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ORIGINAL COMMUNICATIONS.

NOTE *on the* EXISTENCE *of a* PAIR *of* SUB-CUTANEOUS ORIFICES *in the* HEAD *of the* EEL *and* CONGER. By the REV. W. HOUGHTON, F.L.S.

HAVING been occupied at intervals during the last three months in dissecting a number of eels (*Anguilla acutirostris*) and a couple of Congers, I observed the invariable presence of two sub-triangular openings in the fleshy portion of the head, just at its juncture with the spinal column. My first impression with regard to the use of these orifices was that they were connected with the auditory organs, and that they probably led to the vestibular cavity. Although so far, I believe, as has hitherto been observed, the existence of external auditory organs in the whole class of fishes is very exceptional—the skates amongst the cartilaginous order, and a few of the members belonging to the *Gadidæ* and *Clupeidæ* amongst the osseous order alone possessing them—still I thought it not improbable that the eel, which is commonly supposed to hear well, and which is occasionally an overland traveller, might prove another exception to the general rule. I may observe that Mr. Cholmondeley Pennell, in his recently published work, 'The Angler Naturalist' (p. 397), asserts the presence of an "ear or auditory aperture" amongst the various mucus pores about the head, but from the most minute examination of a large number of eels' heads I can confidently affirm that no such external auditory aperture exists. I have, therefore, no doubt that Mr. Pennell must have mistaken two of the mucus pores for ears.

Upon my inserting a bristle in each of these orifices, and on clearing away the flesh from the head, I found that each bristle traversed a closed-in duct or tube in the cranium, and came out just above the orbital bone (see Pl. I, fig. 1). On making a vertical section of the skull, and examining with great care the vestibular sacs, I became convinced that the tubular ducts had no connection with them nor with the auditory nerve (fig. 4). Each of these tubes, which in the common eel is just wide enough to admit a fine piece of silk-gut, terminates in a membranous fold or hollow in the subcutaneous tissue just above the eye (fig. 5), and contains a certain quantity of thin fluid or lymph, which, by the way, bears no resemblance to *mucus*. Are these cavities reservoirs for the supply of fluid to lubricate the surface, and may we conjecture that the lymph is drawn up the tubular ducts by capillary attraction? There is little reason to doubt that the cranial ducts *are* connected with the so-called "mucus system" which is very complicated in the eel tribe, but *in what manner* they are so I have hitherto been unable to satisfy myself, and leave the determination of the question to the investigation of more experienced anatomists.

On the Illusive Appearances *produced by some* Transparent Objects. By Richard Beck.

To view an object by passing light through it, or, as it is commonly termed, to look at it as transparent, is a method of examination not only peculiar to the microscope, but also one to which the naked eye is quite unaccustomed. It frequently conveys to the mind most imperfect ideas of an object, and in very many instances it produces appearances which even in shape bear no resemblance to the true structure: of this fact, which is somewhat difficult of proof, most conclusive evidence may be furnished by a careful examination of the scales of Lepisma Saccharina.

This insect may be found in most houses, frequenting damp warm cupboards, or as an associate in the dark of black-beetles and cockroaches, and its scales have been long known to microscopists.

The insect, which is very active, should be caught without injury in a clean pill-box with a few pin-holes in the lid, and a drop of chloroform over these holes will soon make the inmate insensible, when it may be turned out upon a piece of clean paper.

The best way to remove the scales is to press one of the ordinary 3 × 1 glass slides gently upon the part from which the scales are required, and they readily adhere to the glass, appearing to the naked eye like a smear of dust; under the microscope they present a considerable variety, not only of size and shape, but also in the character of their markings.

Upon the scales that are most abundant the more prominent markings appear as a series of double lines, which run parallel and at considerable intervals from end to end of the scale, whilst other lines, generally much fainter, radiate from the quill and take the same direction as the outline of the scale when near the fixed or quill end; but there is in addition an interrupted appearance at the sides of the scale which is very different from the mere union or "cross-hatching" of the two sets of lines (see figs. 1 and 2, the upper portions).

Fig. I.

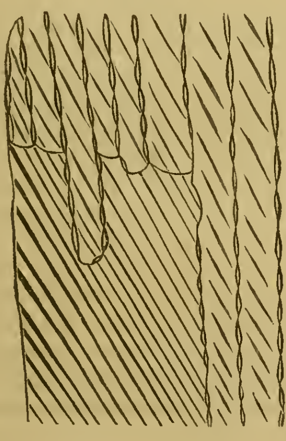
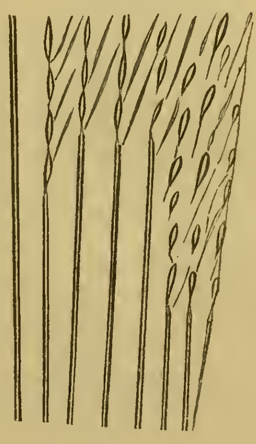


Fig. II.



The scales themselves are formed of some truly transparent substance, for water instantly and almost entirely obliterates their markings, but they reappear unaltered as the moisture leaves them; therefore the fact of their being visible at all under any circumstances is due to the refraction of light by superficial irregularities, and the following experiment establishes this fact, whilst it determines at the same time the structure of each side of the scale—a matter which it is impossible to do from the appearance of the markings in their unaltered state:—

Having removed some scales from the insect on a glass slide as already described, cover them with a piece of thin glass, which may be prevented from moving by a little paste at each corner. Fig. III may then be taken as an exaggerated section of the various parts.

A B is the glass slide with a supposed scale, C, closely adherent to it, and D, the thin glass cover, secured to A B by a very little paste at the corners. The object thus prepared should then be placed under a high power, the $\frac{1}{8}$ and No. 3 eye-piece, with the achromatic condenser illumination, answering well.

If under these circumstances a very small drop of water

Fig. III.

(E) be placed at the edge of the thin glass, it will run under by capillary attraction, but when it reaches the scale (C), it will run first between it and the glass slide A B, because the attraction there will be greater, and consequently the markings on that side of the scale which is in contact with the glass slide will be obliterated, while those on the other side will for some time at least remain unaltered; when such is the case the strongly marked vertical lines disappear, and the radiating ones become continuous (see fig. I, the lower left hand portion).

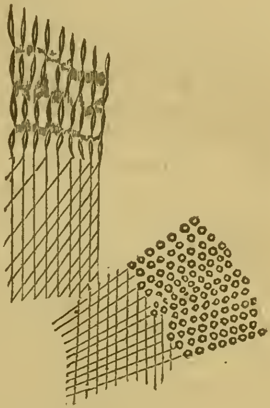
To try the same experiment with the other or inner surface of the scales, it is only requisite to transfer them, by pressing the first piece of glass by which they are taken from the insect, upon another piece of glass, to which a few scales will adhere, and then the same process as that already described may be repeated with them, when the radiating lines will disappear, and the vertical ones will become continuous (see fig. II, left portion).

These results therefore show that the interrupted appearance is produced by two sets of uninterrupted lines on different surfaces; the lines in each instance being caused by corrugations or folds on the external surfaces of the scales.

Whilst some may like to try this experiment for themselves, others will be satisfied with the appearance which a few scales are almost sure to present in every slide that is mounted. Figs. I and II already referred to are parts of a camera lucida drawing of a scale which happened to have the opposite surfaces obliterated in different parts ; this is seldom the case, and generally it is only the outer surface of the scale that is in such a condition.

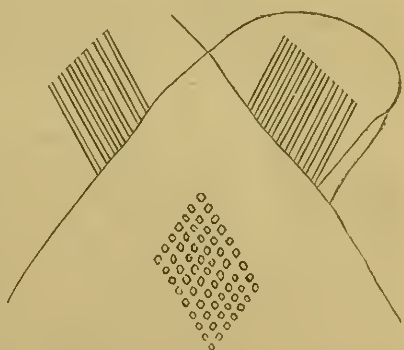
Fig. IV shows parts of a small scale in a dry and natural state; at the upper part the interrupted appearance is not much unlike that seen at the sides of the larger scales, but lower down, where lines of equal strength cross nearly at right angles;* the lines are entirely lost in a series of dots, and exactly the same appearance is shown in fig. V, to be produced by two scales at a part where they overlie each other, although each one separately shows only parallel vertical lines.

Fig. IV.



Considerable disturbances produced by the passing of light through transparent bodies are very common in microscopic objects, and when such is the case great care is required in the true interpretation of structure.

Fig. V.



In many cases I believe it may be almost impossible to arrive at the truth, yet some kind of analysis, that which I have alluded to being only one of many, should I think be employed before so many hasty and speculative theories are started upon the structure of many microscopic objects.

* The faint lines in this figure merely show the direction and not the character of the lines.

On the Importance *of* Raphides *as* Natural Characters *in* Botany. By George Gulliver, Esq., F.R.S.

It seems amazing that the importance of raphides in vegetable economy, and their great value as natural characters in systematic botany, should have received so little attention. Probably the chief reasons for this neglect are, that these beautiful crystals have been commonly regarded simply as curiosities, rather accidental than essential, and that sphæraphides and other forms have been too often confounded with raphides. Hence, indeed, has arisen such confusion that we frequently hear them alluded to merely as microscopic marvels and irregular products; and the character of raphis-bearing, which I have assigned to such orders as Balsaminaceæ, Rubiaceæ, and Onagraceæ, regarded as worthless. But if we restrict the term raphides, as proposed and defined etymologically in one of my former papers ('Ann. Nat. Hist.' for Sep. 1863), taking care to distinguish raphides from sphæraphides, that objection will cease altogether, and the value of raphides, as natural characters, become at once evident. Among British plants, it will be immediately seen what very different things the sphæraphides of Lythraceæ and Haloragaceæ are from the raphides of the intervening order, Onagraceæ; and that, though *Oxalis Acetosella* is not a raphidiferous plant, it abounds in sphæraphides. Numberless examples of the same kind might be cited.

I have been led to these remarks by Dr. Lankester's valuable paper in the last number of the 'Quarterly Journal of Microscopical Science,' and most cordially agree with the following remarks in that paper:—"The biography of our indigenous plants has yet to be written, microscope in hand, and it is not till the minute details of the cell-life of each plant has been recorded that we shall be in a position to arrive at the laws which govern the life of the vegetable kingdom." Now, as structure and function lie at the root of the best botanical classification, it is to be hoped that Dr. Lankester's hint will not be disregarded by the excellent editors of the new edition of 'English Botany,' so that some of the spare surface of the plates of that great national work may be employed to render them not less equal to the present state of science than they were to that science in the time of Sir James Edward Smith. To this end, no doubt, careful attention must be given to such characters as those afforded by the raphides, and by the forms, contents, and intimate structure of the pollen, hairs, and tissue-cells; as well as by the anatomy of the fruit of Umbelliferæ, and by outlines quite as accurate, plain, and instructive as those engraved by Andersson and other foreigners of the parts of fructification in Cyperaceæ and Gramineæ.

But as to the value of raphides as natural characters, and to their importance in the vegetable economy at all, doubts such as those above cited will at present be entertained. Schleiden asserts that "the needle-formed crystals, in bundles of from twenty to thirty in a single cell, are present in almost all plants," and that "inorganic crystals are rarely met with in cells in a full state of vitality" ('Principles of Scientific Botany,' translated by Dr. Lankester, pp. 6 and 91). And under the head of "Raphides," in the last edition of the valuable 'Micrographic Dictionary' (which I now quote from memory), we are told that there are few of the higher plants that do not contain them; that they are very abundant in Monocotyledones generally, as well as in Cactaceæ, Euphorbiaceæ, Urticaceæ, &c., among Dicotyledones; and that they occur in vast quantities in the leaves of Araceæ, Musaceæ, Liliaceæ, Iridaceæ, and Polygonaceæ, and in the sepals of Orchidaceæ and Geraniaceæ. The meaning of the illustrious German is plain; and that sphæraphides and other kinds of crystals are all called raphides in the 'Micrographic Dictionary' is equally certain, as any one may see by comparing the raphides of *Orchis* and *Arum* with the sphæraphides of *Parietaria* and *Geranium.*

Let us therefore note a few of the leading facts which I have at present obtained, premising that the term raphides will be restricted throughout this paper to the needle forms generally occurring in bundles, so easily broken up that the individual crystals are very apt, under gentle friction, to separate from each other and from the tissue in which they are produced. We shall thus exclude even other acicular but less slender crystals occurring either singly or two, three, or four together, sometimes as if partly fused into each other, and by no means easily separable either from one another or from the plant-tissue in which they exist; and, of course, the curious starch-sticks of the latex of Euphorbiaceæ ('Ann. Nat. Hist.' for March, 1862, p. 209) will be totally rejected from the order of saline crystals.

Adopting this course, we shall soon perceive that the formation of raphides must be an important and special function in the economy of certain plants, and that the result of this function may afford valuable natural characters, sometimes more universally available than any other single character ever before adopted or proposed.

To show this, it will be sufficient to confine our attention, on the present occasion, to the leaves, and parts which are modifications of leaves, where we shall surely find raphides abundantly in certain plants, and at all seasons and in every variety of soil; while in other plants raphides are as surely not so produced. Nay, even of two species belonging to different but closely allied orders, and growing close together in the very same spot of earth, the one will as constantly abound in raphides as the other will be destitute of them. But the last species may abound in sphæraphides instead; and these are so widely different from raphides that it would be a needless waste of time to repeat their diagnostics, which may be realised in a few minutes by any one who will compare them in such plants as *Epilobium* and *Myriophyllum*. Further, several species of one order, as Liliaceæ, may thus regularly differ in the presence or absence of raphides, of which *Endymion* and *Allium* afford curious examples.

Proceeding with our inquiry, it will be found that some raphidiferous orders may stand in the very centre of other orders not producing raphides. Thus, for example, as numbered and expounded, from other characters, in Professor Balfour's admirable 'Manual of Botany:'

100. Loranthaceæ.	102. RUBIACEÆ.	103. Valerianaceæ.
101. Caprifoliaceæ.		104. Dipsacaceæ.

Now, Rubiaceæ is not more distinguished here in print than in the type of nature as a raphis-bearing order, so far as my examination of the British plants has yet extended. In other words, I have never found a species of the central order without a plentiful crop of raphides, while search was vainly made for any traces of such crop in several species of the four surrounding orders.

Further, with the instructive company of Professor Babington's 'Manual of British Botany,' we may view an order conversely; that is to say, regularly devoid of raphides, and yet standing between two orders as regularly raphidiferous:

80. DIOSCOREACEÆ. 81. Hydrocharidaceæ. 82. ORCHIDACEÆ.

And here we shall find Hydrocharidaceæ differing as remarkably in the want of those raphides in the possession of which, on the contrary, its next neighbours are so rich.

Again, as for Monocotyledones, which are said in our books to abound so much in raphides, I have often examined all the grasses of a field, of which no less than eleven species were determined, besides four species of *Carex*, and never found raphides in any one of them. Nor have my examinations of *Alisma* and *Potamogeton* been more successful; and yet raphides are plentiful in all the orders standing in Professor Babington's book between those orders of which *Alisma* and *Potamogeton* are the types.

But, disregarding botanical arrangements, if we try at random such plants as may be met with in a short walk, we shall find that various species near in habit, however remote in alliance, and growing in the same place, with their leaves or roots more or less in contact, differ in nothing more constantly than in the presence or absence of raphides. Thus, we shall scarcely find raphides in trees or shrubs, though these plants, like numberless other Phanerogamia, abound either in sphæraphides or minute crystals, of which good examples may be seen in the petioles, leaves, or bark of *Salix, Populus, Ulmus, Tilia, Lonicera, Vinca,* &c.; and in the first pool may be found *Lemna, Callitriche, Stratiotes,* and *Hottonia,* of which *Lemna* only is a raphis-bearing plant. On the same hedge-bank we find various species of Onagraceæ and Rubiaceæ, intermixed with as many species of Umbelliferæ, Leguminosæ, Labiatæ, and Filices, and all the plants of the two former orders as certainly affording raphides as all the plants of the four latter orders will be devoid of raphides. Moreover, of two plants, such as *Galium palustre* and *Valeriana sambucifolia,* growing together in the same damp place, the first will as regularly contain raphides as the second will be destitute of them. A collection of a very large number of similar examples has accumulated in my note-book, from which those now given are selected because they are among several of which the accuracy of the facts has been verified at various seasons and years and in diverse soils, and which facts first convinced me of the crudeness of the existing knowledge of the subject.

As to the real value of such facts, and the exceptions which may be found to weaken their significance, doubtless very extensive and elaborate researches are yet required. We may expect, especially as regards exotic botany, that they will be more or less modified, corrected, extended, and confirmed; for we know that Nature, as if in abhorrence of our definitions of organic productions, is prone to furnish exceptions to the best and most comprehensive botanical and zoological characters.

But surely the sum of the observations which we have already adduced is sufficient to prove that she has appointed certain plants as laboratories of a special compound in the peculiar form of raphides, while to other plants that function is not assigned, though these may abound in different crystals, some of which may occur also with raphides in truly raphidiferous plants. By chemists the raphides are said to be phosphate of lime, and no physiologist will doubt the importance of this salt in the vegetable and animal economy. Thus we can easily understand the utility, and the cause of that utility, even of such abject and despised things as the common Duckweed ('Ann. Nat. Hist.' for May, 1861, and January, 1863). Besides the instances now adduced with regard to raphis-bearing plants, we have elsewhere ('Ann. Nat. Hist.' for November, 1863, fig. 1) proved that this function is a central one, second only in rank to the preservation of the species, and always, in some plants, at work from the ovule to the seed-leaves, thence, through the regular leaves and their modifications, to the parts of fructification; in the root also, as in Dioscoreaceæ and Smilaceæ; this function indeed never ceasing during the vigorous life of the plant from the cradle to the grave; and, in short, being an essential and significant result of that life. So far, then, from considering raphides as minor or accidental formations, we must conclude that they are the expression of a necessary, fundamental, and constant phenomenon in the very nature of the plant-life in such cases as we have already noticed. And so really practical may this truth be, that, for gardening purposes, I have easily picked out, simply by the raphides, pots of seedling Onagraceæ which had got accidentally and inconveniently mixed with pots of other seedlings of the same age, and at that period of growth when no botanical character before in use would have been so readily sufficient for the diagnosis.

In conclusion, it may be remarked that any truly accurate and comprehensive plant-history must include such important products as the raphides; and whenever they may be available botanical characters, as we have shown that they often really are, where could any one exponent be found more constantly present and surely expressive of the nature and economy of the plant? And so we may hope that no history or arrangement, pretending to be a natural one, either of the whole or part of the vegetable kingdom, will henceforth appear without a proper indication of those examples in which a very essential, significant, intrinsic, and characteristic function of the plant-life is the production of raphides.

On the Ultimate Distribution *and* Function *of very* Fine Nerve-fibres.

We desire to call the attention of our readers to some important observations and conclusions by Dr. Beale, with reference to the ultimate distribution of nerve-fibres in various tissues recently arrived at from *direct observation.* Most physiologists have endeavoured to ascertain the functions of nerve-fibres, and the ultimate destination of certain branches, by experiments upon living animals; but Dr. Beale has for many years past devoted himself to the study of this subject in a very different manner. He has sought to establish many general propositions by direct anatomical observation, and has devised new methods for preparing the tissues, and for examining the thinnest possible sections under very high powers varying from 1800 to 3000 diameters.

Perhaps one of the most important and interesting of his conclusions is the demonstration of the existence of nerve-fibres, which probably bear to the vaso-motor nerves distributed to the coats of the small arteries the same relation that afferent or excitor fibres bear to efferent or motor-spinal nerves. The paper in which this inference is arrived at is published in the last number of the 'Archives of Medicine' ("Of very fine Nerve-fibres ramifying in certain Fibrous Tissues," &c. By Lionel S. Beale.)

The author states that researches upon which he has been long engaged have convinced him that the *ultimate nerve-fibres* in all tissues are much finer and more abundantly distributed than is generally supposed, and that the active terminal branches of many nerves, where they ramify abundantly in tissues, have been included by many authors in the so-called connective tissue. The terminal branches of all nerve-fibres are so very fine as not to be visible by magnifying powers in ordinary use—many in the frog being less than the 1-100,000th of an inch in diameter. In man and mammalia they are wider than this, but appear as faint granular and too often scarcely visible bands. In the frog, although so fine, they are much more distinct, and being firmer, are much more easily studied than in mammalia.

All peripheral nerve-fibres are connected with nuclei (germinal matter), but these nuclei are separated by much greater distances in the nerves distributed to some tissues than others. The nuclei are for the most part *oval,* but in some cases they are *triangular.* These bodies, which exist in great number in many sensitive surfaces, as, for example, just beneath the epithelium of the mucous membrane of the fauces, have been and are still considered by many authorities to be connective tissue-corpuscles. Not a few observers in this country as well as on the continent, following Virchow and his school, consider that they communicate with each other by tubes, and thus form a new canalicular system for conveying nutrient juices.*

The so-called nuclei *are never terminal,* but a fibre always passes from each nucleus in two or three different directions. Not only nuclei, but nerve-fibres have by many observers been included under the head of connective tissue. Nor, indeed, can these fine terminal nerve-fibres be demonstrated in fibrous tissues in which they exist in great number by the ordinary processes employed in demonstration. They can only be seen in exceedingly thin sections, and with the use of the highest powers. Not only are nerve-fibres present in certain forms of connective tissue, but there are many fibrous tissues *destitute of vessels* to which nerves are distributed. In the *cornea,* in the fibrous tissue about the *pericardium,* the *pericardium itself,* and the bundles of fibrous tissue in connection with *the vessels and various organs* in the *abdominal cavity* of the frog, nerve-fibres are very numerous.

Dr. Beale has succeeded in demonstrating nerve-fibres in connection with the vessels in so many tissues of the frog, and of certain mammalia, that he is strongly inclined to the opinion that in vertebrate animals nerve fibres exist wherever vessels are present. These remarks apply not only to the smallest arteries and veins, but also to the *capillaries.*† Since the capillaries are devoid of muscular fibre-cells, and do not possess contractile power, it is probable that these fine nerve-fibres associated with the capillary vessels are *afferent* fibres.

In the papillæ of the frog's tongue, for example, besides the bundle of sensitive nerve-fibres passing up the central part of the papillæ, there are very fine nerve fibres distributed to the vessels, and some fine fibres in the connective tissue external to the vessels. Similar fibres exist in the small papillæ, to which neither vessels nor dark-bordered nerve-fibres are distributed. The nuclei connected with these fibres are about the 1-300th of an inch or more apart. Now these fibres are not ordinary fibres of connective tissue, for the author traced them into undoubted nerve-fibres. More-

* See a paper on the "Distribution of the Nerve-fibres to the Mucous Membrane of the Human Epiglottis." 'Archives,' vol. iii, p. 249.

† See figs. 5 and 9, in plate xxiii, 'Phil. Trans.,' 1860.

over the fibres and nuclei are much more abundant in connection with some capillaries than others. They are very numerous upon the smallest vessels of the ciliary processes of the eye (ox), as well as upon those which are provided with muscular fibre-cells, and many are to be found in the connective tissue upon the free border of the finest vessels. He considers that these branches are in part afferent or excitor and partly efferent or motor nerves of the vessels.

The fact of the presence of undoubted nerve-fibres in tissues destitute of vessels, and deriving their nutriment from the plasma permeating vessels situated perhaps at some distance, is another strong argument in favour of the existence of afferent nerves, bearing to the vaso-motor branches the same relation as the excitor fibres bear to the spinal motor nerves. Such fine nerve-fibres are distributed to the cornea of all animals, and very fine fibres ramify upon different planes in the substance of the proper corneal tissue. From their distribution we are justified in assuming that these fibres are not ordinary sensitive fibres, but are nevertheless concerned in transmitting impressions of some sort from periphery towards nervous centres, while in certain morbid states they are probably instrumental in transmittiug impressions which produce the sensation of pain. Ordinarily, these afferent and efferent fibres preside over the nutritive process, and it is easy to conceive how any alteration in the amount of nutrition passing to the tissue must influence, through the nuclei and afferent fibres, the ganglia from which the vaso-motor branches take their rise. Thus the calibre of the minute arteries may be altered by the slightest modification in the supply of pabulum to the tissues outside capillary vessels dependent upon any mechanical or chemical alteration in the tissue whereby the activity of the nutritive changes becomes altered. Normally, the balance between the quantity of pabulum taken up by the tissue and that escaping from the capillaries would be maintained through these afferent and efferent fibres, and it is easy to understand how any derangement of afferent fibres, nerve-centre, or efferent branches would disturb the nutritive process.

