited space, to follow them, and we must be content with stating that the large number of 1500 ova were found by Lacaze-Duthiers in the uterine cavity.

Passing on to the early stages in the development of the ovum we find a striking difference between the fertilized and unfertilized eggs; in the former the oil-drops are arranged peripherally and form a circle around the ovarian sphere, while in the latter the yolk is free from oil-drops and is set a good deal towards one side of the egg, while the oil-drops are limited to other parts.   The first stage in fission was not observed; in the next, there were four cells of equal size, which, like the unfertilized egg, consists of two parts, in one of which all the oil-drops are collected, while the other, which contains the nucleus, only consists of a finely granular protoplasm; these two sets of structures may be known as vegetative and animal.   In the next stage four small animal cells are separated off, which immediately take up a central position.   The further stages of cleavage may be summed up in a few words; the animal pole having given rise to four blastomeres, continues to divide and grow over the vegetative cells, which divide more slowly.   It is remarkable that this mode of cleavage has not hitherto been observed in the Gephyrea, for *Phascolosoma* has been found to exhibit equal cleavage of all the blastomeres and to form an archigastrula; nevertheless *Trochus* among the Mollusca, and *Salmacina* among the Annelids present just the same relations as *Bonellia*, and similar relations have been observed in some marine Planaria and Hirudinea; to adopt the nomenclature of Haeckel we here have to do with an amphigastrula.   When the now subjacent macromeres begin to increase they give rise to the enteric epithelium; but the centre of the embryo is still occupied by the four large macromeres, which are remarkable for the possession of a large oil-drop, while the protoplasm is reduced to a fairly large investing portion, containing the nucleus on one side.   When the endodermal and ectodermal cells become differentiated an orifice—the blastopore—appears; and the ectodermal cells soon pass into its inner margin.   As to the mesoderm, it does not first have the appearance of two large cells, as in *Lumbricus* (Hatschek, &c.), but appears as a closed circular layer.

At this point there are some gaps in Dr. Spengel's observations, and we pass on to the characters of the embryo and of the free-swimming larva, in which we soon observe in the ectodermal cells the characteristic green pigment, together with cilia which appear on cells which are without pigment and which continue to be so.   A section taken at about this stage displays a mass of

endodermal cells surrounded by a thin mesoderm which, again, is covered by an ectoderm in which, in addition to two cells, supplied with long cilia, there is a thickening of several layers of cells; this is regarded by our author as the first rudiment of the supra-œsophageal ganglion. The embryo now begins to elongate, and from the body, which is divided by the two bands of cilia into three regions, there is developed in the first and semicircular segment an eye on either side, while the whole creature takes on the form of a rhabdocœlous Turbellarian, and is seen to be possessed of a great power of contractility. The next succeeding stages appear to be somewhat difficult to follow out, and although the mesoderm is seen to divide into an ectodermal and an endodermal portion, no cœlom to speak of is immediately formed. The oil-containing cells of the endoderm give rise to a cavity and the rudiments of the œsophagus are developed. The development of the nervous system goes on at a rapid pace, but the ventral cord does not extend to the hinder end of the body, and the author was not able to observe in it the central canal reported by Greef. Great changes go on in the mesoderm; the splanchnic plate remains thin, but the somatic becomes greatly thickened, and there is, further, differentiated an external circular and an internal longitudinal layer; here ends the sexually indifferent stage of the larva, a worm-like creature, containing chlorophyll, ciliated over its whole surface and divided by two bands of cilia into three regions, of which the foremost is supplied with two large pigment spots. The enteron is a closed oil-containing sac, in which the rudiments of the œsophagus may be made out; the mesoderm is, in the anterior region, formed of a compact mass of vesicular cells, and, in the rest of the body, consists of a thin splanchnic, and of a differentiated somatic plate, in which, besides muscles, there is a mesh of tissue.

The Female of Bonellia.—The first stages in further differentiation affect the mesh of tissue just mentioned, and the indifferent cells contained in it; the changes which occur convert the "parenchymatous" larva into a "bladder-shaped worm," with a spacious cœlom, containing fluid. Whence comes this fluid? the author is not quite able to say, though he offers what he thinks is a plausible explanation. About the time when the conversion of the mesodermal cells is completed there may be seen at the hinder portion of the enteron two closed vesicles given off from the enteron, one on either side, which form, by the breaking through of their walls, a means of communication between the interior of the body and the sea-water; and the fluid is, as the author supposes, nothing more than sea-water. This change in the characters of the mesoderm does not affect the cephalic portion of it where there is, by a metamorphosis of the portion of the enteron anterior to the œsophagus, developed the cephalic lobe (or so-called "proboscis"). Passing over various points we come to the changes which take place in the epidermis; the ciliated bands, first the posterior and then the anterior, disappear, the cells of the epidermis become flatter, and dermal glands begin to be formed. The muscular bands become so arranged that the circular ones are peripheral, the oblique internal, and the longitudinal median in position. On the

ventral side and posteriorly to the mouth appear two important organs; the hinder pair consist of two setæ, each of which lies in a cellular sac, which is apparently its matrix; in front of these there is a pair of extremely delicate tubes which project freely into the cœlom, and are covered by epithelium and by a peritoneal investment; they have a narrow, although distinct, lumen. Unable to give any account of these orifices, the author regards them as primitive segmental organs; they disappear very soon. As to the generative organs, the ovaries appear very early in the form of large cells, with round nuclei, placed near the hinder portion of the ventral vessel.

The Male.—The history of the male of *Bonellia* is one of the most interesting in comparative anatomy; Schmarda, regarding the funnel of the uterus as the testis, considered that *Bonellia* was hermaphrodite. Lacaze-Duthiers considered that all the specimens he had seen were females, and Kowalevsky was of the same opinion, until in 1868 he found in the female ducts a number of small Planarian-like parasites, which he regarded as being the male form of this interesting creature. In 1877 Vejdovsky discovered (and in 1878 gave an account of his observations *) the ventral nerve-cord; Selenka has reported the presence of two sub-œsophageal ganglia and of a pair of segmental organs; while, on the other hand, Greef has lately expressed his dissatisfaction as to the reality of this Planarioid form being the male of *Bonellia.*

Dr. Spengel found the males forming green scales on the proboscis of the female, and they, when, after some difficulty, separated from it, exhibited themselves under the form of elongated small worms with a green coloured epidermis, two eyes at their anterior end, and an oily enteron—in fine they appeared to be *Bonellia-larvæ,* save only that they had lost their two bands of cilia. Further investigation showed that they possessed germ-cells, altogether similar to those of the female, connected with masses of somewhat smaller cells, arranged in a central and a peripheral group; the latter are the true seminal cells; increasing in size, they become separated from the surrounding tissue and swim about in the body-cavity of the males. Meantime the mesoderm in the anterior region becomes more compact, the rudiments of the œsophagus disappear, and the hinder portion of the enteric tract becomes fused with the mesoderm.

It is impossible here to enter into the details of the organization of the male, and we must refer in a very few words to their " morphology." The anterior portion of the body represents the " cephalic lobes" of the female, the ventral cord is essentially the same as it is in the asexual larva, but the cellular elements are not, as in the female, arranged metamerically; they form a connected cord; the digestive system is in a very elementary condition. No vascular system appears to be developed, but this is probably due to the mesodermal cells going completely to form the sperm. In conclusion, it is observed that the male of *Bonellia* is a Gephyrean in all essential points, and that, subsequently to the larval stages, all interest is centred on the male organs, while the loss of the ciliated

* See this Journal, *ante.* p. 290.

bands and of the eye-spots is to be correlated with their parasitic mode of life.

Pelagic Annelids from the Canary Islands.*—Prof. Richard Greeff describes several interesting species found by him off the coast of Lanzarote, one of the Canary Islands.

1. *Acicularia Virchowii.*—This animal attains a length of 5 to 9 mm., its greatly elongated body consisting of twenty-six to thirty-nine segments. The head-segment or prostomium is prolonged into a movable conical frontal process, which serves as a tactile organ. The head also bears a pair of leaf-like parapodia, directed somewhat forwards. These properly belong to the second segment or peristomium, but there is no separation between the two. The remaining segments bear outwardly directed parapodia, each consisting of notopodium and neuropodium, with a small prominence between them bearing setæ. The form of the two divisions of the parapodium is curious: each is more or less quadrate in outline, and attached, mushroom-like, by a stalk on the centre of its inner surface.

On the surface of the parapodia are a number of circular disks, each made up of numerous facet-like areas, like a compound eye. Further examination of these bodies shows that each consists of a deep cup-like depression of the surface, filled with a bundle of close-set parallel rods, some of which are occasionally seen projecting far beyond the surface of the disk, having evidently been partially ejected. Observation of the living animal showed that these curious organs acted as adhesive disks; they adhered to the slide and cover-slip, sometimes the whole follicle being extruded and looking like a stalked sucker. It seems probable that they may also act as urticating organs.

A description is also given of the alimentary canal, nervous system, and generative organs: a dorsal vessel containing a clear colourless fluid was made out.

The author found a larva of *Acicularia*, on the point of metamorphosing; it was chiefly distinguished from the adult by its circlet of long, outstanding setæ just behind the head.

2. *Pontodora pelagica* (nov. gen. et sp.).—The most interesting point about this species is the character of its segmental organs, which open by ciliated apertures at the summits of little stalked, cup-like structures on, and at the base of, the parapodia. Sometimes each cup has several ciliated apertures, sometimes only one, in which case it bears a strong resemblance to a *Vorticella.* The internal apertures of the segmental organs were not observed. The length of the body is 1·6 mm.

Greeff places *Pontodora* in the family *Syllidæ.*

3. *Pelagobia longicirrata* (nov. gen. et sp.).—In this species, which attains a length of 3 mm., there was no prostomium to be seen, the mouth being, to all appearance, actually terminal. There are no true peristomial cirri, but the peristomium bears, on each side, a pair of short simple feeler-like processes, and, farther back, a ciliated lobe. A pair of simple eyes, with lens and pigment, is present in this

* 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 237.

as in the former genus. It also may be placed provisionally in the family *Syllidæ*.

4. *Phalacrophorus pictus* (*nov. gen. et sp.*).—The length of the body is about 6 mm. There are two simple eyes, sessile on the extremities of the cerebral ganglion. The central lobe (Ruder) of the parapodia is ciliated, the cilia being in some places collected into bundles, which possibly represent the apertures of the segmental organs. The pharynx is provided with a pair of curved jaws. This genus is considered as an aberrant form of the *Lycoridæ*.

5. *Sacconereis Canariensis* (*nov. sp.*).—The author was prevented from tracing out the whole life-history of this species, but the probability is that, as in the species described by A. Agassiz, the impregnated egg gives rise to a sexless female or "nurse" (*Autolytus*), which, by budding, gives rise to the male (*Polybostrichus*) and female (*Sacconereis*). The female was found with her ventral nidamental pouch full of eggs and larva. Four stages of the latter are described, and also a newly discovered larva; the adult form of which is unknown.

6. *Observations on the Tomopteridæ.*—There has been a good deal of difference of opinion as to the presence of a pair of small appendages on the head of *Tomopteris*, over and above the blunt frontal feelers and the long bristled tentacles. Greeff considers that these are always present, but that they have escaped notice owing to their small size, and the fact that they are often tucked in under the head, and frequently broken off when the animal is caught. He calls them the first pair of tentacles, the well-known long setose appendages being the second.

Greeff has also investigated the "rosette-like organs," and his results are entirely opposed to those of Vejdovsky.[*] He fails to find anything of the nature of a lens, denies altogether the visual function of the organs, and considers them to be parapodial glands.

An account of the muscular system of *T. Eschscholtzii* is given, and the paper concludes with a description of three new species, *T. Kefersteinii*, *T. levipes*, and *T. Eschscholtzii*.

Annelid Jaws from Scotch and Canadian Palæozoic Rocks.[†]—Mr. G. J. Hinde describes fifty-five different forms, the greater proportion of which are from Canada, the strata in which they were imbedded being principally shallow water deposits. After referring to the very few recorded instances of the discovery of any portions of the organism of errant annelids as distinct from their trails and impressions in the rocks, he describes the principal varieties of form and of the structure of the jaws, classifying them from their resemblances to existing forms under seven genera, five of which are included in the family Eunicea, one in the family Lycoridea, and one among the Glycerea.

The jaws occur as small, dark, shining objects, very varied in form, dispersed through the rock, quite detached from each other and from the positions they occupied in the head of the animal. The material of which they are composed appears to be nearly entirely of a chitinous character, and so far free from calcareous matter that it undergoes no change in nitric acid.

There is very great variation in the dimensions of the jaws; the greater number do not average more than $\frac{1}{12}$ inch in length, but a few are $\frac{1}{3}$ inch long and $\frac{1}{10}$ inch wide. In order to form an idea of the relative length of worms with similar jaws, the principal jaw-plate was measured in a specimen of the existing *Eunicea sanguinea* (whose body was 8 inches long), and was found to be $\frac{1}{3}$ inch long and $\frac{1}{15}$ inch wide. If the length of these animals is in proportion to that of their jaws, then the largest of the fossil jaws would belong to an annelid of about 13 inches in length, whilst the greater part would not be more than $3\frac{1}{4}$ inches.

Organization of Batrachobdella Latasti, C. Vig.*—This Hiru-dinean was found living parasitically upon a Batrachian of Algeria, *Diploglossus pictus*, which, added to a certain external resemblance, led to its being taken for *Glossiphonia algira*. Like the latter, it has only two eyes, but is otherwise distinguished by its smaller size, its more regular form, not attenuated in front, its green colour, and its proportionally larger posterior sucker. The following are the results of its anatomical study by C. Viguier.

Genital Organs.—The genital orifices are in the male on the twenty-first ring, and in the female between the twenty-third and twenty-fourth. There is no developed penis, but a simple button, as in the *Glossiphoniæ*, which is generally placed a little to the right of the median line (looked at from the lower surface). The epididymi are very large, and, after a certain number of folds, each gradually narrows into a very slender deferent canal. Twelve testes relatively large are arranged in two regular and parallel rows. The female apparatus is composed of two very small pyriform ovaries, from which start slender oviducts, passing into a very small transverse and always exactly median matrix situated immediately above the vulva.

Digestive Apparatus.—There is, as in the *Glossiphoniæ*, an exsertile trunk, behind which the œsophagus has the aspect of a muscular tube with longitudinal and annular fibres. Above the genital orifices there is a large, pyriform, brownish swelling, visible by transparent light in the living animals, and which is constituted, from without inwards, by somewhat voluminous brown cells, and by large clear cells with a brilliant nucleus, disposed all round the lumen of the digestive tube. Immediately behind this swelling, which performs, no doubt, the function of a liver, are the first lateral cæca, which pass in front of the first testes; five other cæca on each side pass between the testes of each row. Lastly, a seventh pair of narrow cæca comes behind the last pair of testes. The axial portion of the digestive tube presents between the cæca small turbid cells, perhaps hepatic cells. Behind the seven pairs of narrow cæca, and where the cavity of the body is no longer occupied by the testes, are four pairs of large cæca —the first two directed slightly forward, the third nearly transverse, the fourth directed backward. The terminal portion of the digestive tube makes a small loop to the left, and is then directed in a straight line to the anus.

* 'Comptes Rendus,' lxxxix. (1879) p. 110; 'Ann. and Mag. Nat. Hist.,' iv. (1879) p. 250.

Circulatory Apparatus.—The circulatory apparatus is nearly identical with that described by Budge in *Clepsine;* but the vascular loops of the head advance further in front of the eyes.

Nervous System.—The nervous system nearly agrees with that described by Baudelot in *Clepsine.* The sub-œsophageal portion of the collar results from a more considerable grouping, and the terminal mass of the chain from a smaller grouping than in *Clepsine.* The number of large cells contained in the vesicles attached to the ganglion is less than figured by Baudelot.

In short, *Batrachobdella* approaches the *Glossiphoniæ* or *Clepsinæ* by its nervous system and circulatory apparatus, while the general arrangement of the genital organs is rather that which is found in *Ponbdellæ* or *Pontobdellæ;* and the digestive apparatus, although presenting a trunk as in *Clepsine,* differs from what is seen in all the other Hirudineæ by the arrangement of the cæca and presence of a hepatic swelling.

New Alciopid.*—In describing the eighth species of this interesting group which is now known to constitute a portion of the Mediterranean fauna, Dr. Richard Greef calls attention to the great size of the dorsal lamellar cirri of *Alciopa Krohnii;* the dorsal, as well as the ventral cirri, are not rounded, but are continued into an elongated conical tip. As in the other species of the genus, and in connection with its pelagic mode of life, the whole body is transparent, the only exception being the red eyes beneath the first pair of dorsal cirri, and the lateral brown glands, which are so situate as to be with difficulty visible ; the eyes are also separated considerably from one another, owing to the great breadth of the cephalic region. The muscular supply of the parapodia is exceedingly well developed, inasmuch as four powerful muscles pass out, on either side, from the inner face of the body-wall to these organs and break up in the cirri ; one of these pairs passes so close to the ganglion as to be easily mistaken for a nerve-cord.

In the characters of its nervous system and of its sensory organs this new species agrees very generally with the other Alciopids. Special organs which appear to belong to the " segmental " series are very briefly mentioned ; they form cellular tubes, very similar to racemose glands, and lie, coiled in the body-cavity, on either side of the enteric tube, while they give off a canal which appears to pass into the body; unfortunately, the author was unable to make out either their external or their internal orifices.

Organization and Classification of the Orthonectida.†—Professor A. Giard has now completed his researches on this important group of Vermes, his discovery of which was announced in a preliminary paper published in 1877,‡ reproduced in this Journal.

1. *Rhopalura ophiocomæ.*—For the generic description and mode of occurrence of this species we refer to the abstract just mentioned.

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* ' Mitth. Zool. Stat. Neapel,' i. (1879) p. 448.

† ' Journ. Anat. et Phys.,' xv. (1879) p. 449, also ' Comptes Rendus,' lxxxix (1879) p. 545.

‡ ' Comptes Rendus,' October 29, 1877 ; see this Journal, i. (1878) p. 23.

The ectoderm of each metamere is composed of a single transverse row of large cells, of which the first and last metamere contain four each, the others, with the exception of the papilliferous zone, in which the number is not readily made out, contain six or eight each.

The endoderm forms a sac, the external surface of which exhibits the appearance of delicate muscular bands. These, the author believes, are due not to separate muscular fibres, but to processes of the endoderm cells, of the same nature as the well-known process of the ectoderm cells of *Hydra*, so that *Rhopalura* may be said to possess a *splanchnopleural pseudo-mesoderm*, while *Hydra* has a *somatopleural* pseudo-mesoderm. If this discovery is confirmed it will be one of very great importance.*

2. *Intoshia* † *gigas.*—This species is two and a half times as long as *Rhopalura*, which attains a length of 0·108 mm. The body is somewhat flattened, instead of regularly cylindrical, less produced at the ends than *Rhopalura*, with less distinct metameres and no papilliferous zone. Each segment is composed of several rows of cells, these latter being much smaller as well as more numerous than those of *Rhopalura*. No trace was discoverable of the muscular bands, although the author is inclined to think that they exist in a reduced condition.

3. *Gemmiparous Reproduction of Orthonectida.*—Under certain circumstances the cells of the endodermal sac undergo great modification, and the sac, increasing greatly in size, breaks through the endoderm, and escapes as a sporocyst. In the interior of this buds are formed, and from these secondary buds arise, sac-like bodies being finally produced, formed of one layer of cells, from which a second layer is afterwards formed by delamination.

4. *Oviparous Reproduction.*—A few developmental stages of *Rhopalura* were observed : enough to show that yolk-division is of a well-marked amphiblastic type, and that the gastrula is formed by epiboly. Caryolytic figures were observed in the nuclei of the dividing cells.

In *Intoshia* development is as markedly archiblastic : the blastula is composed of columnar cells radiating from the central cleavage cavity. The central end of each cell subsequently becomes divided off to form an endoderm cell ; the inner layer arises therefore by delamination.

5. *Systematic.*—The *Orthonectida* are defined by the author as follows :—Metazoa, retaining throughout life the planula form ; having a ciliated ectoderm which exhibits a division into metameres, which do not correspond with any internal division ; having also a sacciform endoderm, giving rise to a splanchno pleural pseudo-mesoderm. Reproduction (*a*) asexual, by gemmæ, and (*b*) sexual, the sexes being probably lodged in different individuals.

The group includes a single species of *Rhopalura* (*R. ophiocomœ*), and three species of *Intoshia* (*I. gigas*, parasitic on *Ophiocoma neglecta* ;

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* Professor Giard's figures are unfortunately not good enough to enable the reader to judge for himself of the soundness of the author's conclusions. They show nothing more than a striation of the endoderm.

† This genus should properly be *McIntoshia*, having been named in honour of Dr. McIntosh.

I. linei, on *Lineus gesserensis ;* and *I. leptoplanœ* on *Leptoplana tremellaris*).

The relations of the group the author expresses in the following table :—
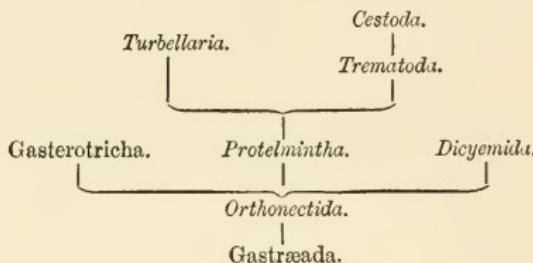
6. The author discusses the bearing of his discovery upon the gastrula theory, and comes to the conclusion that, although the structure of the *Orthonectida* seems to support Ray Lankester's planula theory, or Metschnikoff's parenchymula theory, the primitive form of the Metazoa is the gastrula by invagination.

Echinodermata.

New Organs of the Cidaridæ.*—Mr. C. Stewart calls attention to the existence in the members of this family of five organs, each borne immediately below the outer extremities of the compasses. In form they are identical with the external branchiæ of the other families of the Desmosticha, but their walls are more delicate. The author agrees with Müller in denying the existence of external branchiæ in the Cidaridæ, and believes that the organs described functionally replace them. They are diverticula of the peritoneum-bounded chamber in which the jaws are lodged, and if their function be respiratory, he thinks the chamber must communicate with the surrounding water near the tips of the jaws. These branchiæ would then have their interior bathed with water, their free surface by the fluid of the body-cavity. It is suggested that the function of the compasses, their muscles and ligaments, is not the movement of the jaws, but to vary the capacity of the jaw chamber and so cause a renewal of its water.

In speaking of the pedicellariæ of *Dorocidaris papillata*, the frequent occurrence of four-jawed examples of the armed variety on the anal region was pointed out; also that in all armed pedicellariæ of this family which end in a single fang this is hollow, and has an opening on the outer border near the tip; at its proximal end the hollow opens into the special chamber of the jaw. The resemblance of these to the gemmiform pedicellariæ of the Echinidæ is indicated.

The existence of a series of spines projecting from the inner surface of the corona between the inner ambulacral pores is shown in *C. tribuloides* and *Phyllacanthus baculosa ;* and also that in *D. papillata* the amount of spicula development in the genital gland is very variable.

* 'Trans. Linn. Soc. (Zool.),' i. (1879) p. 569.

Echini of the 'Challenger.'*—Professor Alexander Agassiz has just published a preliminary report on the Echini of the exploring expedition of H.M.S. 'Challenger.' It was not Agassiz's intention to publish this preliminary notice, as he hoped to be able to issue the descriptions of the species with his final report on the group; he found himself, however, compelled, for the sake of retaining for the material of the 'Challenger' expedition the priority of discovery, to notice, however briefly, the magnificent collection entrusted to his care by Sir Wyville Thomson.

In contrasting this collection with those made during the two expeditions of the U.S. steamer 'Blake,' Agassiz says that these latter contain some of the most interesting forms obtained by the former, often complementing more or less imperfect 'Challenger' material. Among the Cidaridæ, Arbæciadæ, and Diadematidæ many new species were found, and a new genus allied to *Astropyga*. Among the Echinothuriæ, a number of new species were dredged. Of the Echinometradæ nothing of importance was collected. Among the Temnopleuridæ excellent series of the species of *Salmacis* and *Temnopleurus* were obtained, a *Cottaldia*, hitherto only known from the chalk, and an exquisite genus *Prionechinus*, allied to *Salmacis*. The most interesting feature of the Echinidæ proper was the occurrence of several northern forms in deep water in the tropics. Not a single new species of Clypeastroids was found, and the number of specimens even was quite small. They do not play any important part in shaping the character of the fauna of deep water, and are, perhaps, the most strictly littoral group of Echini, indicative, at least in the present epoch, of comparatively shallow water, inside of the 100-fathom line, and probably giving us a good guide as to the depth of the sea and the nature of the bottom of the cretaceous and tertiary shores, where they occur in such large numbers. One recent species of *Catopygus* is interesting, as adding another of the cretaceous forms to those still living.

By far the most interesting group of Echini is that of the *Pourtalesiæ*—the species were found in abundance; of *Pourtalesia* there are six species. In *Cystechinus* there are three species, *C. Wyvillii* and *C. clypeatus* have quite stout tests, while in *C. vesica* the test is reduced to a mere film, so that even in alcohol the shape of this sea-urchin reminds one of the crown of an old felt hat which has seen its best days. The test of all the *Pourtalesiæ* is quite delicate, the amount of limestone being, at the great depths where they occur, reduced to a minimum, and yet even at the greatest depths they are found associated with Ophiurans, which are by no means wanting in lime. Among the Euspatangia, *Spatangus purpureus* occurred in the tropics at a depth of 400 fathoms, and *Echinocardium australe* was dredged at the great depth of 2675 fathoms. In Australia it is a littoral zone species. Among the Brissina two species of *Hemiaster* were obtained allied to *H. prunella*, a new species of *Rhinobrissus*, and two new ones of *Schizaster*.

* 'Proc. Am. Acad. Arts and Sci.,' xiv. (1879) p. 190 ; 'Nature,' xx. (1879) p. 534.

No better idea can be given of the value of this extraordinary collection than by stating that there are described in this list no less than forty-four new species. At the time of the publication of Agassiz's 'Revision of the Echini,' there were scarcely over two hundred species of Echini known, and since that time less than fifty species have been added to the list. In the specific diagnosis of the species only the principal localities are given; the details are reserved for the full report, which we believe is in good progress, many of the requisite illustrations being already engraved.

Anal Plates of Echinocidaris.[*]—Professor F. Jeffrey Bell draws attention to the fact that the number of anal plates in this genus is not so constantly four as the student would be led to think from the statements made by all the writers who have defined it; it was first noticed by Professor Alex. Agassiz, that a specimen of *E. Dufresnii* might have five anal plates, while Mr. Bell's observations show that the number not only varies in the species in question, but in other species also of the same group; and that the variation may not be confined to these being only one more in number, but that there may be as few as three, and as many as six, or even ten; in those examples in which there were six or ten, it is curious to note that two of the anal plates retain the characteristic form of a right-angled triangle, and together occupy about one-half the anal area. From the figures given by Professor Bell, it would seem that the variations are exhibited in nine out of fifty-four specimens examined.

In a further paper [†] Mr. Bell describes and figures the dentary apparatus of three species of the genus *Tripneustes*, which exhibit gradational characters of apparently considerable importance in the determination of species.

Cœlenterata.

Phylogeny of the Ctenophora.[‡]—Professor Haeckel has recently read to the Jena Society (16 May, 1879) an important paper on this subject; the notice has for its basis a new form of the Anthomedusæ to which Haeckel has given the name of *Ctenaria ctenophora*.

The author commences by pointing out that the morphological characters of the Cœlenterata are such as to lead to a firm belief in their common ancestry; these, which are best seen in the Hydromedusæ, have not been quite so obvious as regards the Ctenophora; the majority of modern zoologists have associated them more or less intimately with the Anthozoa, but so long ago as 1866, Professor Haeckel suggested that they were more closely allied to the Hydrozoa, and this view later observations, but more especially those now to be recorded, considerably support. The Pacific form under investigation is regarded as being intermediate between the Gemmaria-like Anthomedusæ and the Cydippoid Ctenophora; the whole result may be summed up in saying that the Ctenophora appear to have been developed from the Anthomedusæ, and especially from the family of the Cladonemidæ.

A most interesting part of the paper is a review of the more

important homologies between the Ctenophora and the Medusæ (specially *Cydippe* and *Ctenaria*).

CTENOPHORA.		CRASPEDOTA (Cladonemida).
1. Gastric cavity	=	Umbrella-cavity.
2. Oral margin	=	Umbrella-margin.
3. Inner surface of gastric cavity	=	Subumbrella.
4. Mouth of infundibulum	=	Primitive simple Medusa-mouth.
5. The two lateral pouches for the tentacles	=	The two lateral pouches for the tentacles found in some Cladonemida.
6. The two lateral tentacles	=	The two lateral tentacles of some Craspedota.
7. The eight adradial "ctenophores"	=	The eight adradial lines of some Anthomedusæ.

It is also pointed out that the four primitive peri-radial canals of the Ctenophora appear to be homologous with the four peri-radial canals which are found permanently in the majority of the Craspedota; the eight adradial canals of the Ctenophora, which are formed by the division of the four peri-radial ones, are also to be found in some Cladonemida; while those pinnate branches, which are in the Ctenophora converted into genital glands, form either generative glands in some Craspedota (*Gonionemus, Ptychogena*) or simple glands which have no generative function (*Catablema, Ctenaria*).