Dr. Beale thinks that the rapidity of growth of tissues is determined solely by the supply of pabulum, and this supply is regulated and equalised by a special system of nerves which is, however, connected with the cerebro-spinal system, and may influence it, or be influenced by it. He has been led to the conclusion that nerves invariably form complete circuits, and that there are afferent or excitor nerves and efferent or motor nerves presiding over the nutritive processes, which may act independently of the cerebro-spinal nerves or centres.

It might be asked, if the author holds that there is a complete circuit in the case of the afferent and another in that of the efferent fibres distributed respectively to the tissues and small arteries, or if the afferent and efferent fibres form part of the same circuit, in which case an impression might be transmitted to, and a motor impulse start from, the same ganglion-cell; but he postpones the consideration of this part of the question.

The fine nucleated fibres distributed in the neighbourhood of capillary vessels, and to tissues which do not receive a vascular supply at all, form, in the tissues of the frog generally, fine trunks consisting of several very fine fibres, and these unite to form larger trunks, which, as a general rule, are accompanied by one or more dark-bordered fibres, but in the bladder, in the heart, and also in the mesentery, large trunks exist which are composed entirely of these very fine fibres, and at certain points plexuses are formed. In the cornea the individual fibres are not so distinct, nor are the fibres so decidedly separated from each other as in the drawing accompanying the author's paper. Many seem to be in course of splitting, an appearance more like that seen in the sympathetic branches of birds and mammalia, where the fibres in a trunk appear to be connected together forming bands.*

It is quite certain, therefore, that the fine fibres above described are independent of the dark-bordered fibres. But, it will be asked, are all the fine fibres in the trunks—for example, in those represented in the figure—afferent fibres? In a trunk passing from the cornea, doubtless, all are of this nature, but Dr. Beale has seen many such fibres passing amongst the muscular fibre-cells of the bladder, and also to the contractile coats of the small arteries, so that at least in this case it is probable that some of the fibres entering into the formation of the plexus figured, are *afferent* and others *efferent*. There are no characters by which one class of fibres can be distinguished from the other. Amongst the nerves forming the large bundle which supplies a limb, some bundles of fine fibres, which probably belong to the same class, are to be found, but the author has never seen large bundles of very fine fibres like those in the bladder and mesentery, in the voluntary muscles. Such bundles, however, do exist in connection with the heart.

The bundles of fine fibres at their peripheral distribution form plexuses and networks. The author has never seen any *termination* in any case. The fine nerve-fibres distributed to

* The arrangement of the nerve-fibres in the cornea of various animals is fully described in an elaborate paper by Dr. Ciaccio, of Naples, in No. XI of this Journal.

small arteries and veins also form networks, and very fine fibres can be traced ramifying amongst the muscular fibre-cells on different planes. Kölliker suggests that 'such fibres ramifying on the outer part of small arteries and veins distributed to voluntary muscle, and on fine vessels on the arterial side of capillaries destitute of a muscular coat, are of the sentient kind. The latter fibres are probably afferent or sentient, but Kölliker's remarks on this question are very undecided, and he does not profess to have studied the subject carefully. It is very hard to conceive what purpose could be served by the free distribution of sentient fibres upon and in the substance of the *muscular coat* of an artery. Some of the fibres running with vessels distributed to voluntary muscles are certainly motor branches, for, after running parallel with vessels for some distance, they diverge and are distributed to the muscular fibres. Kölliker considers certain nerves for the most part on the surface of the muscle as *sentient fibres*, but he adduces no facts which show that this view is correct.*

It is important to state definitely that the bundles of very fine fibres, distributed to the frog's bladder and in other tissues, are not visible in specimens prepared in the ordinary manner and examined in water or weak glycerine. In the bladder from which the specimen figured in No. xiii of the 'Archives,' plate I, was taken, there was no appearance whatever of these very fine fibres when the specimen was first prepared, but after the prolonged action of dilute acetic acid, a great number of bundles, many of which were as much as $\frac{1}{2000}$th of an inch in diameter, and very many finer compound fibres, made their appearance. The vast majority of these bundles of fine fibres were not only destitute of true dark-bordered fibres, but of any one fibre more than the $\frac{1}{60,000}$th of an inch in diameter.

It is scarcely probable that any observer will doubt that the fibres figured are true nerve-fibres. Their mode of arrangement, the manner in which the trunks branch and ramify amongst the muscular fibre-cells, the character of the nuclei connected with the fibres, and the change produced in them by the action of acetic acid, show them to be nerve-fibres. The author has already proved that very fine fibres invariably form the continuation of dark-bordered fibres, and that fibres, as fine as some of the finest of these, ramify in the same sheath with the dark-bordered fibre, even in the case of the dark-bordered fibres distributed to voluntary muscle ('Phil. Trans.' 1862).

But that these very fine fibres in the bladder, which the author

* "Croonian Lecture," 'Proceedings of the Royal Society,' 1862.

believes have now been demonstrated for the first time in his specimens, are true nerve-fibres, is placed beyond all question by the fact of their being continuous with ganglion-cells. He has seen several ganglion-cells from which such fine fibres alone (every one being less than the $\frac{1}{50,000}$th of an inch) proceed. From different parts of one ganglion-cell sometimes six or seven or more very fine fibres may be traced, while not a single dark-bordered fibre comes near to the cell or bundle of fibres under consideration.

Dr. Beale fears that the accuracy of these observations will be questioned by many fellow-workers in Germany, and more especially by those of the Dorpat school, and the difficulty of preparing the specimens is so great, that his conclusions are scarcely likely to be confirmed for some time to come. The appearances are, however, so distinct that he has been able to demonstrate the most important points to the students of his physiological class. As the specimens will keep for a considerable length of time, they can be examined by any one desirous of seeing them.

It would seem then that in the frog these fine fibres are distributed to *capillary vessels*, to *fibrous tissues devoid of capillaries*, to the *tongue* and *palate*, to the *unstriped muscle of the bladder*, *pharynx*, *gullet*, *stomach*, and *intestines*, to the *unstriped muscle distributed* to the *coats of arteries*, and to the *muscular fibres of the heart*, and probably they are to be made out in many other tissues than those above named.

The author is unable to enter fully into the question of the distribution of the different classes of nerve-fibres to the various tissues of the frog's bladder, nor can he discuss satisfactorily their several offices; but on these important questions he offers the following remarks:—

With reference to the kind of nerve-fibres, it is certain that—

1. Dark-bordered fibres are distributed to the bladder of the frog, and that the very fine terminal fibres, resulting from the subdivision of these, are freely distributed with the ultimate branches of other nerve-fibres.

2. That there are fine fibres running in the same sheath with the dark-bordered nerve-fibres, as he has described in the case of dark-bordered fibres distributed exclusively to voluntary muscle. See 'Archives,' vol. iii, and 'Phil. Trans.,' 1862 (just published).

3. That there are very *many* bundles of very fine fibres which sometimes run with dark-bordered fibres, and sometimes also form special trunks destitute of dark-bordered fibres.

4. That many of these very fine fibres are directly connected with ganglion-cells upon the outer surface of the bladder.

5. It is certain that *many* ganglion-cells have no dark-bordered fibres whatever in connection with them; but the author has demonstrated that some ganglion-cells are connected with dark-bordered fibres.

In considering the function of this most elaborate and beautiful nervous arrangement, it must be borne in mind—

1. That the muscular fibre-cells and vessels of the bladder are freely supplied with nerves.

2. That nerves ramify upon the surface of the mucous membrane.

3. That the bladder contracts when the nerve-fibres, distributed to the skin of the animal, are irritated, and its contraction seems also to be under the influence of the will of the animal.

The author thinks it probable that the nerves, distributed to the muscular fibre-cells of the bladder, are branches of the same trunks as those distributed to the vessels, and are connected with the ganglion-cells. As already stated, the numerous nerve-fibres in the cornea and other fibrous tissues are purely afferent, and through the centre into which they are implanted, they influence the motor fibres distributed to the nearest vessels. In the bladder there are afferent fibres corresponding to those in the cornea, and efferent or motor fibres distributed to the vessels, and also to the muscular fibre-cells.

Whether the dark-bordered fibres are purely sensitive, or whether some spinal motor fibres thus pass directly to the bladder, the author is unable to say. It is probable that the fine fibres running with the dark-bordered fibres of the bladder correspond to those in the same sheath with purely motor or sensitive dark-bordered fibres. It is, however, not possible to discuss this question advantageously until many points in connection with the general distribution and function of the different classes of nerve-fibres are cleared up.

The most important of the many conclusions arrived at from this investigation is the demonstration of numerous fine nerve-fibres around capillary vessels, and the inference that there are afferent fibres corresponding to and influencing the efferent or vaso-motor branches distributed to the small arteries. The inference that *all* small arteries and the fibres of unstriped as well as striped muscular fibres are freely supplied with nerve-fibres, is also most important.

On some Parasitical Insects *from* China.

By Henry Giglioli.

Some time since, Mr. Swinhoe, who has done so much towards advancing our knowledge of Chinese ornithology, presented me with several parasitical insects, which he had met with during his zoological investigations in China. Finding them interesting and mostly new, I thought that a description of them might be useful.

They are seven in all; four belonging to the *Anoplura*, and the three others to the *Diptera*. I shall commence with the former; first giving my best thanks to Mr. H. Denny, of Leeds, who has most kindly assisted me in identifying the species.

It is to that persevering Italian naturalist, Francesco Redi, that the history of epizoic parasites owes its beginning, towards the latter part of the seventeenth century. Since then, De Geer, Fabricius, Latreille, Leach, and Burmeister, have contributed not a little to that part of entomology which the recent labours of Léon Dufour, Denny,* and Gervais,† have so much advanced.

De Geer first divided them into—*Pediculi* (with a suctorial mouth, and inhabiting chiefly mammals), and *Ricini* (with a mandibulated mouth, and living mostly on birds). Dr. Leach included both divisions under the term *Anoplura*.

Those I shall describe belong to the *Ricini*. These creatures abound on birds, many species of which possess their peculiar louse, and some even two or three species, found only on them; they hide amongst the feathers, on the extremities of which they appear when the bird dies.

Some authors opine that the down next to the skin constitutes their nourishment, while others, with more reason, think that they live on the blood of their host.

The Anoplura here described all belong to the old genus *Philopterus* of Nitzsch, which has by subsequent authors been divided into several genera.

Genus Lipeurus, Nitzsch.

Body more or less narrow and elongated. Head of moderate size, rather narrow; cheeks rounded, no *trabeculæ*.

* H. Denny, 'Monogr. Anoplurorum Britanniæ.'

† Walckenaer et Gervais, 'Hist. Nat. des Insectes Aptères,' vol. iii, pp. 307—361, Paris, 1844.

‡ 'Thierinsekten,' p. 34.

Antennæ greatly modified and cheliform in the male, having the first joint much longer and thicker than the rest; in the female they are straight and simple. Last segment of the abdomen notched behind in the male, truncated and notched, or wholly cleft.

The species of this genus have been observed on diurnal *Raptores, Gallinæ, Grallæ, Natatores,* and *Cursores;* they are of large size.

Lipeurus Diomedeæ, Dufour. (Pl. I B, figs. 1, 2.)

Pediculus Diomedeæ, Fabricius.*

This large and interesting species has been known to naturalists a long time as inhabiting the common albatross (*Diomedea exulans*). After Fabricius, Dufour described it† at length, together with two other lice peculiar to the same bird. The most remarkable fact relating to my specimens is, that they come from the *Diomedea brachyura,* which inhabits only the Pacific north of the line, while the *D. exulans* is only found south of the equator. Thus it is very strange that two of the parasites inhabiting these birds should be identical, for the following species is also found in both.

The *L. Diomedeæ* is $\frac{3}{10}$ths of an inch in length; its form is elongated, and it is of a blackish-chestnut colour. The body is nearly glabrous; only a few hairs are scattered about the fore part and sides of the head, and on the sides of the abdomen.

The head is rather narrow, elongated, and quadrilateral; in the male deeply notched behind; in the female it has a more triangular shape, and is less notched behind. Dufour describes the head of the female as white, margined with chestnut-brown. In my specimens the white is reduced to a median line, rather larger than that on the head of the male.

Antennæ in the female (fig. 1) shorter than the head, nearly straight, and composed of five cylindroid joints. Those of the male (fig. 2), in form and insertion, resemble more mandibules or *maxilli-pedes* than *antennæ.* Redi first drew attention to this remarkable fact in his *Pulex pavonis.*‡

In the male *L. Diomedeæ* the antennæ consist, as in the female, of five joints, and are about $\frac{1}{20}$th of an inch in length.

* Joh. Christ. Fabricii, 'Entomologia Systematica,' tom. iv, p. 421, Hafniæ, 1794. He describes it thus:—"Capite obtuso albus, abdominis lateribus nigris."

† L. Dufour, "Description et Iconographie de trois espèces du genre *Philopterus,* parasites de l'Albatros;" 'Ann. Soc. Ent. de France,' vol. iv p. 669, figs. 1 and 2, 1834.

‡ F. Redi, 'Exp. circa Gen. Ins.,' tab. 14.

The first joint is very thick and rounded, the convexity being outwards; on the basal portion of its inner side is a spine-like process; its proximal half is white, the rest chestnut-brown. The second and third joints are much smaller, both bent, and forming an elbow with the first. A little behind the extremity of the third joint, on its outer side, are placed the two terminal pieces, which are the same as in the female, showing how the normal type is not altogether done away with. This last part performs the tactile functions which belong to the antenna, while the rest is used as a prehensile arm, and embraces the female during copulation.

The eyes are prominent, lateral, and hemispherical, of moderate size. The mandibules are oblong, and bifid at their extremity, situated behind a large, rounded space, which is a suctorial apparatus.

The *thorax* consists of two distinct segments, the *prothorax* and the *metathorax;* it is longer than the head, and gradually widens from above downwards; its sides are notched by a row of small tubercles. The metathorax is about three times as long as the prothorax, which supports the anterior pair of legs. Dufour states that the inferior part of the metathorax is divided into three longitudinal portions in the males. These were not very distinct in the specimens I examined; but the mesial dorsal groove, and the tuft of long, stiff, reddish hairs, directed backwards on the anterior side of each of its posterior angles, were very distinct; each tuft consists of seven long setæ; they are common to both sexes.

The *abdomen* is longer than the head and thorax together; it is composed of nine segments, the last one being small and inconspicuous; in the male it forms a single truncated process, divided by a cleft, but not bifid; in the female it is deeply cleft, forming two processes, each provided with two long setæ, which had been broken off in my specimens. The inferior margin of each abdominal segment is bordered by a narrow white line.

The anterior pair of legs are very short, thick, and strong, being evidently scansorial; the middle and posterior pairs are much longer, especially the last; the *coxæ* are of moderate size; the *femora* and *tibiæ* long and strong; the *tarsi* rudimentary, and terminated by two curved claws of equal size, and parallel. On the inner side of the distal extremity of the *tibiæ* in the anterior pair of legs is a pointed spine. This species is found on the *Diomedea exulans* and on the *D. brachyura,* and probably on the other species of Diomedea.

Genus Docophoroides, Denny, MSS.

This genus has been proposed by Mr. Denny, and will be published in his forthcoming work on 'Exotic Anoplura.'

The species which form it present the same general characters as the genus *Docophorus*, but they have the head rather smaller in proportion, the thorax larger, and the *antennæ* in the males are modified, though not so much as in the preceding genus.

Docophoroides brevis. (Pl. I B, figs. 3, 4.)

Docophoroides taurus, Denny.

Philopterus brevis, Dufour.

This smaller species also infests *D. exulans*, from which Dufour described it.* I have it from *D. brachyura.*

Body short, broad, and ovate; of a uniform brown-chestnut colour. Length $\frac{3}{20}$ths of an inch. Head large, sub-triangular, broader in the male at the base; occipital border sinuous, with the posterior angles detached and rounded, provided with a few diverging hairs. The anterior part of the head terminates in a truncated snout, with a chaperon-like, circumscribed space of a lighter colour, separated from the rest of the integument by a whitish line. On each side of the head in both sexes, above the insertion of the *antennæ*, is a pointed process directed backwards.

Antennæ simple, and nearly straight in the female; composed of five cylindro-conoid joints. Those of the male are sub-cheliform; the modification, however, is not carried so far as in the *L. Diomedeæ.* The first point is cylindrical, about half as long as the second; the third is bent, and obliquely truncated distally; the two last joints, having the normal form, are inserted in the midst of this truncation.

Eyes hemispherical, of moderate size.

Thorax about as long as the head, marked by a mesial longitudinal groove; it diminishes from down upwards. The *prothorax* is distinct from the metathorax, which has a small tuft of setæ on the interior of its posterior angles.

The abdomen is broader than the head, very broad in the female, and about as long as the head and thorax together; in the male it is narrower and longer. It is composed of eight segments, and in the female is cleft at its extremity; in the male the abdomen, besides the eight segments, has an additional rounded piece, covered with large setæ; above it, on the median line, is the reproductory apparatus, with a

* Loc. cit., p. 674, fig. 3.

copulating organ (fig. 5), which has a dilated extremity of the shape of an arrow-head, with a duct running through its middle.

The legs are thick and short, the *femora* very thick and rounded; the first pair are shorter than the other two, and have two spines at the distal extremity of their *tibiæ;* on the under margins of the *tibiæ* of the intermediate and posterior pair of legs are seven or eight tufts of *setæ,* bent backwards.

Genus Docophorus, Nitzsch,* Denny.†

Body broad. Head very large, temples rounded; two movable trabeculæ in front of the antennæ, which are alike in both sexes. The last segment of the abdomen is entire and rounded in the male They live on all birds except *Gallinæ* and *Columbæ.*

Docophorus mandarinus, Giglioli, sp. nov. (Pl. I B, fig. 9).—This small and curious species inhabits the Chinese blackbird, *Merula mandarina.* Its length is about $\frac{1}{10}$th of an inch; its body has the shape of a flask, the head being the stopper; it is of a light-brown colour.

The head is enormous, triangular, produced anteriorly into a broad truncated snout, with a large space divided off by a narrow white line. *Trabeculæ* large and rather obtuse.

Antennæ straight, composed of five cylindroid joints, the basal one being the largest. Posterior angles of the head large and rounded, with a few divergent hairs on the edge; occipital line sinuous. Mandibules thick and bifid.

Thorax about half as long as the head; it widens gradually downwards, but is always narrower than the head. The *prothorax* is very narrow, the metathorax is wider, but both are very short, and, were it not for the legs, would be confounded with the abdominal segments; the metathorax, as these, has a transverse line of long setæ on its inferior margin.

The abdomen is divided into eight segments, the last being cleft in the female. I possess no male.

Legs short and thick, especially the first pair, which are evidently scansorial; the *femora* are broad and convex externally; the *tibiæ* are short and thick, with spines at their distal extremities; the tarsi are rudimentary, and terminate in two claws.

Genus Nirmus, Nitzsch.‡

Body narrow. Head of moderate size; temples more or less

* 'Thierinsekten,' p. 31.
† 'Anop. Brit.,' p. 63.
‡ 'Thierinsekten,' p. 33.

rounded; *trabeculæ* obsolete or fixed. Antennæ equal in both sexes, or rarely thicker in the males.

They are found in considerable numbers on all birds.

Nirmus mandarinus, Giglioli, sp. nov. (Pl. I B, figs. 7 and 8).—Body long and narrow; its total length is rather more than $\frac{1}{10}$th of an inch. This species inhabits also the *Merula mandarina;* another, the *N. merulensis,* infests the European blackbird. This Nirmus is of a whitish colour, edged all round with brown.

Head decidedly triangular, rather large; in front, a small space is divided from the rest by a white line; the occipital line is nearly straight. *Antennæ* simple, composed of five cylindroid joints; *trabeculæ* small and inconspicuous; mandibules rather slender.

Thorax shorter than the head, and much narrower; distinctly divided into a prothorax and metathorax.

The abdomen is very large; it is at first narrow, then enlarges, and is truncated and broad distally; it consists of eight segments, the last being very slightly cleft; a few hairs are scattered on it.

Legs rather long and thick, even the anterior pair; the terminal claws are also long and much curved.

The three remaining insects I shall describe are Diptera, and belong to the *Pupiparæ,* insects which live by sucking the blood of mammals and birds, on which they are found, by means of an apparatus more conformable to that of certain Acarina than to the proboscis of other *Diptera.*

Two of my species belong to the family of the *Coriaceæ* or *Hippoboscidæ,* one being an *Ornithomyia,* the other a *Strebla.* Before describing them I must give my best thanks to Professor Westwood, of Oxford, for the kind aid he has given me.

Genus Ornithomyia, Latreille.

Eyes distinct; ocelli usually three in the vertex; wings incumbent, full sized; nerves distinct, extending to the apex; antennæ ciliated; tarsi with tridentate claws. They inhabit only birds.

Ornithomyia Chinensis, Giglioli, sp. nov. (Pl. I B, fig. 10.)—This is as yet the only species received from China. Mr. Swinhoe found it on the *Turdus obscurus.* It is, when living, of a dark-green colour. The total length of its body is $\frac{3}{10}$ths of an inch.

The head is rounded, the occipital line being quite straight. The *antennæ* are short, sub-ovate, and covered with thickish hairs. Ocelli not very distinct; eyes large, occupying the whole of the sides of the head; facets pretty equal in size. The buccal apparatus is distinct; the *clypeus* of the fore part of the head very conspicuous.

Thorax quite round, with a few hairs scattered over it.

Abdomen also globular, thickly covered with short hairs; in one of my specimens it terminates in three rounded prominences, the middle one being double and covered with very thick bristles. The abdominal and thoracic spiracles are very distinct.

Legs thinly clad with hairs, of moderate length, very strong, and the tarsi are six-jointed, the fifth joint being the largest; the sixth supports two very large acuminated and sharp claws, bent on themselves; the foot-cushions are whitish, and of moderate size.

Wings about $\frac{5}{20}$ths of an inch in length; ribs very distinct, the first one fringed with a row of short, thick hairs.

Genus Strebla, Wiedemann.

Eyes small, triangular. Ocelli? Wings incumbent, rotundate, longer than the abdomen, with parallel veins. These small flies, of which only two or three species are known, infest only and live exclusively on bats.

Strebla molossa, Giglioli, sp. nov. (fig. 12).—This interesting species is found on the Chinese *Molossus*, together with the following.

Head rounded, covered with hairs, and placed far between the anterior legs. *Antennæ* short and broad, covered with hairs. A sub-ovate clypeus is very distinctly marked off from the rest of the head. Eyes rudimentary; I could find no ocelli.

Thorax oval and elongated, covered with short hairs; it has a median groove on the ventral side.

The abdomen is elongated, covered with long, thick hairs; in one specimen, very likely a male, towards its extremity were two long blade-like organs, doubtless subserving copulatory purposes; in the other specimen the abdomen terminates in a median rounded prominence.

Legs of moderate length, the posterior pair the longest; they are very hairy, and the joints broad and flattened. The tarsi end in two very sharp, uncinated claws; the foot-cushions are large, and covered with long, thin hairs; the last joint of the tarsi, which supports the claws, widens considerably distally.

Wings ample, long, and broad, fringed all round with short hairs, and covered with a downy hair, amongst which are scattered a few larger hairs; veins distinct and parallel; length about $\frac{1}{10}$th of an inch. The length of the body is a little more than $\frac{1}{10}$th of an inch.