Ctenaria ctenophora, which belongs to the family of the Cladonemida, has an ovate umbrella provided on its outer surface (exumbrella) with eight *adradial meridional costæ*, which are principally made up of rows of urticating cells, and these are the parts which are homologous with the "ctenophores" of the Ctenophora; the subumbrella has its musculature only feebly developed and passes into a delicate velum. The gastric cavity is small and is separated by a constriction from a large and pyriform apical cavity, which occupies the aboral third of the umbrella; this latter is homologous with the "infundibulum" of the Ctenophora and with the "brood-cavity" of Eleutheria. The mouth is surrounded by sixteen simple tentacles. Four simple and hemispherical gonads (generative glands) lie in the wall of the gastric cavity; four short peri-radial canals arise from the constriction between the gastric and apical cavities and soon bifurcate to form eight adradial canals which pass to the margin of the umbrella; these eight canals are provided with glandular diverticula and are connected together, at the margin, by a circular canal; with this last there are connected two peri-radial tentacles, which form two long hollow tubes, which are beset with a series of lateral filaments. From these notes it will be gathered that although *Ctenaria* presents us with nothing new, it unites in itself a number of characters, of which a part only have been hitherto observed in any one genus of the Anthomedusæ; thus it has, for example, the eight urticating costæ of *Ectopleura*, the apical cavity of *Eleutheria*, the gastric characters of *Cytæis*, the gastro-canal arrangement of *Cladonema*, and the pinnate tentacles and tentacle-pouches of *Gemmaria*.

After dealing with the important questions of the homologies of the different parts in the Medusæ and the Ctenophora, Professor Haeckel comes to a consideration of the ontogeny and phylogeny

of the latter group; as to the former point it is to be observed that cœnogenetic arrangements obtain very largely; the history of the germ is compressed and simplified, owing, doubtless, in large measure to the great development of the food-yolk. The results, however, of the elaborate comparison which has been instituted between the organs of the Ctenophora and of the Anthomedusæ seem to make it highly probable that the Ctenophora took their origin in the Cladonemidæ, and had for their ancestors Hydroid polyps of the Tubularian group.

The author finally remarks that the most important ontogenetic character in the Ctenophora is that the funnel is the first organ to appear, and that from this there are given off four peri-radial canals, which, by bifurcation, give rise to eight adradial ones. It is only after this that the so-called stomach, which is invested by ectoderm, appears.

Zoantharia malacodermata of the Coasts of Marseilles.* — M. Jourdan gives a short account of his investigations into the structure of these animals, in which he points out that the walls of their body consist of three layers, (1) an external cellular layer or ectodermic; (2) a fibrous and mesodermic; and (3) cellular and endodermic.

In the ectoderm there are to be found among other structures epithelial elements which are probably sensitive and are apparently " analogous " to the chromatophore-pouches found in *Actinia equina;* the presence of neuro-muscular cells is, it may be noted, distinctly reported. The structure of the mesodermal layer of *Cerianthus* was found to be different to that of the other zoanth malacodermata; it is stated to be composed of a thick muscular layer covered in by two planes of connective tissue; there are in it smooth muscular fibres which are longitudinal in direction and are arranged in radiating laminæ; below the internal fibrous layer there is a layer of circular muscular fibres. The fibrous layer of *Calliactis* is stated to be exceptionally thick and to be traversed by permanent pores in addition to being provided with a number of spots of circular muscular fibres which seem assuredly to act after the manner of a sphincter.

The tentacles, which have the same structure as the walls of the body, are characterized by the presence of a layer of longitudinal muscles subjacent to the ectoderm; the œsophageal walls have likewise the same structure as the body-walls, but their external cellular layer is remarkable for the presence of special glandular elements. M. Jourdan promises more detailed observations.

Blastology of the Corals.† — Dr. W. Haacke, of Jena, deals with this subject in a paper which is couched in the language of Haeckelian morphology. After pointing out the absence of any good evidence as to the metameric characters of the corals, the author states that he regards the typical form as being a simple pyramid, the base of which corresponds to the oral and the apex to the aboral end of the body of the coral " person."

The Octocoralla or Alcyonaria offer the simplest conditions; in correspondence with the eight tentacles ranged round the peristome, the gastric cavity is provided with eight "mesenterial" filaments, which form, in the oral half of the body, gastric filaments, and in the aboral, generative sarcosepta; these eight divisions are the indications of the presence of eight *parameres*, and a half of each forms an *antimere*. After a series of considerations of the results attained to by a number of observers, of which it is impossible to present any abstract, the author comes to the conclusion that the body of the Octocoralla is formed of eight unequal parameres, which are so arranged round the primary axis as to give to the body the appearance of a bilateral symmetry; but the author is careful to point out that this last application is a somewhat wide one, and that all we can justly say is that the Alcyonarian is *octamphipleural*.

The Hexacoralla offer some points of difficulty, inasmuch as the number of their divisions may reach to several hundreds in some forms, and this multiplication of secondary and tertiary systems leads to the difficult question as to whether they each correspond to a paramere; if we accept the view that each tentacle corresponds to a paramere, then if we take such a form as *Actinia mesembryanthemum*, in which there are 192 tentacles, we find that the six largest tentacles of the first cycle correspond to the six largest parameres; and that they, as well as the next succeeding cycles of 6, 12, 24, and 48 tentacles will be each of them bilaterally symmetrical (eudipleural); but as this will not apply to the sixth cycle of 96, in which the proper sarcosepts are not paired, and they consequently would be asymmetrical, it is difficult to see how the view of Koch, by which each tentacle is regarded as corresponding to a paramere, can be substantiated. To this is opposed the view of Professor Haeckel, who regards each paramere as a sixth of the coral "person," and as made of six interradial (of the second cycle) and of six times thirty-one tentacles, of which the median (peri-radial) one belongs to the first cycle, and the lateral (adradial) thirty to the 3rd, 4th, 5th and 6th cycles respectively. This view appears to recommend itself to Dr. Haacke, who finds in *Euphyllia spheniscus* the six parameres very distinctly marked out by their coloration.

In the Tetracoralla there are four parameres.

As to the development of the different groups, we know very little as to the stages, subsequent to the gastrula, in the Octocoralla; Kowalewsky's figures seem to indicate that when the eight parameres are formed, the two lateral are much the larger, and this observation shows how it is possible, although indeed the ellipse-shaped mouth would do just as well, to draw a dorso-ventral median plane through the creature; similarly, the greater length of two of the gastric filaments (Kölliker) in the Pennatulidæ, supports the doctrine of the octamphipleural character of the Octocoralla, to which we have already referred.

There is somewhat more detailed information with regard to the Hexacoralla. Lacaze-Duthiers has shown that in the gastrula there are first developed two sarcosepts perpendicular to the median plane

* Cf. Dana's 'Atlas of Corals,' pl. vi. fig. 1.

of the body; Dr. Haacke is, however, careful to point out that this " bilaterally-symmetrical" stage is not to be confounded with that which obtains in the Vertebrata, for the latter are only comparable to a single paramere made up of two antimeres set on either side of a median plane, while in the coral there are two parameres even at this stage; two new sarcosepts then appear and the larval becomes tetra-pleural, and this stage is followed by the hexamphipleural stage, which is only of *short duration;* other sarcosepts are developed, and twelve can shortly be made out; hereafter, in some forms, the number of sarcosepts is increased. As to the cause of this apparent bilateral symmetry, the author considers that the dipleural form of the Vermes and other Bilateria is to be easily referred to a creeping mode of life, to locomotion in a definite direction, while the regularly pyramidal form is due to adaptation to a sessile mode of life.*

In conclusion, he points out the natural characters of the group of the Octocoralla, which never have either more or less than eight tentacles and sarcosepts; while the difficulties as to the Hexacoralla are resolved by showing that the number six recurs with sufficient constancy to justify us in believing in the arrangement having been transmitted from a six-rayed ancestor; this arrangement may, how-ever, have become subsequently obscured by the formation of a larger number of sarcosepts.

Porifera.

Spongiological Studies.†—A paper under this title has just been published by Professor E. Metschnikoff.

1. *Development of Halisarca Dujardinii.*—Of the two Neapolitan varieties investigated, one corresponded with F. E. Schulze's descrip-tion, while the other was distinguished by forming thin, soft, slimy incrustations on stones. The larvæ of the two were similar, except that that of the first was twice as large as that of the second. The spermatozoa of the adult occurred in seminal capsules with a distinct epithelial investment. The younger eggs were beset with large club-shaped processes of their substance, standing out at right angles to the surface, and completely disappearing as the egg reaches maturity. No true vitelline membrane was observed, but a thin investment to the egg existed, probably formed of endothelial cells.

Yolk-division is complete. The first four blastomeres are similar, but afterwards a distinction is observable in larger and smaller masses arranged radially around the blastocele. The latter is at first small, becoming practically obliterated at one stage of division, but latterly appears again, and increases in size, the larva then consisting of a single layer of cylindrical cells surrounding a large central cavity. In this cavity, a number of cells now appear, constituting the mesoderm; their exact mode of origin was not ascertained, owing to the opacity of the embryos. The mesoderm cells are of two kinds, ordinary, finely granular cells, and "rosette-cells," with large, highly-refracting gra-nules: these latter are by far the more numerous and undergo rapid multiplication, completely filling up the segmentation cavity.

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* Cf. Hatschek, this Journal, *ante,* p. 567.
† 'Zeitschr. wiss. Zool.,' xxxii. (1879) p. 349.

The ectoderm cells next acquire long cilia, and those in the region of one pole of the now elongated embryo, undergo a slight increase in thickness; the embryo will afterwards become attached by this, its posterior end.   But the differentiation of the ectoderm into cells of two kinds is only temporary: as it further increases in size the cells once more become uniform.   In the meantime the granular cells of the mesoderm increase in number, filling up large interspaces between the rosette-cells, which previously were in close contact.

The cilia next become converted into slowly moving processes, and eventually disappear, leaving the ectoderm as a layer in which the separate cell-bodies are only distinguishable by the aid of silver nitrate: the outermost layer of the cells, at the same time, becomes firm and cuticle-like.

After a pause of two days in development, the formation of the canals begins,—Metschnikoff's account of this process being of the highest interest.   These cavities are formed by a grouping of the granular mesoderm cells, which become arranged side by side, around intercellular spaces, so that, in this case, the endoderm is actually a secondary product of the mesoderm.

2. *Anatomical Observations on Ascetta.*—The author was able to prove conclusively the presence of a true ectoderm, instead of a syncytium as Haeckel maintains, the contours of the cells being well brought out by silver nitrate.   Haeckel's statement that the lowest sponges consist merely of ectoderm and endoderm is also denied: a distinct mesoderm was found in *Ascetta*, in the interior of the granular amœboid cells of which the spicules were found to be produced, and not in the gelatinous interstitial substance.   Nothing new was made out as to the structure of the endoderm, but the observations of Haeckel and Carter as to the passage of ciliated into amœboid cells were confirmed.

3. *Embryological Observations on Calcareous Sponges.*—In *Ascetta primordialis* the process of development resembles closely that described above in *Halisarca*.   A one-layered blastula is formed, and from its cells large granular mesoderm cells are produced, which accumulate in, and finally fill up the segmentation cavity.   Amongst these large granular cells occur small elements with few granules, probably the foundation of the endoderm.   In *A. blanca*, the formation of mesoderm cells is confined to the lower pole of the ovoidal blastula, the process having some resemblance to one of invagination.   But in neither species is there any true gastrula stage; the inner set of cells forms a mere parenchymatous mass, and never a definite epithelioid layer; from this mass endoderm and mesoderm are subsequently differentiated.

In *Sycandra raphanus*, Metschnikoff confirms his own earlier and Schulze's later observation, that the ciliated hemisphere of the blastula undergoes invagination within the non-ciliated, and not *vice versâ*, as Schulze formerly believed.   In the blastula, previously to invagination, a cavity was observed in the non-ciliated hemisphere, dividing the latter into two layers of cells, an internal in contact with those of the ciliated hemisphere, and an external.   The former remain large, and

form the mesoderm, probably answering to the internal cell-mass of *Halisarca ;* the latter become flattened and form the ectoderm.

At the conclusion of the invagination process, when the blastopore has closed up, the embryo consists of an external layer of ectoderm cells, and an external mass of large cells in which are seen the developing spiculæ. The ectoderm cells send out pseudopodia, and confer upon the whole larva the power of executing amœboid movements. While these continue no distinction between the ectoderm cells can be seen, but if the larva is irritated, by touching it with a needle, the pseudopodia are drawn in, and the cell-contours become evident, so that, as in *Ascetta,* the syncytium theory breaks down.

In *Leucandra* the developmental process is essentially the same ; so that there are two types of development amongst the calcareous sponges, one represented by *Ascetta,* the other by *Sycandra, Leucandra,* and *Ascandra.*

4. *The Ingestion of Nutriment in Sponges.*—Metschnikoff directly observed the ingestion of carmine in *Halisarca, Ascetta,* and *Spongilla,* by both the endoderm and the mesoderm cells, but in neither case by the ectoderm. In *Ascetta,* also, the extrusion of particles from a spontaneously formed aperture in a cell was observed. In *Spongilla* the cells of the ciliated chambers, like those of the ectoderm, were not observed to take in nutriment ; this has an important bearing on Balfour's theory.*

In *Halisarca* it was also observed that when the sponge was overfed, the endoderm cells increased to such an extent by the ingestion of carmine, that the canals disappeared entirely, and the sponge appeared like a mass of carmine, disk much shorter, containing amœboid cells, with an ectodermal investment. This phenomenon is interesting as being of the same nature as the obliteration of the alimentary canal during digestion, in certain Turbellarians.†

5. *General Remarks.*—The author mentions having found a *Spongilla* in which there was no trace of ciliated chambers, and states further that he has observed, in the young of this species, the chambers disappear, and subsequently reappear—the amœboid or parenchymatous cells undergoing conversion into ciliated cells. The conclusion deduced from this, that the " endoderm " is formed periodically from " mesoderm," and is therefore a secondary structure, is borne out by the facts of development as seen in *Halisarca* (Metschnikoff), *Aplysilla* (Schulze), and other genera, in which the embryo consists of a solid mass of parenchyma with an ectodermal investment. This lends support to the view that the true primary germ-lamellæ are the ectoderm or epiblast, and a neutral parenchymatous internal layer (lower layer cells of Vertebrata), from which latter the mesoderm or mesoblast, and the endoderm or hypoblast take their rise as secondary formations.

The author concludes with some criticisms on the gastrula theory of Haeckel and the planula theory of Ray Lankester. He considers that the stage originally succeeding the blastula (a hollow sphere of

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* 'Quart. Journ. Micr. Sci.,' January 1879, and this Journal, *ante,* p. 177.
† This Journal, *ante,* p. 287.

similar, ciliated cells) was not the gastrula, but the *parenchymella*, or planula with internal mass of parenchyma, and that this arose from the blastula, by some of the cells of the latter losing their cilia and making their way into the blastocœle, like the reproductive cells of *Volvox*. This theory, according to which the gastrula is a secondary larval form, is supported by the absence of a gastrula stage in the lower sponges and cœlenterates, by the fact that the gastrulæ of different animals are not homologous, and by the occurrence of pseudogastrulæ.

Development of Horny Sponges.*—Dr. C. Keller, of Zürich, records the following observations on the development of *Chalinula* made at the Zoological Station, Naples.

Multiplication is both asexual (by buds) and sexual : the breeding season being in March and April. The sexes are separate : before sexual maturity both sexes have a brownish-yellow colour ; at the breeding season, the female becomes rose-red, and finally yellowish red. It takes about twelve to fifteen hours for the larvæ to escape : afterwards the sponge rapidly dies down. The egg is surrounded with a special follicular investment. Yolk-division is amphiblastic (total, but unequal) : no cleavage cavity was observed.

An amphigastrula was formed with an epiblast formed of a single layer of flagellate cells, and giving rise to the adult ectoderm ; and a hypoblast which forms both mesoderm and endoderm of the adult.

Protozoa.

Reticularian Rhizopods.†—Mr. H. B. Brady continues his account of the 'Challenger' specimens. The greater part of the paper is taken up with systematic descriptions of species, of which the following are new :—*Frondicularia compta, Flabellina foliacea, Ramulina globulifera, Uvigerina puncta* and *U. interrupta, Sagrina virgula,* and *S. divaricata, Spirillina inæqualis, S. limbata,* and *S. obconica, Planorbulina echinata, Globigerina æquilateralis, G. digitata,* and *G. conglobata.*

The part of the paper of greatest general interest is the concluding section, "Notes on Pelagic Foraminifera." The forms at present known to occur at the surface are :—*Globigerina bulloides, inflata, rubra, sacculifera, conglobata,* and *æquilateralis ; G. (Orbulina) universa ; Hastingerina pelagica,* do. var. *Murrayana ; Pullenia obliqueloculata ; Sphæroidina dehiscens ; Candeina nitida ; Pulvinulina Menardii,* do. var. *tumida, P. Canariensis, crassa,* and *Micheliniana ; Cymbalopora bulloides ;* and *Chilostomella ovoidea.*

As to the question whether *Foraminifera* live both at the bottom and at the surface, the author summarizes the more important facts as follows :—

1. We have positive evidence that Foraminifera do live at the bottom of the deep sea, from the common occurrence at great depths of certain forms with composite or arenaceous tests ; and we have negative evidence in the same direction in the entire absence from

the surface fauna of many hyaline genera which are abundant in bottom dredgings.

2. Both in *Pulvinulina* and *Globigerina* (but notably in *Pulvinulina*) species closely allied to the surface forms are found in the bottom ooze, though they never occur at the surface; amongst others, *Globigerina dubia* and *G. digitata*, *Pulvinulina elegans*, *P. Karsteni*, *P. pauperata*, and *P. favus*. Hence there is no à priori improbability that the other members of the same genera are capable of supporting life at the bottom.

3. A comparison of specimens of the same species, taken at the surface and at the bottom, demonstrates at least that the average size of the former is less than of the latter, and that the thickness of the cell-wall of the largest surface specimens bears no comparison with that of adult bottom specimens.

4. Nothing comparable to the thick-shelled *Orbulinœ*, still less to those with tests composed of several layers, is to be met with in the surface fauna.

5. No surface *Globigerinœ* have hitherto been obtained by means of the towing net from points on our own shores at which they are found at the bottom.

6. A fact adduced by Dr. Wallich, of some weight, as I think, namely, that *Globigerina* shells are found in the digestive cavities of *Ophiocomœ* living at the bottom at great depths.

7. The testimony of many experienced observers (Ehrenberg, Parker and Jones, Wallich, and others), that the *Globigerinœ* in the small soundings which they had for examination contained the sarcode bodies, the colour and nature of which each has described, with which statement the author's results from the material taken in the "tow net attached to trawl" generally agree.

On the whole, Mr. Brady is inclined to think that these lowly organisms may be both deep-sea and pelagic, their simple organization enabling them to live equally well at the surface and on the sea bottom.

Structure of Haliphysema Tumanowiczii.*—This interesting organism, as to the nature of which so much discussion has lately been made, has now been examined by Professor Ray Lankester, who arrives at the conclusion that *Haliphysema* is, as Mr. Saville Kent and Mr. Carter believe, a Reticularian Rhizopod, and not, as Professor Haeckel thinks, a sponge. Of the specimens examined, furnished by Mr. Kent, some were fresh, others preserved in chromic acid.

It is unnecessary to say anything about the well-known spicular test; the point of chief interest is Professor Lankester's description of the contents. These were best made out in chromic acid specimens mounted in balsam and crushed so as to crack the test and allow of the separation of the soft internal substance. The latter was found to be "a continuous mass of protoplasm, exhibiting no central cavity, and devoid of all structure." Scattered through the protoplasm are great numbers of vesicular nuclei, like those of *Pelomyxa*, and most abundant in the basal or prominent portion of the "core" of protoplasm.

* 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 476.

At the distal end, the protoplasm contained bodies much larger than the nuclei, the smaller of which consisted of mere vacuolated protoplasm, while the larger were composed of granular protoplasm with a nucleus; none possessed a cell-membrane. There was evidence that these egg-like bodies multiply by division. They agree with the "ova" figured by Haeckel, and are of quite the same nature as the nucleated germs of some Foraminifera.

The protoplasm itself "has the appearance of being built up by a meshwork of fine fibrillæ, or, to put it in another way, appears to consist of denser substance, honeycombed by very small 'vacuoles,' or spaces of less dense substance."

The external protoplasm, first seen by Saville Kent, was observed in some of the preserved specimens, having been fixed by the chromic acid in the "streaming" condition on some of the spicules. Nuclei were sometimes found imbedded in it, so that these evidently are carried out of the test in the stream of protoplasm.

Professor Lankester concludes as follows :—" From the preceding account it appears that the structure of *Haliphysema* is not quite so simple as that which has been supposed to characterize the body-substance of the Lituolida. It seems to me very possible that we shall continually find among the larger members of the various groups of organisms classed as 'Foraminifera' as high a structural differentiation as that exhibited by any of the naked fresh-water forms of Gymnomyxa (Rhizopoda), such as *Pelomyxa*, *Chlamydomyxa*, and *Actinosphærium*. Possibly when means are taken to overcome the difficulties of observation presented by their opaque and resisting shells, the larger 'Foraminifera" may prove not only to be nucleated, but to be as highly organized (though not in the same way) as the Radiolaria."

Professor Lankester seems to doubt Mr. Kent's suggestion that the organisms from which Haeckel's beautiful figures of *Haliphysema* were taken, are "remarkable isomorphs or external facsimiles of the Foraminiferal type."

Observations on New Infusoria.*—Dr. Aug. Gruber gives a short preliminary notice of some new forms, which appear to be of great interest, and of which he promises more elaborate details.

Three of the new forms occupied ramified tubes; these creatures are called *Stychotricha socialis*, *Oxytricha tubicola*, and *Maryna socialis* (gen. nov. et sp. nov.); the two former belong to the hypotrichous, and the third to the holotrichous division of the Infusoria: the author points out that they exhibit considerable analogies to the colonial forms described as existing among the Flagellata. *Tillina magna* (n. g. et n. sp.) exhibits the same processes of division as were observed by Stein in *Colpoda cucullus*. The two new marine forms which belong to the genus *Cothurnia* (Vorticellidæ) are respectively remarkable, (1) *C. socialis* for a very primitive mode of forming colonies — the new individuals formed by fission always remain attached by their long stalk to the investments of the older forms, and they are all remarkable also for the formation of a special peristomial operculum; (2) in *C. operculata* there is also an operculum

* 'Zool. Anzeiger,' ii. (1879) p. 518.

which is specially remarkable for the attachment to it of a delicate membrane which arises from the hinder part of the animal, and is able, when the animal contracts itself, to shut down the operculum of the shell.

Influence of the different Colours of the Solar Spectrum on Infusoria.[*]—Señor Serrano y Fatigati has instituted experiments on this subject with results agreeing with those of M. E. Yung [†] in the case of the ova of frogs, fish, &c., viz. that the violet rays accelerate and the green rays retard the development of Infusoria.

Supposed new Fresh-water Species of Freia.—See 'Proceedings,' p. 989.

Lithamœba discus, a New Rhizopod. — This interesting form is described by Professor Ray Lankester,[‡] who discovered it in some water sent him by Mr. Bolton from the Olton Reservoir near Birmingham.

The body is discoid, and has a diameter of $\frac{1}{125}$ inch. In the protoplasm of which it is composed are imbedded a great number of highly refracting, often uniform, concretions, the largest of them $\frac{1}{750}$ inch in length, but most of them not more than a quarter of that size. The composition of these curious bodies was not made out; they were not affected by dilute acetic acid or potash, but were dissolved by strong hydrochloric acid. Probably they are of similar nature to the granules of *Amœba*.

There is a single large nucleus, $\frac{1}{500}$ inch in diameter, of an irregularly trapezoidal form, and enclosed in a distinct membrane. It consists of a ground-substance, with a number of angular granules imbedded in it.

Included food materials—diatoms, &c.—were observed in the protoplasm, the centre of which is occupied by a very large contractile vacuole $\frac{1}{330}$ inch in diameter; a portion of the contents of this "are discharged periodically to the exterior." The vesicle does not entirely collapse, but divides into two smaller ones, which afterwards enlarge and fuse together.

The protoplasm exhibits a distinct vacuolar structure, especially well shown by treatment with osmic acid and picro-carmine. In this it resembles Greef's *Polomyxa*.

The application of iodine brings out the presence of a fine cuticle, so fine that it is ruptured by the extrusion of the pseudopodia. These are very interesting: their protrusion begins "with a minute rupture of the cuticle. Through the orifice thus produced the fluid protoplasm exudes in a spherical form, and as it increases in quantity the rupture of the cuticle is increased, whilst concretions from the more central portion of the disk-like body flow into the enlarging lobe. With great rapidity the whole extrusion appears to fuse once more with the disk, and a new rupture or extrusion takes place at another point of the margin. A new cuticular pellicle must be formed very
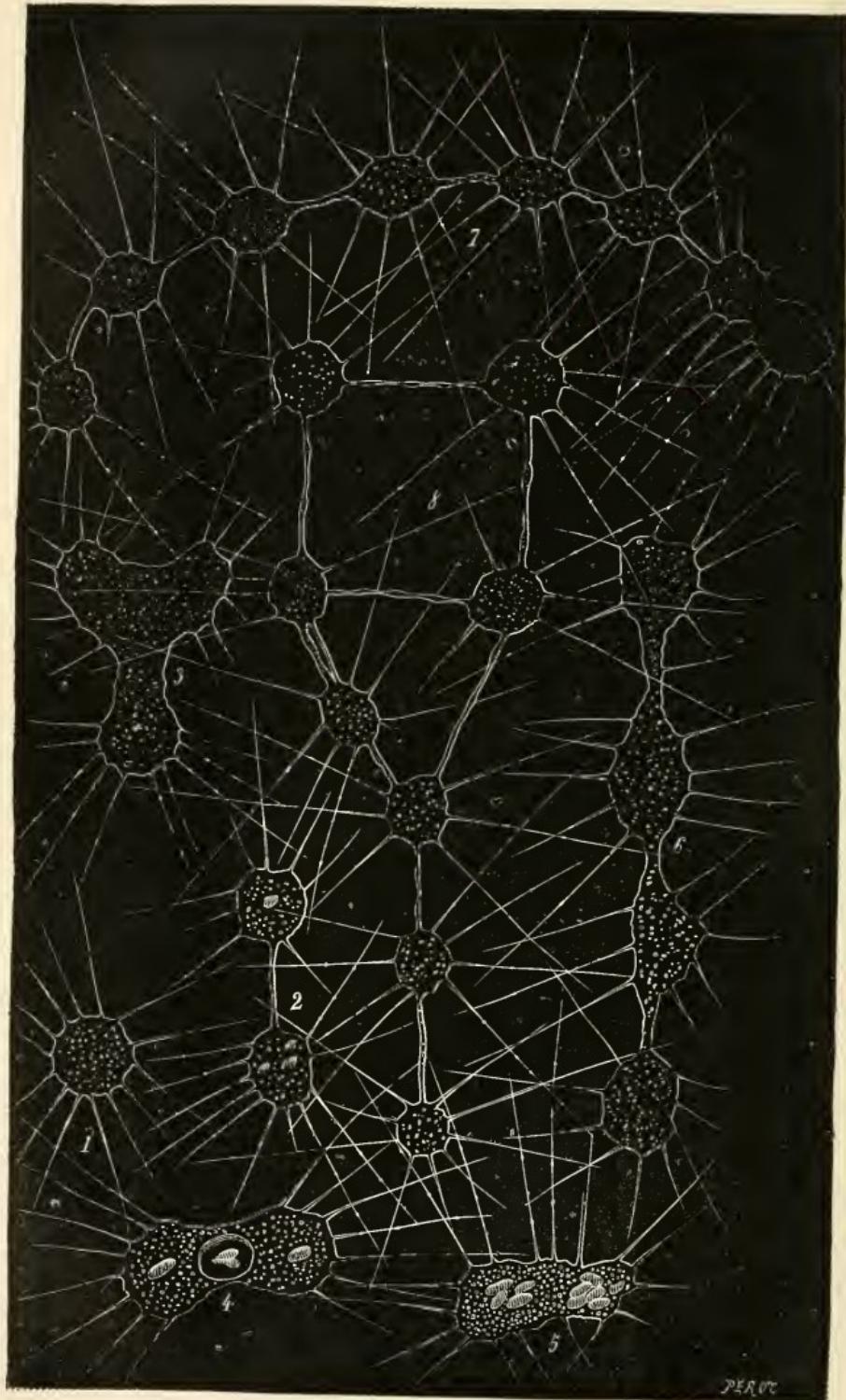
Monobia confluens.

rapidly on the surface of the hernia-like extrusions of protoplasm."
No filamentous pseudopodia were observed.

The characters of the nuclei and cuticle are quite peculiar, and
altogether *Lithamœba* takes, Professor Lankester considers, a very
distinct position among the amœboid Gymnomyxa.

New Moneron.[*]—M. Schneider describes a new form of this
interesting group under the name of *Monobia confluens*, which he has
found in fresh water.

In its simplest form, in a state of repose, it forms a small and
almost spherical mass of fine granular protoplasm, which has a bluish
hue by transmitted light, and is provided with neither nucleus nor
vacuole (Plate XXVI, Fig. 1). From this homogeneous body radiate
in all directions pseudopodia of extreme delicacy, and about four
times as long as it, and so transparent and fine as to be almost invisible
but for the small swellings, which are placed here and there on them,
and which refract the light more strongly. These pseudopodia are
rectilinear, move slowly and coalesce at their extremities, so that they
recalled to the author the similar processes in the Foraminifera.

When the creatures become active they lose their spherical form
and move about by a general contraction of their bodies. The form
which they then take varies much less than in other Protozoa; it is
usually that of a Savoy biscuit inflated at the ends and slightly con-
tracted in the middle, the extremities being the seat of the emission
of the pseudopodia (Fig. 4). Sometimes they become triangular, when
the pseudopodia radiate from each apex; or, again, they may become
much more irregular and give off processes from every protuberance
(Figs. 3 and 5).

The creature was never observed taking in food, but foreign
bodies were often observed in somewhat great numbers in its interior,
and these were sometimes contained in a vacuole of digesting matter,
though no *proper* contractile vacuole was ever present.

When nutrition has effected a considerable increase in the size of
the body, growth gives place to reproduction, which is thus effected :
the body elongates and there appears a central constriction, which,
getting narrower and narrower, finally disappears altogether, so that
there are two individuals instead of one; but this does not happen
very frequently ; in most cases the two spheres remain united
(Fig. 2), and a second means of communication between them, parallel
to the former, is often effected by the fusion of two of their pseudo-
podia. As often as this relation is established, the bond of union
widens by afflux of plasma and the granules of each body pass into
that of the other, and the process thus begun may be continued until
at last we may get an association of eight, as shown in Fig. 7 ; nor
do the variations end here, for as M. Schneider expresses it, "the
next day each member of the colony had pulled upon the common
cord and a new resultant had been produced from these opposite
caprices. My Monera were now grouped as drawn in Fig. 8, in a
square surmounted by a triangle, the latter surmounted by an arrow."

* ' Arch. Zool. Exp.' (Lacaze-Duthiers), vii. (1878) p. 585. Fig. 6 of the Plate
is not described in the text.

The colony was never the same at the end of the day as it had been at the beginning. No other mode of reproduction than that by fission was observed.

Dealing with the systematic position of *Monobia*, the author remarks that it might be as justly placed with the Foraminifera as *Myxodictyum sociale*, which Professor Claus has relegated to that class; he, however, bears in mind the almost general presence of a nucleus in the Foraminifera, and concludes that, until our knowledge of the mutual relations of the Protozoa is more complete, it is necessary to retain Haeckel's group of the Monera.

Eozoon Canadense.[*]—Professor Möbius replies in detail to Principal Dawson's criticism of his Monograph (see p. 275), and it is needless to say adheres to his original view. He points out more particularly that not a single one of all the specimens of *Eozoon* which he studied came from the hands of "dealers or injudicious amateurs" as suggested, but all directly or indirectly from Messrs. Dawson and Carpenter, and promises that if he is furnished with other specimens which Principal Dawson recognizes as the genuine representatives of *Eozoon*, and showing the organic nature contended for, he will examine them with care and conscientiousness, and if he finds a true organic structure will avow it without hesitation.

BOTANY.

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

Development of the Embryo of Phanerogams.[†]—Famintzin has undertaken a close investigation of this subject, with especial reference to the following statements of earlier observers (in particular Hanstein and Westermeier), viz. "That the three primary layers, the dermatogen, periblem, and plerome, show no clear separation in their products of division, but pass over into one another at their boundaries; and that a uniform origin of these three primary layers in the embryo occurs only in the tigellum (the hypocotyledonary portion of the stem), and then only in Dicotyledons; while in the whole of the embryo of Monocotyledons, and the cotyledonary portion of Dicotyledons, a more or less indefinite, and in many cases altogether irregular, cell-division takes place, without any trace for a considerable time of a separation into primary layers; and that it is only at a later period that such a differentiation can be recognized." This statement Famintzin finds must be considerably modified. His observations were made chiefly on *Capsella bursa-pastoris* and *Alisma plantago*; his main results, as far as regards these plants, being as follows:—

1. In the embryo of both these plants, the results were altogether the same as to the independence and origin of the three primary layers. In both a perfect regularity was observed in their origin; when once differentiated, the three layers remained perfectly distinct during the whole period of the development of the embryo, never

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[*] 'Am. Journ. Sci. and Arts,' xviii. (1879) p. 177.
[†] 'Mém. Acad. Imp. Sci. St. Petersbourg,' xxvi. (1879) No. 10.

passing over the one into the other. Although minor differences were observed in the course of development even in the same plant, the final result was the same; that the first separation of the three primary layers is brought about in this way, that in an optical transverse section of the embryo each of its constituent quadrants appears to be composed of an inner plerome-cell, two periblem-cells, and two dermatogen-cells.

2. The second important result, both in *Alisma* and *Capsella*, is that the cotyledons—as to whose foliar nature no doubt has been entertained—cannot be regarded, as is the case with the other foliar organs, as outgrowths of the dermatogen and the periblem of the axial portion of the embryo. The cells from which the three primary layers which compose them originate, are of altogether equal value with those of the axial portion. In both plants the two inner of the primary layers do not originate by outgrowth from the layer already formed and differentiated in the axial portion, but by division, by walls parallel to the surface, of the layer which lies beneath the dermatogen in the upper half of the embryo. The divisions which give rise to the three primary layers, as well as those which afterwards arise in these layers, are altogether of equal value in both parts of the embryo, and correspond with one another.

3. The first division walls in the embryo of *Alisma* are transverse, and are formed successively in strictly basipetal order. To the first three walls the three principal portions of the future embryo—the cotyledon, the central portion, and the root—owe their origin, and they remain completely differentiated during the whole course of its development. The uppermost cell gives birth to the cotyledon, the second to the central portion, on which the stem-bud (plumule) is formed, the third to the root; by the transverse divisions which follow, the hypophysis and a portion of the pro-embryo (suspensor) are formed.

4. The place of origin was accurately determined by the detection of two dermatogen-cells in the central portion of the embryo, which were readily distinguished from the other superficial cells of this layer both by their form and by the divisions which occur in them.

5. In *Capsella* the differentiation of the tissue in the growing cotyledons in the earliest stages of their development, and the cell-divisions in the pro-embryo, must be regarded as new.

Development of the Embryo-sac of Angiosperms.*—M. Vesque, in a further communication on this subject, considers that the recent discovery of Strasburger fills up a space which previously appeared to separate Phanerogams from Vascular Cryptogams. According to the recent observations of the author, the primordial mother-cell of the embryo-sac, as defined by Warming, divides, by transverse septa, into two, three, four, or five special mother-cells, the homologues of the mother-cells of the pollen of Phanerogams, or of the spores of Vascular Cryptogams. These septa are formed in succession from below upwards, or from above downwards, according as the primordial

* 'Comptes Rendus,' lxxxviii. (1879) p. 1359; and 'Ann. Sci. Nat. (Bot.),' viii. (1879) p. 261.

mother-cell does or does not exhibit an apical increase during the formation of the walls.

The groups of Fluviales, Ranunculaceæ, and Cruciferæ present two special mother-cells; three have been observed in the greater part of Monocotyledones and Apopetalæ; four or five in Gamopetalæ, Santalaceæ, Aristolochiaceæ, &c.

The observations of the author lead him to apply the term embryo-sac to the collection of cells which proceeds from the primordial mother-cell.

In certain Liliaceæ, such as *Lilium*, each of the special mother-cells produces, by the division of its nucleus, a tetrad of nuclei which are the homologues of pollen-grains and of macrospores. The septum which separates the first and second cells becomes resorbed before the division into tetrads commences. The single cavity which results (the *embryo-sac* properly so called) finally encloses eight free nuclei which behave in the way that Strasburger has described. In the remaining Liliaceæ, *Agraphis*, *Muscari*, &c., the first and second cells alone give birth to four nuclei, while the lower special mother-cells produce an apparatus to which M. Vesque has given the name *anticline*. In *Lachenalia*, on the contrary, the first cell alone gives rise to a tetrad; three of its nuclei form the sexual apparatus; the fourth unites itself with the undivided nucleus of the second cell and coalesces with it.

The Amaryllidaceæ, Iridaceæ, Aroideæ, Juncaceæ, Cyperaceæ, &c., differ but little from the common type of Liliaceæ, which occurs again very commonly in the Apopetalæ, as in the Euphorbiaceæ, Papaveraceæ, Rosaceæ, and allied families.

The exception presented by Monocotyledones, among which the presence of a single tetrad has been established, occurs frequently among Apopetalæ—in Saxifragaceæ, Onagrariaceæ, &c.—and becomes, so to speak, the rule among Gamopetalæ; while Caprifoliaceæ and Valerianaceæ do not present this character, and thus offer a greater resemblance to ordinary Apopetalæ. The first cell always produces a complete tetrad, even in the most highly organized Gamopetalæ, such as Compositæ.

The cells to which the author gives the name of *anticlinal* present remarkable differences in their development. Sometimes they are arrested immediately after their development (*inert anticlinals*); sometimes they increase and divide after impregnation, and thus produce the albumen (*active* or *albuminigenous anticlinals*), as in Ericaceæ, Scrophulariaceæ, Labiatæ, &c.; sometimes again they elongate and ramify in order to reach, in the tissues of the chalaza or even of the placenta, as in *Osyris*, &c., the nutritive substances which they bring to the other anticlinals to enable them to divide (*cotyloid anticlinals*). The part which the development of the albumen takes in the production of the special mother-cells suggests a comparison with the prothallium of Vascular Cryptogams. This remark applies also to the albumen which is formed in the first and second cells by the division of the central nucleus, whether the multiplication of the nuclei be accompanied by the simultaneous formation of septa, as in Plantagi-

naceæ, Compositæ, &c., or whether the septa appear only at a later period, as in Ranunculaceæ.

From these considerations, the mature embryo-sac may be classified under four types :—

1. Embryo-sac consisting of two special mother-cells; two tetrads; antipodals without anticlinals (Fluviales, Ranunculaceæ, Cruciferæ, &c.).

2. Embryo-sac consisting of three or four special mother-cells; two or more tetrads; antipodals; one or two inert anticlinals (the greater part of the Liliaceæ and allied families; Euphorbiaceæ, Papaveraceæ, Rosaceæ, Caprifoliaceæ, &c.).

3. Embryo-sac consisting of three or four special mother-cells; a single tetrad; no antipodals; one or two inert anticlinals (Onagrariaceæ, Saxifragaceæ, Boraginaceæ; Primulaceæ; Apocynaceæ; Compositæ, &c.).

4. Embryo-sac consisting of four or five special mother-cells; a single tetrad; no antipodals; one or two active anticlinals; an inert or cotyloid anticlinal (Aristolochiaceæ, Santalaceæ, Scrophulariaceæ, Labiatæ, Ericaceæ, &c.).

Angiosperms and Gymnosperms.* — Professor Strasburger has supplemented his previous researches on this subject by a publication of great importance. Owing to a change of view as to the homology of the ovule in Gymnosperms, the terms for the two great classes previously suggested by him, Archisperms and Metasperms, are now abandoned. The main results at which he has arrived may be summed up as follows : —

The points which have specially engaged the author's attention are the development and homology of the ovule in Angiosperms and Gymnosperms; the origin of the embryo-sac, and the processes that take place in it before impregnation; the formation of endosperm; the structure, development, and homologies of the flower and inflorescence in Gymnosperms; and some questions as to fertilization and the formation of the embryo in the same class. He is able to confirm his previous observations on the development of the embryo-sac and the processes which take place in it in the case of *Monotropa* and the Orchideæ, and considers them to be of general application. He disputes Warming's and Vesque's † statement that the two or four cells formed by the septation of the mother-cell of the embryo-sac ever coalesce into a single cavity; it is only one of these cells, usually the lowermost, that develops into the embryo-sac, pressing aside its sister-cells. The germinal apparatus and the antipodal cells are formed in the same way in the embryo-sac; there is never any formation of tetrads in the sister-cells. Strasburger also disputes Vesque's assertion that antipodal cells are not formed in many Gamopetalæ. These assertions are illustrated and proved by a large number of drawings. The author does not agree with the view of Warming and Vesque that the cells formed by the division of the mother-cell of the embryo-sac are

* ' Die Angiospermen und die Gymnospermen,' von E. Strasburger, Jena, 1879; see ' Bot. Zeit.,' xxxvii. (1879) p. 514.

† See this Journal, *ante*, p. 904.

homologous to pollen mother-cells, and supports his contrary opinion by cogent arguments. He would rather find a homologue to the pollen-grain in the embryo-sac itself.

As to the homology of the ovule, Strasburger abandons his earlier view that it is a bud; he would now rather compare it to a sporangium. In the details of the comparison he does not, however, agree with Warming, but considers the funiculus as the homologue of the pedicel of the sporanginm, the nucule that of the capsule itself. In this connection he investigates the phenomenon of oolysis in *Rumex* and *Helenium;* and comes to the conclusion that it is not, as generally supposed, a phenomenon of reversion. The fact that in these cases leaf-pinnæ finally appear in place of the ovules which spring from separated carpellary structures, and buds in place of the terminal ovules, he regards as a substitution of one structure for another, vegetative organs being produced instead of reproductive. Since the two processes compete with one another, a variety of intermediate forms make their appearance, according as one tendency or the other preponderates. If oolysis were really a reversion phenomenon, it might be expected that a structure would sometimes be formed resembling the sporangium of a cryptogam; while, on the contrary, the result is always the production of purely vegetative leaflets, or of a bud. The conception of the ovule as the homologue of a sporangium is confirmed by many facts; such as the position of the ovules, in certain plants, on the median line instead of the edge of the carpel, and their occasionally unquestionable origin from the axis of the flower.

With respect to the relationship of the ovule to the pollen-sac, the author maintains that in this case there is no homology; malformations never show a single ovule, but always a considerable number, in place of an anther-lobe; so that this latter may be regarded as homologous to a sorus.

In the latter portion of his treatise Strasburger enters into a detailed account of the structure and development of the female flower in the Coniferæ and Gnetaceæ; and he now regards as ovules the structures previously described by him as ovaries. The investigation of the history of development of the ovule leads him to the important conclusion that the mode of formation of the embryo-sac in Gymnosperms agrees in essential points with that in Angiosperms. As in these, the mother-cells of the embryo-sac arise from the cell-layer immediately beneath the epidermis, and from the first step in division. Inner cells become the mother-cells of the embryo-sac, while the outer ones may be regarded as "Tapetenzellen" of Warming. The mother-cells, whether formed singly as in Abietineæ, or in numbers as in Taxaceæ, are each divided by septa into three cells; the lowermost of each now becomes the embryo-sac, and supplants the other two.

The ovule of Gymnosperms, notwithstanding some not unimportant differences, is unquestionably homologous, in its first stages of development, to that of Angiosperms. The processes that take place in the embryo-sac are also comparable in the two cases. In Angiosperms the nucleus divides, and its derivatives pass into the ends of the embryo-sac, where four nuclei take the place of the original one.

The processes in the embryo-sac of Gymnosperms also commence with a division of the nucleus; after which appears the first difference, namely, that the septation continues, instead of ceasing when four nuclei have been formed in each end of the embryo-sac. But after impregnation the formation of endosperm begins afresh by cell-division or division of the nucleus. Strasburger is inclined to regard the cells of the germinal apparatus and the antipodal cells as endosperm-cells; the germinal cell appears to him to be a very reduced archegonium.

With regard to the relationship of Gymnosperms to Vascular Cryptogams, Strasburger is disposed to look on the former as directly descended from the Lycopodiaceæ. The genetic connection of Angiosperms with Gymnosperms he considers much more doubtful; but is unable to regard the Gnetaceæ as the ancestors of the former.

Investigations on the process of fertilization, especially in *Juniperus virginiana*, resulted in the detection of a canal-cell, previously overlooked in the Juniperaceæ, originating only very late, at the commencement of impregnation, and very soon becoming disorganized.

The formation of the embryo in *Cephalotaxus* and *Araucaria* presents several remarkable peculiarities. Among others, the apex of the rudiment of the embryo consists of large cells containing but little protoplasm, which form a kind of protective apparatus, and are afterwards thrown off. The apex of the stem is therefore formed from inner cells.

Nucleus of the Embryo-sac.[*]—In his ' Cell-formation and Cell-division,' Strasburger states, as a universal rule, that no fresh formation of nuclei takes place in the embryo-sac; all the nuclei proceeding from one another by division. According to Darapsky, an exception to this rule occurs in the case of *Hyacinthus ciliatus*, where the large size and great clearness of the nucleus in the embryo-sac when in a state for fertilization present favourable conditions for observation. During the development of the endosperm in this plant, the fresh formation of nuclei for the cells of which it is ultimately composed can be readily observed.

Gymnospermy of Conifers.[†]—A contribution to the literature of this subject is furnished by Čelakovsky, in a description of a proliferous fir-cone carefully examined by him.

The rachis of the cone was produced into a terminal shoot, the internodes of which were moderately elongated, and the scales much smaller than in the ordinary cones, and exhibiting transitions to axillary buds. Near the apex was a dense rosette of large, leafy buds arranged in several spiral rows. Above this were several whorls of sterile acicular leaves, and finally a leafy spiral terminal bud consisting of ciliated bracts. With respect to the position of the ovules on the fertile scale or on the two bracts of the bud, the abnormal structures show beyond a doubt that they spring from the back or under side of the bracts; and a careful examination proved that the origin of the ovule was clearly in the channel-like depression

* ' Bot. Zeit.,' xxxvii. (1879) p. 553.   † ' Flora,' lxii. (1879) p. 257.

between the rolled-in margin and the median line of the entire fertile scale. The position of the ovule on the back of the bract in the bud shows that it cannot possibly be an axillary shoot to this bract. Another corroboration of the ovular theory and gymnospermy of Conifers is that, as far as has at present been observed, the ovules, in retrograde metamorphosis, never develop into shoots, but begin to disappear as soon as the metamorphosis commences.

The general result of Celakovsky's observation is—in opposition to the earlier view of Strasburger—to confirm the prevalent theory that the ovule of Conifers is truly gymnospermous.

Reproductive Organs of Cycadeæ.[*]—In sequel to his observations published in 1877, M. Warming has re-examined the subject with fresh material. The principal results before arrived at are fully confirmed; but he now considers that both Strasburger and himself were in error in the supposed observation of a canal-cell to the "archegonium"; what he previously described as such he now believes to be a large nucleus of the central cell which descends towards its lower extremity. M. Warming also confirms the remarkable observation that in *Ceratozamia* the embryo is never formed in the seed until after having been sown in the soil. The embryo has only a single cotyledon, which is unilateral, and embraces the summit of the stem; the radicle and the tigellum are very short in proportion to that of the pro-embryo; their structure appears to be identical with that of Coniferæ.

True Mode of Fecundation of Zostera marina.[†]—According to M. A. Clavaud, it is not correct, as generally supposed, that the anthers fertilize the pistils of flowers enclosed in the same spathe, these organs not being nearly mature at the same time. There is dichogamy and proterogynous dichogamy. Neither is the assertion correct that the extremity of the pollen-cell penetrates into the ovary through a stylar canal open at the summit of the stigmatic branches. This apical opening does not exist, and the extremity of the pollen-cell is inert. The pollen-tube does not grow from the terminal elongation of the pollen-grain; it is always a lateral swelling situated at a certain distance from this extremity, which, when applied to any point of the stigmatic surface, penetrates by means of a notable "gelification" of the walls, which produces later the destruction of the stigmata.

Arrangement and Growth of Cells.[‡]—Professor Sachs has been pursuing his investigation of these difficult subjects in the Botanical Institute at Würzburg, and contributes a further instalment of results.

The chief point which he desires to bring forward with respect to the growth of cells is that the normal direction for the formation of a new wall is always at right angles to that from which it starts, and

* 'Bull. Acad. Roy. Copenhague,' 1879, p. 73; French résumé, p. 9.
† 'Acta Soc. Linn. Normandie,' ii. p. 109; 'Bull. Soc. Belg. Micr.,' v. (1879) p. 197; see 'Bot. Zeit,' xxxvii. (1879) p. 535.
‡ 'Arb. Bot. Inst. Würzburg,' ii. (1879) p. 185.

that in the less common but still numerous cases in which the direction is different, this is always the result of disturbance. Division at right angles appears to be a common property of the protoplasm of cells in a condition to divide; and this would seem to be a fact of fundamental importance, although we are altogether in ignorance as to its cause. Whenever an apparent departure is witnessed from this law, it must be the result of forces at work during the division, which deflect the wall from its normal direction. The essential factor in all growth is the increase in volume of the organ on the one hand, and its change in form on the other hand.

With respect to the formation of cells, the author refers to a view which he has already previously expressed, that many organs which have ordinarily been described as unicellular, are in reality not cellular at all. This is especially the case with the Cœloblastæ. The ends of the shoots of *Caulerpa*, *Mucor*, &c., play the same part in these plants as the cellular growing point in the higher plants; and the same is the case with the ends of the shoots of *Codium* and of the fruticose lichens. The Sphacelariaceæ present a beautiful passage between the truly cellular and the non-cellular plants. In this group the whole of the growing part of the plant is non-cellular, and the apical cell corresponds to the earlier growing end of the shoot in higher plants. The formation, growth, disappearance, and new formation of growing points are a consequence of distribution of growth; the growing point is, however, not the only, although a very common manifestation of this distribution.

Various Forms of the Cell-nucleus.[*] —At the conclusion of his paper on " Cell-formation and Cell-division," Professor Strasburger thus sums up the main results arrived at.

The processes of division are identical in animal and vegetable cells; as also is the behaviour of the nucleus, with unimportant deviations. The greatest variation which has at present been observed in the division of the nucleus is that between the " nucleus-spindle " with differentiated disk, and the " nucleus-barrel " without any differentiated disk. The " nucleus spindle," exclusive of the disk, is composed of slender threads usually converging towards the poles; the " nucleus-barrel " of stronger threads of one kind only, and only slightly approximating towards the poles. The various special forms are classified as under, viz. :—

I. " Nucleus-spindle "; with differentiation into " threads " and " disk."

  1. The threads converging strongly towards the poles.

    a. The poles clearly marked.

      α. The elements of the " plate " uniformly distributed in the equatorial plane of the " spindle." Many animal ova.

      β. The elements of the " plate " more or less regularly distributed in the equator round the " spindle." Endothelium of the frog.

        * 'Bot. Zeit.,' xxxvii. (1879) p. 281.

    b. The poles not clearly marked.

        a. The elements of the " plate " distributed regularly in the equatorial plane of the " spindle." Most vegetable cells.

        β. The elements of the " plate " lying outside the " spindle " in the equator. An unusual case in the integuments of the ovule of *Nothoscorodon fragrans.*

  2. The threads only slightly or imperceptibly converging towards the poles.

    a. The ends of the threads marked by knots. Embryo-sac and integument of *Monotropa.*

    b. The ends of the threads not especially marked. *Spirogyra.*

  II. " Nucleus-barrel " formed of a single kind of rod-like elements.

    1. The elements of the " barrel " strongly converging towards the poles. Integument of ovule of *Nothoscorodon fragrans.*

    2. The elements of the " barrel " only slightly or imperceptibly converging towards the poles. Epithelium of larva of salamander ; cartilage of larva of batrachia.

Conducting Tissue for the passage of Pollen-tubes.* — The structure and development of the tissue which serves the special purpose of conducting the pollen-tube from the stigma, through the style and ovary to the micropyle of the ovule, has been made a special subject of study by M. G. Capus.

By a conducting tissue the author understands one composed of cells, usually elongated, delicate, and but slightly united, the union of which forms a cylinder occupying the centre of the style, or lining the walls of a central stylar canal. The pollen-tube carries on a parasitic existence, obtaining the nutriment necessary for its rapid elongation from this conducting tissue. The development of this tissue hence depends greatly on the number of pollen-tubes for which it is destined to supply the nutriment, and therefore on the number of ovules to be fertilized.

This conducting tissue is always a modification and extension of the epidermis, whether on the surface of the stigma itself, as a lining to the stylar canal, or on the walls of the ovary or of its dissepiment intermediate between the base of the style and the ovules. At the period of impregnation the cells of this tissue are filled with a dense, granular, oily and nearly opaque substance. In certain cases the periblem or hypodermal tissue takes part, along with the true epidermis, in the origin of the conducting tissue. Again, but rarely, the conducting tissue may owe its origin to proliferation, or the tangential division of the epidermal cells ; more often to a similar division of the hypodermal cells. The stigma, properly so called, is nothing but the apical termination of this conducting tissue of the style.

In the ovary it is never continued below the spot from which spring the lowest ovules. It is much more strongly developed in ovaries with parietal placentation and a large number of erect ana-

* ‘Ann. Sci. Nat. (Bot.),’ vii. (1879) p. 209.

tropous ovules than in those with parietal placentation and a small number of pendent anatropous ovules, or in unilocular ovaries with a single erect orthotropous ovule. In almost all cases the pollen-tube has to traverse a longer or shorter free space between this conducting tissue, where it is in the immediate proximity of the placenta, and the micropyle of the ovule; and the cause of this deviation of the pollen-tube from its previous course is altogether unknown. The conducting tissue of the placenta is frequently raised in the form of more or less prominent papillæ or hairs; and the same is the case with that of the stigma and even of the style.

The style may be either hollow in the centre, the cavity being then lined by the conducting tissue, or it may be solid, the central portion being then loose and large-celled, and forming itself the conducting tissue. Most commonly ovaries with parietal placentation are terminated by a hollow style. In plurilocular ovaries with axile placentation, there are frequently a number of separate stylar canals corresponding to the number of loculi.

The cells which form the conducting tissue do not always remain united into a compact continuous tissue; those which line the stylar canal frequently become detached over a smaller or larger extent of the surface, and produce a kind of soft jelly. The cells of the conducting tissue frequently contain starch, oil, and amorphous chlorophyll. The pollen-tube traverses the style either within the conducting tissue, or in immediate contact with it, or with its papillæ, drawing its nutriment from its cells. The stigma, even when apparently terminal, is always really lateral, and formed from the edges of the carpellary leaf rolled over and meeting. In the same manner there is a double formation of conducting tissue for every carpel within the ovary; and in those cases where the style is solid, it is formed by the coalescence of the opposite edges and sides of a primitive canal.

Seminal Integuments of Gymnosperms.[*]—M. Bertrand publishes an exhaustive paper on this subject, in which he sums up the present state of our knowledge under the following heads:—

(1) Ovules of Gymnosperms. He here discusses the orthotropy of the ovules of Gymnosperms; the number of their integuments; their development; their "pollen-chamber"; their vascular system; and the morphology of their different parts. (2) The transformation of the ovular into seminal integuments; including the closing of the micropylar canal; the formation of the membranous seminal integuments; the formation of the partially fleshy and partially woody, or partially dry and partially woody integuments; and the arillus. (3) The disposition of the seminal integuments in the principal genera of Gnetaceæ, Coniferæ, and Cycadeæ. (4) The accessory envelopes and disseminating organs of the seeds of Gymnosperms. This includes an account of the accessory envelopes in *Welwitschia, Ephedra, Gnetum,* Coniferæ, and Cycadeæ; and of the direct and indirect organs of dissemination in the various families. The paper is illustrated by six plates.

[*] 'Ann. Sci. Nat. (Bot.),' vii. (1879) p. 61.

Relationship of Intercellular Spaces to Vessels.[*] —Dr. Von Höhnel points out that one important functional difference between true vessels and intercellular cavities is that, while in the latter the pressure of the air never differs materially from that of the surrounding atmosphere, in the former it may either be considerably less (when transpiration is very active), or in some cases more than double as great. Except in a few special instances, the fibrovascular bundles consist of vessels in close apposition with one another, without intercellular spaces.

In these exceptional cases the author has succeeded in establishing the following laws :—(1) In no case, in the vascular bundles of the stems of Phanerogams, is a vessel which is still functional bounded immediately by an intercellular space. (2) In the leaves of Phanerogams a tracheid or vessel is never directly bounded by an intercellular space. (3) Throughout the plant the functional vessels and tracheids are always separated from the intercellular spaces by at least a single layer of living cells.

Peculiarities in the Power of Living Parts of Plants to conduct Electricity.[†]—Investigations of this subject conducted in Sachs's botanical laboratory in Würzburg, have led Dr. Künkel to conclusions which may be briefly summed up as follows :—Parts of plants, the elongation of which is mainly in one direction, exhibit differences in the power of conducting electricity according as the direction of growth is ascending or descending.

Influence of Electricity on Vegetation.[‡]—A series of experiments carried on by M. Naudin appears to lead to an almost opposite conclusion from the results previously transmitted to the Paris Academy by MM. Grandeau and Leclerc, that the flowering and fructification of plants are retarded and impoverished when they are excluded from the influence of atmospheric electricity.

The earlier experiments were made on tobacco and maize at Nancy and Mettray ; and later ones on the tomato and other plants in the warmer climate of Antibes. In both sets isolation was effected by enclosing the plants in an iron cage, covered with a small-meshed iron netting. For the first fortnight of M. Naudin's experiments, there was no apparent difference between the plants in the cage and others grown under precisely similar conditions outside it ; but after this time the plants in the cage were decidedly stronger than those in the open air, and this difference became more pronounced as time went on. The periods of flowering, and of the formation and maturing of the fruit, were contemporaneous ; but as regards the quantity of vegetable matter produced in a given time and on the same extent of soil, there was a great difference in favour of the caged plants. M. Grandeau believed that trees exert an injurious influence on plants in their neighbourhood by withdrawing atmospheric electricity from them ; but this again was not confirmed by M. Naudin's results. He attri-

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[*] 'Oesterr. Bot. Zeitschr.,' xxix. (1879) p. 137.
[†] 'Arb. Bot. Inst. Würzburg,' ii. (1879) p. 333.
[‡] 'Comptes Rendus,' lxxxix. (1879) p. 535.

butes this phenomenon rather to the shade cast by trees, and especially to the exhaustion and desiccation of the soil by their roots, which often extend to a great distance. On the other hand there are many plants which seek the neighbourhood of trees, and which even thrive only under their shadow; and these, probably, must be adapted to a diminution of atmospheric electricity. M. Naudin states that, in some cases at least, the same species is not only more vigorous, but flowers earlier, with larger flowers, under the shade of trees than in more open situations.