The following most interesting insect belongs to that anomalous family the *Nycteribiidæ*, wingless, long-legged, spider-like creatures, which inhabit exclusively Vespertiliones. Professor Westwood, who kindly examined my specimens, proposed to make them types of a new genus; and having lately studied the *Nycteribiidæ* with some care, I cannot but agree as to the propriety of such a thing.

Genus Polyctenes, Westwood and Giglioli.

Head large and prominent, elongated, obtuse, and rounded in front; on its posterior dorsal part is a plate of a nearly semicircular form, edged all round with thick spines. On the sides of the fore part of the head are two three-jointed organs (antennæ?), bent backwards. A short neck-like piece joins the head to the thorax, which is elongated and divided into two parts.

The *prothorax* is double the size of the *metathorax*, and is bordered posteriorly with a line of large spines, as those on the head in the male.

Abdomen of moderate size; it enlarges distally, and is segmented.

Anterior legs rather short, the two following pairs rather long and slender.

Polyctenes molossus, Westwood and Giglioli (Pl. I B, figs. 13 and 14).—This remarkable creature inhabits the Chinese *Molossus*.

Body of a light colour, about $\frac{5}{40}$ths of an inch in length.

Head rounded in front, where a well-marked clypeus, of a nearly semilunar shape, is divided off; just under its posterior angles are inserted the two antennæ (?); over their insertion are five large spines on each side; these do not exist in the other specimen, which I take to be a female. Each antenna consists of three rather thick, cylindroid joints, the basal one being the longest and the thickest; a few hairs fringe their inner borders, and they are bent backwards. Do they at all correspond to the organs which have been termed *palpi* and *maxilli* in *Nycteribia?* The integument of the head is finely striated; a few hairs are scattered over it. I could make out nothing like eyes, and therefore suppose that those organs do not exist.

The buccal apparatus appears well developed, and very similar to that of *Nycteribia*. At the back of the dorsal part of the head is a large semicircular plate, wider than it; its anterior margin is fringed with large truncated spines, while the posterior margin has a row of lanceolate spines; in the female this plate is rather smaller, and has anteriorly a double row of large spines, and posteriorly an incomplete row of large hairs.

The *thorax* is large, covered with hairs; the prothorax is sub-oval, fringed posteriorly by a line of large lanceolate spines; the prothorax in the female is more distinct, and has not the posterior line of spines. The *metathorax* in the male is much smaller than the prothorax, and ends in a point; in the female it consists of two oval pieces.

The *abdomen* is divided into nine segments in both my specimens, one of which I take to be a male; it has a broader abdomen, with a pointed, bent, copulatory organ on the last segment. In the female the last segment has a rounded terminal prominence. In both sexes the abdomen is covered with hairs.

The anterior legs are short and strong, terminating in two small claws and several spines; their *femora* are very broad. The intermediate and posterior pairs of legs are much longer and more slender. Their tarsi terminate in two uncinated and sharp claws, with two tubercles at their base in the male, and lower down on the tarsi of the female are two more claws. I observed no rudiments of wings.

All the insects described in this paper were collected at Amoy.

TRANSLATION.

On Myoryktes Weismanni; *a* new Parasite, *inhabiting the* Muscles *of the* Frog.*

In the course of his investigations into the termination of the nerves in the cutaneous thoracic muscle of the thorax of *Rana temporaria*, Prof. Kölliker observed several nematode worms. These were sent to Prof. Eberth, who gives the following account of the parasite, the discovery of which was briefly announced in our last number.

A portion of the muscle in question, which had been rendered slightly transparent by acetic acid, when examined by the naked eye, exhibited nothing remarkable; but under a magnifying power of about 60 diam., the author discovered, after some search, three minute nematodes. A higher power enabled him to ascertain that two of these worms lay partly extended and partly coiled up in the interior of the primitive fibres, and only one free in the perimysium. The former were themselves again included in an excessively delicate cylindrical sacculus of varying length, and either straight or curved. The walls of this sac were in close contact with the adjoining fibrillæ, which were compressed together by it. The walls of this tubular sac appeared in some places to meet, so that the cavity seemed to end in an acute point; but careful observation and focussing showed that the cavity was continued beyond this constriction, gradually enlarging to its original diameter, and terminating in a well-defined, rounded opening, which appeared, as it were, to have been bored through the sarcolemma.

A similar opening was several times noticed in fibres of the same muscle which contained no parasites. In the length of about 1½mm., of three contiguous fibres, one presented four such perforations, either disposed in a line parallel with the longitudinal axis or irregularly placed. In the former, the tube commencing at one of these orifices was clearly seen to open through the next one. No tube could be seen proceeding from the third orifice; whilst the fourth,

* 'Zeitsch. f. wiss. Zool.,' xii, p. 530.

again, communicated with a tube which became much attenuated towards its termination. Each of the other two fibres presented a single orifice, but only one of these was seen clearly to be in connection with a tube which gradually narrowed and terminated in a short extremity; the third fibre contained no parasite.

Nematodes were also found in a cylindrical closed sacculus, which otherwise differed from the former only in the greater thickness of its walls. But this appeared to be merely the cast-off outer integument, from which the worm had not yet fully freed itself, and which had, probably, become distended at both ends by a fluid secretion from the inhabitant. On this account the structure might readily be taken for an elongated, cylindrical cyst, in close apposition with the body of the worm, except at the two ends.

The same thing was subsequently observed in fresh specimens. The parasites were on this occasion also seen between the fibrillæ, moving sometimes in a straight, sometimes in an oblique direction, and always surrounded with the above-described delicate pouch, which, from its consistence, seemed to consist of a viscid or mucous substance.

The two sexes of the parasites observed in March were exactly alike in outward appearance and size. Their length was from 0·162—0·216 mm., and breadth 0·0135—0·0162 mm. The body was cylindrical, straight, and terminated at each end, after narrowing, for a short distance, in a knob-like, rounded enlargement, which was less and not so well defined at the anterior than at the posterior end.

In the mouth was contained a short, horny rod, terminating in front in a minute head, and which might serve as a boring instrument. A very delicate transverse line in the integument immediately behind the oval opening probably indicated a fine annular ridge, or an annular series of numerous fine tubercles or denticles, but no structure of the kind could be clearly made out even with a magnifying power of 500 diameter. The supposition was suggested by the observation that the diameter of the holes in the sarcolemma corresponded, for the most part pretty exactly, with that of the worm at the situation of this fine line.

The integument is smooth, and beneath it may be seen a thin, longitudinal muscular layer. There are no median lines.

The œsophagus is a cylindrical canal, lined with a firm structureless membrane. The intestine is lined with a simple tesselated epithelium. The rectum is short, and without epithelium. The anus is situated a little in front of the knob-like caudal enlargement.

The female generative tube is double, and the vaginal orifice slightly prominent, or placed at the commencement of the hinder fourth of the length.

The *testis* is a short, cylindrical tube, which opens with the intestine. There is a pair of spicula.

The rudimentary generative products consisted of minute nuclei. In the female these were surrounded with a granular substance, and became minute polygonal egg-cells. In the male no further development towards zoosperms was observed. Nothing definite as regards nerves and ganglia could be made out.

In the first case, the author, besides the thoracic muscle, found some of the parasites in various other striped muscles, as in the tongue and heart, although in small numbers; they were also seen by him in the peritoneal coat of the liver, and in the submucous tissue on the tongue. None were found, though sought for, in the intestine and other viscera, nor under the peritoneum of the abdominal cavity. The young condition of the parasites, the frequent occurrence of free individuals in the connective tissue, left no room for doubt that they had only just commenced their migration. The author endeavoured, therefore, by further observations, to ascertain the ultimate fate of the host.

In all, ninety individuals of *Rana temporaria* were examined —thirteen with success. In spring (March), the author found the parasite always in every sixth frog, to the number of two or three in the thoracic muscle; whilst in June, in thirty-one frogs, they occurred only three times in three distinct individuals, and never more than one in each. At this time, therefore, they had become rarer, especially the males, which were never met with after April.

The investigation was carried on in the remainder of the winter-frogs, in some of which the parasites had been first noticed. Of fresh frogs, the author has examined only a few, and these without success. They are not included amongst the ninety above mentioned.

Afterwards the author confined his examination to the thoracic muscle, being convinced that the minute and delicate parasites may be easily overlooked in preparations which are not very transparent; nor in the other muscles is it easy to make equally thin sections without disturbing the fibres. Even in the thoracic muscle it is often difficult to perceive the nematodes.

It next became evident that the parasites, having once penetrated into the tissues, increased in size as the season advanced, and arrived at sexual maturity. Whilst in March the vermicules were 1·162 mm. long and 0·162 mm. broad, they had in June attained a length of 0·594 mm. and a breadth of 0·189 mm. But excepting the reproductive organs, no other parts at this time exhibited any special change. These organs contained at this time, together with young germs, instead of the minute ova, one or two larger ones, 0·06 mm. long and 0·0108 wide, and of an elongated form, and consisting of an extremely delicate membrane and a vitellus containing several oil-globules, and surrounded, as it seemed, by a very delicate vitelline membrane. Sometimes, though rarely, these ova were found in the primitive fibres. At this season males were never observed, nor could any zoosperms be seen in the females. From this circumstance, as well as from the occurrence of the larger oil-globules in the vitellus, it would appear that the ova were unimpregnated. On this account, and owing to the small number of ova met with (about four), the author did not attempt any experiments in the way of transplantation.

Having communicated his first observations, made in March, to Professor Leuckart, the author learnt from him that, as far back as in 1861, Dr. Weismann, of Frankfort, had noticed a nematode worm in the *rectus femoris* of *Rana temporaria*, which corresponded in every particular with his description. In confirmation of this, Professor Leuckart also forwarded Weismann's original drawing, which left no doubt as to the identity of his worm with that described in the present paper, notwithstanding the existence of some apparent differences in the minor details.

From what has been said, it will be seen that the new parasite differs from *Trichina spiralis* both in structure and habits; and, as far as can be judged from Mr. Bowman's figure ('Phil. Trans.,' 1840, p. 480), in outward appearance it bears no resemblance to the nematodes found by him in the primitive fibre of the muscles of the eel, and Mr. Bowman gives no details respecting the structure, &c. The two are, however, allied in this respect—that both appear to reach sexual maturity in the muscle.

The muscular tissue itself does not appear to suffer any injury from the presence of its guests, which are nourished, not at the expense of the muscle, but probably only by the fluids with which it is pervaded.

In this respect it would appear to differ, so far as its effect upon the muscular tissue is concerned, from both *Trichina* or *Gordius*, whose invasion is eventually, at any rate, attended with destruction or injury to the muscular substance forming their nidus.

REVIEWS.

Skin Diseases of Parasitic Origin: their Nature and Treatment. Including the Description and Relations of the Fungi found in Man. By W. Tilbury Fox, M.D. Lond. London: R. Hardwicke, 192, Piccadilly. Pp. 210.

Mycologists and medical men have to thank Dr. Fox for the comprehensive and elaborate treatise before us, the first original one on the subject in the English language. It treats only of *vegetable* parasites on man, which would seem to be a not very extensive field for observation; yet, limited though it may appear, it has been so neglected or inadequately treated hitherto, that its condition was little better than chaotic; and this too, in a very few years, for thirty have not passed since Schönlein first described the fungus which causes favus, and which now bears his name. Though the knowledge of the parasites is so recent, many of the diseases to which they give rise have been long recognised, and were treated of by the ancients. It may be also mentioned in connection with the history of the science, that Leeuwenhoek, in his 'Arcana Naturæ,' published near the end of the seventeenth century, has figured the *Leptothrix buccalis,* a small organism which grows on the decaying food between the teeth and papillæ of the tongue.

The author is already known in connection with the subject of vegetable parasitic disease, by a paper he published in the 'Lancet' (1859, p. 283), in which opinions were broached of a very novel kind, but which are similar to those he now advocates in the present work. That he should still (in 1863) stand firmly on the same ground which he occupied in 1859, after much additional research, is, of itself, no slight proof of the validity of his views.

The parasitic vegetables of man are not, it must be confessed, at first sight, a very enticing field for the researches of the botanist; and thus it has happened that those which have been observed and described owe their discovery and description to medical men, who, as a rule, do not possess sufficient knowledge of the lower forms of vegetable life, in general, to undertake the proper examination and classification of these parasitic growths. Thus, to use the words of Mr. Berkeley, it has come to pass that "parts of plants have been described as whole, undeveloped fungi referred to algæ, though agreeing with them neither in habit nor physiology; the commonest moulds, altered by situation, have been described as new; whilst in numerous instances slight variations of the same fungus have been treated as separate species." Moreover, it must be remembered that few medical men have the inclination to work at minute botany, even if they could spare sufficient time to compare the plants with already published descriptions; test their specific differences, or the contrary, by artificial cultivation; and thoroughly investigate the limits of their variation; by which course alone the errors detailed above can be avoided.

Yet though the mere student of fungi may feel an antipathy to the contagious diseases in which these minute organisms occur, the organisms themselves will well repay a thorough microscopic examination. It is merely necessary to refer to the excellent plates* of Dr. Fox's book (to the accuracy of which the writer of this article is enabled, in many cases, to testify), to prove that to the microscopist the subject is by no means devoid of interest.

The work before us is divided into two parts. The first treats more especially of the *diseases* caused by the growth of parasites; and though this Journal is not the place to discuss medical matters, it may be mentioned that the author well establishes his chief point—the essential difference between eruptive and parasitic disease. The physician will also be indebted to Dr. Fox for the very simple classification of these parasitic skin diseases under one generic title of *Tinea*, as follows:—1, *Tinea favosa*; 2, *T. tonsurans*; 3, *T. circinata*; 4, *T. sycosis*; 5, *T. decalvans*; 6, *T. varicolor*; 7, *T. Polonica*; 8, *T. pilaris*; 9, *T. tarsi*. He places at the end that interesting disease of India, the podelcoma, or fungus foot, which has lately attracted considerable attention. Many of these, it may be mentioned, have been considered as different forms of the same disease by writers; and Dr. Buzen, in his 'Lectures on Parasitic Affections of the Skin,' reduces them to three:—*T. favense*, *T. tonsurante* (including *T. circinata* and *Plica*

* The author tells us in his preface that many of the figures are by a new process—Kerography—which, in some cases, answers better than wood for microscopic appearance.

Polonica) and *T. pilade* (including *T. sycosis* and *T. decalvans*). The author also considers that the only state of the organism which will afford a fitting soil for the growth of fungi is what he calls the "tuberculous or non-specific eruptive crasis or tendency;" but though this may be generally true, it is not universally so, for the writer of this has seen *T. sycosis* more than once in persons certainly affected also with syphilitic eruptions; indeed, Dr. Fox himself says (p. 41) that the two diseases (parasitic disease and syphilis) may be associated.

Chapter 5, which contains a microscopic description of the fungi themselves, is, as stated in the preface, mostly a condensation of the diffuse descriptions in Küchenmeister's manual. It also contains some useful hints for examination of the fungi by the microscope, and shows how they may be distinguished from foreign bodies which imitate their appearance. The characters of the different kinds of fungi are of little importance, as Dr. Fox shows that they are insufficient for diagnosis and liable to variation. The chapter on the appearances presented under the microscope by the lesions produced, will be read with interest by all who, interested in the science of medicine, care to know something more of disease than how to cure it. The plants never grow except where the hair-follicles are present, a little way down which is their primary seat, where all the conditions most favorable to their development are to be found.

Fungi are found pretty commonly on and in both man and the lower animals. Our author mentions several papers and books on the subject, and an interesting account may be added of some very singular forms of fungi found in the intestines of species of Julus and allied genera, by Dr. Leidy, of America, who has paid a good deal of attention to the subject; it will be found in vol. v of the Smithsonian papers, published in 1853.

A list of those which have been described and named by various authors as growing on man will be interesting; it is from the fifth chapter of the book in review. Parasitic fungi are Epiphytes or Entophytes, as they occur on the skin and its appendages or the mucous membranes and internal parts of the body respectively.

A. Epiphytes.—1, *Achorion Schonleinii* (parasite of *Tinea favosa*); 2, *Trichophyton tonsurans* (of *Tinea tonsurans* and *T. circinata*); 3, *T. sporuloïdes* (of *T. Polonica*); 4, *T. ulcerum*; 5, *Microsporon Audouini* (of *T. decalvans*; 6, *M. mentagrophytes* (of *T. sycosis*); 7, *M. furfur* (of *T. versicolor*); 8, Puccinia (favi of Austen; found growing in cases of *T.*

favosa, tarsi, and *versicolor;* also in the disease called acne); 9, The nail fungus (referred to Aspergillus, Achorion, and Microsporon, by different authors); 10, Mucor (Mucedo); 11, Aspergillus (several kinds); 12, Pœnicillium (glaucum); 13, *Chionyphe Carteri* (Berkeley; the fungus which causes podelcoma in India).

B. Entophytes.—1, Torula (*Cryptococcus Cerevisiæ;* 2, Sarcina (*Merismopædia ventriculi*); 3, *Oïdeum albicans* (in thrush and diphtheria in the mouth); 4, *Leptothrix buccalis* (including some found on other mucous surfaces besides that of the mouth); 5, Leptomitus (probably one species, but described as several, viz., *L. urophilus, Hannoveri, uteri, oculi,* and one unnamed); 6, Bennett's lung fungus (probably Oïdeum); 7, Cholera fungi of Busk and others (perhaps Torula; many were foreign bodies); 8, Lowe's fungus of diabetic urine (an early condition of Aspergillus).

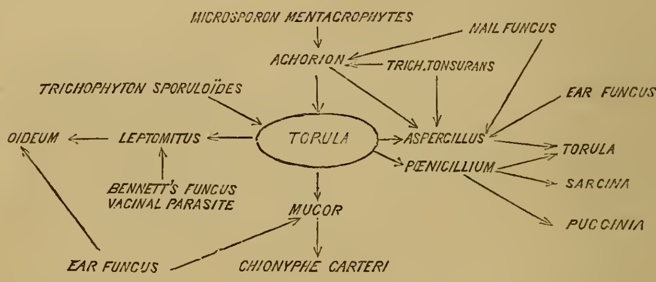
To this list may be added Dr. Farre's Oscillatoria, found in the intestines, of which an account is to be seen at the end of Dr. Lankester's translation of Küchenmeister's manual, the paper having been read before the Microscopical Society in 1842. It was probably introduced into the body with drinking-water, but has as good a claim to be recorded as many in the above list, especially since Sarcina is considered by some as the spores of an Oscillatoria. If one is to be guided merely by the position of the fungi on the body, it is not evident why, in the list just given, Mucor and Pœnicillium are to be reckoned amongst Epiphytes, whilst Bennett's lung fungus and *Leptomitus urophilus,* though growing in similar situations, are considered Entophytes.

A consideration which we consider of importance does not appear to be so regarded by Dr. Fox—the essential distinction, that is, between *true* and *false* parasites. In the second part of the treatise before us, Dr. Fox, speaking of the difference between Epiphytes and Entophytes generally allowed to exist, says (p. 149)—"I confess I do not comprehend the distinction here pointed out; in either case the fungi require each its own particular soil for growth, which latter takes place in consequence of the implantation of the germs upon a suitable habitat; and the properties and tendencies of the vegetations are the same in the two cases." Now, the distinction of Epiphytes and Entophytes is pretty nearly that of true and false parasites; *Tricophyton ulcerum* and Puccinia only among the former being false, and *Oïdium albicans,* and possibly Sarcina, among the latter, true parasites; so that the above quotation may be considered as expressing the author's view of the alleged distinction. But though his view is true as far as the parasite is concerned, how different it is for the patient on whom it grows, whether the fungus is luxuriating absolutely on his tissues, or merely on some effused morbid product, on which it grows as it might on any other decayed matter. As Dr. Fox well shows, the growth of the fungi which cause tinea requires the existence of a peculiar soil, which depends on a particular diathesis and condition of blood; whereas it is evident that such fungi as the forms called Leptomitus, Mucor, Bennett's lung fungus, Leptothrix, Cryptococcus, and perhaps Sarcina, require no such blood-condition; but, with *Tricophyton ulcerum* and Puccinia, are to be considered as merely accidental phenomena growing on soil external to the human body and foreign to it, such as dried pus or mucus, decaying food, acid fluids, and the like; they cause no lesion, and are not parasites on the human body in the true sense of the word.

Dr. Fox's view on the vexed question of *Sarcina ventriculi* is that it is never a *cause* of disease (*i e.* it may be called a *false* parasite). He adduces a good deal of evidence on his side, but the question cannot yet be considered as settled. The writer has seen two cases of continual vomiting during life of a fluid full of Sarciniæ, and no lesion could be detected after death. (A case in point is also recorded in the 'British Medical Journal' for February 5th, 1859.)

But the real value of the treatise under review is in the record of the results which the author has arrived at by experiments and observations on the relations subsisting between the various so-called species of parasitic fungi, both Epiphytes and Entophytes. These results are contained in the second part of the work, and may be summed up thus:—Starting with the proposition, which he proves, that there is no such thing as spontaneous generation of fungi, and that the same fungi may exist in various forms under different conditions of soil, medium, and the like, Dr. Fox shows conclusively how inadequate are the published descriptions of the parasites to distinguish one from another, and how they assume one another's forms. He remarks that there is "no want of descriptions of the various parasites found; but when the attempt is made to apply them practically, many will indicate as well one as another fungus" (p. 115). Moreover, he demonstrates that the distinctions of the different kinds of tineæ are those of degree, not of kind; and he firmly declares that the fungus which produces them is one and the same, merely modified in appearance by its seat and the soil, the latter being always of the same kind, but more or less favorable to the growth of fungi.

The proofs of the identity of the various fungi are too numerous to give a digest of them here. This diagram, however, from p. 176, gives a general idea of their connections, Torula being the centre round which they group themselves.



Leptothrix is not included in this diagram by Dr. Fox, though he considers it allied to Torula.

These difficult experiments consisted in growing the fungi in saccharine solutions and other media, carefully excluded from the air; they were frequently examined, and the plants were seen to pass through many forms generally considered as distinct. As in such experiments great exactitude is rightly demanded before implicit faith can be placed in the results obtained, Dr. Fox states that more details can be forthcoming, if necessary. Supposing everything correct—and we firmly believe so from the great care evidently bestowed on his experiments by the investigator, and from what he says in the preface—absolute proof of the identity of these fungi is given.

There is only one fallacy into which we think it possible Dr. Fox may have fallen, and that is, the mistaking of *similarity* for *identity*; we are reminded of this by figures 8, 10, 11, and 13, of plate ii, which represent the results of an experiment proving that Sarcina can be produced from the aggregation of the spores of Pœnicillium. These quaternate aggregations of spores certainly present some similarity to Sarcina; but, if correctly figured, scarcely seem to be identical. It is possible, though by no means proved, that Sarcina may be the spores of a fungus, as Mr. Berkeley observes, ('Gardener's Chronicle, 1857)—though why it should never develop a Mycelium under the most favorable circumstances for such development is not evident—but that every quaternate aggregation of spores is Sarcina, does not follow; indeed, that aggregation has anything to do with its formation is very problematical.

Many of the diseases (tinea) have been made to produce one another, and more proof of this kind could be brought, but Dr. Fox rightly objects to turning his patients' skins into miniature botanic gardens.

An excellent and philosophical theory of the treatment of tinea in accordance with the views propounded concludes the work.

The author says (preface, p. vi), "I claim for my facts the character of trustworthiness, since everything has been rejected which repeated observation has not, in my mind, shown to be the truth." This character of trustworthiness is evidenced throughout the treatise, which also shows unmistakeably the great care and research bestowed on its preparation. We hope that the subject will not be considered as exhausted, but that the appearance of Dr. Fox's book will lead to further observation on the parasites of man, both by botanists and medical men.

We may mention that the book is well printed and got up by Mr. Hardwicke, and that only two misprints were observed by the writer of this article.

A Manual of Ophthalmoscopic Surgery. By JABEZ HOGG. London: Churchills.

MR. HOGG was one of the earliest English writers on the advantages and uses of the ophthalmoscope, and his work on the application of that instrument to diseases of the eye has deservedly reached a third edition. It does not come within our scope to criticise a work like this, but we cannot forbear our commendation of those portions of Mr. Hogg's work which treat of the microscopic structure of the eye. Whatever value the ophthalmoscope possesses as an instrument which enables the surgeon to look quite into the interior of the eye, there can be no doubt that the value of this instrument has been greatly enhanced by the light which microscopic investigation has thrown upon the minute structures of the eye. Nay, more, we believe that those who have been best trained to observe with the microscope will be found most competent to use the ophthalmoscope. Both instruments, in fact, involve the same general principles of optics, and by both the observing eye is helped to obtain a more accurate knowledge of the thing observed. It is very evident, from the way in which Mr. Hogg has treated his subject in the introductory chapters, that he has approached the study of the ophthalmoscope with that knowledge of optical principles that peculiarly fits him to be an instructor in the art of using this instrument, and we have no hesitation in recommending his work to all those who are anxious to master the important art of distinguishing the various forms of disease that are indicated by the state of the interior of the eye. The work is illustrated with a series of chromo-lithographs of diseased conditions of the interior of the eye, and also woodcuts representing the microscopic structure of the liquids of the eye.

Das Mikroskop, und die mikroskopische Technik; ein Handbuch fur Ärzte und Studirende. (*The Microscope, and its Mode of Application, &c.*) By Dr. HEINRICH FREY. 8vo, Zurich, 1863, pp. 472.

A WELL got-up and imposing-looking work on the microscope has lately appeared under the above title, which, however, is anything but fully expressive of its contents. The work, in fact, consists of two principal divisions. The first 156 pages only relate to the instrument itself, its appurtenances, and the various methods to be followed in the observation, preparation, and preservation of objects; the remainder, except the last 22 pages, is simply a sort of compendium of such parts of histology as may be useful to the medical student. The last 22 pages, which are numbered consecutively to the rest, and evidently intended to form part of the book, contain merely lists of prices of the various forms of instruments constructed by all the more eminent continental and English makers — matters, we should conceive, hardly worthy of being placed in the body, as it were, of a professedly scientific work, though useful enough perhaps to the student who may be in search of an instrument, and at a loss to know where to look for one suited to his wants or means

The technical part of the book appears to have been conceived with the same design, and pretty much on the plan—a little amplified it is true—of Dr. Beale's excellent 'Microscope in Clinical Medicine, and How to Work with the Microscope.'

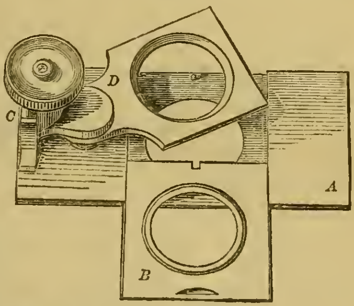
Considering its scope and objects, the work, though perhaps scarcely called for, in the presence of so many others of the same kind, is well done, and contains a great amount of useful information.

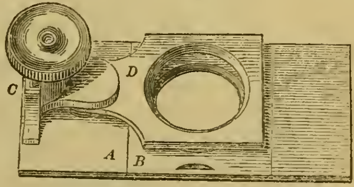
The seventh section or chapter is particularly full upon the subject of the application of reagents of different refractive power, or different chemical properties in the examination of objects; and we are unacquainted with any work in which these matters are better treated of. The eighth section is devoted to colouring matters; and with reference to this we may remark that Dr. Frey does not seem to be acquainted with the peculiar effects of magenta-dye on the blood-corpuscles, nor of tannic acid on the same bodies.

We have already observed that the book is well got up. It is beautifully printed, and on excellent paper, and abundantly illustrated by woodcuts; but we cannot avoid remarking that it affords the most glaring instance with which we are acquainted of an unscrupulous method of swelling the bulk of a book, and of adding to its apparent richness of illustration, too often adopted by our German brethren in science. We allude to the incessant and perfectly needless repetition of the same woodcut in different places; for instance, there is a large cut occupying more than half a page, representing merely a section of the compound microscope, which occurs three times on nearly as many pages, viz., pp. 18, 22, 24; whilst another cut, representing in two places (pp. 21 and 48) the mode of arrangement of the lenses in a compound, correcting objective, does duty at p. 59 for Hartnack's immersion-lens! A large figure of Hartnack's instrument recurs three times, occupying at least a quarter of a page each time; one of M. Nachet's twice, &c., &c. In the histological part also the same figures, and some at any rate not original ones, recur over and over again. A section of the gastric mucous membrane is given in pp. 265 and 306; one of a Peyer's gland, in pp. 261 and 312, &c., &c.; whilst actually on opposite pages (190 and 191) is the same little woodcut of organic particles in urine, both in sight at the same time. This is book-making with a vengeance.

NOTES AND CORRESPONDENCE.

Ross's New Compressorium.—Microscopists who have suffered the inconvenience inseparable from ordinary forms given to a compressorium, will thank us for calling their attention to an enterely new pattern devised by Mr. Ross. It consists of a stout plate of brass (A), about three inches long, having in its centre a piece of glass like the bottom of a live box. This piece of glass is set in a frame (B), which slides in and out, so that it can be removed for the convenience of preparing any object upon it, under water, if desirable. The upper movable part D, attached to a screw motion at C, is admirable for simplicity and efficiency. At one end of the brass plate A, which forms the bed of the instrument, is an upright piece of brass (C), accurately grooved, so as to receive a vertical plate, to which a downward motion is given by a single fine screw, surrounded by a spiral spring, which elevates the plate, as soon as the screw pressure is removed, by turning the milled head the reverse way. The vertical plate carries an arm precisely at right angles to its own plane, and terminating in a square frame (D) capable of receiving very thin or somewhat thicker glass, according to desire. This is the upper part of the compressorium, and the exact amount of pressure required is completely under command by the motion of a single screw. The arm has likewise a horizontal motion, so that the upper plate D can be turned completely



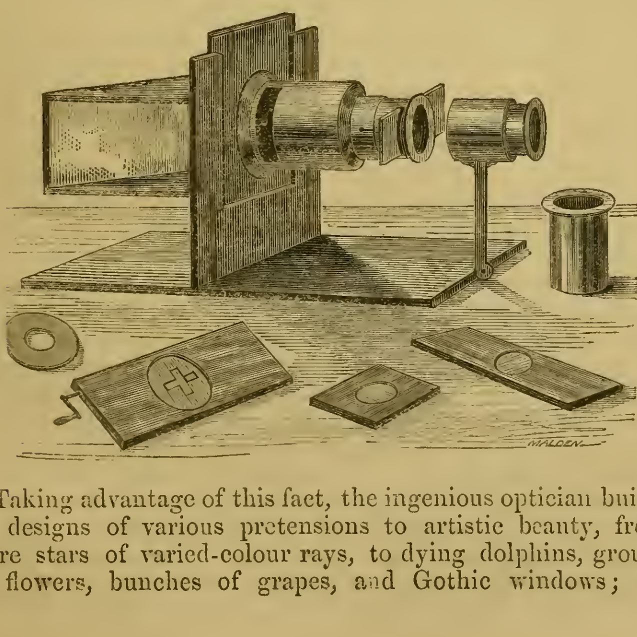


off the lower one, B. Should the thin upper glass be broken, it can be instantly replaced, as no cement is required. It is merely needful to remove the fragments and slip a fresh glass in. We do not know any compressorium that is at once so accurate and so easily used. It often happens that, on account of the trouble of an ordinary compressorium, a microscopist simply uses a slide and a piece of covering glass, and finds, when too late, that an exact means of regulating the pressure would have been desirable. With Mr. Ross's new pattern the convenience is so great that it should always be employed if there is a chance of the screw motion being advantageous.—From the *Intellectual Observer* for Oct., 1863.

Cheap Lantern Polariscope.—Mr. Samuel Highley, the microscope and philosophical instrument maker of Green Street, Leicester Square, has just introduced an arrangement that has long been a desideratum with those who delight in popularising science, namely, a polariscope that could be used in conjunction with the numberless magic-lanterns that are now scattered over the kingdom and our colonies, without entailing the risk and trouble of sending them to the optician "to be fitted" with such an adjunct, and at a cost that is within the means of most persons who indulge in such pursuits.

Doubtless most of our readers are familiar with the magnificent chromatic phenomena of polarized light, too seldom shown in our lecture-rooms, on account of the hitherto costly character of the apparatus necessary for its proper display, though frequently shown on a small scale in microscopes at soirées and on our drawing-room tables. All who have seen such instruments will readily understand how beautiful the effect must be when such objects are projected on a screen by means of a powerful light.

By the aid of the polariscope we are enabled to make slices of crystals, homogeneous in aspect, reveal their "*inner nature*," as the Germans have it; so that by the characteristic appearance of the rings produced, or angle between the optic axes, we are enabled to determine between the two species of a mineral which may be identical as to chemical constitution. Thus, if two fragments of crystal came into our hands, by a chemical assay we might find that each consisted of carbonate of lime; but an optical examination in the polariscope would at once show us that one piece was the species calcite, while the other was arragonite; the former, belonging to the hexagonal system of crystallization, being characterised by a single (uni-axial) system of prismatically coloured rings, with a cross in the centre, changing from black to white according to the position of the analyser; while the latter belonged to the trimetric system, characterised by a double (bi-axial) system of rings, grouped like a figure of ∞; and these optical differences would also indicate differences in the physical properties of the two fragments, such as their hardness, specific gravity, cleavage, fracture, &c. Then, again, minerals of various chemical constitution belonging to such crystalline systems as exhibit bi-axial axes, may be distinguished by determining the angular value between the centres of the two systems of rings, the distance between the centres of the two loops in the figure of ∞ form being greater in some species that in that of others. Thus, the extensive series of micas are now arranged into a few groups characterised by the angular distance between the centres of the bi-axial rings. But the most gorgeous effects are produced by films of those very cleavable minerals, mica and selenite; for every plate of a given thickness having a definite colour-value, we are able to produce an indefinite variety of colour-tints. If the film of selenite is uniform in thickness, it produces an even tint; if of varying thickness, a magnificent assemblage of colours is the result.



Taking advantage of this fact, the ingenious optician builds up designs of various pretensions to artistic beauty, from mere stars of varied-colour rays, to dying dolphins, groups of flowers, bunches of grapes, and Gothic windows; or, descending from the sublime to the ridiculous—of which these designs are susceptible—a baker is changed into a sweep: for every design has two phases of colour, one being what is technically termed "complementary" to the other, dependent upon the position of the analyser; for if the grapes appear "ruby bright," by rotating the analyser a quarter of a circle they change to green, or a group of *blue* flowers to the "sere and *yellow* leaf." But these chromatic displays are not confined to mineral structures; for vegetable bodies, such as *tous les mois*, one of the starches, shows a black cross, similar to that seen in calc-spar; and such substances as whalebone and rhinoceros-horn present the most gorgeous display of colour, the phenomena being dependent upon varying degrees of tension in the structure of those and similar bodies.

To those who would wish to make themselves familiar with this interesting and important branch of physical science, we would recommend the works of Woodward and Pereira, both being treated in a popular style.

But to return to Mr. Highley's instrument, figured in the annexed woodcut. The various parts are mounted on what the inventor calls a "gout-board support;" the upright is fitted with an adjustable panel, that carries a bundle of glass plates on one side and the stage and power on the other; this allows of the entire arrangement being accurately "centred" with any lantern with which it may be employed; when adjusted, the panel is clamped by means of a milled-head screw. The "bundle" consists of such a number of thin glass plates as will give a bright reflected beam of polarized light, and is attached to the panel at the proper angle for producing such a beam. The spring stage for carrying selenite designs, unannealed glasses, pressure and heating clamps, and the larger objects, is formed within a large tube attached to the front side of the panel; and to the front of this is screwed a spring jacket, within which slides the power and stage for the smaller crystals employed. To the front part of the base-board an adjustable rod is fixed that carries the analyser, which consists of a large prism, made expressly for the purpose of giving a large and *pure* field of colour, the absolute field attainable being, of course, dependent on the intensity of the source of light employed, as oil, oxy-calcium, oxy-hydrogen, or the electric. Provision is made for rotating both the smaller and larger objects, when necessary for the demonstration of certain phenomena. When selenite designs are shown on the screen, the crystal power is replaced with another of suitable construction. To use this polariscope, the nozzle is placed at right angles to the screen, and the base-board is then clamped to the table. The front lenses of the magic-lantern are removed, the condensers only being employed, and the source of light moved till a beam of *parallel* rays is produced; the lantern-nozzle is then pointed at the bundle till the rays are incident at the polarizing angle for *glass,* the proper direction being indicated for the uninitiated by a white line marked on the framework, the right adjustment of parts being further indicated by the appearance of an even disc of light upon the screen. A design is then inserted in the large stage, its lines of construction focussed, the analysing prism inserted in its jacket, and the coloured effect produced and varied either by the rotation of the prism or the rotation of the design or crystal.

By removing the panel from the support and placing it before a window, with nozzle pointing upwards, and adding a suitable power, it may be then used as a table polariscope, or the light of a reading-lamp may be employed as the source of light.

By this simplification of parts, Mr. Highley is enabled to supply an instrument—which, for practical purposes, can hardly be surpassed for efficiency—at one half the price at which the gas polariscopes hitherto constructed have been sold. We fancy that many will appreciate this attempt to bring a costly instrument within the reach of experimentalists.

PROCEEDINGS OF SOCIETIES.

Microscopical Society of London.

October 14*th*, 1863.

Charles Brooke, Esq., *President*, in the Chair.

Dr. Pigott, of Halifax, and W. H. B. Hunt, Esq., were balloted for, and duly elected members of the Society.

Mr. Beck read a paper, being a description of a stand for a simple microscope, as an arrangement for using the magnifiers with both eyes.

November 11*th*, 1863.

Charles Brooke, Esq., *President*, in the Chair.

W. Vicary, Esq., W. T. Suffolk, Esq., Wm. Berry, Esq., F. Walker, Esq., Edward Tyer, Esq., J. Browning, Esq., Edward Wilkinson, Esq., and E. Cowan, Esq., were balloted for, and duly elected members of the Society.

The following papers were read:—

1. "On the genus Bacteriastrum," by H. S. Lauder, Esq.
2. "On Diatomaceæ, Series No. 11," by Dr. Greville.
3. "On the Distribution of Nerves to the Skin of the Frog, with Physiological Remarks on the Ganglia connected with the Cerebro-spinal Nerves," by Dr. Ciaccio.

The President called the attention of the meeting to the Quekett Memorial Fund. He stated the object of the fund to be the award, at intervals, of a medal to persons producing papers of interest, or otherwise forwarding the progress of microscopical science. He also announced that the list of subscribers was still open, the sum subscribed not being as yet adequate to carry out the object proposed with efficiency.

December 9*th*, 1863.

Charles Brooke, Esq., *President*, in the Chair.

Charles Robinson, Esq., and John Jordan, Esq., were balloted for, and duly elected members of the Society.

Dr. L. Beale read a paper "On the Blood-corpuscles,"

PRESENTATIONS TO THE MICROSCOPICAL SOCIETY, 1863.

October 14th, 1863.

	Presented by
Figures of the Structure of Invertebrate Animals, by Robert Garner, Esq., F.L.S.	The Author.
Hunterian Oration, delivered at the Royal College of Surgeons, by G. Gulliver, Esq., F.R.S.	Ditto.
Researches on the Development of the Spinal Cord of Man, Mammalia, and Birds, by Dr. Lockhart Clarke	Ditto.
International Exhibition, Jurors' Report, Class XIII.	F.C.S. Roper, Esq.
Synopsis of the Geology of Durham and part of Northumberland, by R. House, Esq., & J.W. Kirby, Esq.	The Authors.
The Popular Science Review, Nos. 8 and 9	The Editor.
The Intellectual Observer, Nos. 18 to 21	Ditto.
Quarterly Journal of the Geological Society, No. 75	The Society.
The Canadian Journal, Nos. 45 and 46	Ditto.
Transactions of the Tyneside Naturalists' Field Club, Vol. VI, Part 1	Ditto.
Smithsonian Report, 1861	Ditto.
Boston Journal of Natural History, Vol. VII.	Ditto.
Proceedings of the Boston Natural History Society, 1862	Ditto.
Micro-photograph taken by Mr. Davis, Cornhill	E. G. Lobb, Esq.

November 11th.

Quarterly Journal of the Geological Society, No. 76	The Society.
Proceedings of the Linnean Society	Ditto.
Bulletins des séances de la classe des sciences	Ditto.
Annuaire de l'Académie Royale, 1863	Ditto.
Intellectual Observer, No. 22	The Editor.
Journal of Photography, No. 201	Ditto.
The Annals and Magazine of Natural History, Nos. 67 to 71	Purchased.

December 9th.

Intellectual Observer, No 23	The Editor.
The Canadian Journal, No. 47	Ditto.
Photographic Journal, No. 139	Ditto.
Journal of Photography, Nos. 202 and 203	Ditto
Annals and Magazine of Natural History, No. 72	Purchased.
On the Cotton-fibre, and on the Manner in which it Unites with Colouring-matter, by Walter Crum, Esq., F.R.S., and 36 Microscopic Slides from which the Drawings for the Plates were taken	The Author.

W. G. SEARSON, *Curator.*

Literary and Philosophical Society, Manchester.

Microscopical Section.

Annual Meeting, May 18th, 1863.

A. G. Latham, Esq., in the Chair.

The annual report of the section for session 1862-63 was read, and officers appointed for the ensuing session.

A communication on "The Structure of the Cotton Fibre," by Mr. Charles O'Neill, F.C.S., was then read, in which the author states that chloride of zinc, as neutral as it could be made by digesting with metallic zinc, and also diluted sulphuric acid, would, under favorable circumstances, exhibit all the phenomena described by the author in his first communication. Chloride of zinc, however, required to be heated to its boiling-point, and sulphuric acid appeared very capricious in its action. The appearances produced by these reagents lead him to the same conclusions with regard to the structure of cotton; but he is more decidedly of opinion than he was before, that the so-called medullary matter is in reality a shrunk membrane similar in appearance to the membrane in dried quills. Finding that all known solvents of cotton gave the same appearances, Mr. O'Neill tried the action of solvents on gun-cotton, and found a further confirmation in the action of ether upon it.

It is well known that there art two modifications of gun-cotton, one soluble, the other insoluble in ether; but the author finds three varieties—(1) soluble in ether, but insoluble in ammoniuret of copper; (2) insoluble in ether, but soluble or dilutable in ammoniuret of copper; and (3), perfectly unacted upon either by ether or ammoniuret of copper. Operating on the first variety on the stage of the microscope with ordinary ether, it is almost instantly dissolved, with no evidence of structure, until, after a while, careful observation shows some remains of spiral vessels. By gradually diluting the ether with alcohol, the action is slackened until a point is arrived at when exactly the same phenomena are produced as by the copper solution. About two thirds ether and one third alcohol was found to be a suitable mixture; but this will evidently vary with different preparations.

Mr. O'Neill considers the number of turns of one spiral to be certainly not greater than from 1100 to 1300 in the inch, and generally much less than this, the mean of many countings running between 600 and 700 for the contracted fibre.

Mr. A. G. Latham made the following communication:—

It may be remembered that some few months ago I proposed to this section as a subject for discussion, "The Causes of the Metallic Lustre of the Scales on the Wings of certain Moths."

I then suggested that the metallic markings, and lustre of the scales themselves forming these markings, are consequent on the fact of the scales containing a particular pigment or colouring matter, while other members thought it might proceed solely from light reflected from the irregular surfaces of the scales.

On examining lately, by transmitted light, the wings on one of the clear-winged moths—*Sesia tipuliformis*—I found on the transparent portion of the wing, and in addition to the markings on the wing, certain other scales of battledore form, and perfectly transparent.

An examination with a higher power showed these scales to be highly striate, and, therefore, in the most proper condition for producing, according to the advocates of the theory I oppose, metallic lustre and metallic markings; and that they are in a condition to produce these effects, were the theory correct, is further shown on examination by reflected light—when, as might be expected from the markings, the scales are most beautifully opalescent, but, wanting internal pigment, give out no metallic markings on the wing, and a strong proof is, therefore, given in favour of the theory broached by me.

Ordinary Meeting, October 19th, 1863.

Professor W. C. Williamson, F.R.S., in the Chair.

The following paper "On Transparent Injections," by Messrs. J. G. Dale, F.C.S., and Thos. Davies, was read by the Secretary.

After enumerating the various desiderata of a transparent injecting fluid, it was observed that soluble colouring matters failed to fulfil them, owing to the action of endosmos, causing them merely to dye the tissue sought to be injected. This defect is shown to be remedied by the use of insoluble colouring matters in an exceedingly fine state of subdivision, which can only be prepared by precipitation under constant agitation, and the following recipe is stated to succeed admirably, showing vessels of $\frac{1}{2000}$ of an inch, with a clear outline even under a $\frac{1}{5}$ objective, without any grain or extravasation of the colouring matter:—

Take 180 grains best carmine, $\frac{1}{2}$ fluid oz. ammonia, com. strength, SG 0·92, or 15 degrees ammonia meter, 3 to 4 oz. distilled water. Put into a small flask, and allow to digest without heat 24 to 36 hours, or until the carmine is dissolved. Then take a Winchester quart bottle, and with a diamond mark upon it the spot to which 16 oz. of water extend. The coloured solution must then be filtered into the bottle, and to this pure water must be added until the whole is equal to 16 oz. Next dissolve 600 grains in potash alum in about 10 fluid oz. of water, and add to this under constant boiling a solution of carbonate of sodium, until a slight permanent precipitate is produced. Filter and add water up to 16 fluid oz. Boil, and add this solution while boiling to the cold ammoniacal solution of carmine in the Winchester quart, and shake vigorously for a few minutes. A drop now placed upon white filtering paper should show no colouring ring; should it do so, the whole must be rejected. Supposing the precipitation to be complete or very nearly so, shake vigorously for half an hour. and allow to stand till quite cold; the shaking must then be renewed, and the bottle filled up with cold water.

After allowing the precipitate to settle for a day, draw off the clear supernatant fluid with a syphon. Repeat the washing till the clear fluid gives little or no precipitate with chloride of barium. So much water must be left with the fluid that at last it must measure 40 fluid oz. For the injection fluid take 24 oz. of the above coloured fluid, and 3 oz. of good gelatine, allow these to remain together all night, then dissolve by the heat of a water bath, after which it should be strained through fine muslin. On injecting, the ordinary precautions for a gelatine injection are alone necessary.

Professor Williamson stated that, owing to the unexpected absence of his esteemed friend, Mr. Sidebotham, he had been suddenly called upon to give the members of the society an address at the opening of the session. With so short a warning it was not an easy task; still, as a few stimulating words might lead to extra exertion, he would make a few remarks on the present position of the microscopic observers. Their numbers in Manchester were necessarily small compared with London. Perhaps there were not twenty microscopists in this city really at work; few were able to devote the time to the energetic and laborious efforts which original investigation required, and of these fewer had the talent or even the ambition to undertake what requires weeks, months, nay, often years of arduous toil. The hindrances are increased by the fact, that there is rarely a definite end sufficiently certain of attainment in the way of a new discovery, calculated to repay the expenditure of labour.

Hence, in a small society like ours, we cannot expect great or brilliant results. But further, the present is not an epoch like that when Ehrenberg revolutionised an entire branch of science, or when Grew laid the foundations of vegetable physiology, and Malpighi that of the animal kingdom. These men revealed entirely new fields of inquiry. But though no such new worlds of histology are opened out to us, there are such a multitude of secondary details requiring elucidation, that we cannot take up a plant or insect without stumbling upon a multiplicity of problems awaiting investigation. One shrewd observer, when eating his orange, discovers upon them some brown scales. He follows up the inquiry they suggest, and the result is an elaborate paper on the coccus of the orange.