His general conclusion is that the influence of atmospheric electricity on plants is complex, varying with the species, and being also modified by climate, season, temperature, degree of light and moisture, and perhaps also by the geological structure or mineralogical composition of the soil.

Absorption of Rain and Dew by the Green Parts of Plants.*— The ancient view of Hales and Bonnet that plants have the power of absorbing rain and dew, was combated by De Candolle, Meyen, Treviranus, and especially by Duchartre, whose conclusions to the contrary effect have been accepted since his time by nearly all vegetable physiologists. The subject has been recently reinvestigated by the Rev. G. Henslow, whose experiments appear to have established conclusively that the older view is the correct one. Not only has this conclusion been confirmed by an independent series of researches carried on by M. Bousingault,† but it is in harmony with the practical experience of all horticulturists.

Without entering into the details of his experiments, which will be found recorded in the paper itself, it may be stated in general terms that the results arrived at by Mr. Henslow are, that dew is not absorbed by saturated tissues at night; but that absorption does take place at and after sunrise, when transpiration recommences, and an indraught is caused by the moisture retained on the leaves; further, that when leaves are purposely or naturally killed by excessive drought, they then do absorb water; as may be proved by the balance, and in other ways.

Decrease of the Power of Absorption in Branches dipped in Water.‡—From a fresh series of investigations on this subject, Dr. F. von Höhnel has come to the conclusion that experiments on the rate of absorption of fluid by cut branches have little value in determining the phenomena which take place in the living plant, an important factor in the former being that the decrease of absorption which takes place after a time is largely due to the formation of mucilage and the appearance of bacteria, causing a partial or entire closing of the vessels.

Water-pores.§—Under this term Langer describes those orifices in the epidermis of the leaves and other green parts of plants which serve

* 'Journ. Linn. Soc. (Bot.),' xvii. (1879) p. 313.
† 'Ann. Chim. et Phys.,' May 1878.
‡ 'Bot. Zeit.,' xxxvii. (1879) pp. 297, 313.
§ 'Oesterr. Bot. Zeitschr.,' xxix. (1879) pp. 79, 105.

for the elimination of drops of water. He has studied their structure and function in detail, following the observations of Borodin, de Bary, and others.

Water-pores are not always to be distinguished by their appearance from ordinary stomata, but may frequently be known by being larger and remaining open when the normal stomata are closed. They have been long known to exist in many plants, as, for instance, many species of fern, water-plants like *Callitriche verna* and *autumnalis*, *Hippuris vulgaris*, and *Ranunculus aquatilis*, and succulent plants like *Colocasia*, *Crassula*, &c. By some authors they have been treated as organs of secretion. They are either solitary or arranged in groups, and are most common on the upper side of the leaf. In *Crassula lactea* small depressions are visible to the naked eye near the margin of the leaf, which the Microscope reveals to be groups of from twenty-five to thirty of these water-pores, covered by a very thin transparent parenchyma. They are distinguished from the ordinary stomata by being rounder, with a nearly circular opening, and by the guard-cells being destitute of chlorophyll. An actual excretion of water was not observed in these—as was the case also in many other instances—and is probably only a temporary function of them. Very similar structures occur in several species of *Crassula*, and others belonging to the same natural order. The leaves of *Primula Sinensis* exude a large amount of water, which the author believes to escape through two large water-pores which he found on the lower side of each tooth. The excreted water yielded carbonate of lime on evaporation. *Colocasia antiquorum* has long been known for the remarkably copious exudation of water from its leaves. Langer found on the upper side of the leaf, near the apex, three gigantic water-pores, through which the elimination appears to take place, with wide-open crevices. The remainder of the stomata on the upper side of the leaf were much smaller, but also wide open. Similar pores were observed on the leaf-stalk, where also an exudation of water takes place. After being placed for fifteen hours in the dark the large water-pores still remained wide open, while the smaller stomata were more or less completely closed.

The observation of these and many other examples led the author to the conclusion that the two functions of the diffusion of gases and the elimination of water are not sharply differentiated in the stomata, but that an ordinary stoma may, at certain times and under certain conditions, become converted into a water-pore, its guard-cells losing their contractile property, and the fissure usually becoming more circular.

Respiration of Plants.*—M. H. Moissan has undertaken a careful series of experiments for the purpose of determining afresh the relation between the volume of oxygen absorbed by plants and that of carbonic acid emitted in respiration. The observations were made by means of carefully constructed apparatus, on a considerable number of trees, shrubs, and herbaceous plants, and with the following results:—

Every living organ absorbs oxygen from the air, and disengages

* 'Ann. Sci. Nat. (Bot.),' vii. (1879) p. 292.

carbonic acid gas.   The amount of carbonic acid emitted in respiration has no direct connection with that of the oxygen absorbed.   In general, at low temperatures, the quantity of oxygen absorbed is greater than that of carbonic acid evolved.   There is a certain temperature, different in different species, in which the two amounts are nearly equal; above this temperature, the production of carbonic acid is in excess of the absorption of oxygen.

Respiration of Marsh and Water Plants.[*] — Recent investigations by E. Freyberg have been specially directed to the two facts, that the roots of marsh plants can grow and even flourish in media containing very little oxygen, or even none at all, and that marsh plants are, with very few exceptions, useless to mankind.   A series of experiments brought out the fact that marsh plants (rice, *Mentha aquatica, Caltha palustris*, &c.) show a much smaller power of respiration than land plants belonging to the same natural order (wheat, *Lamium album, Ranunculus bulbosus*, &c.), and consequently require much less oxygen.   This low power of respiration appears to be accompanied by a small proportion of nitrogen in their chemical composition; a connection depending on well-known physiological facts, the seat of respiration being the protoplasm or albuminoid contents of the cells.   In the case of the only two marsh plants which are extensively grown as food-material, rice and the sugar-cane, their value depends not on any nitrogenous constituents, but on the presence of a large amount of a carbo-hydrate.

Influence of Light, Warmth, and Moisture on the Opening and Closing of the Anthers of Bulbocodium vernum.—Kerner has already observed that the anthers of this plant, belonging to the Colchicaceæ, open in the morning and close in the evening.   Mikosch has investigated[†] the cause of this phenomenon, and attributes it to the action of a special layer which forms the innermost portion of the wall of the anther, and which exists only in anthers possessing the property of similar movements.   This layer consists of three or four rows of cells, compressed from below inwards, the walls of which always remain thin.

Chemical Researches on the Formation of Coal.[‡]—M. Frémy finds, as a result of some laborious and complicated experiments, that the plants which have produced coal have done so by undergoing a process of fermentation, which, in converting them into peat, has completely destroyed every trace of vegetable structure, and it is only when the peat has been subjected to the influences of heat and pressure that it has been converted into coal.   Coal is not, therefore, an organized structure, as has been supposed.

With regard to the impress of plant-life which is so frequently to be observed in pieces of coal, M. Frémy suggests that it may be very fairly considered that these marks were made when the

* ' Landwirthschaftliche Versuchs - stationen,' xxiii. p. 463; see ' Naturforscher,' xii. (1879) p. 257.

† ' Oesterr. Bot. Zeitschr.' June 1878.

‡ ' Comptes Rendus,' lxxxviii. (1879) p. 1048.

coal was still plastic. His experiments showing that the principal constituents of vegetable bodies become, when exposed to heat and pressure, converted into substances very like coal, are exceedingly interesting.

New Carbo-hydrate.[*]—Prof. Schmiedeberg describes a new carbo-hydrate of the formula $C_6H_{10}O_5$, discovered in the bulbs of *Urginea Scilla*, and hitherto described as a gum, for which he proposes the name *sinistrin*. When pure it is colourless, a white powder when dry, absorbing water readily from the air, and then becoming transparent and gum-like. It is soluble in water, insoluble in absolute alcohol, is not coloured by iodine, does not reduce oxide of copper. Sinistrin is precipitated from its aqueous solution by acetate of lead when there is great excess of ammonia, but not otherwise; when decomposed with lime-water, a slightly soluble amorphous lime-compound is produced. Sinistrin rotates the pole of polarized light to the left; the concentration and temperature of the solution have no influence on the amount of rotation. Saliva and yeast do not saccharify it; but when a dilute solution is warmed with from one to four per cent. of sulphuric acid, it passes over altogether into sugar. This sinistrin-sugar probably consists of levulose and an optically inactive sugar, apparently in the proportion of 5 to 1. Sinistrin is contained in such quantities in the bulbs, along with sugar, that it constitutes the greater part of their dried substance. The author considers it probable that sinistrin is formed from the direct products of assimilation. The pure cellulose of the bulb, when decomposed by dilute acids, yields no trace of levulose, but only sugars with rotation to the right.

Calcium phosphate in the Living Cells of Plants.[†]—In examining the leaves of *Soja hispida* and *Robinia pseudacacia*, MM. Nobbe, Hänlein, and Couneler found, especially in the first-named species, in the parenchymatous cells of the mesophyll, a quantity of peculiar, colourless, moderately refractive bodies, of a roundish, elliptical, or ovoid form, their average size about that of the cell-nucleus, one, or rarely two in a cell. A careful investigation of these structures showed that they consisted of calcium ortho-phosphate.

B. CRYPTOGAMIA.

Cryptogamia Vascularia.

Germination of Fern-spores.[‡]—Recent observations by Rauwenhoff, of Utrecht, point to a somewhat different interpretation from that at present generally accepted of the first processes in the germination of the spores of ferns and other vascular cryptogams.

The phenomena presented by the germination of a fern-spore are as follows :—A more or less considerable (but often very small) swelling of the exospore takes place from absorption of water. After some time—less or more according to the species—the wall of the

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[*] 'Zeitschr. Physiol. Chemie,' 1879, p. 112; see 'Bot. Zeit.,' xxxvii. (1879) p. 513.
[†] 'Landwirthschaftliche Versuchs-stationen,' xxiii. p. 471; see 'Naturforscher,' xii. (1879) p. 276.
[‡] 'Bot. Zeit.,' xxxvii. (1879) p. 441.

spore opens at the point of junction of the three ridges in radiate, or in the middle of the single ridge in bilateral spores. Through this opening protrudes a papilla, which develops protoplasm and chlorophyll like a young cell, and, either at once or after a short time, puts out a second papilla, the first rhizoid; both cells subsequently developing in various ways. The usual explanation of these appearances is that when the exospore bursts, the endospore develops and forms the wall of the first cell of the prothallium, as also usually of the first rhizoid; the contents of the spore passing over into these two cells.

In following out this process, Rauwenhoff met with the difficulty that, although chemical tests failed to detect the presence of cellulose in either the endospore or exospore before germination, this substance is clearly present in the papilla and in the parietal portion of its contents in the earliest stages of germination. He gives a detailed description of the phenomena observed in the germination of the spores of *Gleichenia*, which are especially favourable for observation, owing to the transparency of the cell-wall of the spore, and comes to the conclusion that the source of the wall of the first prothallium-cell and of the first rhizoid is not the endospore or inner shell of the original wall of the spore, but a new cellulose wall secreted out of the protoplasm of the spore before it opens, and increasing in the ordinary way by intussusception.

The source of the ordinary interpretation of the first stage in germination is doubtless a false analogy with the process of development of the pollen-tube, which undoubtedly results from the growth of the intine or inner coating of the wall of the pollen-grain.

That the germination of the spores of other vascular cryptogams will be found to agree with that of *Gleichenia* rather than with the development of the pollen-tube of phanerogams, where observation of these processes is possible, is concluded by Rauwenhoff from the following considerations. A section of pollen-grains in which the pollen-tube has begun to develop, shows that where the tube has broken through, the wall consists of fewer layers than elsewhere, that is, of the extine only. In fern-spores, on the contrary, the wall is of the same thickness, and consists of as many layers after germination as before; showing that the protruding wall of the papilla must be a new membrane. The changes in the contents of the spore on germination are also much more extensive than those of the papilla of the pollen-grain when the tube is formed. The intine of pollen-grains consists, moreover, of cellulose, which is certainly not generally the case with the endospore of such fern-spores as have been carefully examined. This explanation also corresponds with what is known to take place in the formation of the zygospore of *Spirogyra* and other Conjugatæ, as well as with the processes observed in the germination of the spores of Equisetaceæ, Hepaticæ, and Bryineæ.

Bilateralness of Prothallia.*—In opposition to the opinion of Bauke,† Leitgeb still maintains his view that the bilateralness of the

* 'Flora,' lxii. (1879) p. 317.   † See this Journal, *ante*, p. 451.

prothallium of ferns (i.e. the exclusive tendency of one side to produce antheridia and archegonia) is the result mainly of a difference in the supply of light, rather than of gravitation; the organs of reproduction being produced only on the shaded side. His conclusions were confirmed by the following observations on *Ceratopteris thalictroides*.

Prothallia of this fern are produced with ease by sowing the spores on a nutrient fluid. When lighted from above, the prothallia expand on the surface of the water, or raise themselves above it, turning one side to face the light. Only the shady side produces archegonia, the rhizoids springing either from it or from the marginal cells, and growing downwards into the fluid. But when the light reaches the prothallia from below, the result is quite different. They grow down into the fluid to meet the light, but curve, as soon as the true surface begins to develop, so that one surface is placed at right angles to the incident light. The conditions with respect to contact with the substratum are therefore here the same on both sides, and yet the archegonia, as well as those rhizoids which spring from the surface, are produced on one side only, viz. the shady side. The rhizoids also do not grow downwards, but spread themselves over the surface of the fluid; they are therefore not positively geotropic, but to a certain extent negatively heliotropic.

These prothallia are also instructive in another respect. The rhizoids are, as is well known, produced especially at the basal end of the cells. This occurs also in the parts of the prothallium which grow obliquely downwards, proving that it is not gravitation that determines their place of origin, but that it depends on the contrast of base and apex of the prothallium.

Development of the Prothallium of Salvinia.[*] — Prantl has closely followed out the history of development of the prothallium and reproductive organs of *Salvinia natans*, with the following results, which are not in every respect in harmony with those previously arrived at by Bauke.[†] In addition to the wall of the sporangium, the true spore is surrounded by a small-celled integument, the exospore of Pringsheim, but more correctly called the epispore by Russow and Sachs. This is firmly attached to the thick yellow exospore, which, on germination, becomes detached in three lobes from the apex of the spore. At the same time the epispore is also burst into three lobes. The ripe spore always swims on the surface of the water, and is not merely buoyed up by algæ, as Hofmeister supposed; the entire epispore serving as a swimming apparatus. Germination takes place, under favourable conditions, about Christmas.

The germination, development of the prothallium, fertilization, and the development of the young plant until the "peltate leaf" has attained its full size, take place in the dark, but with formation of chlorophyll. The first cell-formations in the prothallium are exceedingly difficult to follow. The meniscus-shaped anterior portion of the spore is first of all separated from the large spore cavity by a single basal wall, the "hyaline membrane" of Pringsheim. A young

* 'Bot. Zeit.,' xxxvii. (1879) p. 425.   † This Journal, *ante*, p. 753.

prothallium seen from above, i. e. from the apex of the spore, has a nearly equilateral triangular form with rounded angles alternating with the lobes of the exospore. The first wall is vertical, cutting off one of these angles. This portion, which may be called the sterile third, develops into the large-celled knob which is always found at the base of the archegonial surface of the prothallium, and never bears archegonia. The further cell-division and formation of the archegonia is described in detail in the paper. In the majority of cases the archegonia are formed only on the ventral surface of the prothallium which bears the "lump" behind; but sometimes extends somewhat on both sides, and even reaches the dorsal surface. The distinction between the dorsal and ventral surfaces is clearly not due, as in ferns, to a difference in the illumination, but is inherent in the prothallium.

The original tripolar development of the prothallium appears to present some analogy with that of Hymenophyllaceæ, except that the large spore-cavity is first of all divided off by a septum. The mode of formation of the archegonia reminds one again of *Selaginella*, in which the archegonia form three rows alternating with the lobes of the exospore. In *Salvinia* there are only two rows; the third side remaining sterile, and forming the "lump."

Muscineæ.

New Bryum.[*]—Mr. H. Boswell describes a *Bryum* gathered in Teesdale, without flowers or fruit, the form and texture of the leaves, however, appearing distinct and sufficient to render it well marked.

The name—*B. Origanum*—was suggested by the peculiar odour, and it is thus characterized:—

"Stems elongated, about an inch or more, copiously radiculose and forming dense soft tufts. Leaves ovate and ovato-lanceolate, shortly pointed, scarcely acuminate, concave, nerved almost to the apex, cells leptodermous, oblong and nearly rectangular, margins plane, slightly recurved when dry, formed of a single row of narrower cells."—Shady old wall, Teesdale.

In soft dense tufts, foliage full green, the young leaves at the summit rosy-pink, the old foliage of former years and lower part deep brown, stems and leaves matted with numerous radicles. Habit and general aspect much as in *B. barbatum* Wils., or some forms of *B. æneum* from Norway—from the former it differs in the form of the leaves, which are not piliferous-acuminate, in the nerve ceasing below the apex, in the form of the cells, and their very thin walls.

Fungi.

Structure of Chætomium.[†]—W. Zopf has investigated the structure and development of this genus of Sphæriaceæ,[‡] and contributes the results to the 'Proceedings' of the Botanical Society of Brandenburg. He regards all the species which have hitherto been described as modifications of a single one—which he calls *Chætomium bostrychodes*,

* 'Naturalist,' v. (1879) p. 33.
† See 'Hedwigia,' xviii. (1879) p. 91.
‡ Placed, in Cooke's 'Handbook of British Fungi,' among the Perisporiacei.

distinguished by an ellipsoidal perithecium, minute spores, about 6 μ in diameter, and a tuft of elegant hairs.

Proposed New Genus of Fungi—Peniophora.*—Dr. Cooke proposes to separate sixteen species of the two Friesian genera of *Corticium* and *Stereum* (of the order Auricularini of Hymenomycetous Fungi), and to unite them in a new genus under the name of *Peniophora* (πηνίον, a shuttle). He points out that Fries paid little or no attention to microscopic characters, so that his whole classification of the Hymenomycetes was limited to what could be detected by a common lens. In these days of microscopic research such a limit is scarcely satisfactory, and in the above two genera there are structural features which indicate that Fries' arrangement was not so perfect as it might have been had he brought the Microscope to his aid.

The new genus includes those species in which the hymenium is beset with short, rigid, uncoloured, rough, projecting cells ("metuloids") which are attenuated upwards or subfusiform and give the surface a velvety appearance, the old genera retaining only the species in which these shuttle-shaped bodies are absent, the hymenium being naked.

Vine Fungi.†—The various fungi which attack the vine, either as parasites or as saprophytes, have been carefully studied, enumerated, and described by von Thümen, and classified according to the part of the plant on which they are found. On the grapes he describes only a single species, *Macrosporium uvarum* (new); on the woody parts no fewer than twenty-four species, a large number of them new, belonging to the genera *Fusarium*, *Diplodia*, *Leptothyrium*, and others. Parasitic on the leaves are six species, all described as new; while on the root is a single species, *Rœsleria hypogœa*, new not only specifically, but also generically, belonging to the Helvellaceæ.

Propagation of Cluster-cups.‡—Dr. Cooke, in his 'Introduction to the Study of Microscopic Fungi,' calls attention to the difficulty of accounting for the appearance of the cluster-cups (*Æcidiacei*) bursting through the cuticle of the leaves of the plants on which they are found. The question is as to the manner in which their spores reach the interior of the leaf where they germinate. It certainly cannot be by way of the stomata, for these are too small, nor would this account for the preservation of the spores until the succeeding year. Equally difficult is it to imagine a process by which they can gain access to the interior of the growing leaf through the roots, nor have they been traced passing through the tissues of the plants. Dr. Cooke mentions the fact, however, that the Rev. M. J. Berkeley was able to propagate cluster-cups by growing plants from seeds which had been placed in contact with their spores.

Following this hint, and noting the fact that certain species ripen and discharge their spores at the time when the plants on

* 'Grevillea,' viii. (1879) p. 17.
† F. von Thümen, 'Die Pilze des Weinstockes,' Vienna, 1878 ; see 'Hedwigia,' xvii. (1879), p. 118.
‡ 'Am. Naturalist,' xiii. (1879) p. 467

which they are found are in blossom, Mr. M. A. Veeder, of New York, anticipated that these spores would be found along with the pollen in the interior of the ovary, thus coming into contact with the seeds and depositing the germs of future growth. Acting upon this hypothesis, he examined the flowers of *Podophyllum peltatum* and *Arisœma triphyllum* growing within a few feet of plants of the same species whose leaves were covered with cluster-cups, and in many instances found the orange-coloured spores among the pollen in the ovary. He also found pollen from *Podophyllum peltatum* mingled with the spores dusted over the leaves of a plant of the same species at a distance of several feet from any blossom, indicating, apparently, that it had been transported by insects.

Onion-smut, Urocystis Cepulæ.*—A parasitic fungus, excessively destructive to the onion, was first observed in North America, in the States of Connecticut and Massachusetts, about twelve years since, and was first described by Dr. Farlow † under the name of *Urocystis Cepulæ.* Although committing great ravages on the crops in those States, it was very local, being unknown in that of New York. Hitherto the fungus has been supposed to be confined to the New World ; but M. Cornu has now detected it in the neighbourhood of Paris, on an early variety of the white onion known as the "*Oignon de Nancy.*" It attacks the bulb-scales and the bases of the leaves, reducing them to a black powder. Dr. Farlow considers that the fungus has invaded the onion from some wild species, and Dr. Cooke considers it a variety of *Urocystis Colchici,* a parasite of the autumn crocus.

Lagenidium Rabenhorstii, a new Phycomycete.‡ — W. Zopf reports the discovery of this new parasitic fungus, which was causing great ravages among the *Spirogyra* and other Conjugatæ in the water in the Zoological Garden in Berlin, to the Proceedings of the Botanical Society of Brandenburg. The reniform biciliated zoospores attached themselves to the host, penetrating the cell-wall by means of a perforating tube, and developing in the interior into a mycelium, which, in its non-reproductive condition, is unicellular, of small dimensions, and unbranched. The zoosporangia become subsequently separated by a septum. Sexual plants spring from two zoospores which penetrate into the same cell of the host; the antheridia and oogonia resembling those of the class generally. Though coming nearest to *Lagenidium* of any known genus, it differs from the species hitherto known in the form of the zoospores and the number of the cilia.

The author divides the family of Saprolegniaceæ into two groups : —(1) the typical Saprolegnieæ, in which there is a distinct differentiation of a vegetative and a reproductive portion, including the genera *Saprolegnia, Pythium, Cystosiphon,* &c.; and (2) the Ancylisteæ of Pfitzer, in which no such differentiation is evident, and in which must be included the genera *Ancylistes, Myzocytium, Lagenidium,* and *Achlyogeton.*

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* 'Comptes Rendus,' lxxxix. (1879) p. 51.

† Twenty-fourth Ann. Rep. of the Sec. of the Massachusetts State Board of Agriculture, Onion-smut, 1877.

‡ See 'Hedwigia,' xviii. (1879) p. 94.

Protomyces graminicola.*—Dr. Schrœter has detected this fungus, recently described by Saccardo, in great quantities on *Setaria viridis* and *S. glauca*, and finds it identical with *Ustilago Urbani* Magnus. He considers it an endophytic Phycomycete, belonging either to the family Peronosporeæ or Pythiaceæ.

The fungus was especially abundant on the above-named grasses where they constituted the most abundant weeds in potato-fields; and in this situation Schrœter found on *Setaria* a conidia-bearing fungus, the identity of which with the one in question he could not doubt. This corresponded very closely with the smaller species of *Peronospora*, such as *P. pygmœa*, but was distinguished by the acute ends of the branches. He considers the fungus to be therefore a true *Peronospora*, but belonging to a new section, which he calls *Sclerospora*, distinguished by the unequally thick dark-brown envelope consisting of several layers, formed out of the oogonium wall, and the dusty spores. With the exception of *P. Schleideniana* on *Allium Cepa*, this is the only *Peronospora* hitherto detected parasitic on a monocotyledon. Schrœter thinks that the parasite may be of economical value from its destructive influence on very widely distributed agricultural weeds.

Conidial Fructification in Mucorini.†—Dr. Cunningham describes the complete life-history of *Choanephora*, a mucedinous fungus, parasitic on the corolla of *Hibiscus* and other shrubs in India, including no less than four distinct forms of fructification. Of the reproductive bodies one kind, the zygospores, are sexual, and the other three nonsexual:—conidia, sporangial spores, and chlamydospores. The sporangial and chlamydosporic reproductive bodies appear to be more closely allied to one another than to the conidia. They are new and independent cells formed within the tubular system of the parent plant; but the conidia are merely isolated portions of that system, being, in fact, only the tips of the terminal filaments of the aerial portion of the plant. The distinction is not merely an anatomical one; the fact that the difference in the nature of the conditions favours the development of the various forms of fructification, indicates a physiological distinction also. The conidial fructification is the form characteristic of active nutrition and vegetative growth. Given a very rich nutritive medium and fully developed normal conidia, a luxuriant development of mycelium occurs, followed, sooner or later, by an abundance of conidial fructification. With diminishing nutrition there is progressively poorer mycelial development and less-developed conidial fructification. When this degeneration has reached its utmost limit, when the conidial fructification is reduced to its poorest and simplest type, the sporangia begin to make their appearance; and when the conditions of nutrition are too greatly lowered even to allow of this, we find the chlamydosporic fructification providing for the preservation and diffusion of the plan.

Dr. Cunningham's observations are in one point inconsistent with those of Van Tieghem and Le Monnier, who deny that true conidial fructification ever occurs in the Mucorini; and the conjunction of these various forms in one species would destroy Brefeld's proposed

* 'Hedwigia,' xviii. (1879) p. 83.
† 'Trans. Linn. Soc. (Bot.),' i. (1879) p. 409.

classification of the Mucorini or Zygomycetes into two sub-families, one distinguished by sporangial, the other by conidial non-sexual fructification.

Beech Disease, Phytophthora Fagi.[*]—Professor Hartig finds that this disease of young beech-seedlings is spread by the oospores which germinate in the soil. The mycelium differs from that of other Peronosporeæ in being septated. The mode of formation of the sporangia is similar to that described by de Bary in the case of *Phytophthora infestans*. The germinating filaments of the zoospores creep along the surface of the leaf, and penetrate between the epidermal cells, sporangia being produced in the course of two or three days. The mycelium and sporangia develop chiefly in the cotyledons, much less luxuriantly in the foliage-leaves.

The formation of oospores takes places as follows :—On the inter-cellular mycelial filaments are formed numerous not very long lateral hyphæ, which swell up into a club-shaped form, producing oogonia at the extremity. The oogonium is thin-walled, filled with protoplasm, and is divided off from the hypha by a partition wall, being thus elevated on a short stalk. In the neighbourhood of each oogonium is produced at the same time a much smaller antheridium by the swelling into a club-shaped form of the apex of a hyphal branch, which usually becomes attached to the oogonium near its base. The wall of the oogonium not unfrequently exhibits an indentation at this spot; but the coalescence of the two sexual cells consists simply in a union of growth, and the resorption of the substance of the wall of the oogonium at a small round spot; there is no forcing itself of the antheridium into the oogonium by means of a beak-like process. The contents of the antheridium, which is divided off from the hypha by a septum, then pass over into the oogonium; the protoplasm of the oogonium some-what contracts, and an oospore is produced, at first with a thin, after-wards with a very thick wall. The oospores may either germinate directly, or they may retain their power for at least three years.

The disease has at present nearly confined its attacks to nurseries, where the young plants are very crowded. The practical remedy appears to be to refrain from planting the seed in soil likely to be infected with the oospores.

Berggrenia—New Genus of Discomycetes.[†]—Dr. Cooke describes an aberrant genus of the Discomycetes which possesses a general interest to the mycologist as a new arrangement or inversion of organs. The fungus was collected in 1874–75, by Berggren, of Lund, during his visit to New Zealand, and the name *Berggrenia* is proposed for it. It is ovate, pyriform, somewhat clavate, about one inch in height, and nearly as much in breadth, but compressed laterally to one-fourth of that thickness in one direction. It looks very much like a *Tremella*, being a little plicate or rubbed below and inflated, so that the centre is hollow, and though attenuated a little at the base

[*] 'Forstwissenschaftliches Centralblatt,' i. (1879); see 'Bot. Zeit.,' xxxvii. (1879) p. 511.

[†] A paper read by Dr. M. C. Cooke at the annual meeting of the Woolhope Club, at Hereford, October 2, 1879; see 'Gardeners' Chronicle,' 1879 (Oct. 25) p. 533.

there is no distinct stem.   The base is watery white, the upper half a bright reddish orange.

For some time Dr. Cooke was puzzled with this, which at first he regarded as a *Tremella*, or *Guepinia*, or it might be an ally of *Spathularia*; softened and examined under the Microscope no external trace of hymenium could be found, nothing but a tough cellular tissue of large and uniform cells, until cutting open one of the specimens, he found the inner walls softer, rugose, and so different in texture that at once, more out of curiosity as to the character of the cells, than hope to find the hymenium, he examined a portion of the inner wall, and found it to consist entirely of an effused hymenium of large, closely packed, cylindrical asci, each containing its eight elliptical sporidia, but without paraphyses.   In fact there is here an inflated fleshy sac, with the hymenium enclosed and covering the whole of the inner surface.   It is a *Spathularia* turned inside out, and is of far more importance than a mere new species or genus could be, presenting a most interesting subject for study, and adding yet another to the contrarieties of the antipodes.

With respect to the affinities of the new fungus, there is no doubt whatever that the hymenium is entirely enclosed, normally.   Perhaps *Sphærosoma* comes nearest to it, except that it has a thicker and firmer periderm, and is moreover hypogæous.   This affinity is sufficient to prove that it is not impossible for a plant of such a structure to be a Discomycete, and Tulasne considered *Sphærosoma* to be a Discomycete although evidently so very closely related to *Genea*.   Indeed, in Dr. Cooke's opinion *Sphærosoma* is further removed from the Discomycetes in the direction of the Tuberacei than *Berggrenia* from some species of *Peziza*.

There is a great similarity in the character of the fruit, and in the fleshy stroma, as to texture, &c., between *Cyttaria* and *Berggrenia*; in fact, the latter resembles the former, inverted, and the areolæ suppressed.   The hymenium is confined in some *Cyttariæ* to a few nearly closed cells, and although the relationship is by no means close in any direction, *Berggrenia* should be placed, it is suggested, in the Bulgariacei, nearest perhaps to *Cyttaria*.   The discovery hereafter of intermediate links may render the affinities clearer than at present they seem to be.

Microphytes in the Blood and their relation to Disease.* — Mr. T. R. Lewis contributes a paper of fifty pages on this important subject, giving a critical *résumé* of the work of former observers, as well as the results of his own investigations.

Mr. Lewis, first of all, goes over the evidence for the opinion that bacteria are the actual cause of the morbid symptoms in splenic fever, septicæmia, infectious pneumo-enteritis of the pig, and recurrent fever, the diseases in which there is the strongest evidence for a *contagium vivum*.   He then recounts some observations of his own as to the occurrence of bacteria in the blood of perfectly healthy animals, and gives his reasons for thinking that the presence of microphytes in the blood is a mere epi-phenomenon, having no

* 'Quart. Journ. Micr. Sci.,' xix. (1879) p. 356.

causal relation with the disease.   The chief reasons adduced may be summed up as follows :—

1. It is by no means proved that the various forms of *Bacillus*, *Spirillum*, &c., occurring in certain diseases are specifically distinct from forms having no relation whatever to any pathological conditions.

2. All the representatives of the Schizomycetes may be and have been introduced into the blood without causing any morbid symptoms.*

3. In the diseases supposed to be due to bacteria, the microphytes are "never to be detected in the earlier stages of the disease, but only at a brief period before and after a fatal termination."

4. "The poisonous properties of septinous blood and of other decomposing animal solutions gradually disappear toward the third or fourth day, a fact which is scarcely reconcilable with the doctrine that the poison resides in the almost imperishable 'spores' of the bacilli, which existed during the earlier stages of decomposition."

5. Septinous fluids retain their virulent properties after filtration through fine porous materials, the effect of the filtration being to free them from "visible molecules of every description."

6. "The coagulum produced by boiling a septinous fluid is more virulent than the fluid itself."   Eleven hours' boiling does not destroy the poisonous properties of such a fluid ; a watery extract of the residue of such a fluid evaporated to dryness has an intense toxic effect.

7. The poison (septine or sepsin) of some of these fluids may be made to combine with acids so as to form salts, which latter retain all the toxic properties of the original fluid. †

8. The living tissues, under the influence of a chemical irritant (iodine or ammonia), may secrete a virulent fluid, capable of communicating disease from animal to animal.

Mr. Lewis concludes " that the living tissue elements of the body itself play a much more important part in the elaboration of septinous and allied poisons, than what has of late been ordinarily ascribed to them."

Crenothrix polyspora, the Cause of the Unwholesomeness of the Berlin Water.‡—According to Dr. Zopf, this is a nostoc-like fungus, which has developed, from some unknown cause, in enormous quantities in the wells of Berlin.   The filaments are enclosed in a gelatinous envelope ; but the cells readily become isolated, and develop into new filaments.   There are also very minute gonidia produced by division of the cells of a filament ; these are also enclosed in gelatinous envelopes and develop into filaments, and, under certain circumstances, into palmella-like colonies of cells.   From the absence of chlorophyll, *Crenothrix* appears to occupy an intermediate position

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* With regard to these two points, cf. Koch, ' Wundinfectionskrankheiten,' *ante*, p. 754.

† The possibility that the non-living contagium indicated in §§ 5, 6, and 7 may itself be a result of organic action, should not be lost sight of.

‡ ' Entwickelungsgeschichtliche Untersuchung über *Crenothrix polyspora*,' von Dr. W. Zopf, Berlin, 1879 ; see ' Bot. Zeit.,' xxxvii. (1879) p. 546.

between the Oscillarieæ and the Bacteria. Rabenhorst's name, *Creno-thrix Kühniana*, would, however, appear to be justified by the laws of priority. Largely distributed through the water of wells and water-works, it occurs also in the soil. Both the filaments and the palmella-colonies are coloured ochre-yellow or brown by deposition of iron.

Fungi Parasitic on Fungi.*—A careful examination of a very large number of examples has convinced S. Schulzer that in many cases where forms of fungi have hitherto been believed to be different stages in the same cycle of development, they are really distinct species, the one parasitic on the other; and that very great care is required to determine which of these two is the case.

In some cases the parasite appears to exercise no injurious influence on the host; but far more frequently in time partially or completely destroys it, and then presents very much the appearance of springing from it as a succeeding stage of development. In the case of the larger Hymenomycetes, the parasite often prevents the formation of the spores, its own conidia then appearing to take their place. Thus *Artotrogus Ditmarii* causes sterility in the lamellæ of *Nyctalis asterophora*; *Lactarius deliciosus* shows no indication of the formation of lamellæ when attacked by *Hypomyces lateritius*; and *Agaricus cæsareus* is similarly affected by *Mycogone rosea.*

Poison of Marsh Fever.†—The physical cause or poison to which marsh or intermittent fever is due, was made the subject of special investigation during the spring of the present year by Signor Tommasi, professor of pathological anatomy at Rome, in conjunction with Professor Klebs, of Prague. According to an account laid by the former before the Academy of Rome,‡ the investigation was rewarded with complete success.

The two investigators spent several weeks during the spring season in the *Agro Romano*, which is notorious for the prevalence of this particular kind of fever. They examined minutely the lower strata of the atmosphere of the district in question, as well as its soil and stagnant waters; and in the two former they discovered a microscopic fungus, consisting of numerous movable shining spores of a longish oval shape, and ·9 micromill. in diameter. This fungus was artificially generated in various kinds of soil; and the fluid matter thus obtained was filtrated and repeatedly washed, and the residuum left after filtration was introduced under the skin of healthy dogs. The same thing was done with the firm microscopical particles obtained by washing large quantities of the surface soil. The animals experimented upon all had the fever with the regular typical course, showing free intervals, lasting various lengths of time up to sixty hours, and an increase in the temperature of the blood during the shivering fits up to nearly 42°, the normal temperature in healthy dogs being from 38° to 39° centigrade. The filtrated water only caused changes in the temperature of the body, even when five times the original quantity of water was administered, and the trifling fever

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* 'Oesterr. Bot. Zeitschr.,' xxix. (1879) pp. 112, 155.

† 'Times,' 1879, October 8.

‡ 'Transunt. Acad. Lincei,' iii. (1879), p. 216.

actually caused was not of an intermittent character. The animals artificially infected with intermittent fever showed precisely the same acute enlargement of the spleen as human patients who have caught the disease in the ordinary way, and in the spleens of these animals a large quantity of the characteristic form of fungus was present. The fungus was also found abundantly in other lymphatic vessels of the animals. As the fungus here grows into the shape of small rods, Tommasi and Klebs gave it the name of *Bacillus malariæ*.

The strictly scientific method pursued in this investigation does not admit of a doubt that the accomplished investigators have really discovered the cause of the disease in question. The discovery may be regarded as another of the series of which those in connection with inflammation of the spleen and diphtheritis were earlier examples. Against the intermittent fever poison, which is connected with this newly-discovered microscopic fungus, the medical art was formerly as powerless as it is still against diphtheritis and inflammations of the spleen. For intermittent fever, however, medicine was provided with a remedy when the virtues of quinine were made known, and it may be reasonably expected that, as in the latter case, so against the poison of the diphtheritic fungus and that of splenetic inflammation, medical science will sooner or later discover their appropriate antidote.

It is announced * that Drs. Marchiafava and Valenti have since detected the *Bacillus* in human patients in a more advanced stage than in the animals originally dissected.

Development of Bacteria.†—The following are the results of a series of experiments undertaken by A. Prazmowski in the botanical laboratory at Leipzig on the development of various bacteria, and especially on their alleged power of producing spores.

1. *Bacillus subtilis.* With regard to this species, the author fully confirms the observations of Brefeld with respect to the production and germination of the spores. But as regards the statement of Cohn and Van Tieghem, that it is the cause of butyric fermentation, he believes he has proved that this is certainly not the case.

2. The butyric ferment, Vibrion butyrique, *Amylobacter*, or *Bacillus Amylobacter*. The young rods are difficult to distinguish from those of *B. subtilis;* but in nutrient solutions they develop into longer and distinctly septated threads. The formation of the zoogloea-form is, however, very different. A single rod is always the origin of a zoogloea-colony; after coming to rest it divides into two derivative rods, which then separate and lie nearly side by side. After this has been repeated several times, a copious development of mucilage takes place. The author contests Van Tieghem's statement that this organism has the power of causing fermentation in cellulose and other carbo-hydrates, maintaining, on the contrary, that the substance produced is always butyric acid, as is proved by the smell as well as by chemical analysis.

3. *Vibrio Rugula.* This bacterium was found in cultures of the butyric ferment.

4. *Bacillus Ulna.* This species is readily distinguished from

other bacteria by its size, and by its peculiar somewhat heavy movement.

In a communication to the French Academy,[*] Van Tieghem disputes the accuracy of Prazmowski's observations as far as *Bacillus Amylobacter* is concerned, and repeats his previous results. The correctness of his conclusion he considered to be proved by the invariable disengagement of hydrogen.

Experimental Researches on a Leptothrix.[†]—M. Feltz presented, on the 9th of June, a "rectification" of his earlier communication,[‡] in which he details his correspondence on this subject with M. Pasteur, who was of opinion that the so-called new form was the *Bacterium* of anthrax-poisoning, and furnished him with a guinea-pig suffering from the disease, and with another poisoned with his own *Leptothrix*. The result of the examination of their blood was to convince M. Feltz of the correctness of M. Pasteur's view. M. Pasteur adds a short note, in which there is one point of especial importance in these days—" Je me suis abstenu généralement de donner des noms spécifiques à ceux de ces organismes que je pouvais croire nouveaux."

Antidote to Bacteria-poisoning in Frogs.[§]—Bacteræmia is, in the frog, always accompanied by an alteration in the characters of the blood-corpuscles, and this alteration has a proportional relation to the gravity of the condition of the poisoned frog ; a small subcutaneous dose of phenate of soda (e. g. about $\frac{4}{1000}$ milligramme for each gramme of the frog's weight) is found to be an efficient antidote.

Sugar-refining Gum, Leuconostoc mesenteroides.[||]—It has long been known to the manufacturers of beet-root sugar that a gelatinous gummy substance, of a firm and elastic consistency, composed of white lumps of moderate regularity intimately associated into a kind of parenchyma, makes its appearance on the sacks in which the cut beet-root is pressed, on the presses themselves, on the sieves through which the juice passes, and less often in the boiled syrup. This substance is known in France as *gomme de sucrerie*, in Germany as *Froschlaich* (frog's spawn). The part of this substance soluble in alcohol contains mannite, fatty acids, glycerophosphoric acid, and a nitrogenous principle, betain or oxynevrin. The insoluble part, much the most considerable, is almost exclusively composed of a substance with the composition $C_{12}H_{10}O_{10}$, endowed with a rotatory power to the right ($a_1 = 223°$), three times that of cane-sugar, and greater than that of dextrin or starch. It has been called by Scheibler *dextrane*. At first supposed to be a non-organized protoplasmic product of the cells of the beet, several observers subsequently determined its organic nature ; and it was seen to have considerable affinity with *Nostoc* on the one hand, and with Cohn's genus of bacteria *Ascococcus* on the other hand.

Van Tieghem has recently subjected this organism to a searching

* ' Comptes Rendus,' lxxix. (1879) p. 5.   † Ibid., lxxxviii. (1879) p. 1214.
‡ See *ante*, p. 454.   § ' Rev. Internat. Sci.,' iv. (1879) p. 88.
        || ' Ann. Sci. Nat. (Bot.),' vii. (1879) p. 180.

investigation, derived from experiments both on the beet and on the date and carrot. He considers it to have a close analogy with *Nostoc* in its mode of germination and development, its structure in the adult state, and its reproduction; but, differing in the absence of chlorophyll, he proposes for it the distinctive name of *Leuconostoc*, a new genus of bacteria, most nearly allied to *Ascococcus* and *Myconostoc* of Cohn. It would then occupy a position in the family of Schizophytæ, and in Cohn's tribe of Nematogenæ, in the same section as *Nostoc* and *Hormosiphon*, but constituting by itself the only member of the series destitute of chlorophyll, known as Phycochromaceæ. It develops with extraordinary rapidity in a suitable medium, but has not the character of a ferment. Its effects are extremely injurious to the industry.

Excrescences on the Root of the Alder.[*]—Tubercular excrescences on the root of the alder have long been a subject of investigation, and have been referred by some to malformation and hypertrophal growth, by others to the prick of an insect; while M. Woronine attributes them to the attacks of a parasitic fungus, to which he gave the name *Schinzia Alni*, and of which he believed he had detected both the mycelium and the spores.

M. Gravis, who has subjected these bodies to fresh examination, has been unable to confirm the observations of Woronine. He considers them to partake rather of the nature of a gall; the substances found in the cells he regards as amylaceous or albuminoid reserve-materials stored up for the purpose of nutrition. Even should the phenomenon be due to the attacks of a parasitic fungus, M. Gravis thinks its systematic position has yet to be determined.

Lichenes.

Vitricole Lichens and the Schwendenerian Hypothesis.[†]—Dr. Nylander has a note in 'Flora' upon Vitricole Lichens, from which the Rev. J. M. Crombie gives the following extract, which bears directly upon Schwendener's theory.

After observing that he had already [‡] stated that it was useless to study the germination of lichens from spores cultivated at home,[§] because in Nature itself not only the earliest stages of germination, but also the whole development of lichens, can readily be perceived on quartzose rocks or smooth bark of trees,[||] Dr. Nylander proceeds to notice that the same may still more easily be observed on glass which has been exposed for a long series of years in districts where lichens are of common occurrence. "There, on the very pure surface of the glass, we have under the Microscope before our eyes, numerous germinations and prothalline formations, and then gradually advancing the beginnings of the primary glomeruli of the thallus (as

* 'Bull. Soc. Roy. Bot. Belg.,' xviii. (1879) p. 50.
† 'Flora,' lxii. (1879) p. 303; see 'Grevillea,' viii. (1879) p. 30.
‡ 'Flora,' 1877, p. 356, and 1878, p. 247.
§ *Vide* also Crombie in 'Pop. Sci. Rev.,' 1874, pp. 267–8.
|| To this also may be added, on mortar of walls and houses, as in the suburbs of London.

are sufficiently well figured in 'Tul. Mem. Lich.,' t. 3, f. 3), and behold the whole process of evolution from the germinating spore to the perfect thallus, and at length to the formation of the perfect apothecium. All of these are seen to be formed of themselves, that is, by an innate power or impulsion of procreation, which is inherent in the spore, the only aiding materials being those lent by the atmosphere, especially rain-water. Upon the very pure glassy substratum where these vital phenomena go on, no trace of any *Protococcus* (or *Pleurococcus*), nor of any element of a heterogeneous thallus can be detected in the vicinity, although innumerable examples of such germinations have been examined in very favourable circumstances, especially in *Lecanora galactina* Ach., *Lecanora exigua* Ach., and *Lecidea alboatra* Hoffm., growing upon glass. The prothalline commencements of *Lecanora exigua* radiate dendritically around the spores, and are of a blackish colour, forming the hypothallus, in which minute, cellulose, thalline glomeruli are produced, presently exhibiting gonidia forming themselves in the cells (as in Tul. Mem., *l. c.*); often also we see apothecia produced even in a very young plant. The same is the case with the beginnings of *Lecanora galactina*; * but here the hypothallus is white, consisting of white, byssine, appressed filaments, laterally apposite and contiguous. All these hypothalli are very closely agglutinated to the glass; and there are no traces whatever of any *Protococci* in connection with them."

These observations of themselves (Mr. Crombie says) in connection with Vitricole Lichens (which, in this country, he has only observed on broken pieces of bottles on garden-wall tops, chiefly in Scotland) are amply sufficient to show how untenable is Schwendener's hypothesis, which, in the concluding words of Nylander's paper, is thus "reduced to the nothingness from which it ought never to have emerged."

Parasitism of Lichens on Mosses.†—H. Zukal, having observed the frequent occurrence of luxuriant lichen-growths in the midst of tufts of moss, has determined the cause to be a parasitism of the lichen on the moss.

The stem and leaves of *Plagiothecium sylvaticum* were penetrated in all directions by the hyphæ of the thallus of a *Pertusaria* and those of *Hypnum splendens* by a *Lepraria*. The stems of a plant of *Polytrichum commune*, up to the rosette of leaves, were found to be infested with minute patches of the thallus of a *Cladonia*. In one case the lichen had attached itself to the apex of the leaf of the *Polytrichum*, and completely penetrated the leaf with its rhizines. The gonidial layer of the lichen was in these cases normally developed.

Colorific Properties of Lichens.‡—The subject of the colouring matters contained in lichens—to which Dr. Lauder Lindsay directed attention in 1853–5—has recently reacquired, he says, considerable interest in connection with the introduction of colour-tests, as

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* This Mr. Crombie says he can entirely corroborate from his own observations on this species, as growing on mortar in the north suburbs of London.

† 'Oester. Bot. Zeitschr.,' xxix. (1879) p. 189.

‡ 'Grevillea,' viii. (1879) p. 25.

characters for species in lichens, and the development of *fast dyes* from lichens capable of competing with the coal-tar and other recent products of the chemist's laboratory.

During the last twenty-five years the principal changes in our knowledge of the chemistry of these colouring matters consist in (1) the addition of sundry (supposed or really) new substances, confusing to a still greater degree the previous confusion of *names;* and (2) certain proofs of the correctness of the opinion, that several, at least, of the bodies described by different chemists as differing trivially in constitution are referable to the same substance. A new series of conjoint researches by competent chemists and lichenologists are therefore required. Not only are *new* fields of research open, but the need of a *revision* of all previous analyses is even more evident. Chemists themselves are forced to make this admission, but the subject has not as yet proved a sufficient counter-attraction to the innumerable other interesting problems daily exposed for solution in organic chemistry. Meanwhile, the crude researches of lichenologists may serve to pave the way for the subsequent more scientific and precise analyses of chemists, by indicating the *directions* in which chemical inquiry is likely to prove useful or successful.

The foregoing along with other considerations have induced Dr. Lindsay to submit the results of another more systematic and complete series of experiments, supplementary to those presented in 1853–5. These results include a general inquiry into colour-development in the whole family of lichens, and the experiments are on the one hand a repetition, and on the other an extension, of the former series, and illustrate generally the *colour-reactions* of lichens.

A *solution* of the lichen colorific principles was used in hot water or alcohol, boiling the lichens, previously reduced to powder or minute fragments, as the majority, at least, of the colouring principles, while insoluble in cold and sparingly so in hot water, are readily soluble in cold or boiling *alcohol.* The reactions developed are thus the effects of reagents on the *alcoholic or aqueous decoctions of the lichen-thallus.*

Whilst the specimens experimented on were for the most part comparatively *old,* a parallel series of experiments was made on *fresh* lichens in their own places of growth with, on the whole, similar results.

Dr. Lindsay has prepared a voluminous series of elaborate tables of details of his experiments which is not however yet published.

Microgonidia.[*]—Dr. J. Müller, of Geneva, replies to the objections brought forward by de Bary, and reasserts the correctness of the discovery by Dr. Minks of the "microgonidia" of lichens; which he states have now been detected also by nearly all the Geneva botanists; by Dr. Tuckermann, of Amherst, and by Herr Stodder, of Dorten, without any chemical preparation, and by Tolles' immersion-systems $(\frac{1}{6}, \frac{1}{10}, \frac{1}{16},$ and $\frac{1}{25})$. For the observation of the "microgonidia," Dr. Müller recommends immersion objectives, with Abbe's condenser, and an illumination of white light only reflected from white clouds, &c.

[*] ' Flora,' lxii. (1879) p. 294.

Algæ.

Formation of the Siphons and Tetraspores in Polysiphonia.[*]— Professor Wright considers the frond of *Polysiphonia* as not, correctly speaking, articulated or jointed. As regards the development of the central tube, in the living state there is no central cavity in the frond; but there is a central cell many times longer than broad, putting one in mind of a prosenchymatous cell, with four or more rays proceeding from about its central portion, and its two poles somewhat drawn out. In the early disk-shaped condition of the frond a division takes place, apparently simultaneously, into a central cell, and four others surrounding it in the form of a cross, the central cell being the smallest. As development progresses, the central cell or tube grows only in length, or, at least, very little in breadth; while the four surrounding cells grow both in length, width, and depth, forming ultimately what are known as the "siphons." The evolution of the tetraspores is very much the same as in *Griffithsia*.

Fertilization of Red Algæ by the Agency of Infusoria.[†]—Professor Dodel-Port, of Zurich, has communicated to 'Kosmos' an account of some exceedingly interesting observations made by him on the fertilization of a Floridean alga, *Polysiphonia subulata* T. Ag., which appears from his researches to present a singular combination of analogies with the anemophilous and entomophilous phanerogamous plants. An abstract of Professor Dodel-Port's paper, with figures, appears in 'Nature.'[‡]

Like many other Florideæ, *Polysiphonia subulata* is diœcious, and the male and female plants appear often to grow at a considerable distance apart. The antherozoids, which are produced from antheridia presenting a considerable external resemblance to microscopic ears of maize, are described as mere globules of protoplasm, containing a small, highly refractive nodule and a few plasma granules, but entirely destitute of cell-wall, and of the cilia by means of which the antherozoids of so many algæ make their way through the water in search of the female organs which they are destined to fertilize. The antherozoid is thus precisely analogous to the pollen-grain of an anemophilous phanerogamous plant.

The female reproductive organ in this plant is a multicellular body forming an outgrowth from the apical parts of the branches of the thallus. The youngest of these carpogonia is found nearest the apex, those lower down being more mature. The structure of the carpogonium is described by Professor Dodel-Port in detail, but the most important point for our present purpose is the presence at its summit of two hair-like organs—a forked hair composed of several cells, and a trichogyne, a slender, colourless, unicellular hair, a little shorter than the forked hair, and produced from the surface of the carpogonium at a later period, making its appearance, in fact, about the time when the unfertilized carpogonium arrives at maturity. When full grown, it

* 'Trans. Irish Acad.,' xxvi. (1879) p. 47.
† 'Kosmos,' 1879; see 'Pop. Sci. Rev.,' iii. (1872) p. 421.
‡ 'Nature,' xx. (1879) p. 463.

is of a cylindrical form, abruptly rounded off at the extremity, and its narrow interior canal is filled with colourless, finely granular protoplasm. The trichogyne is most important, as it is the receptive organ, analogous to the elongated style which occurs in so many phanerogams. Fresh antherozoids of *Polysiphonia subulata*, on coming into contact with the upper part of the trichogyne, which seems to some extent to act as a stigma, immediately adhere to it firmly, when the granular contents of the antherozoid pass into the interior of the trichogyne, and a part of them descending the canal in the latter reach the carpogonium, of which they fertilize the central cell. This process, as will be seen, is very analogous to that which takes place in phanerogamous plants.

In the case of anemophilous or wind-fertilized diœcious plants, it is well known that the chance of fertilization is usually greatly increased by the enormous quantity of pollen which the male flowers yield to every passing breeze, and a similar provision is found to prevail in the case of diœcious *Polysiphonia*. It is perfectly clear that the antherozoids of this plant, being quite destitute of any locomotive organs, must be passive in their further proceedings, and they are no doubt carried along in all directions by the currents and other movements of the water until, on meeting with the trichogyne of the female plant, they adhere to it, and fulfil their duty. When the two sexes grow at no very great distance apart, Professor Dodel-Port seems to think that the small marine animals, crustacea, annelids, starfish, infusoria, &c., which swarm in the submarine forests of Florideæ, may aid importantly in effecting the transportation of the fertilizing element to the female organ; but in the course of his investigations he discovered that certain minute animals interfere in the process in a much more curious and interesting fashion, vividly reminding us, indeed, in the singular adaptation of means to ends, of the wonderful relations unquestionably existing between insects and flowering plants. On the growing thallus, and especially on the youngest branches, Prof. Dodel-Port constantly found an immense number of the well-known bell-animalcules (*Vorticella*), which were, as usual with them, in incessant motion. These little creatures were found to feed upon the antherozoids floating about in the water; but besides those which they manage to swallow, a considerable number are whirled about in the vortex caused by the cilia of the animalcule, which no doubt stops them in the course impressed upon them by larger submarine currents, and keeps them, as it were, hovering about the neighbourhood where their business lies. As the *Vorticellæ* are constantly changing their position by the contraction and extension of their little foot-stalks, the whirls set up by them in the water must become very complex, and the best proof that the action of these little vortices upon the antherozoids is beneficial to the plant, is to be found in the fact that it was through their agency that the author was enabled to observe the attachment of the antherozoids to the trichogyne. The presence of the *Vorticellæ*, in fact, imparts to the passive antherozoids a motion analogous to that with which the ciliated sperm-cells of other Algæ are endowed. In the case of the *Polysiphonia*, the beneficial action of

the whirls produced by the *Vorticellæ* is supposed to be increased by the presence in the immediate vicinity of the trichogyne of the forked hair above mentioned. This hair, it is believed, will divide the whirls, and thus produce subsidiary whirls, tending directly to bring the antherozoids into contact with the trichogyne.

In his conclusion, Prof. Dodel-Port makes the following remarks:—" The total absence of active organs of locomotion in the antherozoids of Florideæ points to a common ancestor from which the different branches of the Florideæ have inherited the immobility of the antherozoids. During the differentiation of the red seaweeds many forms have no doubt died out in consequence of fertilization not taking place through the passivity of the male cells, while other forms have retired to localities which favour the process of fertilization by the active currents of the water in spite of the immobility of the antherozoids. It is well known that we now find most of the existing species of Florideæ on the coasts of the warmer seas, which are constantly washed by the waves ; while the northern coasts, which are covered with crusts of ice during a great portion of the year, are very poor in red seaweeds. Future researches will have to show how far in many of these aquatic plants the differentiation of the genera took place in the direction of an adaptation to the small marine animals which inhabit them, and favour their fertilization in the way I have pointed out."

Cell-structure of Griffithsia setacea, and Development of its Antheridia and Tetraspores.[*]—Professor E. P. Wright has made a careful examination of this red alga, well known to all collectors of seaweeds. In regard to the process of formation of the antheridia and tetraspores, Dr. Wright observes, that at first they are hardly distinguishable ; very early, however, the mass of protoplasm completely isolates itself in the former case, while in the latter it remains attached by a little pedicel of protoplasm, which was found in every species of *Polysiphonia* in which he watched the development of the tetrasporic fruit. After the mass of protoplasm is well formed, it divides into four parts. Although the antherozoids of the Florideæ are ordinarily described as motionless, Dr. Wright observed in those of *Griffithsia* an obscure amœboid movement, quite sufficient to enable them to cling to or even enter a trichogyne. Various other interesting points in the structure of the cells and in the production of the sexual and non-sexual reproductive organs are described.

Reproduction of Cutleria.[†]—A careful examination of *Cutleria* at the zoological station at Naples, has led Falkenberg to confirm in the main Reinke's statements ‡ as to its mode of fertilization. This is not effected by a "diffusion-current," but by the actual coalescence of a single antherozoid—presenting in this respect a contrast to *Fucus*—with the "receptive spot" of the oosphere. The attractive force of the oosphere on the antherozoid appears to extend over a distance of

[*] 'Trans. Irish Acad.,' xxvii. (1879) p. 27.

[†] 'Mittheil. Zool. Station Neapel,' i. (1879) p. 420; see 'Bot. Zeit.,' xxxvii. (1879) p. 510.

[‡] This Journal, *ante*, p. 605.

several centimetres. The impregnated oospore germinates without any intermediate period of rest, and develops at once into a cellular filament ; this condition being described by Reinke as that of the " resting larva." In this state Reinke believed he had detected the production of " secondary spores," which, however, Falkenberg regards as a pathological product. This condition is only of short duration ; in six or eight weeks lateral branches are produced, differing altogether in appearance from the primary germ-plant, consisting of plates of tissue with marginal growth. At this stage the germ-plant perishes. The impregnated female zoospores (zygospores) do not, on germination, produce at once a *Cutleria*-thallus, but a second generation, consisting of flat creeping shoots, which develop as lateral branches from a primary " germ-foot," and which differ materially from the ordinary *Cutleria*-thallus, both in the direction of their growth, and in the position of the growing point.

The author considers the phenomena here described as a connecting link between the conjugation of similar zoospores (zoogametes), and the impregnation of a passive oosphere by mobile antheroids.