Even where members are not prepared for original researches they still may do excellent service by examining the ground gone over by other men, whose views require corroboration before their somewhat startling conclusions can be unhesitatingly received. He would refer to such inquiries as Dr. Hicks's on the conversion of the protoplasm of the Volvox into free-moving Amœbæ, and to those of Dr. Balbiani on the sexuality of the Polygastrica, as illustrations. These researches require re-examination and further confirmation; and whilst the latter would give the results attained a fixed place in scientific annals, their rejection, should they prove erroneous, would remove stumbling-blocks out of the way. In fact, all discoveries required careful reinvestigation. Observers were often too sanguine, and drew large inductions from small and defective data, and this work of supervision was one in which our members might successfully engage. He also thought it desirable to warn the members against the contracting tendencies of minute microscopic research as opposed to philosophic breadth. If men limit their ambition to resolving the small markings of diatoms, apart from the great physiological questions to which they bear relation, they will inevitably succumb to this paralysing influence. They must be careful not to lose themselves in the mere examination of details, but to keep in view that the discovery of general laws should be their object, to the attainment of which the former was only a means. Mere details were useful, but to limit our attention to them crippled the intellect, and rendered it unable to combine them and trace out their connection with general laws. It was by keeping the attention fixed on this higher object that placed our most distinguished histologists on the pedestals they now occupy; and as it is the duty of every man to do what he does in the best manner he can, it behoves all members to keep this lofty aim carefully in view.

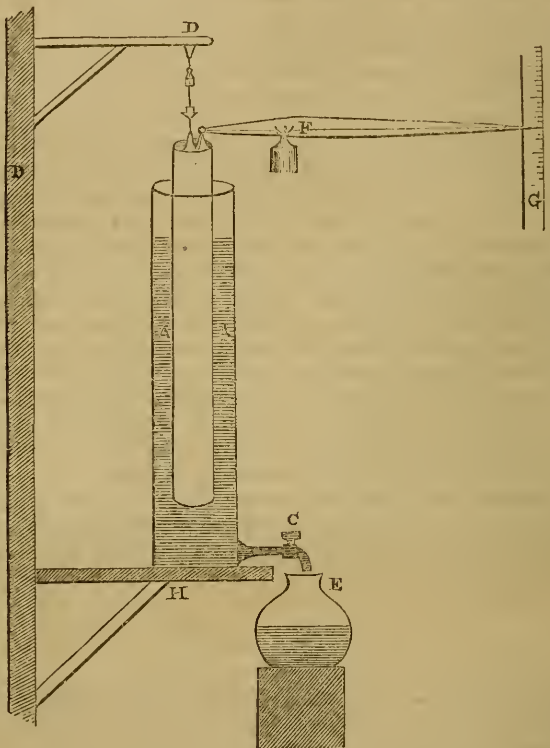
The results would then not only advance science and benefit their fellow-men, but, if worldly fame were their object, they would reap it in the fullest measure to which they were entitled.

November 17th, 1863.

A paper was read "On an Apparatus for Measuring Tensile Strengths, especially of Fibres," by Mr. Charles O'Neill, F.C.S.

In the sketch, A is a cylindrical metallic vessel to hold water, and provided with a cock, C. B is a hollow cylinder of glass or metal, closed at the lower end, and so weighted as to float vertically in stable equilibrium with a portion out of the water; upon its upper end a hook or clamp to hold the fibre is fixed. D is a fixed support, with another hook or clamp to hold the other end of the fibre. F is a lever with a long and short arm, the long arm passing over the scale G. H is the table or support, and E is a vessel into which water drawn from A is received. When using the apparatus it is nearly filled with water, and the fibre to be tested is properly secured to the fastenings on B and D, then drawn taut. Water is now allowed to flow slowly from C until the fibre breaks. The quantity of water drawn off is ascertained, and from it the strain put upon the fibre calculated. The indications of the long arm of the lever are also noted in order to show the stretch, and also to give the elements for a correction to be made upon the quantity of water drawn off.

Stops and guides, not shown in the sketch, serve to keep the floating cylinder off the sides of the vessel, and prevent it falling too far upon the rupture of the fibre.



The principle upon which the apparatus works is so simple that it hardly requires explanation. At the beginning of the operation the weight of the tube is wholly supported by the water; by drawing off the water the support is very gently removed and the weight thrown upon the fibre. The relation between the actual weight put upon the fibre and the weight of water drawn off will vary for every different dimension of the containing vessel and floating cylinder, but in regularly shaped vessels it will always be in the direct ratio of the sectional areas of the floating vessel, and the difference between this and the sectional area of the containing vessel, *i. e.* in cylindrical vessels the sectional area of the ring of water surrounding the floating cylinder.

In the apparatus brought down for illustration and actually in use by the writer, there were three floating cylinders, whose sectional areas bore the following ratios to the ring of water by measurement:

Large cylinder	1 : 0·925
Medium cylinder	1 : 20·610
Smaller cylinder	1 : 492·6

In actually testing, by means of a chemical balance, the relation between the weights of water drawn off and the weights put upon a fibre, the following numbers were found:—

Large cylinder ...	0·926 gr. water	= 1	gr. strain.
Medium cylinder	21·09 gr. ,,	= 1	gr. ,,
Smaller cylinder	476·10 gr. ,,	= 1	gr. ,,

The large discrepancy in the case of the smaller cylinder is owing to the difficulty of measuring it correctly; its sectional area was computed to be 0·001989 inch.

This apparatus has several advantages: the strain is put on in the most gradual manner, without jerks or shocks; it can be put on at any rate per minute or hour, and there is hardly any assignable limits to either its power or delicacy. By the smaller floating cylinder a strain of 0·0002 grain can be measured, and by increasing the size of the apparatus a strain of a hundred tons could be put on with the most perfect gradation.

Mr. O'Neill also read a paper, entitled "Experiments and Observations upon Cotton."

(1) The author began to make experiments upon the chemistry of cotton-dyeing, but found himself compelled to abandon experiments upon manufactured cotton, and to come down to the primary fibre or hairs of cotton.

(2) He has made very numerous experiments upon seventeen samples of cotton supplied to him from reliable sources, and compared their physical and chemical properties.

(3) He has given about 400 experiments upon the length of cotton-hairs, measured separately by a simple process, which he fully described, and exhibited a diagram upon an enlarged scale, showing the mean, maximum, and minimum lengths of the seventeen qualities of cotton experimented upon. The table below is a *résumé* of the experiments, but the author furnishes it in this abstract with the caution that, taken apart from the detailed measurements as given in the full paper, it may give rise to incorrect conclusions.

NAME.	Price.	Date.	Longest Fibre. in.	Mean Length. in.	Shortest Fibre. in.
Sea Island Edisto	26d.	Dec., 1860	2·00	1·680	1·35
Sea Island	54d.	Mar., 1863	1·95	1·501	1·10
Queensland Cotton			1·80	1·475	1·20
Sea Island	16d.	Dec., 1860	2·05	1·444	1·10
Egyptian	9¼d. to 9½d.	,,	1·55	1·252	0·95
Egyptian (fair)	22d.	Mar., 1863	1·50	1·185	0·85

NAME.	Price.	Date.	Longest Fibre. in.	Mean Length. in.	Shortest Fibre. in.
Maranham			1·40	1·220	0 95
Benquella			1·50	1·177	0·85
Pernambuco	23d.	Mar., 1863	1·50	1·1675	0·75
Maranham	8½d.	Dec., 1860	1·35	1·127	0·85
Mobile	6⅞d.	Dec., 1860	1·20	1·035	0·75
Orleans	7⅛d.	Dec., 1860	1·25	1·002	0·70
Upland	6⅝d.	Dec., 1860	1·20	0·9925	0·80
Orleans (good middling)	22¾d.	Mar., 1863	1·15	0·970	0·85
Surat (fair Dhollerah)	17¾d.	Mar., 1863	1·15	0·9425	0 75
Surat (Dhollerah)	5¼d.	Dec., 1860	1·10	0·925	0·55
Surat (middling Comptah)	15d.	Mar., 1863	1·05	0·905	0·70

(5) The author has determined the tensile strengths of the hairs of the various qualities of cotton by means of the apparatus described in the previous abstract, and has given, in a series of tables, the breaking weights in grain of every hair tested, with remarks upon them. The following table gives the mean and maximum strengths of the hairs; but, like the preceding table, it ought not to be taken apart from the detailed tables, where the particulars of the breaking of about twenty hairs of each kind of cotton are given:

	Mean. Grains.	Maximum Grains.
Edisto Sea Island	83·9	142·5
Sea Island (good quality)	90·0	132·0
Benquella	100·6	218·8
Sea Island Cotton	102·6	203·0
Uplands	104·5	212·6
Surat (fair Dhollerah)	105·8	215·5
Maranham	107·1	187·2
Egyptian (fair)	108·0	157·9
Mobile	118·8	172·3
Egyptian	127·2	191·0
Orleans	139·7	289·4
Pernambuco	140·2	251·1
Surat (Dhollerah)	141·9	236·6
Maranham (good middling)	142·9	242·4
Queensland	147·6	246·2
Orleans (good middling)	147·7	264·0
Surat (middling Comptah)	163·7	280·2

West Brighton Microscopical Club.

November 23rd, 1863.

Dr. William Addison, F.R.S., President, in the Chair.

Members and visitors present:—Drs. Halifax, Kebbell, Dawson, Humby, Pearce, Cobbold (of the Middlesex Hospital), and Messrs. Oldham, Murray, Malden, and Hennah (Honorary Secretary of the Society).

Mr. J. Jardine Murray, F.R.C.S.E., called the attention of the meeting to the importance of the subject of human and animal parasites, and adverted especially to the particular viscera in which the Entozoa were most frequently found. He said, that our knowledge of their structure and development could only be extended by microscopic research, combined with the adoption of the experimental method of breeding worms, which was several years ago introduced by Dr. Kuchenmeister. He had enjoyed an opportunity of witnessing the results of some of these experiments during his residence at Edinburgh. He also alluded to the employment of micro-photography, and pointed to the illustrations (by Dr. Halifax) on the table, as affording admirable portraits of some of the most remarkable characters presented by the Cestoda. He congratulated the club on the variety and value of the specimens collected together for inspection that evening, and proposed that they should endeavour, if possible, to verify the existence of nerve-fibres in the Nematoda. In this view, he had, with the assistance of his friend Dr. Cobbold, that afternoon removed some fresh living examples of *Ascaris mystax* from a cat, and he had also procured a large number of active Nematodes (belonging to the genus Ophiostoma) from the stomachs of two dog-fishes. In conclusion, he requested Dr. Cobbold to offer a few words of explanation respecting the various microscopic preparations, specimens of Entozoa preserved either in spirit or in carbolic-acid solutions, and also as regards the original illustrations which he had been so good as to contribute that evening.

Dr. Cobbold, F.L.S., reverted to the pleasure and profit he had derived from attendance at the meetings of the club on previous occasions, and proceeded to give a general account of the most recent discoveries in entozoology, many of which were illustrated by the specimens he had brought with him, and more particularly by that portion of them which had been presented to him by Professor Leuckart, of Giessen. Amongst the microscopic preparations there were also several interesting specimens for which he was severally indebted to the kindness of Dr. Weinland (of Frankfort), Mr. Lubbock, F.R.S., Dr. McIntosh (of Perth), Mr. Hulke, F.R.C.S., Dr. Lankester, F.R.S., and to Mr. Murray.

"The question as to the existence of a true nervous system in Nematoda," he remarked, "was one which could not be said to be decided, notwithstanding the very positive statements of certain recent observers, including Mr. Bastian. The various memoirs of Dr. Anton Schneider—an abstract of one of which was recently given by Mr. Busk, in the 'Quart. Jour. Micro. Science,' No. XI, N.S., p. 197—might at first appear quite conclusive, and in favour of the existence both of a peripheral and a central nerve-system; but, on the other hand, we found an excellent observer, Dr. C. J. Eberth, of Würzburg, who is probably equally well acquainted with the cellular and filamentary tissues represented to be true nerve-structures, altogether at variance with Schneider, and expressing his sincerest doubts as to whether these so-called nerves and ganglia-cells had anything whatever to do with a genuine nervous system (see his 'Untersuchungen über Nematoden,' s. 10). The large granular cells observed by Max Schultze in the neighbourhood of the œsophagus in Enoplus, and the more marked structures described by Leuckart, as a central nerve-system in *Trichocephalus hominis* and *Trichina spiralis*, were not, in Eberth's opinion, true nervous elements." For his own part, he must admit that he had all along regarded the lateral lines of Nematoda as representing a peripheral nerve-system; but it could not be denied that the histological elements were very different from those ordinarily presented by the nerve-cords and ganglia of animals higher in the scale of organization.

The following parasites were then exhibited by Dr. Cobbold:

Sexually mature human parasites.—*Fasciola hepatica; Distoma lanceolatum; D. heterophyes; Bilharziæ hæmatobia; Ascaris lumbricoides; A. mystax; Trichocephalus dispar; Trichina spiralis; Oxyuris vermicularis; Tænia solium; T. medio-canellata; T. marginata; T. echinococcus; T. nana; T. elliptica; Bothriocephalus latus;* and *B. cordatus.*

Larval human entozoa.—*Cysticercus cellulosæ;* meazle of *T. medio-canellata; Cyst. tenuicollis;* hydatids and scolices of *T. echinococcus;* embryos of *Trichina;* young of *Dracunculus;* and embryos of *Oxyuris;* and also the so-called *Pentastoma denticulatum*, which is not strictly referable to the class of helminths.

Adult animal parasites.—*Distoma varicum; D. compactum; D. constrictum; D. clavigerum; D. coronarium; D. Boscii; Trichocephalus affinis; Sphærularia bombi; Ascaris megalocephali; A. osculata; A. capsularia; A. retusa; Trichosoma longicolle; Strongylus paradoxus; Echinorhynchus proteus; E. porrigens; E. anthuris; Tænia pusilla; T. cucumerina; T. uncinata; T. cænurus; T. farciminalis; T. serrata; Diphyllobothrium stemmacephalum;* and of the acarine genus Pentastoma, *P. tænioides* and *P. multicinctum.*

Larval forms.—*Cysticercus fasciolaris; C. pisiformis; C. talpæ; Cænurus cerebralis;* scolex of *Tetrarhynchus reptans*, and of another species; and various Echinococci.

The Hon. Sec., Mr. Hennah, also exhibited a male Strongylus (probably *S. spiculatus*) from the common goose; and Dr. Dawson showed specimens of Echinococcus heads taken from an hydatid in the human orbit.

The living Nematodes procured by Mr. Murray were carefully examined, but the members were not satisfied that the microscopic appearances, presented within the lateral canals, were referable to true nervous elements.

At the conclusion of the meeting, the president expressed, on behalf of himself and the members, his thanks to Dr. Cobbold for the loan of the above-mentioned specimens, selected from his cabinet, and also for the explanations he had so efficiently given.

Southampton Microscopical Society.

The annual *soirée* of this association was held at the Hartley Institution on Tuesday evening, Dec. 15th. There were about six hundred ladies and gentlemen present, by invitation from the committee of management. The arrangements were such as met the approbation of all present. Dr. Joseph Bullar, the President, delivered the annual address as follows:

Ladies and Gentlemen,—Another year has passed since we met, and I have now the honour to express, on behalf of the Southampton Microscopical Society, the pleasure they feel at seeing you again at their annual *soirée*. Meetings such as this indicate the increasing taste among the public for natural science, and the endeavour of those who cultivate science as the very business of their lives to make the knowledge they acquire and the facts they discover the common property of all. Everything conspires to aid an increasing activity of mind—a rational curiosity in this direction. Steam has become as great a power in the diffusion of science, as in locomotion and manufactures. Men of creative minds—the discoverers of new truths, are, and ever will be, the few; but the discoveries of these few are now diffused with a rapidity and to an extent amongst all highly civilised peoples hitherto unknown and unimagined. In a few days the new fact, the result, it may be, of years of solitary research and thought, becomes known to every man of science in Europe. Not only the debates and contests of the politician, the victories or defeats of war, or the triumphs of the social reformer, are circulated with the same certainty as the return of day and night; but the news of the contests of science with the hidden secrets of nature, of her triumphal discoveries, and of her application of these newly discovered laws to the beneficial uses of mankind, is diffused with the same sureness and celerity, and by the same means—the press and the steam engine. In addition to scientific papers and magazines, and reports and books, copiously illustrated by drawings, engravings, woodcuts, and plans—and scientific instruments described and measured and figured with perfect accuracy—the instruments themselves are immediately constructed by the first mathematicians of the day, so that any one can purchase them. The new fact may thus be immediately examined and proved by the exact copies of the apparatus or instrument of the original discoverer. A Greek philosopher said there was the same difference between one instructed and one uninstructed as between the living and the dead; and this generation, which is

> "The Heir of all the Ages, in the foremost files of Time,"

shows by its valuing and taking advantage of the new objects so freely offered to its intellect, that it is a living and not a dead or decaying race. Microscopic study is one of the youngest branches of the great tree of science. It is only within ten or fifteen years that microscopes have been brought to high perfection. Men of science, versed deeply and accurately in the laws of light, working together with those of consummate mechanical knowledge and skill, have constructed microscopes combining the two chief requisites (high magnifying power with great clearness), and the large sale of these instruments is the best proof of the increasing interest taken in these pursuits. Three of the principal makers of microscopes in London sold last year 600 microscopes, and 100 of these were of the highest class of instruments. One of these houses alone sold 360 object-glasses (these are the magnifying glasses only) of high powers. The demand, too, for mounted objects is proportionate to the demand for instruments—so great is it that it is with difficulty kept up with. And this increase is in spite of the entire stoppage of any supply to America, owing to her civil war. A large number of these microscopes are supplied to the medical profession, for to us it has become indispensable in distinguishing with greater accuracy and certainty many diseases; but its increased use amongst naturalists is seen by their publications. A 'Microscopical Quarterly Journal,' numerous original papers in the transactions of all our great scientific societies—for there is no branch of natural, and few of physical, science which does not need and employ this instrument—the microscopical societies in the great towns, and the many manuals containing condensed accounts systematically arranged of all recent discoveries, as well as older facts, testify to the great and increasing interest in this science. We have said there is no branch of natural science, and few of physical, which does not need and employ the microscope, and the objects you will see this evening, and which are a few only out of the vast supply, will give some idea of the extent of its field of research. The vegetable kingdom is illustrated from the simplest structures up to the most complex; from cells up to flowers, leaves, pollen, and wood. The animal kingdom is represented by specimens of bone, horn, hair, muscles, ligament, lungs, brain, which form the various organs of man and the higher animals, and which show the form of the materials of which their bodies are composed; whilst the insect tribes, which, from the complexity and delicacy of their structure, and their smallness of size, make some of the best microscopic objects, are shown either as whole insects or as parts. The eyes, the claws, the wings, the proboscis, the tongue, the breathing apparatus, of numerous species—many of the small and complete insects, and parasites living and dying on other insects and animals—supply objects of high interest. Lower in the animal scale, and at that point where animal meets vegetable life, so that it is difficult to decide which is animal and which is vegetable, are the various specimens of the tribes of the *Diatomaceæ*, *Foraminiferæ*, and *Polycistinæ*, whose finely marked shells of flint are objects delicate and very elegant. The geologist scrutinises with the microscope the fossilised animals and plants which lived in bygone ages, as well as the rocks and soils which form our earth, and you can see here sections of coal, of granite, of sandstone, agate, and other minerals. The chemist determines the exact shape of his crystals, and these form objects of much beauty, especially when seen by coloured light by the polariscope, which instrument will be carefully described to you. Amongst the striking preparations are various parts of the tissues of man and animals which are injected; that is to say, the blood-vessels and other tubes are filled with carmine, and thus rendered very evident. Thus infinitely small parts of the skin of the cheek, tongue, lip, nose, eye of man—of the brain of the rabbit—the lung of the sheep, are thus injected. "Beauty is" (said to be) "only skin deep." Our microscopes tell a different story. The texture of the surface of the skin to which, according to this proverb, beauty alone is confined, will bear the minutest scrutiny of our highest magnifying powers. It may be magnified 3000 diameters; that is to say, if, by any possibility, a whole human face could be seen in a microscope, that face would be as large as 3000 faces; or to put it in another way, if this hall, when filled, would contain 1500 people, one face would be as large as twice the number of faces in this completely filled room, and yet every particle of the outer skin magnified in this proportion retains the same finish—and not only this, but the smallest vessels which supply its life by red blood, and the red globules of these ruddy streams which give the skin its colour, its freshness, and its bloom, the nerves which give it feeling, the oil-glands and their tubes which keep it smooth, the mass of fibres which give it firmness, are each and all organized with the same elaborate contrivance, joined with the same perfection of delicacy. You might think there was no beauty in a common slug, but examine its mouth and tongue, as you will have an opportunity this evening, and especially by the light of the polariscope, and the arrangement of its teeth, which are numbered by thousands and are inconceivably small, gives the impression of the texture of some rare and costly fabric of ladies' dress. Indeed, not even the costliest lace or silk which the delicate fingers of Brussels or Honiton construct, or the looms of Norwich and Lyons supply, will bear such close investigation—the workmanship is human, not divine; man's, not nature's. The silk or the thread as it is nature's work has her perfection; but the forms, the arrangements, are by man, and fine as they may be, they are coarse to the lenses. In the snail's mouth, in the green scum of stagnant ponds, in the dust of old hills, on the shores and depths of ocean, are to be found more exquisite patterns than the artistic maker of furniture, of ornaments, or of dress, could conceive, much less execute. It may be thought rather pedantic in an assembly like this, consisting of so large a number of ladies, to expect that many will feel much interest in the scientific aspect of our pursuits. But there is this other view which commends itself both to their taste and their practice, for they are all students, and very earnest students too, of the beautiful. For what is the attention given to the ceaseless changes and varieties of dress, to the choice and harmony of its colours, to the selection of ornaments, to the internal decorations of rooms and of houses, to the shapes and textures and hues of furniture, to the arrangements of flowers and of gardens, but the application of the mind-powers to this branch of knowledge? What is taste but the appreciation of the beautiful, and the power of realising it? The true way towards the realisation of the beautiful in art of all sorts, including the decorative arts, must be through the close study and exact following of nature; and as the arts of design advance, it must happen that these exquisite patterns of nature which microscopes unfold will give to students their best examples; and as all ladies are more or less artists in design, there are good hopes that in the scientific future of our race, the microscope may be habitually employed by the fair students of domestic decorative arts when devising new patterns for their fingers to execute. The painter's eye in all the more extended scenes of nature—in the greater and smaller groups of natural objects—sees and appreciates the beautiful or the picturesque; and the student of the microscope, examining with his powerful lenses the smallest particle of their greater masses which the artist fixes in colours, discovers at every step lower and lower—deeper and deeper as he is enabled to descend towards the invisible—that there is the same consummate fitness and perfect beauty. What the poet sings of suns and moons and planets and stars, when gazing up at those worlds of light, can be said when looking downwards at those smallest created things, even into what may be superficially considered as the refuse and waste of creation, that by their silent beauty they are for ever telling "The Hand that made us is Divine." In thanking the Hartley Council on behalf of our society for the kind way in which they immediately granted our application for the use of this building this evening, may I allude to a proposal which will be submitted to the microscopical society at their next meeting, that a class be formed in which the use of the microscope would be explained and taught and practically illustrated by one or more of the members; and if so, the permission of the council would again be asked to hold the classes here. This would show, especially to ladies, who are apt to overrate the difficulties in the attainment of science, that there are fewer difficulties than they imagine in the attaining dexterity in the use of the microscope and in mounting the various objects, and that there is no branch of science which is more within reach. A thorough good microscope, fit for all such purposes, can now be obtained for five guineas, and the objects for examination can be found everywhere—in every leaf, in every flower, in the pond, in the tank, the sea-side stones, in every living object, in every created thing. And slips of glass and cement are all that are needed to preserve them; and the objects themselves are so neat, so clean, so small, that they may be viewed, prepared, and mounted in any room. Most of the objects which you will see this evening have been procured from the scientific instrument maker, Mr. Wheeler, and they have all been prepared and mounted by himself and the other members of his own family, his sons and his daughters. In a highly civilised state of society, where a constantly increasing number of the educated have that leisure which wealth supplies, there are many who, even to save themselves from ennui, require some intellectual pursuit, and who may find an agreeable and increasingly agreeable occupation in the microscopy of nature; whilst the busy may find in the same study that change of object which is often the only possible relaxation to minds inured to constant mental activity.