Conjugation of Ectocarpus.[*]—It is now some time since Thuret discovered, contrary to his first assertions in 1850, that *Ectocarpus* possesses unilocular sporangia (oosporangia), as well as multilocular sporangia (trichosporangia). The same authority is said to have proved later on that the zoospores issuing from either of these forms of sporangia germinate without any previous reciprocal contact. Janczewski and Rostafinski have obtained the same result ; they say that no conjugation takes place, neither at the moment of the emission of the zoospores, nor during their germination.[†] Since that, however, Reinke has proved sexuality in the Ectocarpaceæ, and in *Zanardinia* and *Cutleria*. Areschoug had already previously observed the conjugation of *Dictyosiphon*, but by a method which gave room for some criticism. In *Acetabularia*, Strasburger has observed that the zoospores only conjugate when they issue from different sporangia. Goebel has proved analogous phenomena in *Ectocarpus pusillus*, which is frequently found in the Bay of Naples on the great algæ, particularly on *Codium tomentosum*. He has seen the zoospores of this species conjugate only when two neighbouring sporangia were open at the same time. The same is the case with *Ulothrix*, according to Dodel. There is, therefore, among the inferior cryptogams, a tendency to cross fecundation.

American Œdogoniaceæ.[‡]—Professor Wittrock, the chief authority on the Œdogoniaceæ, has monographed the American species, including twenty-three of *Œdogonium* and eight of *Bulbochæte*, seven species being altogether new. The family, as a whole, differs but little from its European aspect, all the American forms belonging to types which are also represented in Europe. Those of Greenland and other northernmost parts of America are identical with those of northern Europe ; while those from the southern districts differ

* 'Bot. Zeit.,' xxxvii. (1878) pp. 117, 193.
† 'Soc. des Sci. Nat. de Cherbourg,' 1873 ; Ibid., 1875, p. 9.
‡ 'Botaniska Notiser,' Nov. 5, 1878 ; see ' Bot. Zeit.,' xxxvii. (1879) p. 312.

specifically from those of the south of Europe.   The genus *Bulbochæte*, in America as in Europe, has most representatives in the northern and north temperate zone.

New Genus of Chroolepideæ.*—Dr. Reinsch has detected a new genus of algæ, to which he gives the name *Acroblaste*, and which he refers to the family of Chroolepideæ, attached to small mussels belonging to the genus Turritella, and to small stones, on the coast of Buzzard's Bay, west of Cape Cod, North America.

The individual plants are microscopic, and form small green tufts, resembling at first sight an *Ectocarpus*, the larger plants being copiously branched.   The characteristic reproductive organs, agreeing in their origin and the development of their cell-contents with the conceptacles of *Chroolepus*, are always formed at the apex of the filaments, the zoospores being produced in them.   The mode of growth of the filaments resembles that of *Cladophora*.   While at present placed among the Chroolepideæ, the author thinks it possible that the discovery of sexual reproductive organs may hereafter show *Acroblaste* to form a connecting link between this family and the Phæosporeæ.

Fossil Algæ belonging to the Verticillate Siphoneæ.†—Munier-Chalmas includes under this section of calcareous algæ all the Chlorosporeæ comprised by Harvey in the family Dasycladeæ, and all those fossil genera related to *Larvaria*, *Clypeina*, *Polytrypa*, *Acicularia*, *Dactylopora*, and *Uteria*, many of which have hitherto been mistaken for foraminifera.   The group includes more than fifty genera, mostly found in the Triassic, Jurassic, Chalk, and Tertiary formations.   It is at present represented only by seven living genera, viz. *Dasycladus*, *Halicoryne*, *Cymopolia* (including *Polytrypa* and *Descaisnella*), *Polyphysa*, *Acetabularia*, *Neomeris*, and *Bornetella*; the last a new genus founded on Harvey's *Neomeris nitida*, distinguished by the origin of the sporangia at the side of the radiate threads, instead of at the apex in the centre of the terminal pileus.

The frond of the verticillate Siphoneæ is simple or dichotomous, formed of a tubular axis, from which spring successive whorls of radiating branches.   In many species the axis as well as the rays have their wall encrusted with calcium carbonate, so that the plant is enclosed in a calcareous envelope, which reproduces with exactitude the details of its organization.   This inorganic envelope consists of one or two calcareous cylinders.   The inner one is formed of the axis and the first member of the verticillate rows of cells which spring from it.   The outer cylinder is composed of the outermost cells of the branches which end in an enlarged swelling, the lateral margins coalescing with those of the neighbouring ones.   The fructification may also be encrusted with lime, and contribute to the formation of the outer cylinder, as may be seen in the genus *Cymopolia*.   The fructification sometimes consists of single receptacles or sporangia, as in *Cymopolia* and *Neomeris*, sometimes of a number of smooth shining hollows in which sporangia or spores are formed, as in *Acicularia*, *Maupasia*, *Dac-*

* 'Bot. Zeit.,' xxxvii. (1879) p. 361.
† 'Comptes Rendus,' Oct. 29, 1877; see 'Bot. Zeit.,' xxxvii. (1879) p. 165.

tylopora, &c.   In the fossil forms a calcareous skeleton remains, very liable to be confounded with that of foraminifera, in which are hollow chambers and canals, where the fructification and the rays have been, and by means of which they may be determined with great ease.

The author thus classifies the genera belonging to the group. Those marked thus * are fossil genera ; those marked * * are known in both the fossil and living state :—

I. Cymopolidæ	1. Dasycladus. 2. Halicoryne. 3. Clypeina.* 4. Cymopolia.** 5. Parkerella.* 6. Hermitella.*	A. Decaisnella.** B. Larvaria.* C. Vaginopora.* D. Karreria.* E. Polytrypa.**
II. Acetabularidæ	7. Polyphysa. 8. Acetabularia. 9. Acicularia.* 10. Briardina.* 11. Orioporella.*	
III. Thyrsoporellidæ	12. Thyrsoporella.* 13. Gumbelina.*	
IV. Dactyloporidæ	14. Dactylopora.*	
V. Neomeridæ	15. Neomeris. 16. Bornetella.* 17. Terquemella.* 18. Maupasina.* 19. Zittelina.*	
VI. Uteridæ	20. Uteria.*	
VII. Hagenmulleridæ	21. Hagenmulleria.* 22. Carpenterella.*	

Influence of Light on the Movements of Desmids.*—According to Stahl, when *Closterium* is placed in a vessel which the light reaches only from one side, the cells attach themselves to the glass in such a position that the longer axis of the cell coincides with the direction of the incident light.   If the direction of the light is altered, the position of the cell varies correspondingly with more or less rapidity. There appears, therefore, to be a certain difference between the two halves of the cells in respect to their behaviour towards light, one extremity seeking and the other avoiding it.   It is remarkable that in this respect the properties of the two halves seem to alternate from time to time, causing a change in the direction of the longer axis to the extent of 180°.   Intense light appears to have a very different effect on desmids to that of diffused light, the cells then placing themselves in a position in which the longer axis is at right angles to the direction of the incident light.

New Diatom.†—A new genus and species of diatom from the Santa Monica deposit is described by Mr. Stodder; the following are given as the generic and specific characters :—

" *Discus* (a plate), n. g.   It is a simple disk, translucent like

* ' Verh. Phys.-med. Gesellsch. Würzburg,' xiv. No. 7 ; see ' Hedwigia,' xviii. 1879, p. 100.
† ' Am. Journ. Micr.,' iv. (1879) No. 3.

porcelain, with no dots, puncta, or striæ, or other marks common to diatoms.

"*D. porcellaneus*, n. s.   Characters that of the genus, with a ridge submarginal, giving it the look of a dinner-plate ; other examples have a curved ridge in some (not constant) part of the disk."

Adulteration of Currant Jelly with Diatoms. * — Professor Ch. Menier, of Nantes, in examining with the Microscope some so-called currant "preserves," recognized that the gelatinous consistency was due to diatoms, as was evidenced by the presence of a very fine *Arachnoidiscus japonicus*.

Professor Menier then procured some of the substance (used for various industrial purposes) known as Chinese or Japanese glue, and discovered the same diatom.   This is not found in France, and he was thus able to establish the actual composition of the " preserve."   The colour he found to be due to cochineal and hollyhock, as was shown by the presence of large pollen-grains of the Malvaceæ. The preserve would not, of course, keep long, being quickly invaded by cryptogamic productions.

Professor Menier points out that the Japanese glue is "a very easy and valuable substance for diatomists to explore, and in which discoveries will probably be made."   According to him it is manufactured out of the Algæ of the Japanese coasts that are capable of being transformed into jelly—at any rate, the débris of a number of very different Algæ are found.   M. Bornet considers them capable of being identified.

Palmelline, the Colouring-matter of Palmella cruenta. † —M. Phipson has subjected to careful examination the colouring matter of this minute alga, often found as a red stain at the bottom of walls, &c., especially in winter.   Under the Microscope, it is seen to consist of minute globules, about 4μ in diameter, closely resembling globules of blood, which have a diameter of 5 to 6 μ.   They float freely in a mucous fluid not unlike the serum of blood.

The colouring matter of these globules, to which the author gives the name *palmelline*, presents a remarkable resemblance to the hæmoglobin of blood.   It is insoluble in alcohol, ether, benzin, bisulphide of carbon, &c., but dissolves in water ; it is dichroïc, composed of a red substance combined with an albuminous substance, and coagulates with alcohol, heat, and acetic acid.   Its spectrum shows one or two absorption-bands in the yellow, or between the yellow and green. Like hæmoglobin, it contains iron, the residue on evaporation presenting distinct indications of lime, chlorine, and iron.   Various other interesting properties of this substance are described by the author in his original paper.

Mycoidea parasitica, a new Parasitic Alga. ‡ —Dr. Cunningham describes under this name a new genus of parasitic Algæ, very destructive to the leaves of camellia, rhododendron, and other plants in India.

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* ' Bull. Soc. Bot. France,' xxvi. (1879) Rev. Bibl., p. 66.
† ' Comptes Rendus,' lxxxix. (1879) p. 316.
‡ 'Trans. Linn. Soc. (Bot.),' li. (1879) p. 301.

The parasite makes its appearance in the form of greenish or bright orange patches on the upper surface of the leaf. On detaching one of these pustules from the leaf, and examining it under high powers, it is found to consist of a flattened, subepidermal disk of radiating filaments, from which numerous ascending twigs arise, and these, breaking through the epidermis, develop into the fructifying filaments. The disk consists of a single layer of dichotomous filaments, and increases continually at the margin. The terminal cell of a fructifying filament eventually swells up into an oval, spore-like body; in this is ultimately formed a roundish orifice, from which escape a number of reddish orange (by transmitted light) biciliated zoospores. The sexual reproduction is effected by the fecundation of oogonia by pollinodia. The resulting oospores retain their vitality for a considerable time. Ultimately the contents break up into a number of biciliated zoospores, precisely resembling those produced non-sexually. They rupture the thin wall of the oospore, and swim freely in the subepidermal space and over the surface of the leaf.

With regard to the systematic position of *Mycoidea*, Dr. Cunningham considers that, notwithstanding the difference in the mode of reproduction, its vegetative structure indicates a near affinity with *Coleochœte.* An interesting circumstance connected with this alga is that a number of the primary disks do not give rise to fructifying filaments, but are utilized by fungal filaments, and, in connection with them, contribute to the development of patches of a heteromerous lichen.

Two new Parasitic Algæ.[*]—An addition is made to the small number of known parasitic Algæ in the description by J. Reinke of two species.

The first, a species of *Anabœna*, was discovered by him several years ago in the roots of Cycadeæ, where it forms bright green streaks visible to the naked eye. It develops in the intercellular spaces, but has no obvious injurious effect on the host. Microscopic examination shows it to consist of strings of globular cells embedded in jelly, presenting a close resemblance to *Nostoc.* It has been observed in the roots of *Ceratozamia, Cycas, Dioön,* and *Encephelartos.*

The second species, to which he gives the name *Entocladia viridis,* is parasitic on the long unicellular filaments of *Derbesia Lamourouxii,* growing, however, not within the cell, but in the cell-wall. It is a branched, multicellular, filamentous alga, nearly allied to *Stigeoclonium* and *Chlorotylium.* Although no reproduction of the alga has been observed, this no doubt takes place by means of zoospores.

Method of Cultivating Volvox globator.[†]—This Alga is, according to the experience of many, a most difficult one to keep for any length of time, but Mr. N. E. Brown, of Kew, announces that he has discovered the way to do so.

For several years his practice was to place the *Volvox* in large glass or earthenware jars, small bottles, open dishes, and other vessels, exposed to full sun, or kept in partial or entire shade,

supplying it with rain, pond, and spring water, in turn, but always with the result that after a short time it disappeared. In October, 1878, however, he put a small quantity, probably not more than one hundred individuals, in a four-ounce bottle, having a mouth three-quarters of an inch in diameter, and set this on a shelf at the side of an outhouse, which had no gutter, so that the rain in running off the roof would drip into the bottle ; here it has remained until November 1879, and instead of the few original specimens, they are now abundant. The water has never been changed or replenished, only that which dripped naturally from the roof into the bottle having been added to the original stock, and during the abundant rains of this year the bottle often overflowed. Several times a portion of the water containing the *Volvox* has been placed in the jars and dishes standing in various parts of the garden, but these always died in a short time, whilst those left in the small bottle, treated as above, remained in perfect health and multiplied. The position in which the bottle was placed faced the north, so that it only got the sun in the early morning of the summer months. During the severe weather of last winter, the water was several times frozen into a solid mass of ice, but apparently without injuring the *Volvox*.

MICROSCOPY, &c.

Soap as an Embedding Substance.[*]—Some of the chief objections to the methods of embedding in oleaginous or waxy mixtures seem to be successfully met by the use of the preparation recommended by Dr. Kadyi, and its capability of modification according to the different substances to be embedded is strongly in its favour.

The best materials and proportions are as follows :—28 grammes of shavings of stearate of soda soap (that sold as " weisse Wachskernseife " abroad is best), 100 g cub. cent. of 96 per cent. alcohol, and, generally, 5 to 10 cub. cent. distilled water. The two first ingredients are warmed together on the water bath and to the liquid mass the water is added gradually, until it coagulates quickly into a transparent mass when dropped into a watch-glass. The mixture should be kept in a stoppered bottle.

For use, it is melted or boiled and the object at once plunged in. When cool, sections of it are taken with a razor wetted with strong alcohol, this liquid being also used, warm or cold, to dissolve out the soap from the sections.

Thus used, the material is adapted best to delicate objects ; it possesses transparency and elasticity, and penetrates pores and cavities effectually.

A tougher preparation, suited to harder, such as chitinous, tissues, is obtained by increasing the proportion of soap to an almost equal amount by weight with that of the alcohol.

Logwood Staining Solution.[†]—Dr. E. A. Cook points out that in most text-books this is stated to be good in results but uncertain in action ; and from the numbers of formulæ given for its preparation,

* 'Zool. Anzeiger,' ii. (1879) p. 476.
† 'Journ. Anat. and Phys.' (Humphry), xiv. (1879) p. 140.

it is evident that many experimenters have failed to hit upon a combination satisfactory in all points. The chemical nature of the colouring material of logwood is fairly stable, and affords no reason for any uncertainty, and it appeared desirable therefore to determine under what conditions the solution would yield the best results.

The colouring material consists of two substances—hæmatoxylin and hæmatein, differing by two equivalents of hydrogen. Hæmatoxylin (containing the larger amount of hydrogen) is soluble in alum solution, while hæmatein is slightly, if at all so. The latter is of no use for colouring animal tissues. Hæmatoxylin forms compounds with various metallic oxides which are soluble in alum solution also; and if a tissue be stained with hæmatoxylin, or with hæmatoxylin and a metallic oxide, and immersed in an aqueous solution of alum, the colour will be all discharged from the tissue and taken up by the solution; and the solution will thus take up fresh quantities of hæmatoxylin compound until it reaches a point of saturation beyond which it will take no more from tissues, but will, if over-saturated with it, give up the colouring matter freely to immersed animal material. Such a solution of hæmatoxylin, alum, and metallic oxide has a clear purple colour, becoming red on addition of acids. If alkaline earths, alumina, or hydrated earthy phosphates be suspended in it, they will absorb the colour, and the solution becomes purple. If the solution be treated with a very small percentage of a chromate, the purple will gradually be replaced by a yellowish-brown colour; or if a tissue which has been stained with alum-logwood solution be immersed in an exceedingly dilute bichromate solution, the purple will sooner or later be replaced by the yellow tint. If a section of any abnormal caseous concretion or abnormal growth be immersed in a neutral solution of alum-logwood, it will become of a more bluish purple than ordinary tissue, evidently from the presence in it of more than an ordinary amount of alkaline earthy matter or phosphate.

When the above facts are taken into consideration, it will appear unreasonable to expect tissues hardened in chromic solutions of any kind to colour as readily with an ordinary logwood solution as they would do if immersed in the fresh state. Sections of chromic-hardened tissues are exceptionally difficult to free from chromic compounds most probably because part of the chromic acid is in chemical combination and insoluble, and when freed from the hardening material the tissues will not be left in the natural neutral state, and thus less readily will the nuclei take up the colour. But it has been found that hardened tissues if cut into sections and well washed, may be as readily stained with logwood as fresh tissues if the solution be slightly modified.

It has been found that the cheapest and most practical logwood solution may be made as follows:—Take logwood extract, 6 parts; alum, 6 parts; sulphate of copper, 1 part; water, 40 parts. All ingredients must be free from iron. Grind the alum, logwood extract, and sulphate of copper in a mortar, and when powdered add sufficient water to form a thin paste; leave for one or two days with occasional stirring and then filter. The hæmatein contained in the

logwood extract will be retained by the filter with the dirt, and the solution consists of hæmatoxylin, alum, and sulphate of copper, to which a crystal of thymol may be added to preserve it from mould. Fresh or alcohol-hardened tissues may be stained with this after sufficient dilution; but for chromic-hardened tissues, dilute 8 drops with 120 drops of water, and add one drop of $\frac{1}{10}$ per cent. solution of bichromate of potash just prior to use. Wash the stained solutions in water as usual. A larger proportion of bichromate solution will produce an ugly yellow; and if the mixed solution be kept many hours, some decomposition will go on.

Tissues stained in logwood may be mounted in glycerine or Farrant's solution or in dammar. In the two former they keep unchanged for any length of time; in the latter they are apt to fade unless care be taken, in preparing them for dammar, that the sections be thoroughly freed from water by absolute alcohol before being brought into contact with oil of cloves. If any moisture be left, fading will soon commence, and the preparation be spoiled.

Modification of Farrant's Medium.*—Professor P. Langerhans finds the following a very satisfactory modification of Farrant's medium for microscopical preparations of small animals:—Gummi arab., 5; aquæ, 5—to which after twelve hours add, glycerini, 5; sol. aquosa acid. carbol. (5 p. c.), 10.

With living marine animals it is only necessary to use enough to go under the cover-glass, and to add a little on the following day to make up for evaporation, and the preparation is then ready. The shrinking is very slight, and even many colours are preserved.

Staining Fluids for Vegetable Tissues.†—Mr. A. H. Barrett recommends the following as a simple and successful method of staining one section with two fluids.

The section is first immersed in an aqueous (1 per cent.) solution of Crawshaw's aniline blue dye. It is then removed into strong acetic acid, which seems to fix the colour in certain tissues, remove it from others, and prepare that not stained for the reception of another colouring fluid. It is then again removed into a weak solution of magenta (Judson's dye), also made strong with acetic acid; then mounted in glycerine jelly. The process effectually shows the "differentiation" of parts, both by the different colours and the varying intensity of colour.

The following are the colours with which the tissues of a section of Burdock are stained:—

Pith	Very pale magenta.
Cellular tissue	Deep magenta.
Spiral vessels of medullary sheath	Deep blue.
Pitted vessels	Blue.
Cambium	Deep blue.
Liber cells	Dark magenta.
Laticiferous vessels	Deep blue.
Cuticle parenchyma	Pale blue.
Epidermis	Deep blue.
Hairs	Pale magenta.

* 'Zool. Anzeig.,' ii. (1879) p. 575.
† 'Science-Gossip,' 1879, p. 255.

Chloride of Cadmium as a Fluid for Homogeneous Immersion.*
—Colonel Woodward expresses his approval of one of the new immersion fluids proposed this year by Professor Abbe,† viz. the chloride of cadmium dissolved in glycerine, and sends photographs of *Amphipleura pellucida* taken with the Zeiss $\frac{1}{12}$ and Tolles' amplifier, both with cedar oil and with the cadmium solution. The last picture, as he points out, resembles that taken on the same day with the cedar oil almost as closely as if the two were prints from the same negative. The cadmium solution is not only convenient for use with objectives of considerable focal length (as the $\frac{1}{8}$ of Zeiss, for example), but is especially desirable for photography, as it cannot attack the balsam cement of the front lens of the objective. This he finds the oil of cedar may do. Slowly as it attacks solid balsam when cold, it appears to act more energetically when the temperature is somewhat raised, as happens during micro-photography. In the case of the Zeiss $\frac{1}{8}$ belonging to the Army Medical Museum, the oil of cedar has already in this way penetrated to the space behind the front lens of the objective, which he has in consequence been obliged to return to the maker for repairs. The substitution of the new fluid appears therefore to have advantages for photographic purposes which are well worthy of consideration.

Scientific Value of Microscopic Preparations.‡—Dr. Pelletan, of Paris, complains of the small scientific value of the majority of microscopic objects prepared for sale, though they are often very beautiful in appearance ; the preparations of diatoms being alone, for the most part, satisfactory, often excellent, and sometimes marvellous. Certain preparations of cryptogamic botany are also, he considers, of value, and dissections, &c., of vegetable anatomy, thin cuttings of dense substances, animal, vegetable, and mineral, and particularly sections of wood, but of all other classes it is only by chance one meets with an interesting slide.

Many of the ordinary preparations, however, if not satisfactory to *savants*, interest *amateurs*, and they teach many things that otherwise would not have been known. "They are also useful in England, where they are sold in large numbers, because in that country the Microscope is more used for amusement and as an object of luxury than for working purposes. These slides, that for us have little interest, are therefore in this point of view of real utility. They give to ordinary people the taste for natural objects, and they furnish a thousand little instructions acquired without labour, and are also amusing. We must not, therefore, too much despise them.

"Histological preparations, whether normal or pathological, are those of least value. Preparers, with very few exceptions, have not sufficient knowledge of histology or of the necessary technical methods, or even the will to adopt them, because they are tedious and delicate, and, moreover, it is feared that the increased cost of the preparations would frighten those who might wish to acquire them. There is no foundation for this last reason, judging from the daily demands for

preparations made on these principles, even at an increased cost, when they are really instructive, and it cannot be doubted when we see the most common specimens of *Pediculus pubis* sold in America for 5 fr. 75 c., in which country it is not rarer than it is in France."

Counting of Blood-corpuscles.[*] — Professor Abbe has recently published a paper on this subject, in which he refers in the first place to an apparatus, the plan of which was suggested by Mr. R. Thoma, of Heidelberg. It presents no special novelty in design, its value consisting rather in the appropriate adaptation of the best means known, and the careful technical construction by which the faults of the measuring apparatus are kept within narrow limits, so that they may be neglected in practice.

The leading features are—(1) the method of mixing the blood so as to dilute it in a simple known proportion, and (2) the special apparatus for counting which enables the microscopist to take a determinate volume of the diluted blood fluid. For the first Malassez's mixer is used, modified so as to facilitate the purifying and to keep the consistency constant. The capillary tube holds about 6 mgr. of blood; its volume, which is taken as unity, is made the one-hundredth part of the volume of the mixing bulb (exact to about 0·5 per cent.). The correct length of the capillary is determined from data as to the capacity of the tube and mixing bulb, obtained by weighing, water being used for the latter instead of quicksilver, as on account of the glass ball used for mixing, a non-adhering fluid would not properly fill out the space.

For counting, an adaptation is made of Hayem's chamber, which consists of a slide to which a thin glass plate with a circular hole is firmly cemented and ground down parallel to the surface of the slide, so that a superposed flat plate would enclose a stratum exactly 0·1 mm. deep. For cutting off a definite volume of this stratum, instead of a micrometer in the eye-piece of the Microscope, Gower's method is adopted, and divisions are cut on the bottom of the chamber, so that a square millimetre is divided into small squares, the sides of which are 0·05 mm., and the area $\frac{1}{400}$ square mm. As the blood-corpuscles in the artificial serum of Malassez sink to the bottom in a few moments, the contents of a thousandth of a cubic millimetre in the field of the Microscope may be readily counted, being the contents of any four of the divisions. When normal blood is diluted in the proportion of 1 : 100, about fifty blood-corpuscles are found in this space, and the number being multiplied by 100, gives the contents of the thinned blood per thousandth cubic millimetre, which furnishes figures convenient for comparison.

The divisions on the bottom of the counting apparatus are a great advantage over the eye-piece micrometer, as they avoid the necessity of ascertaining the value of the divisions of the latter, which of course varies with the objective and length of the tube; a fruitful source of errors is avoided, and complete freedom is obtained in the choice of objectives and magnifying power.

[*] 'SB. Jen. Gesell. Med. und Nat.' (1878).

The apparatus is so delicately constructed that, if carefully manipulated, the errors in measuring will never exceed about 1 per cent.

The mathematical theory by which the probable extent of the error of counting is determined may be briefly summarized as follows. If n denote the average number of blood-corpuscles to a given space, the relative frequency of other numbers is expressed by the respective terms of the expansion of e^n (where e denotes the base of natural logarithms) divided by the complete value of e^n. Thus, the probability that k corpuscles will appear instead of n is,

$$W_k = e^{-n} \frac{n^k}{1.2.3 \ldots k}.$$

Making $k = n + \Delta$, where Δ expresses the deviation, positive or negative, from the average number, the above expression becomes approximately

$$W_\Delta = \frac{1}{\sqrt{\pi}} \frac{1}{\sqrt{2n}} e^{-\frac{\Delta^2}{2n}}.$$

Consequently, the "probable error," that is, the error which in repeated observations would be as often exceeded as not reached, may be expressed as a function of n, or, calling this error w,

$$w = 0 \cdot 4769 \sqrt{2n}.$$

If the ratio of this probable deviation to the average number be denoted by ω we get

$$\omega = \frac{0 \cdot 674}{\sqrt{n}}.$$

In a large number of observations, if ω denote the probable error, then, according to the laws of probability,

An error less than		$\frac{1}{4}$ ω occurs once in every			7 cases.
,,	,,	$\frac{1}{2}$,,	,,	,,	4 ,,
,,	,,	1 ,,	,,	,,	2 ,,
,,	greater than	1 ,,	,,	,,	2 ,,
,,	,,	2 ,,	,,	,,	5–6 ,,
,,	,,	3 ,,	,,	,,	23 ,,
,,	,,	4 ,,	,,	,,	160 ,,
,,	,,	5 ,,	,,	,,	1,385 ,,
,,	,,	6 ,,	,,	,,	20,000 ,,

and hence may be directly deduced what reliance is to be placed on the result of a single observation, that is, what approximation to the correct average value may be safely expected when the value of ω has been computed from the above formula, suited to the conditions of the particular observation.

The above formula for ω shows that the probable error expressed as a percentage of the average number decreases in the same proportion as the square root of the average number increases. Thus, the value of ω is reduced to about 5 per cent. if n is made to equal 200, that is, when the counting extends over a volume of four thousandths of a cubic mm. or to sixteen fields of the micrometer, and

the result of this would be that an error of 10 per cent. would have the probability of one-fifth. ω would fall to 2 per cent. if the counting were extended to 1250 or 100 squares, and the probability of an error of 4 per cent. would be one-fifth. An error of 6 per cent. would have the small probability of only one-twenty-third, and an error of 10 per cent. might be expected to occur once in 1400 cases, which is as good as being excluded altogether.

Moreover, the limitation of the probable error to 1 per cent. would be ensured by extending the number counted to a total of about 5000, which, under the conditions here assumed, would correspond to the contents of the whole square millimetre. In this case, therefore, the mean value may safely be assumed as true to within 2 to 3 per cent., because an error of 4 per cent. would occur once only in 160 cases.

This method of judging of the exactness of the results is capable of being applied to various other scientific investigations of the same kind.

Cheilo-angioscopy.[*]—This name is applied by Dr. C. Hueter to his new process for the direct observation of the circulation in the human subject.

The apparatus consists of a frame, something like that used by photographers, for supporting the head of the person under observation, and having attached to it a stand on which a microscope and lamp are supported. The patient's lower lip is drawn out, and fixed with clips on the stage of the microscope: a strong light is then concentrated on its inner surface by means of a condenser, and it is examined by an objective of low power, the superficial vessels which can be seen even with the naked eye being brought into focus.

The vessels look, at first, as if filled with an opaque red injection; but with a little practice and careful focussing, the observer is soon able to make out the movement of the blood stream, and even to distinguish the red and the colourless corpuscles. The epithelial cells of the mucous membrane, and the apertures of the mucous glands, may also be seen.

By the application of slight pressure to the lip, the phenomena of venous stasis may be studied: it is also easy to observe the effect of cold, by touching the lip with ice, or that of innocuous reagents, such as glycerine or ammonia. The various pathological conditions of the circulation, characteristic of certain diseases, are also easily studied with complete accuracy.

Hueter remarks that the pathological observations he has already made by means of cheilo-angioscopy, prove conclusively the importance of the new process: a good deal of practice is, however, necessary, before it can become clinically useful.

Value of the Microscope in Law and Medicine.—Dr. R. H. Ward, of Troy, N.Y., in his able presidential address [†] at the opening meeting of the American Society of Microscopists, held at Buffalo in August last, deals at some length with the legal uses of the Micro-

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[*] 'Cblt. med. Wiss.,' Nos. 13 and 14 (1879).
[†] 'Buffalo Daily Courier,' Aug. 20, 1879.

scope, " a department so large that it might almost be regarded as a new science, under the title of ' Microscopical Jurisprudence.' " The determination of hand-writing is more particularly referred to.