Dr. Bullar was warmly applauded at the conclusion of his address. The company then adjourned to the various rooms, in search of entertainment, which met them on every hand. The library, reading room, and some of the class rooms, were converted into scenes for the exhibition of the wonders revealed by the microscope and polariscope, a number of which, about forty, were placed upon tables, and attended by the following gentlemen:—Professor Aitken; Drs. Sims, Aldridge, De Chaumont, Osborne, Trend, Norcott, Scott, Lake, Maul, Summers, Eddowes, Broster, and Watson; Messrs. Sampson, Tovey, Randall, Keele, Le Feuvre, Murray, Jennings, Shorto, Buchan, Brunke, and Wheeler. Mr. Lucas, sculptor, entertained amazingly a party at the table allotted to him. He exhibited some curiosities, including a series of photographs illustrative of phases in his own life, some of which elicited a vast amount of merriment. Dr. Maul exhibited a series of illuminated stereoscopic views. He also showed the effect of the polarization of light. A collection of photographs and drawings adorned the walls and tables. Altogether was passed one of the pleasantest evenings it is possible to conceive. The entertainers acted under a full determination to do their best in their various departments, and the result was a perfect and gratifying success.

About fifty microscopes were employed by the various members, so that in the course of the evening the large party had ample opportunities of seeing the objects.

Dr. Maddox, who lives in the neighbourhood, exhibited and explained many of his exquisite photographs. He is the first who has adopted stereoscopic photography to microscopic purposes, in order to show what are elevations and what depressions. Some diatoms exhibited this excellently.

Mr. Hill, of Basingstoke, brought a very complete set of British lichens.

Dr. Langstaff explained by diagrams the theory of the polarization of light.

The *soirée* was attended by the professors of the Army Medical School at Netley; and Dr. Aitken, the Professor of Pathology, gave much assistance by lending both microscopes and objects from his microscopic class room, which is the most complete in Europe.

The general arrangements for the evening were made by Mr. Keele, the Vice-President, Dr. Langstaff, Dr. Aldridge, and Dr. Sims, and gave great satisfaction to all.

REVIEW.

Lectures on the Elements of Comparative Anatomy. By THOMAS HENRY HUXLEY. London: Churchill & Sons.

THIS work consists substantially of the lectures delivered by Professor Huxley in the spring of 1863, at the Royal College of Surgeons of England, in discharge of his duties as Hunterian Professor of Comparative Anatomy and Physiology to the College. Although this work may be regarded as fragmentary, consisting, as it does in the first place, of six lectures on the Classification of Animals, and eight lectures on the Vertebrate Skull, the author hopes eventually to bring out subsequently other courses of lectures, and thus to produce a systematic work on Comparative Anatomy. Those who have in any manner regarded the publications of Professor Huxley, will be glad of the prospect of having presented to them a systematic view of the opinions held by one who has distinguished himself by his contributions to almost every department of zoological and physiological inquiry. Professor Huxley says, with regard to this work, that in intention therefore the present work is the first of a series, to be followed in due order by a second volume on "Man and the other Primates," and a third on the remaining Mammalia, and so on. As far as the inquiries with the microscope are concerned, we must content ourselves with drawing attention to those parts of the present volume which are devoted to the classification of animals. We cannot pretend to follow Professor Huxley into those details which lead him to differ with Professor Owen with regard to the theoretical structure of the vertebrate skull. We can only say, with regard to this second part of his work, that it will afford to all students of comparative anatomy, an example of how great is the power of analysis demanded of, and how wide are the inquiries of, the philosophical anatomist. It is only in a very subsidiary way that the minute inquiries of the microscopist can assist the anatomical philosopher in arriving at the general laws which regulate the morphology of the higher classes of the animal kingdom.

It is in the lower forms of animal life that the zoologist must have recourse to the microscope. Whole families and tribes of every division of Invertebrate animals can alone be detected by the aid of the microscope, and it is by its aid alone that the comparative anatomist and zoologist have been enabled to group the various species into something like harmonious relationship. It would be almost impossible for us to criticise the various positions taken by Professor Huxley with regard to the classification of the lower animals. He has recast the groups formerly known so well as the Radiata, of Cuvier, and which embraced so large a field of inquiries open to the microscopist, and we take advantage of the permission of the publishers to reproduce the first lecture of this series entire.

THE GREGARINIDA, RHIZOPODA, SPONGIDA, AND INFUSORIA.

By the classification of any series of objects, is meant the actual, or ideal, arrangement together of those which are like and the separation of those which are unlike; the purpose of this arrangement being to facilitate the operations of the mind in clearly conceiving and retaining in the memory, the characters of the objects in question.

Thus, there may be as many classifications of any series of natural, or of other, bodies, as they have properties or relations to one another, or to other things; or, again, as there are modes in which they may be regarded by the mind: so that, with respect to such classification as we are here concerned with, it might be more proper to speak of *a* classification than of *the* classification of the animal kingdom.

The preparations in the galleries of the Museum of this College are arranged upon the basis laid down by John Hunter, whose original collection was intended to illustrate the modifications which the great physiological apparatuses undergo in the animal series: the classification which he adopted is a classification by organs, and, as such, it is admirably adapted to the needs of the comparative physiologist.

But the student of the geographical distribution of animals, regarding animated creatures, not as diverse modifications of the great physiological mechanism, but in relation to one another, to plants and to telluric conditions, would, with equal propriety, dispose of the contents of a Zoological Museum in a totally different manner; basing his classification, not upon organs, but on distributional assemblages. And the pure palæontologist, looking at life from yet another distinct point of view, would associate animal remains together on neither of these principles, but would group them according to the order of their succession in Time.

Again, that classification which I propose to discuss in the present Lectures, is different from all of these: it is meant to subserve the comprehension and recollection of the facts of animal structure; and, as such, it is based upon purely structural considerations, and may be designated a Morphological Classification. I shall have to consider animals, not as physiological apparatuses merely; not as related to other forms of life and to climatal conditions; not as successive tenants of the earth; but as fabrics, each of which is built upon a certain plan.

It is possible and conceivable that every animal should have been constructed upon a plan of its own, having no resemblance whatsoever to the plan of any other animal. For any reason we can discover to the contrary, that combination of natural forces which we term Life might have resulted from, or been manifested by, a series of infinitely diverse structures: nor, indeed, would anything in the nature of the case lead us to suspect a community of organization between animals so different in habit and in appearance as a porpoise and a gazelle, an eagle and a crocodile, or a butterfly and a lobster. Had animals been thus independently organized, each working out its life by a mechanism peculiar to itself, such a classification as that which is now under contemplation would obviously be impossible; a morphological, or structural, classification plainly implying morphological, or structural, resemblances in the things classified.

As a matter of fact, however, no such mutual independence of animal forms exists in nature. On the contrary, the different members of the animal kingdom, from the highest to the lowest, are marvellously interconnected. Every animal has a something in common with all its fellows; much, with many of them; more, with a few; and, usually, so much with several, that it differs but little from them.

Now, a morphological classification is a statement of these gradations of likeness which are observable in animal structures, and its objects and uses are manifold. In the first place, it strives to throw our knowledge of the facts which underlie, and are the cause of, the similarities discerned into the fewest possible general propositions—subordinated to one another, according to their greater or less degree of generality; and in this way it answers the purpose of a *memoria technica*, without which the mind would be incompetent to grasp and retain the multifarious details of anatomical science.

But there is a second and even more important aspect of morphological classification. Every group in that classification is such in virtue of certain structural characters, which are not only common to the members of that group, but distinguish it from all others; and the statement of these constitutes the definition of the group.

Thus, among animals with vertebræ, the class *Mammalia* is definable as those which have two occipital condyles, with a well-ossified basi-occipital; which have each ramus of the mandible composed of a single piece of bone and articulated with the squamosal element of the skull; and which possess mammæ and non-nucleated red blood-corpuscles.

But this statement of the characters of the class *Mammalia* is something more than an arbitrary definition. It does not merely mean that naturalists agree to call such and such animals *Mammalia*; but it expresses, firstly, a generalization based upon, and constantly verified by, very wide experience; and, secondly, a belief arising out of that generalization. The generalization is that, in nature, the structures mentioned are always found associated together: the belief is, that they always have been, and always will be, found so associated. In other words, the definition of the class *Mammalia* is a statement of a law of correlation, or coexistence, of animal structures, from which the most important conclusions are deducible.

For example: if a fragmentary fossil be discovered, consisting of no more than a ramus of a mandible and that part of the skull with which it articulated, a knowledge of this law may enable the palæontologist to affirm, with great confidence, that the animal of which it formed a part suckled its young and had non-nucleated red blood-corpuscles; and to predict that should the back part of that skull be discovered, it will exhibit two occipital condyles and a well-ossified basi-occipital bone.

Deductions of this kind, such as that made by Cuvier in the famous case of the fossil opossum of Montmartre, have often been verified, and are well calculated to impress the vulgar imagination; so that they have taken rank as the triumphs of the anatomist. But it should carefully be borne in mind, that, like all merely empirical laws, which rest upon a comparatively narrow observational basis, for reasoning from them may at any time break down. If Cuvier, the example, had had to do with a fossil *Thylacinus* instead of a fossil Opossum, he would not have found the marsupial bones, though the inflected angle of the jaw would have been obvious enough. And so, though, practically, any one who met with a characteristically mammalian jaw would be justified in expecting to find the characteristically mammalian occiput associated with it; yet, he would be a bold man indeed, who should strictly assert the belief which is implied in this expectation, viz. that at no period of the world's history did animals exist which combined a mammalian occiput with a reptilian jaw, or *vice versâ*.

Not that it is to be supposed that the correlations of structure expressed by these empirical laws are in any sense accidental, or other than links in the general chain of causes and effects. Doubtless there is some very good reason why the characteristic occiput of a Mammal should be found in association with mammæ and non-nucleated blood-corpuscles; but it is one thing to admit the causal connection of these phenomena with one another, or with some third; and another thing to affirm that we have any knowledge of that causal connection, or that physiological science, in its present state, furnishes us with any means of reasoning from the one to the other.

Cuvier, the more servile of whose imitators are fond of citing his mistaken doctrines as to the nature of the methods of palæontology against the conclusions of logic and of common sense, has put this so strongly that I cannot refrain from quoting his words.*

"But I doubt if any one would have divined, if untaught by observation, that all ruminants have the foot cleft, and that they alone have it. I doubt if any one would have divined that there are frontal horns only in this class: that those among them which have shar canines for the most part lack horns.

"However, since these relations are constant, they must have some sufficient cause: but since we are ignorant of it, we must make good the defect of the theory by means of observation: it enables us to establish empirical laws, which become almost as certain as rational

* 'Ossemens fossiles,' ed. 4^{me}, tome 1^{r}, p. 164.

laws when they rest on sufficiently repeated observations; so that now, whoso sees merely the print of a cleft foot may conclude that the animal which left this impression ruminated, and this conclusion is as certain as any other in physics or morals. This footprint alone, then, yields to him who observes it, the form of the teeth, the form of the jaws, the form of the vertebræ, the form of all the bones of the legs, of the thighs, of the shoulders, and of the pelvis of the animal which has passed by: it is a surer mark than all those of *Zadig*."

Morphological classification, then, acquires its highest importance as a statement of the empirical laws of the correlation of structures; and its value is in proportion to the precision and the comprehensiveness with which those laws, the definitions of the groups adopted in the classification, are stated. So that, in attempting to arrive at clear notions concerning classification, the first point is to ascertain whether any, and if so, what groups of animals can be established, the members of which shall be at once united together and separated from those of all other groups, by well-defined structural characters. And it will be most convenient to commence the inquiry with groups of that order which are commonly called CLASSES, and which are enumerated in an order and arrangement, the purpose of which will appear more fully by and by, in the following table.

TABLE OF THE CLASSES OF THE ANIMAL KINGDOM.

The Limits of the Four Cuvierian Sub-Kingdoms are indicated by the Brackets and Dotted Line.

RADIATA.

Gregarinida. *Infusoria.*
Rhizopoda (?).
Spongida.

Hydrozoa.
Actinozoa.

Polyzoa.

Scolecida (?).
Echinodermata.

ARTICULATA:
Annelida.
Crustacea.
Arachnida.
Myriapoda.
Insecta.

MOLLUSCA:
Brachiopoda.
Ascidioida.
Lamelli branchiata.
Branchiogasteropoda.
Pulmogasteropoda.
Pteropoda.
Cephalopoda.

VERTEBRATA:
Pisces.
Amphibia.
Reptilia.
Aves.
Mammalia.

It is not necessary for my purpose that the groups which are named on the preceding table should be absolutely and precisely equivalent one to another; it is sufficient that the sum of them is the whole of the Animal Kingdom, and that each of them embraces one of the principal types, or plans of modification, of animal form; so that, if we have a precise knowledge of that which constitutes the typical structure of each of these groups, we shall have, so far, an exhaustive knowledge of the Animal Kingdom.

I shall endeavour, then, to define—or, where definition is not yet possible, to describe a typical example of—these various groups. Subsequently, I shall take up some of those further classificatory questions which are open to discussion; inquiring how far we can group these classes into larger assemblages, with definite and constant characters; and, on the other hand, how far the existing subdivisions of the classes are well based or otherwise. But the essential matter, in the first place, is to be quite clear about the different classes, and to have a distinct knowledge of all the sharply-definable modifications of animal structure which are discernible in the animal kingdom.

The first class of which I shall speak is the group of the GREGARINIDA. These are among the simplest animal forms of which we have any knowledge. They are the inhabitants of the bodies for the most part of invertebrate, but also of vertebrate, animals; and they are commonly to be found in abundance in the alimentary canal of the common cockroach, and in earth-worms, They are all microscopic, and any one of them, leaving minor modifications aside, may be said to consist of a sac, composed of a more or less structureless, not very well-defined membrane, containing a soft semi-fluid substance, in the midst, or at one end, of which lies a delicate vesicle; in the centre of the latter is a more solid particle. (Fig. 1, A.) No doubt many persons will be struck with the close resemblance of the structure of this body to that which is possessed by an ovum. You might take the more solid particle to be the representative of the germinal spot, and the vesicle to be that of the germinal vesicle; while the semi-fluid sarcodic contents might be regarded as the yelk, and the outer membrane as the vitelline membrane. I do not wish to strain the analogy too far, but it is, at any rate, interesting to observe this close morphological resemblance between one of the lowest of animals and that form in which all the higher animals commence their existence. It is a very remarkable characteristic of this group, that there is no separation of the body into distinct layers, or into cellular elements. The *Gregarinida* are devoid of mouths and of digestive apparatus, living entirely by imbibition of the juices of the animal in whose intestine, or body cavity, they are contained. The most conspicuous of those phenomena, which we ordinarily regard as signs of life, which they exhibit, is a certain contraction and expansion along different diameters, the body slowly narrowing, and then lengthening, in various directions. Under certain circumstances (though the conditions of the change are not thoroughly understood), it is observed that one of these *Gregarinida*, whatever its form may be, will convert itself into a well-rounded sac, the outer membrane ceasing to exhibit any longer those movements of which I spoke,

Fig. 1.

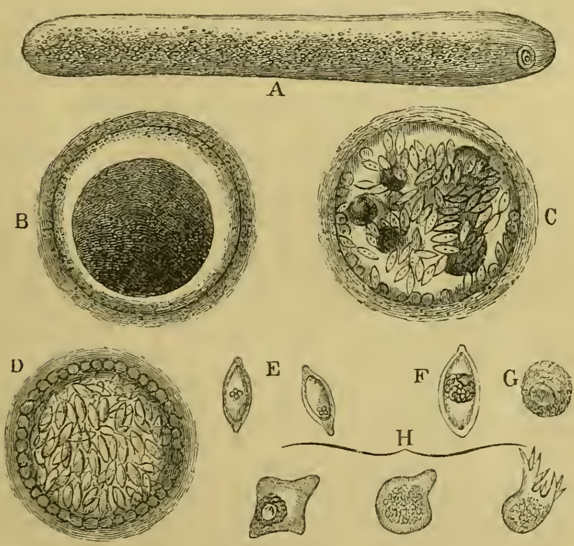


Fig. 1. A, *Gregarina* of the earthworm (after Lieberkuhn); B, encysted; C, D, with the contents divided into pseudo-navicellæ; E, F, free pseudo-navicellæ; G, H, free amœbiform contents of the latter.

and becoming coated by a structureless investment, or "cyst" (Fig. 1, B).

The substance of the body contained within the cyst next undergoes a singular change. The central nucleus and the vesicle disappear; after a time, the mass breaks up into a series of rounded portions and, then, each of these rounded portions elongates, and, becoming slightly pointed at each end, constitutes a little body which has been called a "*Pseudo-navicella*," from its resemblance to the Diatomaceous *Navicula* or *Navicella* (Fig. 1, C, D). Next, the capsule bursts and the *Pseudo-navicellœ* (Fig. 1, E, F) are scattered and passed out of the body of the animal which they inhabit. Though, of course, a great number of them are destroyed, some, at any rate, are devoured by other animals; and, when that is the case, the little particle of protein substance which is inclosed within the *Pseudo-navicella* is set free from its shell, and exhibits much more lively movements than before, thrusting out processes in various directions, and drawing them in again, and, in fact, closely resembling one of those animalcules which have been called *Amœbœ* (Fig. 1, H). The young Amœbiform *Gregarina* grows, increases in size, and at length assumes the structure which it had at first. That, in substance, is all that we know of this lowest division of animal life. But it will be observed, there is a hiatus in our knowledge. We cannot say that we know the whole nature and mode of existence of this, or any other animal, until we have traced it to its sexual state; but, at present, we know nothing whatever of this condition among the *Gregarinœ;* so that in reasoning about them we must always exercise a certain reticence, not knowing how far we may have to modify our opinions by the discovery of the sexual state hereafter.

The process of becoming encysted, preceded or accompanied very often by the mutual apposition of two *Gregarinœ,* was formerly imagined to correspond with what is termed among plants "conjugation,"—a process which in some cases, at any rate, appears to be of a sexual nature. But the discovery that a single *Gregarina* may become encysted and break up into *Pseudo-navicellœ* seems to negative this analogy.

But now, leaving this, I pass on to the next class—that which is indicated in the table as the RHIZOPODA. I have put a query against it, as I shall have to return to it as another of those respecting which our knowledge is incomplete. And at this moment I merely direct attention to the salient and characteristic features of the whole group (Fig. 2).

It seems difficult to imagine a stage of organization lower than that of *Gregarinida,* and yet many of the *Rhizopoda* are still simpler. Nor is there any group of the animal kingdom which more admirably illustrates a very well-founded doctrine, and one which was often advocated by Hunter himself, that life is the cause and not the consequence of organization; for, in these lowest forms of animal life, there is absolutely nothing worthy of the name of organization to be discovered by the microscopist, though assisted by the beautiful instruments that are now constructed. In the substance of many of these creatures, nothing is to be discerned but a mass of jelly, which might be represented by a little particle of thin glue. Not that it corresponds with the latter in composition, but it has that texture and sort of aspect; it is structureless and organless, and without definitely formed parts. Nevertheless, it possesses all the essential properties and characters of vitality; it is produced from a body like itself; it is capable of assimilating nourishment, and of exerting movements. Nay, more, it can produce a shell; a structure, in many cases, of extraordinary complexity and most singular beauty (Fig. 2, D).

That this particle of jelly is capable of combining physical forces in such a manner as to give rise to those exquisite and almost mathematically-arranged structures—being itself structureless and without permanent distinction or separation of parts—is, to my mind, a fact of the profoundest significance.

Though a Rhizopod is not permanently organized, however, it can hardly be said to be devoid of organs; for the name of the group is derived from the power which these animals possess of throwing out processes of their substance, which are called "pseudopodia," and are sometimes very slender and of great length (Fig. 2, E), sometimes broad and lobe-like (Fig. 2, A). These processes may flow into one another, so as to form a network, and they may, commonly, be thrust out from any part of the body and retracted into it again.

If you watch one of these animals alive, you see it thrusting out, first one and then another of its pseudopodia, exhibiting changes of form comparable to those which the colourless corpuscles of the human blood present. The movements of these Rhizopods are quite of the same character, only they are much more extensive and effect locomotion. The creature also feeds itself by means of its pseudopodia, which attach themselves to nutritive particles, and then draw them into the substance of the body. There is neither ingestive nor egestive aperture, neither special motor nor prehensile organs, but the pseudopodia perform each function as it may be required.

But here, again, we labour under an imperfection of knowledge. For, although it is quite certain that the *Rhizopoda* may multiply by division of their substance—in a way somewhat analogous to that which I detailed when speaking of the *Gregarinida*—yet, as in that case, we have no knowledge of any true sexual process. It is a most remarkable circumstance that though these animals are abundant, and are constantly under observation, we are still in doubt upon that essential point,—still uncertain whether there may not be some phase in the cycle of vital phenomena of the *Rhizopoda* with which we are unacquainted; and, under these circumstances, a perfect definition of the class cannot even be attempted.

The next division is the group of the SPONGIDA, which exist under such multitudinous forms in both salt and fresh waters. Up to the last few years we were in the same case, with respect to this class, as with the *Gregarinida* and the *Rhizopoda*. Some zoologists even have been anxious to relegate the sponges to the vegetable kingdom; but

FIG. 2.

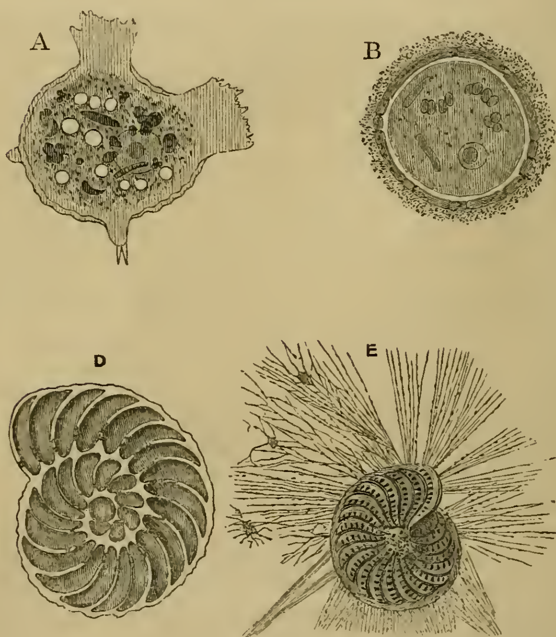


Fig. 2. A, B, free and encysted conditions of an *Amœba* (after Auerbach); E, a Foraminifer (*Rotalia*) with extended pseudopodia; D, its shell in section (after Schulze).

the botanists, who understood their business, refused to have anything to do with the intruders. And the botanists were quite right; for the discoveries of late years have not left the slightest doubt that the sponges are animal organisms, and animal organisms, too, of a very considerable amount of complexity, if we may regard as complex a structure which results from the building up and massing together of a number of similar parts.

The great majority of the sponges form a skeleton, which is composed of fibres of a horny texture, strengthened by needles, or spicula, of silicious, or of calcareous, matter; and this framework is so connected together as to form a kind of fibrous skeleton. This, however, is not the essential part of the animal, which is to be sought in that gelatinous substance, which invests the fibres of the skeleton during life, and is traversed by canals which open upon the surface of the sponge, directly or indirectly, by many minute, and fewer large, apertures.

If I may reduce a sponge to its simplest expression—taking the common *Spongilla*, for example, of our fresh waters,—the structure—removing all complexities, and not troubling ourselves with the skeleton, because that has nothing to do with what we are now considering—may be represented by the diagram (A, Fig. 3). There is a thin superficial layer (*a*) formed entirely of a number of the so-called sponge particles, or ultimate components of the living substance of the sponge, each of which is similar to an *Amœba*, and contains a nucleus. These are all conjoined in a single layer, so as to form a continuous lamellar membrane, which constitutes the outer and superficial layer of the body. Beneath this is a wide cavity, communicating with the exterior by means of minute holes in the superficial layer (*b*), and, of course, filled with water. The cavity separates the superficial layer of the sponge from its deeper substance, which is of the same character as the superficial layer, being made up of a number of aggregated sponge particles, each of which has a nucleus and is competent to throw out numerous pseudopodial prolongations if detached. While the living sponge is contained in water, a great number of currents of water set in to the wide cavity beneath *a*, *a*, through the minute apertures (*b*), which have thence been termed "inhalent."