The ' Bulletin Scientifique du Département du Nord ' also contains an article on the use of the Microscope in medicine, especially pathological histology.*

It is not possible usefully to give an abstract of either paper.

Unit of Micrometry.—In his address mentioned above, Dr. Ward says with regard to the resolutions of the Indianapolis Congress of 1878, that "as too often happens, their incidental faults attracted more attention than their really scientific object. The unit proposed ($\frac{1}{100}$ mm.) was evidently too large for integers, and too short for fractions, and unlikely to receive a single approval either at home or abroad; and the proposal of international action, though its object was universally approved, was in a form not likely to accomplish that object."

The new committee appointed by the various Societies (see p. 154) has not yet made its report

Comparators for Measures of Length.†—Professor W. A. Rogers has devised a comparator of the design shown in Fig. 1 to remedy the defects found to exist in the eye-piece and filar micrometer as well as in the Merz stage micrometer (A a).

The comparator proper consists of a bed-plate, within which is fitted a slide carried by the precision screw b. The object to be measured is held in position upon the moving plate by the clips shown in the figure. Instead of two parallel springs there is a single cord attached to the centre of the moving slide which runs on the guide pulley d, and is attached to a spring which is fastened to a pin on the back side of the bed a little to the right of and below b. The action of the spring, therefore, is wholly in the line of the screw, and as the direction of the cord falls a little below the motion of the slide, it has a slight tendency to keep the slide in contact with its seat without introducing friction. The screw e moves the whole bed-plate, including the precision screw b. The whole comparator has a circular movement in the socket f attached to the original substage e of the Microscope. The filar micrometer is shown at h, and an eye-piece with a micrometer, having some advantages over the usual form, is shown at i. Slow motion to the tube is given through the lever g.

The operation of using the comparator is as follows :—

After the slide containing the graduations to be compared has been placed in proper position under the objective, with the right hand, the screw-head b is set at the zero of position; with the left hand, line 1 is brought in contact with a single line of the eye-piece micrometer; with screw-head b, line 2 is brought in contact with the fixed line of the eye-piece micrometer, and the number of revolutions and parts of a revolution are read off. Screw b is then brought back

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* Cf. ' Bull. Soc. Belg. Micr.,' v. p. 243.
† ' Am. Quart. Micr. Journ.,' i. (1879) p. 208.

to zero, and the setting is made on line 2 by means of the screw c. In moving over the space from line 2 to line 3 with the screw b, it will be seen that *the same part of the screw is used as in going from line 1 to line 2.* Hence the comparison of these two spaces is *independent of the errors of the comparing screw.*

FIG. 1.
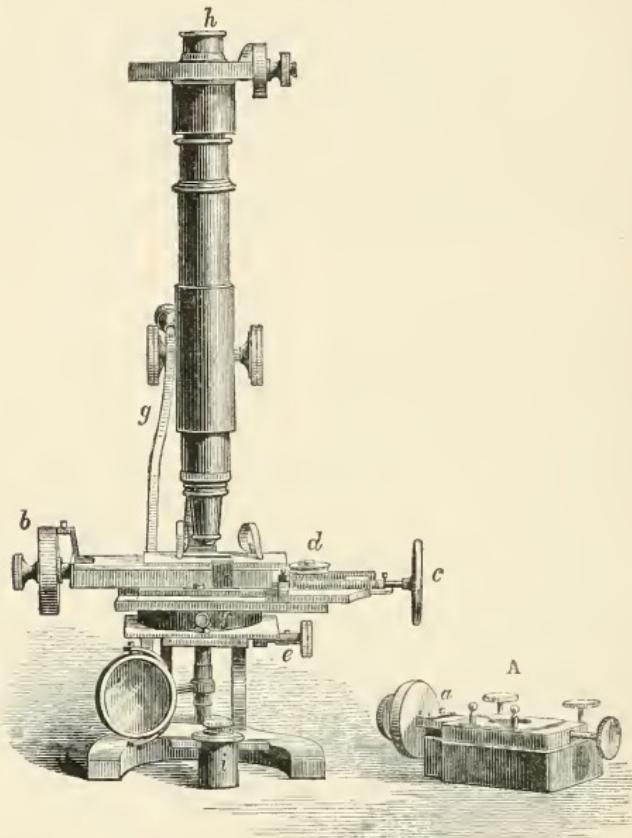
The number of spaces which can be compared in this way is only limited by the length of the screw c, and the length of the opening through the bed-plate.

Again, suppose we measure the spaces 1, 2, 3, 4, ... 100 by a continuous forward motion of the screw. Such measures will involve all the errors of the screw itself. But if after the measures are made we set the screw b back at zero, turn the ruled plate around 180°, and set on line 100 with screw c, the continuous forward motion of the screw b from line 100 to line 1 will be over the same part of the screw as from line 1 to line 100. In the first case the screw measures the accumulated errors of the ruled plate from line 1 to any point up to line 100, but such measures involve the errors of the comparing screw. In the second case the accumulated errors are

measured in the same way from line 100 to line 1. But if we subtract the measures from line 1 to line 100 from the corresponding measures from line 100 to line 1, *the difference will give twice the accumulated errors at any point for strictly periodic errors independent of the comparing screw.* The only exception to this rule is found when the curve of errors takes a wave form. In a general way this will be the case when the maximum error falls near line 25, and the minimum near line 75.

As an an illustration of the character of the work which may be done with a comparator of this form, Professor Rogers gives a Table of the measures of five standard micrometers ruled at different times. As these micrometers are somewhat different in form from any with which he is acquainted he gives a brief description of them.

1. A half-inch is divided into 50 equal parts, the 1st, 25th, and 50th spaces being again subdivided into 10 equal parts. The length of the lines is about $\frac{1}{8}$ inch, the 5th and 10th lines being a little longer.

2. After arranging the position of the ruling carriage, so that the lines of the second series of graduations should begin near the point where those of the first end, coincidence is made mechanically with the first line of the series already ruled. For a short distance the ruling point goes over the same ground twice. A centimetre is then subdivided into 10 equal parts. The 1st, 5th, and 10th spaces are again subdivided into 10 equal parts, and one of the middle subdivisions is still further subdivided, giving ·01 mm. Near by is a band of 21 lines, each space being equal to ·001 mm.

The table shows that the individual errors of graduation are practically insensible.

The errors obtained are, it is to be noted, entirely relative errors. They give no indication whatever of the absolute value of any of the spaces measured. If the entire length of the half-inch is e.g. ·001 inch too long, to each of the corrections given in the table must be applied still further the correction ·00002 inch.

It is therefore necessary to make a careful investigation of the entire length of the half-inch and of the centimetre.

This is done with a comparator adapted to the comparison of spaces, ranging from coincidence to an entire yard or an entire metre. Comparators of this class are usually constructed with two sliding plates, each carrying its own Microscope. A fundamental objection to this form is found in the fact that the Microscopes cannot be brought much nearer together than 3 inches by any direct means. For want of space and of illustrations, Professor Rogers is able to give only a general description of the form which he has had constructed.

It consists of an iron bed 60 inches long and 14 inches wide. V-shaped grooves 6 inches apart run the entire length. In the centre of the bed a fine-toothed rack reaches from end to end. Two sliding plates are carried along the ways by means of a pinion set in the centre of the plates and working so loosely in the rack that the slides are free to follow the law of gravity. A Microscope is

attached to each plate, giving the form usually adopted. Instead of
two Microscopes, however, it is found better to use but one. The
Microscope plate is followed on the other side by plates terminating
in tempered steel tops which are at will either made free or clamped
firmly to the bed of the comparator. If one wishes to compare two
metres the method of proceeding is as follows :—

(a) One stop is set at or near one end of the bed.

(b) The metre with which comparison is to be made is placed in
position under the Microscope so that contact is made between the
end line and the zero line of the eye-piece micrometer.

(c) The microscopic plate is then moved by means of the rack
and pinion till the other end line forms contact with the zero line of
the micrometer

(d) The second stop is then brought up against the other end of
the plate and adjusted so that when contact takes place between the
stops, contact also takes place between the end line and the zero line
of the micrometer.

(e) Having made the adjustment of the stops perfect, the metre to
be compared is then placed in position. When contact is made with
the first stop by mechanical adjustment the end line is brought in
contact with the zero line of the micrometer. The Microscope plate
is then brought into contact with the second stop. If the other end
line is now in coincidence with the zero line of the micrometer the
two metres have the same length. By noting the number of divisions
which the end line falls short of or passes beyond the zero line of the
micrometer, the difference in the entire length can be found, the only
element yet unknown being the value of one division of the micro-
meter.

After the comparison has been made it is better, as a matter of
precaution, to again compare the standard with the distance between
the stops. Since the stops can be set in actual contact with the
Microscope plate at either end it is obvious that this method admits
of a comparison of short spaces as well as of long ones. The only
criticism which it is imagined will be urged against this form of
construction is that founded on a doubt whether the contact between
the stops always indicates the same measured space. The arm of the
pinion has a head of about $2\frac{1}{2}$ inches in diameter. In his own case
the sense of touch has been so far cultivated that he is able to make
100 successive contacts without a single deviation exceeding ·000035
inch, and very few deviations reach ·00001 inch. A comparator of
this form possesses one decided advantage over all others, viz. that
after the stops are once set *any adjustment of the Microscope may be
made without interfering with the comparison.* The only condition
required is that the relation between the stops and the bed shall
remain unchanged during the short time required for the com-
parison. This does not usually take over ten minutes.

In order to compare separate subdivisions of the same standard
we proceed as follows :—

The stops are set e. g. equal to 1 decimetre. After the reading
of the first decimetre has been taken as indicated above, the bar is

then moved along till the first line of the second decimetre forms a contact with the zero of the eye-piece micrometer, when at the same time contact is formed with the first stop. Moving the plate to the second stop the reading for the second decimetre is taken. A comparison of the several values obtained with the mean value will show how much each is in error, provided the entire length is correct.

Tolles' $\frac{1}{75}$ Objective.—Dr. Cutter gives some further particulars respecting this objective (made in 1873), in the 'Journal de Micrographie.'* It works both dry and immersion, is composed of three systems, and has 170° aperture. Its frontal distance is $\frac{1}{250}$ inch. The correction collar moves only $\frac{1}{8}$ of a circle. The aperture of the front lens is $\frac{1}{64}$ inch, and the "diameter of the objective at the other extremity" $\frac{1}{4}$ inch, its length being about $2\frac{1}{2}$ inch. The field is remarkably clear and very flat, the resolution good, and the definition, having regard to the enormous amplification, excellent.

Rezner's Mechanical Finger.†—This form was designed by Dr. W. B. Rezner, of Cleveland, Ohio, and is adapted to any Microscope, whereas the forms heretofore made were only designed for Microscopes having substages.

FIG. 2.
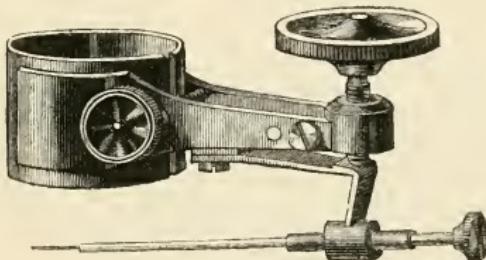
In use, the sleeve, seen in Fig. 2, is passed up over the objective far enough to have firm bearing, and so that the bristle point will be in focus when depressed nearly to its limit; it is clamped in place by the small thumb-screw. The wire in which the bristle is carried is drilled at the point to receive it, and slides easily, but not loosely, through a small sleeve, so that the end of the bristle can be brought into the centre of the field when in focus, and the wire can be revolved so as to view every side of the object picked up by the bristle. The wire stands at a greater angle than is shown in the cut, and the vertical part of the spring is not so long as figured.

When using the finger, the bristle is first raised by means of the micrometer screw till so far within focus as to be nearly or quite invisible, then the objective is focussed on the slide and the desired object sought for and brought to the centre of the field; the bristle point is then lowered by the screw till it touches the object, which

* 'Journ. de Mier.,' iii. p. 297.
† 'Am. Journ. Mier.,' iv. (1879) p. 65.

usually will adhere to it at once, and may be examined by rotating the bristle wire by means of its milled head.

Professor H. L. Smith, in a subsequent paper,* gives some hints which he thinks will greatly facilitate the use of the "finger," and which, though simple, are the fruit of long experience, will save much valuable time, and "conduce to general morality."

The "bristle" or "hair" is to be held in the spring forceps, and, after adjustment, a drop of sealing wax put on the forceps to bind all tight. To make the "hair," cut a slip of glass, and by a spirit lamp draw it out into a slender thread; snip off the thread by a knife, so as to present a bevelled edge (Fig. 3, magnified). This thread is so fine as to be quite flexible, and if dirtied can easily be cleaned. It is not affected
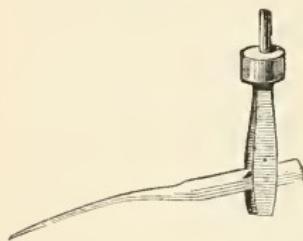
FIG. 3.   FIG. 4.
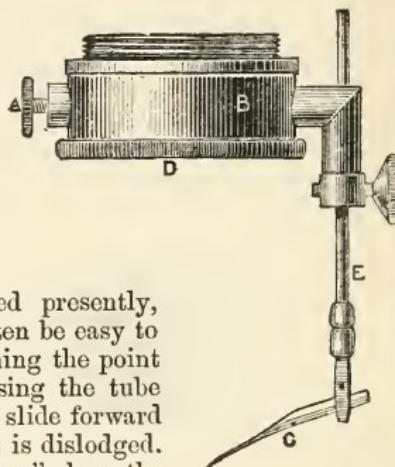
by moisture, applied as described presently, *a very important point.* It will often be easy to pick up a diatom by simply touching the point to the slide, and then by depressing the tube of the instrument, causing it to slide forward on the glass plate till the object is dislodged. His modification of the "finger" has the Society screw, and will receive any objective, though he prefers a $\frac{2}{3}$ inch. (Fig. 4.) When the screw A is loosened, the ring B and the hair C can be revolved, and made to point towards the centre of the field in any required direction, which will be found convenient for pushing a diatom into place in arranging. The objective screws in at D, and by raising or depressing the rod E, the point of the hair can be brought into focus. It should point downwards at a slight angle. If when it has been brought into focus, we unscrew the front lens of the objective slightly, this will throw the point out of focus, and now the objective may, by the rack, be brought down to give a distinct view of the material from which the object is to be picked, *without any danger of the hair point touching it.* When the object is found, then by turning home the unscrewed front lens, the point will come into focus, and by slightly racking down the tube, the point can be made to touch the object, and by racking back to lift it. If dirt is raised a light tap on the tube will instantly set it free, and leave the hair clean, or it may be cautiously wiped off with tissue paper. One of the greatest objec-

* 'Am. Journ. Micr.,' iv. (1879) p. 102.

tions to ordinary bristles, &c., is that after lifting a diatom, it is often impossible to make it let go, on touching the place where one wishes to deposit it, a difficulty rarely experienced with the glass hair. Although somewhat brittle, yet with care it may be used a long while, and can be easily replaced.

The material from which the selection is to be made is spread on a piece of thin glass, and heated red hot, if it contains diatoms, to burn out the organic matter; this piece of glass is attached to an ordinary glass slide, a little to the left of the centre; and to the right is put on the same slide the clean glass cover to receive the picked out specimens, and directly under the centre of this cover, on the under surface of the slide, a small ink dot, which can be easily recognized though out of focus, when, having secured the object on the end of the hair, the slide is pushed along to bring the cover into view. In this way one can readily pass from the crude material to the cover, without danger of detaching the specimen picked up. If the specimens are to be mounted in balsam, it is necessary to put a little thin solution of gelatine on the cover, and dry it.

With regard to the principal part of the manipulation, the method of taking off the object, just where and when we wish, and of arranging into lines, circles, &c.; this process is not his own as to idea; he has

Fig. 5.
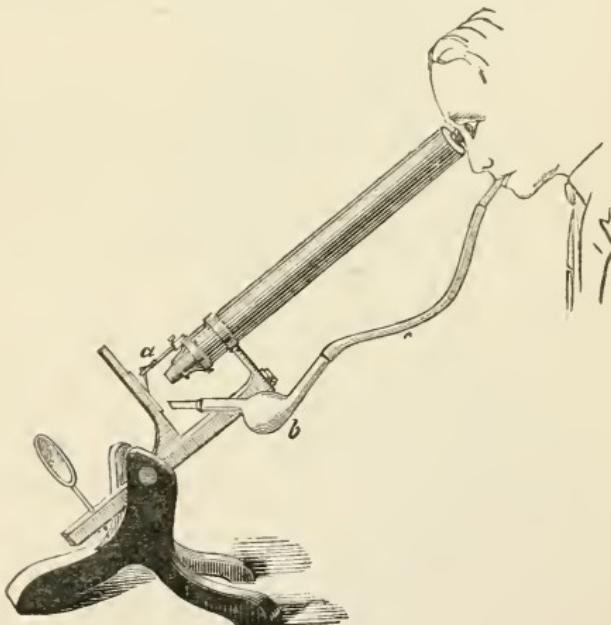
reason to believe it is, substantially, that used by the professional preparers of these objects, though it has never before been made known. Fig. 5 shows the Microscope with the finger attached at a, and the hair just above the slide; b is a glass tube having a bulb, and

attached to the stand; a short bit of tube slides into the end nearest the stage, and may be drawn out till it nearly touches the slide; to the other end is attached a rubber tube *c* with a mouthpiece. When the object on the end of the hair is brought directly over where it is desired to be placed on the cover, the tube is carefully racked down till the object nearly touches the cover; now, by gently breathing through the tube, a film of moisture will form on the cover in the most beautiful manner if the tube be pointed right at its lower end, and will, if we stop breathing, again quickly disappear. Suppose now, we flood the cover with moisture, and depress the tube, the hair touching it, the object will be at once taken off, and by a little manipulation not easily described, but easily performed, and mainly consisting in so placing the hair by revolving the ring that its point, slipping forward on the glass, as the tube is depressed, will push the object here or there, into lines or circles, without danger of its flying off, or being again picked up, if we keep the cover moistened by gently breathing. It is astonishing how gentle a breath will flood the cover with moisture, and one must be very careful not to blow through the tube before the object is dislodged, or it will inevitably be blown away. When the moisture evaporates, as it will at once, the gelatine will hold all fast, and then there is no need of any heating of the cover, which might do harm by possibly charring the gelatine, only one must be sure it is really dry before placing it on the little drop of balsam on the slide. The bulb *b* catches the condensed moisture, and must be emptied occasionally.

Apparatus for Focussing Dissecting Microscopes.*—Herr Hilgendorf, of Berlin, suggests an arrangement to be worked by the *leg* for focussing dissecting Microscopes. These, as is known, strain the eyes, owing mainly to the necessity of using both hands in the dissecting process, which makes the constant adjustment of the focus irksome.

The inventor's apparatus (which can be at once applied to any instrument without the help of a mechanic) consists of a rather strong brass wire, 1½ mm. diameter, which at one end is hooked to the knee, and at the other is twisted round a cork, the latter being hollowed out in the middle, so that it can be pressed firmly over the adjusting screw of the Microscope. The wire should be bent at right angles 5 cm. from the screw; and then, by the raising or lowering of the leg, or side motion of the knee, it can be moved in the desired direction, and the focus varied. The flexibility and elasticity of the wire offer peculiar advantages, and do away with any complicated mechanism of levers and screws.

Improved Mounting for Cameræ Lucidæ.†—Professor L. Melassez suggests an improvement to the mounting of the cameræ lucidæ of Milne-Edwards, Nachet, and others.

These are fixed to the Microscope by means of a ring which encircles the tube, and on which they are jointed. The opticians

* 'SB. Gesell. Naturf. Freunde, Berlin,' 1878, p. 187.
† 'Travaux Laborat. Histol. Coll. France,' 1877-8 (1879) p. 117.

always place this joint at the *side*, so that the draughtsman cannot avoid knocking (his nose) against it, or else is obliged to give a very fatiguing inclination to the head.   This inconvenience may be avoided by placing the joint not at the side, but at the *anterior part* of the camera.

In addition to this, the axis of movement is *vertical*, and when the camera is removed from the eye-piece, it is difficult to put it exactly back in the place it occupied, which is, however, very desirable.   An axis with *horizontal* movement would be much better, and by such an arrangement the camera would be raised and lowered on the eye-piece like the cover of a box.

Zeiss' Travelling Microscope.—Fig. 6 represents the "Travelling Microscope" of Herr Zeiss, of Jena, which was exhibited at the November meeting of the Society.

FIG. 6.
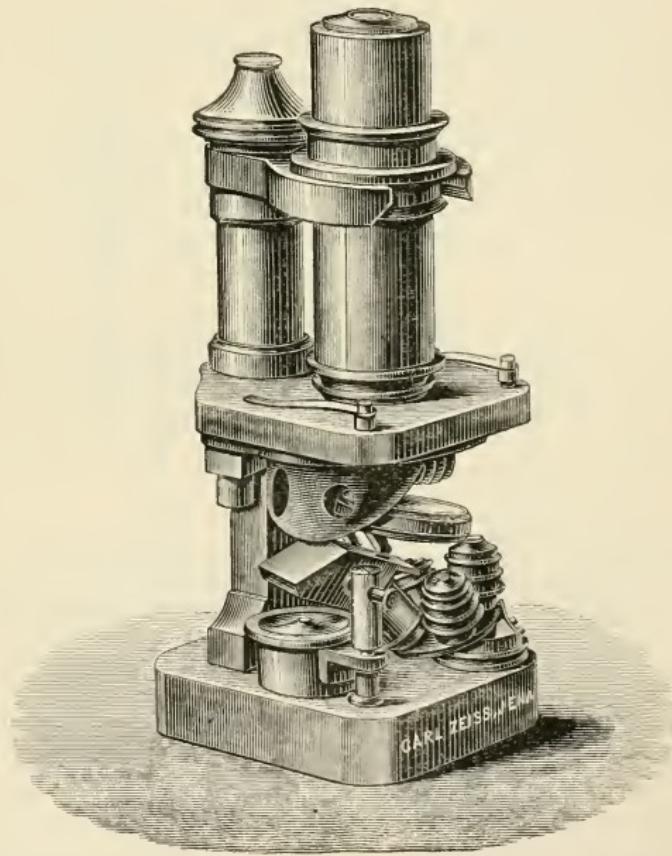
It consists of the Zeiss stand No. VI., the general construction of which is sufficiently shown by the woodcut; and it packs into a case 8¼ inches high by 4 inches square.

The tube can be readily replaced by a Brücke lens ; the stage is hollowed out beneath, and has a concave diaphragm, shown in the foregoing figure, specially adapted to it. The four object-glasses are attached to a revolving "nose-piece," of exceptionally small size, which in packing can be screwed to the foot of the stand. The space beneath the stage is also utilized, in packing, for the Camera Lucida as well as the mirror. The latter is provided with universal movement by an extremely simple and ingenious arrangement. The upper part of the instrument with the stage can be turned round the optic axis.

Schöbl's Dissecting Microscope.*—This instrument, which is shown in Fig. 7, consists of a heavy brass base-plate (17 cm. by 12 cm.), on which is supported the stage (22 cm. by 12 cm.) by three uprights, the mirror being attached to one of them.

Fig. 7.
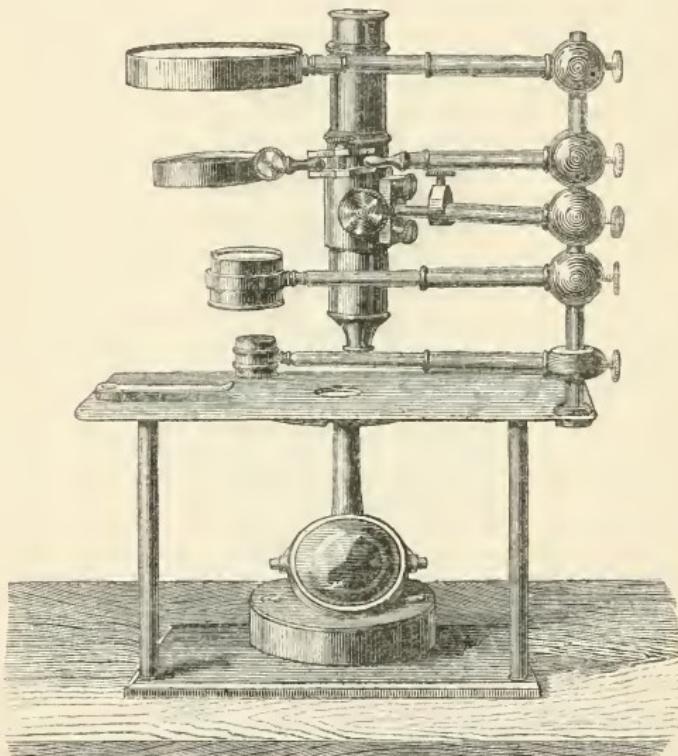
At one of the corners of the stage furthest from the observer is an upright rod 16 cm. high, to which five movable arms of $2\frac{1}{2}$ cm. diameter are attached, each arm being capable of being fixed by a screw, as shown in the figure. The lowest carries an aplanatic lens magnifying 30 times; the next, a similar lens, magnifying 15 times, the third, an ordinary dissecting Microscope, magnifying up to 150

* ' Arch. Mikr. Anat.,' xvii. (1879) p. 165.

times; and the fourth and fifth carry two other lenses of low magnifying power (7 and 3 times), the former having a jointed attachment to allow of the lens being placed in any position.

The arm carrying the Microscope is ordinarily turned away from the stage to the left of the observer, while the other arms which are not in actual use are placed forwards so as to be out of the way, but are at once available when required.

The inventor claims the following as the special advantages of the instrument:—

(1) The stage is entirely free for work, nothing being in the way of the observer's hands or head on the side at which he stands.

(2) It allows of a particularly rapid and convenient change of powers; and

(3) The preparation need never be moved from its place during work, and thus a great saving of time is effected.

Ward's Improved Microtome.—At the November meeting of the Society, an improved form of microtome was exhibited and described by Mr. F. H. Ward. It is a modification of the one introduced by Stirling, from which, however, it differs in the indicator. The thickness of the section is indicated by means of a screw having thirty-six threads to the inch, to which is attached a wheel containing thirty-five notches upon its circumference; into these notches a spring catch falls in rotation as the screw is turned. This spring is attached to a metal plate through which the screw works, but which is prevented from turning round with the screw by a brass rod fixed into the base of the microtome.

The bottom of the well is removable, and is retained in place by two bayonet catches. When removed from its fitting, the bottom is separable into two halves so as to release the screw. The continuity of the thread in the internal screw is maintained in the two halves when in position by means of two metal pegs on the face of one half accurately fitting into holes on the face of the other. The object of this contrivance is, that when the screw has been turned round to its extreme limit, by a slight backward turn the bottom of the well is removed, the two halves separated and the screw is set at liberty, thus avoiding the wear to the thread and the spring catch, which must inevitably result from rapidly turning the screw in the reverse direction through about two inches of its length.

A thick plate of glass, with an aperture the size of the well, covers the upper brass plate, and slides into position by means of a dovetail on each side.

Matthews' Section-cutting Machine.*—Dr. John Matthews has contrived a machine for making sections of such substances as bone, hard wood, ivory, nut, and other materials which are too hard to be cut with the section knife, and not of a nature to require the lapidary's wheel.

The carriage holding the saw runs smoothly yet firmly between friction rollers, and derives its reciprocating motion from a crank,

* 'M. Journ. Sci.,' i. (1879) p. 823.

which can be turned either by hand, or, when a higher speed is required, driven by a treadle and pulley. The saw is provided with adjustments to secure its parallelism and proper tension; the section is regulated by a screw of fifty threads to the inch, reading to thousandths by means of a micrometer head; the feed is either automatic by means of a cup, in which a suitable quantity of shot can be placed, acting by gravitation on a lever; or, as Dr. Matthews prefers, is capable of being regulated by hand. Owing to the steady motion of the saw when in proper adjustment, sections of suitable tissues can be cut as thin as the thousandth of an inch; the surfaces show no trace of the saw-cut, and are almost polished; very little after-treatment is needed to remove the few scratches left by the saw, and if required for mounting in balsam it can be done at once, taking the usual precautions to prevent penetration, and the consequent obliteration of structure.

Zeiss' $\frac{1}{18}$ Objective.—Colonel Woodward's views on this will be found at p. 988 of the 'Proceedings.'

Micrometry.—A reference to this subject will be found at p. 988 of the 'Proceedings.'

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δ. Arachnida.

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tions of Prof. de Bary. (*Transl.* from 'Flora.') *Rev. Mycol.*, I., pp. 155–8.
PUIGGARI, J.—*See* Muscineæ.
RAVAUD.—*See* Muscineæ.
REESS, Prof.—Lichens.   *Rev. Internat. Sci.*, IV., pp. 335–58.
ROUMEGUÈRE, C.—Lichens of New Granada and Ecuador collected by M. E.
André. [55 sp.]   *Rev. Mycol.*, I., pp. 160–71.

Algæ.