In the floor of the cavity, there are a number of apertures which lead into the canals ramifying in the deep layer, and eventually ending in the floors of certain comparatively lofty funnels or craters. The top of each of these presents one of those larger and less numerous apertures, which have been referred to as existing on the surface of the sponge, and which are fitly termed "exhalent" apertures. For, as Dr. Grant discovered, many years ago, strong, though minute, currents of water are constantly flowing out of these large apertures; being fed by the currents which as constantly set in, by the small apertures and through the superficial cavity, into the canals of the deeper substance. The cause of this very singular system of currents, remained for a long time unknown. It was rendered intelligible by

Fig. 3.

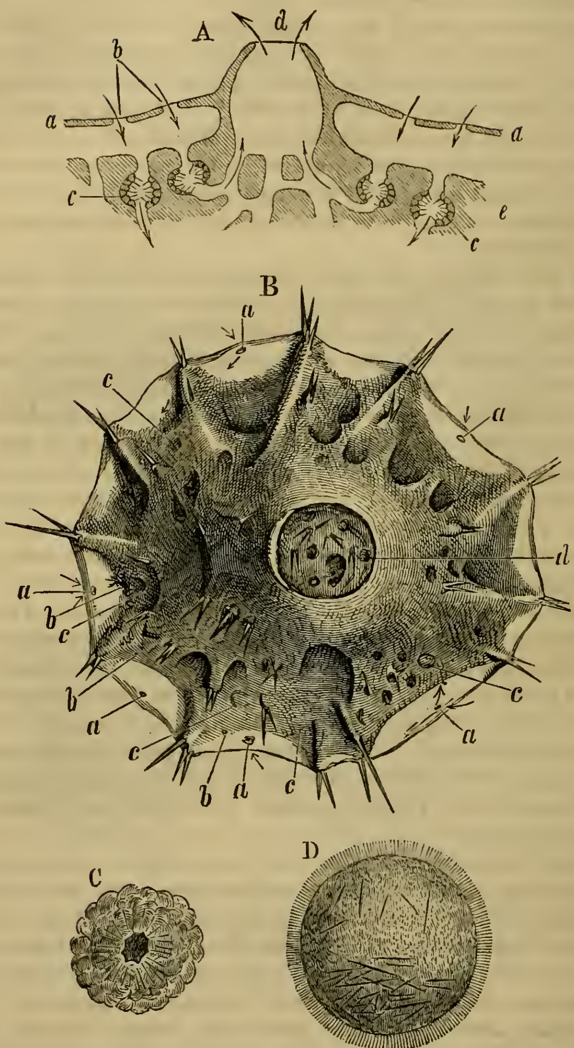


Fig. 3. A, Hypothetical section of a *Spongilla* ; *a*, superficial layer ; *b*, inhalent apertures ; *c*, ciliated chambers ; *d*, an exhalent aperture ; *e*, deeper substance of the sponge. The arrows indicate the direction of the currents. B, a small sponge with a single exhalent aperture, seen from above (after Lieberkühn) ; *a*, inhalent apertures ; *c*, ciliated chambers ; *d*, exhalent aperture. C, a ciliated chamber ; D, a free-swimming ciliated embryo.

Dr. Bowerbank's discovery of the existence of vibratile cilia in the genus *Grantia*, but it is only quite recently that the precise nature of the arrangement of the apparatus which gives rise to these currents in ordinary sponges, has been made out by Lieberkühn and by Carter. The canals which enter the deep substance of the sponge become dilated into spheroidal chambers, lined with sponge particles (Fig. 3, A, *c*, C), each of which is provided with a vibratile cilium; and as all these cilia work in one direction—towards the crater—they sweep the water out in that direction, and its place is taken by fresh water, which flows in through the small apertures, and through the superficial chamber. The currents of water carry along such matters as are suspended in them, and these are appropriated by the sponge particles lining the passages, in just the same way as any one of the *Rhiziopoda* appropriates the particles of food it finds in the water about itself. So that we must not compare this system of apertures and canals to so many mouths and intestines; but the sponge represents a kind of subaqueous city, where the people are arranged about the streets and roads, in such a manner, that each can easily appropriate his food from the water as it passes along.

In the sponges two reproductive processes are known to occur: the one of them asexual, corresponding with the encysting process of the *Gregarinida;* and the other, truly sexual, and answering to the congress of the male and female elements in the higher animals. In the common fresh-water *Spongilla*, towards the autumn, the deeper layer of the sponge becomes full of exceedingly small bodies, sometimes called "seeds" or "gemmules," which are spheroidal, and have, at one point, an opening. Every one of these bags—in the walls of which are arranged a great number of very singular spicula, each resembling two toothed wheels joined by an axle—is, in point of fact, a mass of sponge particles which has set itself apart—gone into winter quarters, so to speak—and becoming quite quiescent, encysts itself and remains still. The whole *Spongilla* lies down, and the seeds, inclosed in their case, remain uninjured through the winter. When the spring arrives, the encysted masses within the "seed," stimulated by the altered temperature of the water, creep out of their nests, and straightway grow up into *Spongilla* like that from which they proceeded.

But there is, in addition, a true sexual process, which goes on during the summer months. Individual sponge particles become quiescent, and take on the character of ova; while, in other parts, particular sponge particles fill with granules, the latter eventually becoming converted into spermatozoa.

These sacs burst and some of the spermatozoa, coming into contact with the ova, impregnate them. The ova develop and grow into ciliated germs (D, fig. 3), which make their way out, and, after swimming about for a while, settle themselves down and grow up into *Spongilla.*

Now that we know the whole cycle of the life of the sponges, and the characters which may be demonstrated to be common to the whole of this important and remarkable class, I do not think any one who is acquainted with the organization or the functions of plants, will be inclined to admit that the *Spongida* have the slightest real affinity with any division of the vegetable kingdom.

The next group to be considered is the division of the INFUSORIA; and here, again, within the last few years, prodigious strides have been made in our knowledge of the subject. Although the *Infusoria* have been favorite studies for many years, still it is only quite recently that the cycle of life of these animals has been made almost completely known, and that we have become acquainted with the true sexual process as it occurs in them

The different species of the genus *Paramœcium* are very common among the microscopic inhabitants of our fresh waters, swimming about by means of the vibratile cilia with which the whole surface of their bodies is covered; and the structure which essentially characterises these animals is probably that which is common to the whole of the *Infusoria*, so that an account of the leading structural features of *Paramœcium* is, in effect, a definition of those of the group.

Imagine a delicate, slipper-shaped body inclosed within a structureless membrane, or *cuticula,* which is formed as an excretion upon its outer surface. At one point (Fig. 4, B *a*) the body exhibits a slight depression, leading into a sort of little funnel (*b c*) coated by a continuation of the same cuticular investment, which stops short at the bottom of the funnel. The whole of the bag formed by the cuticula is lined by a soft layer of gelatinous matter, or "sarcode," which is called the "cortical" layer (Fig. 4, A *a*); while inside that, and passing into it quite gradually, there being no sharp line of demarcation between the two, is a semi-fluid substance, which occupies the whole of the central region of the body. Neither in the cuticle, the cortical layer, nor the central substance, has any anatomist yet discovered a differentiation into cellular layers, nor any trace of that histological composition which we meet with in the tissues of the higher animals; so that here is another case of complex vital phenomena proceeding from a substance which, in a histological sense, is structureless.

At two points of the body (Fig. 4, A *c c*) the substance of the cortical layer exhibits a remarkable power of contraction and dilatation. If you watch one of those points, the sarcode suddenly seems to open like a window and, for a while, a clear space is visible, which then, quite suddenly, shuts again. After a little time the same diastole and systole are repeated. As the systole takes place, it is possible, occasionally, to discern certain radiating canals, which extend from the cavities into the surrounding sarcode, and disappear again before diastole occurs. There is no doubt that the clear space is a chamber filled with fluid in the cortical layer, and since good observers maintain that there is an aperture of communication, through the cuticula, between the 'contractile chamber' and the ex-

Fig. 4.

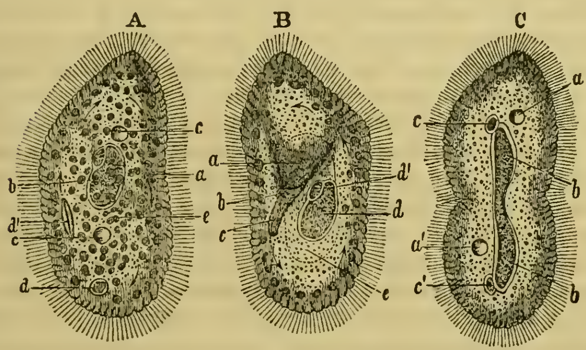


Fig. 4. *Paramœcium bursaria* (after Stein). A, the animal viewed from the dorsal side; *a*, cortical layer of the body; *b*, "nucleus;" *c*, contractile chamber; *d*, *d'*, matters taken in as food; *e*, chlorophyll granules.

B, the animal viewed from the ventral side; *a*, depression leading to *b*, mouth; *c*, gullet; *d*, "nucleus;" *d'* "nucleolus;" *e*, central sarcode. In both these figures the arrows indicate the direction of the circulation of the sarcode.

C, *Paramœcium* dividing transversely; *a*, *a'*, contractile spaces; *b*, *b'*, "nucleus" dividing; *c*, *c'*, "nucleoli."

terior, this fluid can be little more than water. Perhaps the whole should be regarded as a respiratory or secretory mechanism: in one shape or another, it is eminently characteristic of the *Infusoria*. Besides this singular apparatus, there lies embedded in another part of the cortical layer a solid mass, of an elongated oval shape (Fig. 4, A B *d*), which has been called the "nucleus," though it must be carefully distinguished from the "nucleus" of a cell. Upon one side of this, and, as it were, stuck on to it, is a little rounded body (Fig. 4, B *d'*), which has received the name of the "nucleolus." The animal swims about, driven by the vibration of its cilia, and whatever nutriment may be floating in the water is appropriated by means of the current which is caused to set continually into the short gullet by the cilia which line that tube.

But it is a singular circumstance that these animals have an alimentary canal consisting of a mere gullet, open at the bottom, and leading into no stomach or intestine, but opening directly into the soft central mass of sarcode. The nutritious matters passing down the gullet, and then into the central more fluid substance, become surrounded by spheroids of clear liquid (Fig. 4, A *d*), consisting apparently of the water swallowed with them, so that a well-fed *Paramœcium* exhibits a number of cavities, each containing a little mass of nutritious particles. Hence formerly arose the notion that these animals possess a number of stomachs. It was not unnaturally imagined that each of the cavities in question was a distinct stomach; but it has since been discovered that the outer layer of the sarcode is by means of some unknown mechanism, kept in a state of constant rotation; so that the supposed stomachs may be seen to undergo a regular circulation up one side of the body and down the other. And this circumstance, if there were no other arguments on the same side, is sufficient to negative the supposition that the food-containing spaces are stomachs; for it is impossible to imagine any kind of anatomical arrangement which shall permit true dilatations of an alimentary canal to rotate in any such manner. Fæcal matters are extruded from an anus, which is situated not far from the mouth, but is invisible when not in use. It is an interesting and important character of the *Infusoria*, in general, that, under some circumstances, they become quiescent and throw out a structureless cyst around their bodies. The *Infusorium* then not unfrequently divides and subdivides, and, the cyst bursting, gives rise to a number of separate *Infusoria*.

The remarkable powers of multiplication by fission and gemmation which many of the group exhibit are well known; but within the last few years the investigations of Müller, Balbiani, Stein, and others, have shown that these minute creatures possess a true process of sexual multiplication, and that the sexual organs are those which have been denominated "nucleus" and "nucleolus." The nucleus is the true ovary—the nucleolus, the testis, in *Paramœcium*. At particular times, the latter increases very much in size, and its substance is broken up into rod-like bodies, which represent spermatozoa. Two *Infusoria*, in this condition, become conjoined, and the nucleolus (now converted into a spermatic capsule) of each passes into the body of the other. The spermatic filaments are said to enter the nucleus, which then enlarges, and either divides into, or gives off, a number of rounded germs, which become oval ciliated bodies provided with long processes. These make their way out of the body, and, it is believed, are metamorphosed directly into young *Paramœcia.* But, perhaps, further information is required before we can be quite certain on this point.

The subsequent lectures in this volume are devoted to the Molluscous, Annulose, and Vertebrate series of animals. They are treated in the same lucid and original manner as the lower groups of animals to which the above lecture relates. We can recommend these lectures to the study of all young students of natural history who are desirous of taking a comprehensive view of the structure and relations of the animal kingdom. In the second and third lectures, will be found numerous observations on the forms of the molluscous and annulose animals, which will clearly show that it is only by the aid of the microscope that a proper study of the animal kingdom can be undertaken. These lectures by Professor Huxley are copiously illustrated, and as a work by one of the most advanced students of the science of biology, it cannot fail to be interesting not only to those engaged in anatomical and physiological studies, but to all who take an interest in the observation of the structure and functions of the animal kingdom.

ORIGINAL COMMUNICATIONS.

REPORT *of the* MICROSCOPES *exhibited at the* INTERNATIONAL EXHIBITION, 1862.

IN a former number, Vol. II, N. S., p. 197, shortly after the close of the Exhibition, we offered a few remarks on the microscopes contained in it; and we are now glad to have an opportunity of giving the able and full report upon them which has but just appeared in the series of "Jurors' Reports," from the able pen of Mr. C. Brookes, F.R.S.

MICROSCOPES AND ACCESSORY APPARATUS.

The recent Exhibition, like its predecessor in 1851, has been very complete in its display of microscopes, accessory apparatus, and objects. For a brief history of the development of the microscope, the reader is referred to the Report of 1851, p. 265; it may suffice on the present occasion to say that since 1851 considerable improvements have been effected both in the optical and mechanical departments of this important instrument, the employment of which, whether for purposes of mere recreation or of scientific research, has been so largely developed within a few years.

As regards optical construction, a considerable accession of available power has been effected; some very deep powers have been constructed by continental artists, most of these being designed to be used with the intervention of a fluid medium between the external surface of the objective and the covering glass of the object, amongst which those of M. Hartnack are most conspicuous; but no objective yet manufactured for sale at all rivals, in its power of development, the $\frac{1}{25}$th of Messrs. Powell and Lealand. These able artists have likewise been very successful in the construction of the deepest previously acknowledged powers, namely, those of $\frac{1}{12}$th and $\frac{1}{16}$th inch focus; in these objectives excessive angular aperture has been judiciously sacrificed to more comprehensive and practical utility.

In flatness of field, and in perfection of definition, both at the centre and margin of the field of view, few objectives have equalled, and none have surpassed, the recent constructions of Mr. Ross, who appears to have inherited his late father's well-known aptitude in adapting mechanical contrivance to optical requirement. In available angle of aperture considerable advances have been made by several of the leading artists; but as it is palpable that much misconception exists with regard to *available* angle of aperture, the reporter abstains from quoting stated angles. This fact may easily be shown; supposing the focal point to be at a distance of 0·01 inch from the surface of the objective (which for most glasses is a very moderate assumption), a reference to a table of natural tangents will show that an *angular* aperture of 17° will necessitate a *linear* aperture of 0·22 inch; an aperture of 172° will require 0·28 inch, and one of 174°, 0·38 inch, in order to admit the extreme rays, which for objectives of $\frac{1}{8}$th inch focus is manifestly impossible, and *à fortiori* for those of still shorter focus. It may here be remarked that an admirable method of determining the *availble* angle of aperture of an objective was suggested to the jury by Professor Govin, of Turin, which consisted in placing the microscope perpendicular to any plane dark non-reflecting surface (as a table covered with green cloth), and having converted the instrument into a telescope, by placing above the eye-piece a suitable combination of two lenses (such as the "examining-glass" of Mr. Ross), and then examining and marking the greatest lateral distance on either side at which a clear image of some distinct object, such as a narrow strip of white card-board or paper laid on the table, can be perceived. Half the distance between these two points, divided by the vertical distance of the focal point of the objective from the surface of the table, will, by reference to a table of natural tangents, give half the required angle of aperture. This will in many cases be found to be considerably less than what may be termed the *angle of admission of diffused light.*

In regard to angle of aperture, it may be desirable here to state that *large angle of aperture* is necessarily incompatible with that far more generally useful quality of a good objective, *penetration.*

Penetrating power is synonymous with *depth of focus;* that is, extreme distance of two planes, the points of which are *at the same time* sufficiently in focus for the purpose of distinct vision. This distance will manifestly increase as the angle of aperture diminishes, just as in a landscape camera the fore and back grounds can be brought into sensible focus simultaneously only by the use of a small diaphragm, which greatly diminishes the angular aperture of the incident pencils. But at the same time it must be borne in mind that illumination, *cæteris paribus,* increases or diminishes with angle of aperture, and the best working glass will be that in which the best compromise is effected between these two conflicting requisites. For all practical purposes, except developing the markings of diatoms, an objective of moderate aperture will be found most available. It may reasonably be doubted whether the development of the dottings of difficult diatoms is not an object rather of curiosity than of utility, and whether it is worth the labour that has been bestowed upon the production of glasses for that especial purpose; the labour of construction being immensely augmented by the difficulty of duly balancing the aberrations of the more oblique pencils. So much is this the case, that in the best constructed objectives of the largest angles, the visual effect is sensibly impaired when the rays are transmittod through any other thickness of covering-glass than that for which they have been specially corrected.

The introduction of the binocular arrangement of Mr. Wenham has created quite a new era in the history of the microscope. This ingenious contrivance consists in intercepting one half of the pencil emerging from the object-glass by a prism placed immediately above it, the transverse section of which is a trapezium, of such form that the transmitted half-pencil is made to form the usual visual angle with the undisturbed half; the surfaces of incidence and emergence are both perpendicular to the respective directions of the rays, which suffer two internal reflections in passing through the prism.

A binocular arrangement was some years since constructed by M. Nachet, of Paris, which has been considerably improved in the instruments recently exhibited by him; and another was exhibited by Mr. Dancer, of Manchester, which closely resembles a plan previously designed and abandoned by Mr. Wenham. In both of these the pencil is bisected by the double prism, and the two halves diverge equally in opposite directions. As, however, the pencils of rays can hardly be expected to pass through a prism without some sensible disturbance, and as it well known that the superposition of two equally perfect images is not essential for the production of a satisfactory binocular effect, it seems most probable that a better result will be obtained by the construction of Mr. Wenham than by either of the others; and it has this further advantage, that by simply withdrawing the prism, which is introduced in a small sliding frame, the microscope is at once reduced to its original monocular form.

Several new modifications of illuminating apparatus have been introduced in this country since 1851; the principal of these are a condenser of very large angular aperture, by Messrs. Powell and Lealand, in which every requisite modification of the illuminating pencil may be produced by two revolving discs, one containing apertures of various sizes, and the other various diaphragms for excluding the central portion, or for admitting only angular portions, of the pencil of light. These discs are placed immediately below the posterior lens of the illuminator. This method of modifying the illuminating pencil was first applied in Gillett's condenser, as constructed by Mr. Ross, by whom this latter apparatus has recently been modified for the purpose of affording a more efficient illumination for medium powers. A hemispherical condenser has been produced by the Rev. J. B. Reade, which answers remarkably well for the purpose for which it was devised, namely, the development of the markings of diatoms. The plane surface of the hemisphere is placed upwards, and is covered by a diaphragm in which are marginal apertures, capable of adjustment either to an interval of 90° with each other, when the arrangement of the dots to be developed is quadrangular, as in *N. rhomboides*, or *P. hippocampus;* or to one of 60° and 120°, when they are arranged in equilateral triangles, as in *P. angulatum*, &c. An ingenious plan of illuminating by reflected light minute objects, mounted in Canada balsam, has been devised by Mr. Wenham; this consists of a small truncated glass paraboloid, which is temporarily attached to the under side of the slide containing the object, by a little gum, oil, or fluid Canada balsam. The rays internally reflected from the convex surface of the paraboloid, and impinging very obliquely on the under surface of the slide, are *transmitted* in consequence of the fluid uniting medium, and are then internally reflected from the upper surface of the covering glass on to the object. Very minute variations of surface contour may by these means be rendered evident.

Considerable improvements in the brass-work have been recently effected; in the first-class instruments of Mr. Ross, and of Messrs. Powell and Lealand, the rotating stages are most conveniently arranged. It must be borne in mind that the solidity and weight of material necessary to entirely obviate tremor, when high powers are used, is incompatible with portability. On this account more portable forms of stand have been constructed by most of the principal makers; a stand made by Mr. Ladd has been considered to combine lightness and portability with as much rigidity as is compatible with the weight of material employed.

Most praiseworthy endeavours have been made by many exhibitors to produce an efficient instrument at a price compatible with the means of students and others, to whom a first-class instrument is unattainable.

By the aid of an extensive plant of machinery, Messrs. Smith, Beck, and Beck, have succeeded in producing a complete and efficient binocular microscope, at the price that is commonly charged by the first makers for merely rendering a first-class instrument binocular. They have also constructed a still cheaper form of instrument, combining great steadiness with fair optical efficiency. Mr. Highley and Mr. Pillischer have also greatly distinguished themselves in this department. Very cheap forms of compound microscope are exhibited by Mr. Field, who obtained the Society of Arts' prize some years since, but who does not appear to have in any respect improved his model; and others by Mr. Parkes, the cheapest of all, but at the same time it must be added, the least efficient optically; whether the quality is as good as can be procured at the price is a question which none but the manufacturer can determine.

There is a very creditable display of preparations, both British and foreign; but it is to be regretted that one, who has for many years been considered the first British preparer, has contributed nothing to this Exhibition. The German objects prepared by imbibition and transparent injection, imported and exhibited by

Messrs. Smith, Beck, and Beck, are extremely beautiful and instructive.

The works of individual exhibitors, in the British and Foreign departments respectively, will now be briefly noticed.

British Exhibitors.

C. Baker, H.M. (*United Kingdom*, 2853), exhibits a creditable collection of well-constructed microscopes, the prices of which are moderate. The stands are after Mr. Ross's model. The objectives are of very fair quality for general purposes; some of the low powers are very good. His students' microscopes are well and economically constructed.

Professor Beale, M. (*United Kingdom*, 2855), has devised and exhibited an exceedingly simple and convenient form of microscope, for the purposes of clinical instruction and of class demonstration. Over the body of the microscope, which is of small dimensions, a tube is fitted with a bell-shaped mouth at the end. This tube slides freely over the body, but is capable of being fixed at will, by means of a clamping-screw. The slide containing the object is placed across the bell-mouth, and held there by a spring pressing against the back of it, and is thus maintained perpendicular to the axis of the instrument. When the focus is adjusted, the clamping-screw is fixed, and the fine adjustment necessary for the differences of vision in different individuals is effected by drawing out or pressing in the eye-piece. The object and object-glass are thus protected from mutual injury, an accident of by no means unfrequent occurrence in careless or unpractised hands. In this form the instrument is adapted to the clinical examination of secretions, &c., and must be directed by the hand towards day or artificial light. For demonstration to a class, this instrument is attached horizontally to a small wooden stand by means of a clamp, supported by two legs. To the stand a small oil lamp is likewise attached; and a stem proceeding from the lower edge of the bell-mouth carries any desired form of condensing or illuminating apparatus. This stand is capable of being freely handed round a large class, without the focus becoming at all deranged, even when a very deep objective is employed. Professor Beale also exhibits, attached to microscopes of this form, some very beautiful preparations, illustrative of a fact discovered by himself, which has a very important physiological bearing—namely, that if small portions of tissue are, immediately after the extinction of life, immersed in an alkaline solution of carmine, those elements in which growth or development was actually in progress at a time immediately preceding the cessation of vitality, become permanently stained by the colouring matter; while from the "formed material," as he terms it, comprising those portions of tissue in which the development is complete, the colour may be subsequently washed out. This evidently affords a most important means of investigating the processes concerned in the growth and development of the various tissues of which animal frame is composed. Some preparations are also exhibited illustrating the preservative effect of a weak aqueous solution of wood-naphtha and creasote.