BORZÌ, A.—Notes on the Morphology and Biology of the Phycochromaceous
Algæ (*contd.*). Plates 9–12.   *Nuovo Giorn. Bot. Ital.*, XI., pp. 317–388.
Castracane, Ab. Cte. F.—On the Striæ of Diatoms, and on the Value to be
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Accad. Pontif. Nuovi Lincei.' (*In part.*) *Journ. de Micr.*, III., pp. 283–9.
COHN, F.—Desmidiaceæ Bongoënses. (4to. Halle, 1879.)
DICKIE, Prof. G., A.M., &c.—(Botany of Kerguelen Island) Marine Algæ
(exclusive of the Diatomaceæ). Plate 5, fig. 3.
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  ,,   ,,   ,, (Botany of Rodriguez) Algæ.
             Phil. Trans., CLXVIII., pp. 415–9.
  ,,   ,,   ,, *See* Reinsch, P. F.
Dodel-Port, Prof.—On the Fertilization of Red Seaweeds by Animalcula.
4 figs. (*Abstr.* from 'Kosmos.')   *Zool.*, III., pp. 393–402.
FALKENBERG, P.—On Endogenous Formation of Normal Lateral Shoots in the
Genera *Rytiphlœa, Vidalia,* and *Amansia.* (From 'Nachrichten K. Ges. Wiss. Got-
tingen.')   *Bot. Zeit.*, XXXVII., pp. 603–10.

GRÖNLUND, C.—See Kjellman, F. R.

Grunow, A., Hon. F.R.M.S.—New Species and Varieties of Diatomaceæ from the Caspian Sea. (*Transl.* with Additional Notes by F. Kitton.) Plate 21.
Journ. R. Micr. Soc., II., pp. 677–91.

HAUCK, F.—Contributions to the Knowledge of the Adriatic Algæ. XIII. [*Peyssonnelia Dubyi ; P. polymorpha ; Rhodocorton membranaceum.*]
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KITTON, F., Hon. F.R.M.S.—See Grunow, A.
  „   „   „   The Thallus of the Diatomaceæ.
Journ. R. Micr. Soc., II., pp. 38–40.

KJELLMAN, F. R.—Contribution to the Knowledge of the Marine Algal Flora of Iceland, and Supplement by C. Grönlund. *Bot. Tiddsk.,* III., pp. 77–80, 81–3.
  „   „   On the Alga-regions in East Skager Rack, with Remarks on the relations of the Bohuslan Sea Algal Vegetation to the Norwegian. 36 pp. and map. (Stockholm, 1879.)

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KUNTZE, Dr. O.—On the Relationship of Algæ with Phanerogams (*concluded.*)
Flora, LXII., pp. 417–23.

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Atti Soc. Crittog. Ital., II., pp. 103–4.

OUDEMANS, C. A. J. A.—Contribution to the Algological Flora of Holland.
Ned. Kruidk. Arch., III., p. 258.

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SCHNETZLER, Prof. J. B.—Remarks on an Aerial Alga, *Chroolepus Jolithus* Ag.
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TARANEK, K. J.—Diatomaceæ. (8vo. Prag, 1879.)

TURNER, W. B.—The Fresh-water Algæ of the Leeds District.
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ULRICH, E. O.—Descriptions of New Genera and Species of Fossils.—*See* Zool. A. [*Inocaulis arbuscula,* n. sp.]

WRIGHT, Prof. E. P., M.A., &c.—On the Cell-structure of *Griffithsia setacea* (Ellis), and on the Development of its Antheridia and Tetraspores. Plates 12 and 13.   *Trans. R. Irish Acad.,* XXVI., pp. 491–510.
  „   „   „   On the Formation of the so-called "Siphons," and on the Development of the Tetraspores in *Polysiphonia.* Plate 14.
Trans. R. Irish Acad., XXVI., pp. 511–26.

MICROSCOPY, &c.

Abbe, Prof. E., Hon. F.R.M.S.—On Stephenson's System of Homogeneous Immersion for Microscopic Objectives. (*Transl.*)   *Journ. R. Micr. Soc.,* II., pp. 256–65.

ADAMS, Prof. W. G., M.A., F.R.S.—Measuring Polariscopes. Plate 8.
Phil. Mag., VIII., pp. 275–7.

[American] Postal Microscopical Club.   *Am. Nat.,* XIII., pp. 724–5.

American Society of Microscopists. [Report on the Meeting at Buffalo, Aug. 19–22.]   *Am. Nat.,* XIII., pp. 662–3.

BACHMANN, O.—Guide to the Making of Microscopical Permanent Preparations. 196 pp. 87 figs. (8vo. Munich, 1879.)

BARRETT, A. H.—Staining Fluids for Vegetable Tissues.
Sci.-Gossip, No. 179, p. 255.

BEALE, L. S., F.R.S., &c.—How to Work with the Microscope. 5th ed., 520 pp , 99 plates, and 25 figs. (8vo. London & Philadelphia, 1880.)

BURTON, C. E.—On recent Researches respecting the Minimum visible in the Microscope.   *Proc. R. Irish Acad.,* III., pp. 248–54.
  Cleaning Old Slides.   *Sci.-Gossip,* No. 179, p. 256.

Cook, E. A., Ph.D., &c.—Note on Logwood Staining Solution.
                            Journ. Anat. & Physiol. (*Humphry*), XIV., pp. 140-2.
Cossa, —.—Chemical-Microscopical Observations on the Ashes from Etna which fell at Reggio on the 28th May, &c.
                                    Trans. R. Accad. Lincei, III., pp. 248-50.
Crisp, F., LL.B., &c.—On some recent Forms of Camera Lucida. 5 figs.
                                    Journ. R. Micr. Soc., II., pp. 21-24.
Cutter, Dr. E.—The Tolles $\frac{1}{75}$-inch Objective.
                                    Journ. de Micr., III., pp. 297-9
      „   „   The Primer of the Clinical Microscope.
                                    Virginia M. Month., VI., pp. 376, 446.
Donnadieu, Prof. A. L.—Organization of the Microscopical Laboratories at the University of Lyons (*concluded*). Plate X.   *Journ. de Micr.,* III., pp. 270-5.
Duval, M.—Employment of Collodion for Microscopic Sections.
                                    Rev. Sci. Nat., VIII., pp. 58-63.
Edmunds, J., M.D., &c.—Note on a Revolver Immersion Prism for Sub-stage Illumination.   *Journ. R. Micr. Soc.,* II., pp. 32-5.
Folin, Marquis de.—Method of Collecting small Molluscs.
                                    Bull. Soc. Imp. Nat. Moscou, LIV., pp. 202-5.
Fripp, Dr. H. E., Ex.-off. F.R.M.S.—On the Theory of Illuminating Apparatus employed with the Microscope. Part I. 9 figs.
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Howitt, A. W., F.G.S.—Notes on the Examination of thin Slices of Rocks under the Microscope by means of Polarized Light. 4 figs. of Plate 1.
                                    Quart. Journ. Micr. Soc. Victoria, I., pp. 8-14.
Keith, Prof. R.—Note on Diagrams (Plate XII.) exhibiting the Path of a Ray through Tolles' $\frac{1}{8}$ Immersion Objective
                                    Journ. R. Micr. Soc., II., p. 269.
      „   „   Note on Mr. Wenham's Paper "On the Measurement of the Angle of Aperture of Objectives."   *Journ. R. Micr. Soc.,* II., p. 270.
Lang, F. H.—How to Restore Micro-Photographs.
                                    Sci.-Gossip, No. 179, pp. 255-6.
Langerhans, Prof. P.—Modification of Farrant's Medium.
                                    Zool. Anzeig., II., p. 575.
M., H.—How to Remove Air-Bubbles.   *Sci.-Gossip,* No. 179, p. 255.
Mayall, J., Jun., F.R.M.S.—Immersion Illuminators.
                                    Journ. R. Micr. Soc., II., pp. 27-31.
      „   „   The Aperture Question. „   „   „ pp. 134-6.
Morel, Prof. C.—Method of Observing with the Microscope. *See* Zoology A.
Parker, T. J., B.Sc., &c.—On some Applications of Osmic Acid to Microscopic Purposes.   *Journ. R. Micr. Soc.,* II., pp. 381-3.
Pelletan, Dr. J.—On the Scientific Value of Microscopic Preparations. (*Transl.* from ' Journal de Micrographie.')   *Sci.-Gossip,* No. 179, pp. 250-1.
Phin, J.—Practical Hints in the Selection and Use of the Microscope. Abridged for the Use of Beginners. 125 pp. 48 figs. (8vo. New York, 1879.)
Ralph, T. S., M.R.C.S.—Annual Address as the President of the Victoria Microscopical Society.   *Quart. Journ. Micr. Soc. Victoria,* I., pp. 3-8.
Reichenau, W. v.—Protection of Zoological Museums against Insects.
   [Petroleum and Naphthalin combined.]   *Zool. Anzeig.,* II., pp. 573-4.
Renard, A.—On the Microliths of Crystalline Schists.
                                    Bull. Soc. Belg. Micr., V., pp. ccxii.-xvii.
Royston-Pigott, Dr., M.A., F.R.S., &c.—A Further Inquiry into the Limits of Microscopic Vision and the delusive Application of Fraunhöfer's Optical Law of Vision. No. II. Plate 3.   *Journ. R. Micr. Soc.,* II., pp 9-20.
Russell, J. C., M.D.—Description of a New Form of Camera Lucida. 2 figs.
                                    Journ. R. Micr. Soc., II., pp. 25-6.
Schöbl, Dr. J.—A new Dissecting Microscope. Plate 13.
                                    Arch. Mikr. Anat., XVII., 165-7.
Slack, H. J., F.G.S.—The President's Address.
                                    Journ. R. Micr. Soc., II., pp. 113-21.
Sommers, Prof. J., M.D., &c.—Experimental Microscopy.
                                    Proc. & Trans. Nov. Scot. Inst. Nat. Sci., V., pp. 81-5.

PROCEEDINGS OF THE SOCIETY.

Meeting of 8th October, 1879, at King's College, Strand, W.C.
The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 11th June last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors.

	From
Ardissone, Prof. F.—Gli Uffici delle Piante Crittogame. 24 pp. 8vo. Milano, 1873	The Author.
Castracane, Conte Ab. F.—Se e qual valore sia da attribuere nella determinazione delle specie al numero delle strie nelle diatomee. 19 pp. 4to. Roma, 1879. (Extracted from 'Atti dell' Accademia Pontificia de' Nuovi Lincei')	Ditto.
Coues, E.—Birds of the Colorado Valley. Part I. 807 pp., 70 woodcuts. 8vo. Washington, 1878.	U.S. Geological Survey of the Territories.
Coues, E., and J. A. Allen.—Material for a Bibliography of North American Mammals. 4to. Washington, 1877	Ditto.
Cunningham, D. D., M.B.—On certain effects of Starvation on Vegetable and Animal Tissues. 47 pp., 11 figs. 4to. Calcutta, 1879	The Author.
Lanzi, Dr. C. M.—I Funghi della Provincia di Roma. (Extracted from 'Atti dell' Accademia Pontificia de' Nuovi Lincei.') 32 pp., 1 plate. 4to. Roma, 1879	Ditto.
Lewis, T. R. M. B.—The Microscopic Organisms found in the Blood of Man and Animals, and their relation to Disease. 91 pp., 3 plates, and 27 figs. 4to. Calcutta, 1879	Ditto.
Lyngbye, H. C.—Tentamen Hydrophytologiæ Danicæ. 248 pp., 70 plates. 4to. Hafniæ, 1819	Dr. Millar.
Reuss, J. D.—Repertorium Commentationum a Societatibus Litterariis Editarum. 2 vols. 574 pp. and 604 pp. 4to. Gottingæ, 1801-2	Mr. Crisp.
Schwann, Th., Manifestation en l'Honneur de M. le Professeur, —Liége, 23 Juin, 1878. Liber Memorialis. Publié par la Commission Organisatrice. 236 pp., and photograph. 8vo. Dusseldorf, 1879	The Commission.
Smithsonian Institution.—Annual Report of the Board of Regents for 1877. 8vo. Washington, 1878	The Institute.
University College.—Catalogue of Books in the General Library and in the South Library. 545 pp. and 536 pp. Vols. I. and II. A-C, D-N. 8vo. London, 1879	The College.
Beck's Revolving Microscope Table and Lamp	Mr. J. Badcock.
Slide of Scales of a species of the genus Mormo	Mr. J. Beck.
173 Mounted preparations (various)	Representatives of the late Mr. C. Brooke, F.R.S.
Photograph of Dr. A. Farre, F.R.S. (a Past President of the Society)	Dr. Farre, F.R.S.

		From
Clock for the Library		*Dr. Gray.*
Slide of *Peridinium cornutum*		*Mr. J. Levick.*
Diatomaceous Earth from the original find at Santa Monica* ..	⎱	*Mr. H. G. Hanks.*
Zircon Sand with Gold	⎰	
Photograph (on Porcelain) of Prof. E. Abbe		⎰ *Mr. J. Mayall, jun.*
2 Slides of *Eucampia striata* n. sp. et var. *maxima*		*Dr. Stolterfoth.*
Ruling Machine		⎧ *Major Water-house, Repre-sentative of the late J. Waterhouse, F.R.S.*
13 Photographs (described at p. 672 of the Journal)..		⎰ *Col. J. J. Wood-ward.*

On the motion of the President, special votes of thanks were accorded to Mr. Badcock, the representatives of the late Mr. Chas. Brooke, Dr. Gray, and the representatives of the late Mr. J. Waterhouse, for their respective donations.

Mr. Crisp mentioned that during his absence abroad the paper at p. 653 of the October number of the Journal had been printed from the author's original MSS. instead of from the revised MSS., for which it had been held over. The corrected pages would be supplied with the next number.

The following Note from Mr. Wenham was taken as read :—

As statements have been made to the effect that I altogether deny the possibility of obtaining an angle on a balsam-mounted object beyond 82°, the following references will show that, excepting under certain conditions, I have not made such an assertion, which, as it appears recorded with my name attached in the 'Proceedings' of the Society, calls for a notice that it would not otherwise have received from me.

I must therefore state positively, that I never held, and do not hold, any such opinion. The discussion has been long and not very definite, and sufficient attention may not have been given to particulars by some attributing this error to me—to be excused for this reason.

In 'Quart. Journ. Micr. Science,' vol. iii. (1855) p. 303, for the purpose of remedying the loss of aperture on an object in balsam from a dry object-glass, I describe the adaptation of an additional lens in front connected with the cover by a refractive intermedium, thus securing the full effect of aperture.

In 'Monthly Microscopical Journal,' vol. v. (1871) p. 17, I state that "An angle of 82° cannot be exceeded in a dry objective,

* The bottle in which this was sent was broken in transit through the post, and the contents had disappeared.

nor can it be greater on the immersion system, where an interchange of front adapts it to both conditions."

In vol. v. p. 118 the following sentence has been referred to :— "I challenge anyone to get through the object-glass with the immersion front a greater angle, or any portion of the extraneous rays that would in the other case be totally reflected, as no object-glass can collect image-forming rays beyond this limit." At the top of this same page I show distinctly that this remark applies to a dry lens, and the whole article bears reference to a former one (vol. v., page 23), with diagrams used for objectives used on dry objects, or such as those generally in use at that time.

Mr. Tolles having claimed 100° or more of aperture for an immersion lens, in vol. vi. (1871) p. 85 I point out the cause arising from an error in the means of measurement. On the next page I give a series of measurements of the angles of objectives immersed in water, all of which were within the corresponding balsam limit of 82°. Again this referred to the then usual form of objectives that could be used dry.

In vol. vii. (1872) p. 272 I say, "Mr. Tolles has accepted the only condition under which the full aperture can be brought to bear on a balsam-mounted object, viz. that of the tiny hemispheres. I am glad of his announcement that he has succeeded in this, and should like to see the same thing done in this country, particularly with large aperture glasses, say higher than $\frac{1}{8}$th."

In vol. ix. (1873) p. 268 Colonel Woodward having measured the Tolles $\frac{1}{10}$ referred to in the previous controversy, finds the balsam angle only 76°. On p. 270 he continues, "I subsequently extended the measurements to the immersion $\frac{1}{15}$ and $\frac{1}{18}$ by Mr. Tolles belonging to the Museum, and found that the maximum balsam angle was less than 80°. These results, it will be seen, fell within the limits laid down as possible by Mr. Wenham."

In vol. ix. (1873) p. 273 there is a memorandum by Professor Keith, in which he says, "Mr. Wenham's experiments alluded to in his article in the 'Monthly' for January, indicate an explanation, and it seems singular that they did not suggest to him long ago a method of obtaining what Mr. Tolles has obtained—an objective of large angle for objects covered in balsam." Professor Keith's accompanying diagram exactly explains the principle, and is just the same in effect as that of my additional front lens, described and illustrated in 1855, showing that he had not found leisure to look into former points of the question. My diagram is illustrative of Mr. Tolles' subsequent 4-system immersion objectives, the focus being nearly in the centre of the radius of the front lens in both cases.

In vol. x. (1873) p. 12 I say, "I trust that Colonel Woodward having affirmed 'that the position taken by me is certainly true, for objectives as ordinarily constructed,' will allow that this additional lens embodies a deviation from the original question, which was to the effect that there would be no loss of angle aperture of ordinary objectives by the immersion of the front surface in fluids."

As regards the latter phase of the discussion, relative to false

or true apertures, and the best form of apertometer or means of measurement, that is a different branch of the question not as yet concluded.

It will save much confusion if we take Colonel Woodward's recent suggestion* for the nomenclature of the angle of immersion lenses, and instead of water, glycerine, oil, or balsam angles to take the degrees of the primary angle, or that *within* the body of the front lens, of immersion object-glasses, and call it "*interior angle*." The varied exterior angles in the above fluids will then follow and be known by their relative refractive indices. The stumbling-block of 180° (which may mean 82° only in the front lens) will then be entirely cleared away.

Mr. J. Beck read a paper, "Note on the Structure of the Scales of a species of *Mormo*," slides of which were exhibited under the Microscope (see p. 810).

Mr. Crisp expressed a hope that the Fellows would look at the scales at the close of the meeting, as they seemed to furnish a convincing proof of the truth of Mr. Beck's theory.

Dr. Edmunds said that some time ago he had given attention to the Podura scale, and found that he could not determine on which side of it the minute plumules seemed to grow, the scale being so extremely thin and so transparent. He could not, however, help thinking that if they watched the scale very carefully with some kinds of dark-ground illumination, dry, and with the cover hard down upon the scale, they would get appearances which were wholly irreconcilable with the theory put forward by Mr. Beck. In this way they got the "featherlets" projected out of the membrane, giving a beautiful brush-like appearance. Then, if they had the scale mounted in balsam and illuminated by highly oblique light, they would get an appearance almost identical with that which was seen in the former instance; they lost all the hyaline appearance of the scale itself, and saw these featherlets becoming an independent source of light, standing up illuminated from the surface of the scale.

Mr. Beck said he based the statements in his paper entirely independently of what anyone could *see*, because they might see anything according to the way they looked at it. They must rather *reason* according to the nature of the structure they were viewing. In this case they were looking at two membranes united together, but which could be taken apart. They could run moisture up and down on the lower external surface, but could not do so on the upper surface, which was thus shown to be almost smooth. They therefore had a complex substance to deal with, and it was necessary to reason as to what that structure was composed of. Now, considering the whole class of these scales from those of *Lepidocyrtus* down to those of *Lepisma* and others, if they could satisfactorily connect the one with the other, and could show that the appearances could be produced by regular corrugations, then it was much more consistent to

* ' Am. Quart. Micr. Journ.,' i. (1879) p. 277; this Journal, *ante*, p. 783.

say that they were all modifications of the same structure, and that nature had provided a number of corrugations for the purpose of strengthening the scale, rather than plumules which would be of no use whatever so far as they could see.

The President inquired if Mr. Beck had observed all the markings on the scales of Lepidoptera to be on the under surface of the scale?

Mr. Beck said he could not say that they were, but certainly they were so in the Thysanuræ. He had not tried the Lepidoptera, but his impression was that they would be found the same.[*]

The President suggested that the object of this structure might be to prevent the scales from adhering together, since, looking at it from an engineering point of view, there seemed to be far more of these corrugations than were required for the purpose of strengthening the scales.

Mr. W. H. Gilburt read a paper "On the Morphology of Vegetable Tissues," the subject being illustrated by drawings, some of which were enlarged upon the blackboard (see p. 801).

Mr. Stewart said he had listened to the paper with very great interest, as it teemed with original and striking observations, and he was sure that all present would agree that it dealt in a masterly manner with a very important subject, that of how structure was gradually built up. As Mr. Gilburt's views differed so much from those hitherto held on the subject, he thought it would be very desirable that some one should go over the ground again, so as to verify the observations, in which case he would suggest that the cell substance should be taken into consideration as well as the cell outline.

Dr. Stolterfoth's paper "On a new Species of the Genus *Eucampia*" was read by Mr. Stewart (see p. 835).

Mr. Crisp reminded the Fellows that Mr. Bolton's living organisms were always available at the Wednesday Evening Meetings, and had recently been of the greatest interest, including the discoveries that had been made during the vacation by Mr. Levick, Mr. Bolton, and other members of the Birmingham Natural History and Microscopical Society, consisting of *Leptodora hyalina* and *Hyalodaphnia Kahlbergensis* (see p. 877), *Anuræa longispina* (see p. 879), and the new genus of Rhizopods—*Lithamœba discus*, Lankester (see p. 900).

The visit to this country of an illustrious Ex-officio Fellow of the Society, Professor Haeckel, of Jena, was also referred to, which having unfortunately been made during the recess, had rendered it impossible to welcome him.

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[*] See Note to the paper on p. 810.

The following **Objects, Apparatus, &c.,** were exhibited :—

Mr. Beck :—Slides of *Mormo* to illustrate his paper.

Mr. Bolton :—*Leptodora hyalina* and *Hyalodaphnia Kahlbergensis.*

Mr. Crisp :—(1) Nachet's Portable Demonstrating Microscope (*ante*, p. 766). (2) Professor A. de Lasaulx's Mineralogical Microscope (see 'Bull. Soc. Belg. Micr.,' iv. (1878). (3) Fletcher's Microtome (*ante*, p. 466). (5) Roy's Microtome (*ante*, p. 768). (6) Beck's Volute Turntable. (7) Sidle's Congress Turntable. (8) Diego's Turntable. (9) Bulloch's Cox's Turntable. (10) Rezner's Mechanical Finger (*ante*, p. 951).

Mr. Gilburt :—Sections through Cambium and Procambium, to illustrate his paper.

Mr. Guimaraens :—Slides of Zoological and Botanical subjects, prepared by Dr. Marsh, of St. Helens.

Dr. Stolterfoth :—Two slides of *Eucampia striata.*

Mr. F. H. Ward :—Section of wood (" Bois nephritique").

Col. Woodward :—Thirteen photographs of *Amphipleura pellucida* (*ante*, p. 672).

New Fellows.—The following were elected *Ordinary Fellows :*— Professor P. Martin Duncan, M.B. (Lond.), F.R.S., &c., and Messrs. D. B. Cazaux, T. G. Lyon, and A. C. Mercer.

Meeting of 12th November, 1879, at King's College, Strand, W.C. The President (Dr. Beale, F.R.S.) in the Chair.

The Minutes of the meeting of 8th October last were read and confirmed, and were signed by the President.

The List of Donations (exclusive of exchanges) received since the last meeting was submitted, and the thanks of the Society given to the donors, viz. :—

Nachet's Binocular Microscope (older form)	*Mr. Crisp.*
Graham Compressorium, for use with the Paraboloid	*Mr. W. Graham.*
Twelve Slides of the Diatomaceous Earth from Santa Monica, which was sent by Mr. Hanks, mounted by Dr. Gray from the scrapings of the broken pieces of the bottle, and the paper in which it was wrapped (see p. 983)	*Dr. Gray.**

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* Dr. Gray writes that Fellows interested in the matter can have a mounted slide of the Santa Monica deposit by applying and sending a postal box to the Assistant Secretary. Dr. Gray will only be able, however, to comply with a moderate demand, and will not mount any until he knows how many will be required.

Mr. F. H. Ward briefly described a microtome designed by him and exhibited to the meeting (see p. 957). Some sections of wood cut with this apparatus were shown under one of the Microscopes on the table.

Mr. Crisp, in exhibiting Zeiss's travelling Microscope, called attention more particularly to the very light quadruple nose-piece and the ingenious arrangement for giving universal movements to the mirror (see p. 955).

Mr. Beck remarked that the weight of English quadruple nose-pieces was not so much in the nose-piece itself as in the objectives it had to carry.

Mr. Gilburt made a short communication supplementary to his paper read at the last meeting, the substance of which will be found appended to the paper in a foot note at p. 806.

Colonel Woodward's "Note on certain Amplifiers of Zeiss as compared with those of Tolles," was read by Mr. Crisp, and the photographs of *Amphipleura pellucida* taken by both were laid on the table. The note also contained some remarks on the use of chloride of cadmium as an immersion fluid, especially for micro-photographic purposes, which will be found at p. 943. With regard to Zeiss's $\frac{1}{18}$, Colonel Woodward said, "I must add my testimony in favour of the exceedingly satisfactory performance of the new $\frac{1}{18}$ by lamplight, not merely on lined test-objects, which it displays in a more striking manner than even the $\frac{1}{12}$, but especially on such objects as white blood-corpuscles, and similar living tissue elements, bacteria, and the like, for the study of which it appears to me especially suited."

Dr. R. H. Ward's letter as to the matters to be brought before the National (American) Committee on Micrometry, was read.

Mr. Beck said it seemed to him that the important practical question which they wanted to determine was whether the scales which they did use were correct. If they had one from Paris, and another from Holland, they would find both of them to be incorrect. Some means was therefore desired by which they could be tested as to correctness.

Mr. Crisp referred to the paper by Professor Rogers on "Comparators for Measures of Length," which will be found at p. 947.

Mr. A. D. Michael pointed out that it seemed doubtful if there was in existence a really true standard metre.

Mr. Beck said he was not speaking of such minute variations as those which came into considerations of that kind, but of tests as they concerned the practical Microscopist. The question of the absolute length of a metre dealt, he thought, with matters of far greater minuteness than there was any real necessity to take notice of.

Mr. Teesdale referred to the instrument designed by Professor Suringar, of Holland, for testing the accuracy of micrometers, which was exhibited at the loan collection of scientific instruments at South Kensington.

Mr. Forrest's paper "On the Anatomy of *Leptodora hyalina*," was read by Mr. Crisp, the figures in illustration being enlarged upon the blackboard by Mr. Stewart (see p. 825).

Mr. J. Fullagar's Note on a curious fresh-water organism, which he had discovered, was read by Mr. Crisp, together with a letter from Mr. Saville Kent, who said that as far as he could judge it was closely allied to the marine *Freia ampulla* of Claparède and Lachmann, the tubes in one specimen having been apparently deserted by the Infusor and occupied by Rotifer, and promising to give a more precise determination on the receipt of living specimens.

Mr. Stephenson's paper "On a Table of Numerical-Apertures, showing the Equivalent Angles of Aperture of Dry, Water Immersion, and Homogeneous Immersion Objectives, &c.," was taken as read (see p. 839).

Mr. Mayall's paper "On an Immersion Stage Illuminator," was read by Mr. Crisp, and the apparatus which it described exhibited (see p. 837). Another paper, "Aperture Measurements of Immersion Objectives expressed as 'Numerical-Aperture,'" was taken as read (see p. 842).

Mr. Crisp read various letters and other communications received from provincial and foreign societies in connection with the Ex-officio Fellowship.

The President announced that the first Scientific Evening of the session would be held on December 3rd, in the Library of King's College.

The following Objects, Apparatus, &c., were exhibited:—

Mr. Badcock:—Abnormal forms of *Acinetæ*.

Mr. Bolton:—*Ophrydium versatile*, and *Limnias ceratophylli*.

Mr. Crisp:—(1) Zeiss's travelling Microscope (see p. 955). (2) Improved apparatus for counting blood-corpuscles (see p. 944).

Mr. Forrest:—Two slides of *Leptodora hyalina*.

Mr. Graham:—New compressorium.

Mr. Mayall, jun.:—Stage immersion illuminator.

Mr. Ward:—(1) Improved microtome (see p. 957). (2) Sections of wood of *Antiaris toxicaria* (upas tree of Java); double stained.

New Fellows.—The following were elected *Ordinary Fellows* :—Professor F. Jeffrey Bell, B.A.; Dr. C. F. Fischer; Rev. J. E. Vize, M.A., and Messrs. A. G. H. Gibbs, W. H. Gilburt, T. S. Goodall, W. Graham, W. Joshua, G. Williams, and S. King Wilson, M.R.I.

Honorary Fellows :—A. Agassiz, Cambridge (Mass.), U.S.; G. Balbiani, Paris; O. Bütschli, Heidelberg; L. Cienkowski, Kharkoff; P. T. Cleve, Upsala; M. Cornu, Paris; A. Dodel-Port, Zürich; Th. W. Engelmann, Utrecht; H. Frey, Zürich; E. Metschnikoff, Odessa; W. Nylander, Paris; C. A. J. A. Oudemans, Amsterdam; G. O. Sars, Christiania; F. E. Schultze, Graz; J. J. S. Steenstrup, Copenhagen; E. Strasburger, Jena; F. de Thümen, Klosterneuburg (Austria); Ph. van Tieghem, Paris; E. Warming, Copenhagen; A. Weismann, Freiburg, i. Br.; and K. A. Zittel, Munich.

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

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FELLOWS OF THE SOCIETY.

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DIRECTIONS TO THE BINDER.

(1) Pages 653–6, *signature* 2 *x**, are in substitution for the same page, *signature* 2 *x*, and the last are to be cancelled, where not already done.

(2) Pages 210* and 210§§ are to be placed after page 210.

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 in October, November, or December are not called upon for a subscription during the succeeding year, 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 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.