J. H. Dallmeyer, M. (*United Kingdom*, 2888), exhibits microscopes constructed after the model of his late father-in-law, Mr. A. Ross, whose talents were long so successfully directed to the improvement of the microscope. These are, as might be expected, first-class instruments; but in their construction, Mr. Dallmeyer's artistic power has not experienced as successful a development as in his astronomical telescopes previously mentioned.

J. B. Dancer, *Manchester*, M. (*United Kingdom*, 2889), exhibits a patented form of binocular microscope, in which the two pencils pass symmetrically through an achromatized double prism. As previously stated, it is very questionable whether any contrivance for the symmetrical divergence of the pencils by means of refracting prisms is desirable. In this the light is a good deal reduced by the narrowness of the rectangular aperture through which the pencil is transmitted. Mr. Dancer's reputation for the successful production of microscopic photographs is well known, and fully sustained by those exhibited. A group of four well-defined portraits of eminent persons is so small that the width of each containing oval is one fiftieth of an inch.

P. Frith & Co., *Sheffield* (*United Kingdom*, 2899), exhibit some well-made microscopes, at moderate prices, for the amount of workmanship expended on them. Their optical properties are, however, hardly equivalent to the soundness of their mechanical construction.

S. Highley, M. (*United Kingdom*, 2912), exhibits some very commendable forms of microscope for students and general use, at a very moderate price. Among these are the late lamented Professor Quekett's dissecting microscope, neatly packed up as a pocket companion; and Professor Beale's admirable instrument for the lecture-room, at the moderate price of £3 3*s*.

Horne & Thornthwaite, M. (*United Kingdom*, 2916), exhibit a full-sized and well-finished microscope, the only noticeable peculiarity of which is that there is a small amount of tilting or rocking motion communicable to the stage, by means of which an object, not mounted parallel to the surface of the slide, may be brought to coincide with the plane of vision. They exhibit also an aplanatic eye-piece; this is not really so great a desideratum as might be supposed, inasmuch as the best-constructed objectives are usually a little over-corrected, to compensate for the chromatic aberration of the ordinary Huyghenian eye-piece.

W. Ladd, M. (*United Kingdom*, 2925), exhibits microscopes of considerable merit. The instruments of Mr. Ladd have been long and favorably known to microscopists for the substitution of a chain-movement for the ordinary rack and pinion, whereby great smoothness of motion is attained, together with the entire absence of "loss of time." This is applied both to the coarse adjustment, for raising or lowering the body of the instrument, and to the rectangular movements of the stage. The adjustment of the secondary stage is of a very simple and effective kind; the stage consists of three brass plates superposed on each other, the lower one being attached to the body of the instrument, and the upper one to the tube which carries the illuminator. The middle plate is connected with the external ones by two pins distant 90 from each other, and each moved upon the other by a rack and pinion. Mr. Ladd has also a very neatly arranged magnetic stage. Two small magnetic bars are inserted in the stage-plate, and a gilt iron bar placed across these adheres in any position in which it is placed, and supports the object. The quality of the objectives is good, but not first-rate. The lightness and portability of the stand have already been alluded to.

J. Parkes & Son, *Birmingham*, H. M. (*United Kingdom*, 2943), emphatically state that their aim has been to produce convenient, well-proportioned instruments, *at the lowest possible price*, and no doubt this object has been successfully carried out, as their simplest forms of compound microscopes are extremely cheap, the lowest cost being only 10*s*. 6*d*.; these may be the means of introducing a healthy and inviting pursuit amongst large classes to whom more efficient instruments would be obviously unattainable. This firm has boldly attempted to develop a new point of union between art and science, in the production of a large "Fine Art" microscope. As taste is proverbially not amenable to any known law, it is hoped that this "work of art" may not remain unappreciated; but an irresistible conviction arises that the body of a microscope mounted on the back of a dolphin, or a griffin, or anything of that sort, is an incongruous and uncommendable monstrosity.

M. Pillischer, M. (*United Kingdom*, 2945), exhibits a considerable variety of microscopes, some of which may fairly claim the denomination of first-class instruments; and the advance of his recent exhibit from that of 1851 evinces much persevering industry. His brass-work is very good; it is generally on the "Ross" model, except that a little curvature is given to the outline of the vertical supports. The optical work is good, but has not yet reached the highest standard of excellence. The object in his collection which was considered most entitled to commendation, was a very compact student's microscope in a neat mahogany case. The objective consisted in a triple achromatic combination; the first, composed of three lenses, made a good objective of one-inch focus. The addition of the second, a correcting combination of two lenses, gave an indifferent half-inch objective; but the addition of the third combination constituted a very effective glass of quarter-inch focus; and the price of the whole, namely £5, does not exceed that of a quarter-inch objective alone, by either of the first makers.

Powell & Lealand, M. (*United Kingdom*, 2946). The exhibit of this old-established and much respected firm was of very limited extent, but at the same time of first-rate excellence. The form of stand now generally adopted by them is a tripod, combining steadiness and stability with comparative lightness: as the stability of the instrument here depends on breadth of base in place of weight of foot. The object-stage has a concentric circular motion, in addition to the usual rectangular movements. The rectangular movement-plates are made extremely thin, and are raised by a kind of flat pillar from the rotating ring, for the purpose of allowing rays of the utmost obliquity to be thrown upon the object by an Amici prism. The sharply accurate defining power of their objectives has scarcely been exceeded, and not often equalled, especially in those of most difficult execution, the $\frac{1}{12}$th and $\frac{1}{16}$th; but their greatest triumph is in the production of a perfectly defining objective of $\frac{1}{25}$th or $\frac{1}{50}$th-inch focus, working very satisfactorily through a covering-glass of 0·035 to 0·004-inch thickness. Nor is it to be supposed that this immense magnifying power, ranging as it does from about 1700 to upwards of 3000 diameters, that is, in round numbers, from three to ten millions in area, is a mere philosophical curiosity; we cannot doubt that the wonders of creative beneficence will be developed in proportion to our extended means of investigation; and the writer can fully testify to having repeatedly seen, under one of these objectives, evidences of structure that are, under ordinary powers, utterly indistinguishable. This firm also exhibits a compact form of portable microscope, in which the three legs of the tripod fold together; and a very convenient form of illuminating apparatus, which has been already alluded to. They have not devoted their attention to the manufacture of anything but first-class instruments.

The Rev. J. B. Reade, *Ellesborough*, H. M. (*United Kingdom*, 2948), exhibits a hemispherical condenser, which has been found to possess remarkable powers in developing the markings of diatoms, with objectives that were unable to accomplish the same with any previously known simple means of illumination. The construction of this apparatus has already been sufficiently described.

T. Ross, M. (*United Kingdom*, 2952), exhibits a remarkably fine collection of first-class instruments and apparatus, for every kind of microscopical investigation. These instruments differ in quality, and correspondingly in price, only in relation to the completeness of their mechanical arrangements, the workmanship of all being equally good, so far as it extends. The optical parts of all are alike, both ocular and objective, none of a second or inferior quality being manufactured. The stage arrangements are most perfect; the thin traversing plates of the object-stage are attached to a rotating ring, believed to be of such diameter as to admit to the under surface of the object any oblique illumination that can possibly be required. This form of stage was generally admitted to be the best in the Exhibition. The secondary stage for the adaptation of all varieties of illuminating and polarizing apparatus is readily mounted and dismounted, and possesses vertical and rectangular horizontal adjustments, as well as circular motion, the rings both in this and the upper stage being graduated.

Of the objectives it is difficult to say too much; the correction, and consequent defining power of all is excellent, and in the medium powers especially the flatness of the field and the accuracy of definition over its entire surface are most remarkable; the low powers (meaning objectives of one-inch or longer focus) are by no means excluded from this category; but in these, good results in this direction have been long since obtained, and, moreover, the attainment is comparatively easy.

In addition to the usual forms, a Kelner's achromatic eye-piece is exhibited, by which the usual area of the field of view is doubled, but not, it is thought, without a considerable sacrifice of definition. This differs from the ordinary Huyghenian eye-piece in having a double convex field-glass and an achromatic meniscus eye-glass.

Of illuminating apparatus, Mr. Ross exhibits a modification of his well-known Gillett's condenser, specially adapted for the lower powers; and in addition to all other established forms, we find the hemispherical condenser above mentioned, now commonly known as "Reade's kettle-drum." Darker's selenite plates are here very conveniently adapted to the polarizing apparatus. Amongst a great variety of useful accessory apparatus, a new form of compressor is exhibited, in which, by means of a short vertical slide, the upper plate of thin glass is moved parallel to the plane of the instrument.

Smith, Beck, & Beck, M. (*United Kingdom*, 2964), present a copious display of microscopes of various capabilities. One of their large first-class instruments is rendered very portable, by making the legs to fold up; the stage also is removable; it is packed in a comparatively small flat case, replete with every conceivable accessory apparatus.

The first-class instruments by this firm have long been duly appreciated by the public, but their efforts, which were considered most praiseworthy and successful, were those directed to the production of students' microscopes of various kinds, of good working quality, and at a very moderate price, by the aid of an extensive plant of machinery. Perhaps the most conspicuous of these is a binocular microscope, which is rendered complete with eye-pieces, and two objectives, at £10, about the same price as that usually charged by themselves, and the other first-rate firms, for merely adapting Wenham's binocular arrangement to an ordinary first-class instrument. The student's microscope, firmly supported on a solid circular base, comprising two fairly good objectives of one-inch and quarter-inch focus, and sold complete for £5, is a highly commendable instrument.

This firm exhibits as an undoubted novelty a "*Museum Micro-*

scope," consisting of a microscope-body mounted over a large revolving brass drum, in the interior of which are placed a number of independently revolving cylinders, which traverse as they rotate, by the aid of a many-threaded screw. The objects, 500 in number, are placed spirally round the hollow cylinders, and are, by appropriate and simple mechanism, brought successively into the field of view, being illuminated by a reflector placed inside the cylinder. This elaborate contrivance is well adapted for the purpose for which it was designed, and will effectually protect the collection of objects from dishonesty, as well as from carelessness.

Several new accessory apparatus are likewise comprised in this collection. Besides the double nose-piece now generally in use, there is a quadruple nose-piece, for mounting four object-glasses simultaneously, either of which may be brought into the axis of vision. This consists of a revolving piece, with four bent arms attached to the body of the instrument, so that the axes of the four objectives lie in a conical surface, one side of which is coincident with the axis of the body. The weight of this apparatus, when loaded with four objectives, will be nearly twice that of the double nose-piece; and its greater convenience is perhaps open to question; moreover, it is thought to be impossible that the fine adjustment can work with the delicacy essential for high powers, when its spring is so heavily and so unnecessarily loaded. There is also a very ingeniously contrived opaque object-holder, in which, by a simple and effective means of complete rotation in two planes perpendicular to each other, the point of surface under examination may be placed in any required position.

This firm also exhibits a variety of pieces of brass-work in all stages of manufacture, from the rough casting to the finished work, showing the beneficial action of planing, shaping, and slotting machines, designed and constructed by themselves, on the well-known and established principles now generally adopted in mechanical engineering.

J. Swift (*United Kingdom*, 2974) exhibits a microscope stand, in which a chain-movement is concealed in the triangular sliding-bar and its stem, and the rectangular motions of the stage are effected by eccentrics. The chain-movement necessarily gives great smoothness of motion; the advantage of the stage-movement is somewhat questionable.

F. H. Wenham, M. (*United Kingdom*, 2989), exhibits his now well-known and duly appreciated binocular arrangement, which has already been alluded to (p. 22); the most perfect stereoscopic effect is thereby produced, without the definition of the object being sensibly impaired. This is due to the entire absence of chromatic dispersion, the deflected pencil being perpendicularly incident on, and emergent from, the corresponding surfaces; its change of direction is solely due to internal reflection. If the displacement of the pencils be effected by refraction, some amount of chromatic dispersion is unavoidable, which has been found to render such binocular vision extremely irksome, especially if long continued. The construction is now so universally adopted in new instruments, and adapted to old ones, by all the leading British makers, that it would have involved needless repetition to mention it in each particular case.

It would be unjust to conclude these observatiens without a commendatory remark on the extreme not less than unusual liberality, that induced Mr. Wenham to disclaim any personal pecuniary advantage from this most ingenious and useful invention.

J. Casartelli, *Manchester* (2873).

Chadburn Brothers, *Sheffield* H.M. (2805).

Elliott Brothers, M. (2897).

W. J. Salmon (2953).

E. G. Wood (2994).

Microscopes are exhibited by all these firms, but none of them require special notice.

Foreign Exhibitors.

E. F. Hartnack, *Paris*, M. (*France*, 1417), exhibits a fine collection of microscopes, the stades of which are generally on the Oberhauser model, in which the body of the microscope stands up from a heavy, hollow, cylindrical base or pedestal, the upper surface of which forms the stage. The bulk of these instruments is much less than that of the first-class English microscopes; this is not probably attended by any disadvantage, except that, to a considerable extent, magnifying power is conveniently augmented by length of body. The powers generally are very good—unquestionably the best in the foreign department; the deepest is 1 millimètre focal length, and hence about equivalent in magnifying power to the $\frac{1}{25}$th of Powell and Lealand; but in penetrating and defining power it is not comparable with that unique objective.

Several of the deeper powers by this and other foreign artists are corrected for the transmission of the rays from the object to the objective, through some intervening fluid medium, as distilled water. This principle of construction has not been at all carried out in this country; all our objectives being corrected for the reception of rays from air; it may, perhaps, possess advantages that are not at first sight apparent, and deserves more attention than it has has hitherto received.

A. Mirand, Sen., *Paris* (*France*, 1418), exhibit miscroscopes, the stands of which are after the ordinary English model. The objectives are after the usual French plan, consisting of three similar achromatic lenses, superposed, which are either taken at random from a pile, or at best, matched by trial. This principle of construction is manifestly inferior to that universally adopted in this country, especially in all the higher powers, in which the magnifying power is thrown principally on the anterior, and the correction of aberration on the middle and posterior combinations.

J. G. HOFMANN, *Paris* M. (*France*, 1440), exhibits a polarimicroscope, an ingeniously designed and very convenient instrument for the examination of small crystals and crystalline plates, under the influence of polarized light. The object to be examined is placed in the middle of the instrument, at the common focus of two triple combinations, so constructed as to collect the pencils from a large field of view. A polarizer is placed beneath the lower triplet, and an eye-piece and analyser above the upper one. The visual angle is so large that the two axes of bi-axial crystals may frequently be viewed simultaneously, even when separated by a considerable angular interval. This appears to be the most complete and effective apparatus that has been constructed for this class of physical investigations.

NACHET & SON, *Paris*, M. (*France*, 1416), exhibit a good collection of instruments, of which their binocular microscopes are the most conspicuous. M. Nachet has undoubtedly the credit of having been the first to achieve the successful construction of a binocular microscope. The prismatic arrangement for bisecting the visual pencil in the instruments recently exhibited is far superior to that previously adopted by the same firm, and yields perhaps as good a result as can be expected from any *symmetrical* plan of construction; the reasons for preferring the *unsymmetrical* plan of Mr. Wenham have already been assigned. This firm also exhibits some ingenious devices by which the pencil transmitted by the objective is prismatically divided into three and four parts, and directed through as many divergent tubes, to enable a like number of persons to view an object simultaneously; but the advantages which such persons would derive from seeing an object imperfectly together, in preference to seeing it well in succession, is not very apparent.

F. A. NOBERT, M., *Berlin* (*Prussia*, 1410), exhibits a microscope of his own design, and his well-known test lines, for which a prize medal was awarded in the Exhibition of 1851, and a description of which will be found at page 268 of that Jury Report. The microscope is not conspicuous for the convenience of its arrangements; it is tall and vertical, and has a micrometer stage-movement, consisting of a micrometer-screw, with a large graduated head attached to an adjacent *fixed* pillar, and connected with the stage by a Hook's joint, in order to admit an adjustment of the *stage* for focusing. The vertical position of a microscope is always undesirable, where it can be avoided, as the necessarily flexed position of the head incommodes the circulation of the blood, and tends, in conjunction with the active exercise of vision, to produce congestion; moreover, vision is liable to be rendered indistinct by the gravitation of any humours floating on the surface of the eye to the then lowest point, the centre of the cornea.

H. Schröder (*Hamburg*, 37) exhibits some very commonplace microscopes.

A few unimportant instruments in this class may possibly have been overlooked in the foreign department.

Descriptions *of new* British Polyzoa, *with* Remarks *on some imperfectly known* Species. By Joshua Alder, Esq.

The branched calcareous Polyzoa have always commanded attention, from the beauty of their form and structure, while at the same time naturalists have experienced considerable difficulty in defining their specific distinctions. My object in the present paper is to endeavour to clear up some of the difficulties that beset the study of the British species, more especially in the genera Cellepora and Eschara, with regard to some species of which a more than usual difference of opinion exists. Dr. Johnston did much to unravel the synonyms of this class in his 'History of British Zoophytes.' But it is to Professor Busk that we are most indebted for a knowledge of their peculiar structure, and a careful definition of their generic and specific forms. In his 'Catalogue of the Polyzoa in the British Museum,' he points out the importance of those curious organs, the avicularia and vibracula, in the discrimination of species—an attention to which has very materially contributed to the accuracy of definition. The papers of the same distinguished observer, in the 'Journal of Microscopical Science,' still further increased our knowledge of the British species, particularly in the description of those got in Shetland by our lamented friend, Mr. Barlee. Still, however, much remains to be done. The eminent Norwegian naturalist, Professor Sars, has lately published a valuable paper 'On some Norwegian Polyzoa,' which throws much light on our British species, and especially those of Shetland. With the assistance of specimens of his new genera, which Professor Sars has kindly sent me, I shall be able to clear up some points in our Polyzoa hitherto misunderstood, while at the same time I shall have the opportunity of introducing a few new species into the British Fauna.

Genus Cellepora.

Some of the species of this genus have lately been removed to Eschara, including Cellepora Skenei and C. lævis; also the C. cervicornis of British authors, the propriety of removing which is doubtful. The only branched species mentioned by Dr. Johnston, now generally retained in this genus, is *C. ramulosa*. As one or two species have been confounded with this, it will be necessary to re-define it.

Cellepora ramulosa, Linn. (Pl. II, fig. 1.)

Polyzoary erect, white or yellowish, rather glossy, branching dichotomously, and arising generally from a broadish spreading base, the branches cylindrical, and tapering very slightly. *Cells* prominent, ventricose, rather irregularly heaped, smooth, and occasionally punctured round the sides; the apertures smallish, nearly circular, with a strong projecting rostrum below, terminating generally in a sharp point, and with an avicularium placed on one side. *Ovicells* smallish, subglobose, rather broader than long, smooth, and imperforate. Height sometimes reaching to three inches; lateral expansion variable, but often exceeding the height. Breadth of branches about one and a half tenths.

Cellepora ramulosa, Flem., 'Brit. Anim.,' 532; Johns., in 'Newc. Nat. Hist. Trans.,' v. ii, p. 267, t. 12, figs. 3, 4; 'Brit. Zooph.,' 2nd Ed., p. 296, t. 52, figs. 4, 5; Couch, 'Cornish Fauna,' pt. iii, p. 110, t. 20, fig. 2; Busk, 'Catal.,' p. 87, t. 109, fig. 1, 2, 3, (young?).

This species may generally be known by its roughened and spinous appearance. Large specimens are much branched; the branches are round, tapering a little towards the apex, where, occasionally, they are slightly flattened. Professor Busk says * that the ovicells are punctured, but this, I think, is a mistake, as, according to my observation, they are smooth and imperforate, and in that respect are well distinguished from the following.

Cellepora dichotoma, Hincks. (Pl. II, figs. 2, 3, 4.)

This species has been described by the Rev. T. Hincks, in his 'Catalogue of the Zoophytes of South Devon and Cornwall.' It is distinguished from C. ramulosa by its *less spinous* surface, the rostrum below the aperture being blunt, and, excepting in young cells, very slightly projecting. The stem is slender below, and scarcely expanded at the base, becoming

* 'Fossil Polyzoa of the Crag,' p. 58.

broader as it ascends, branching dichotomously, and tapering to a blunt apex. The ovicells are larger and more numerous than in the last species, and are distinctly perforated. Besides the avicularium on one side of the rostrum, there are small, circular avicularia scattered over the surface and between the cells, with a few larger spatulate ones interspersed. The specimens got by Mr. Hincks appear to have been of small size; but on the coast of Northumberland, where the species is not uncommon, it grows rather larger, though seldom reaching above an inch in height. It varies a good deal in form, sometimes spreading in a palmate manner, like an elk's horn (fig. 3), sometimes consisting of more slender cylindrical branches of nearly equal thickness throughout (fig. 2). The typical form, however, is a little ventricose in the centre, and not much branched.

CELLEPORA ATTENUATA, n. sp. (Pl. II, fig. 5—8.)

Polyzoary very slender, white, cylindrical, nearly smooth below, a little roughened above, dichotomously branched, the branches of equal thickness throughout, and diverging on all sides. *Cells* immersed or very slightly raised, excepting those towards the extremities of the branches, which are a little more prominent; their surface is smooth, with small tubular perforations round the margins, and a few circular and slightly raised avicularia on the surface of the cells. *Apertures* nearly circular, with a slightly projecting rostrum below, bearing a small avicularium on one side; the rostra are obliterated in the lower portion of the stem and branches. *Ovicells* free, semicircular, decumbent, a little perforated. Height, about an inch; lateral expansion, rather less; breadth of stem, $\frac{1}{20}$th of an inch.

The species has yet only been found in Shetland, where it was first got by Mr. Barlee, in 1858. It has lately been obtained in the same locality, by the Rev. A. M. Norman. C. attenuata comes rather near to some varieties of the last, from which it may be known by its more slender form and uniform thickness throughout, by its smoother and more even surface, and likewise by the absence of the numerous avicularia of that species. Young individuals of this and the two preceding species are, with difficulty, distinguished from each other. In its typical form this species is very slender, and the cells are placed rather more regularly than is usual in the genus Cellepora, but occasionally a cell may be found reversed, or placed diagonally.

Cellepora cervicornis, Fleming.

Much difference of opinion exists concerning the British species generally known under this name. The points in dispute are:—

1st. Is the species a Cellepora or an Eschara?

2nd. Is it the same as the Eschera cervicornis of Milne Edwards, and the Millepora cervicornis of Pallas?

3rd. Are more than one species confounded by British authors under the name of Cellepora (or Eschara) cervicornis; and does the species figured by Dr. Johnston belong to it?

With respect to the first of these questions, it may be stated that, in its young state, and at the ends of the branches, this species has the character of an Eschara; the polyzoary being much compressed, with the cells arranged back to back, in regular quincunx. The form of the apertures is ovate or nearly circular, and a little contracted below, with a central avicularium on the lower lip. In a more advanced state the apertures become orbicular, and the basal portion is contracted into a narrow slit or sinus. As age advances, additional layers are superimposed, giving the stem and branches a more rounded form, and on each layer the cells become more irregular, until they are confusedly scattered, heaped together, and raised at intervals. In this state the species assumes the character of a Cellepora. A different view of its generic position may therefore arise, according as its older or younger portions are taken for illustration. Admitting its adult state to be the perfect form, I agree with M. Milne Edwards in considering the species to belong to Cellepora rather than to Eschara.*

On the second point I am also inclined to agree with M. Milne Edwards in the opinion expressed below. The E. cervicornis, so well described and figured by that able naturalist in his 'Recherches sur les Eschares,' is more slender in form and less expanded at the top of the branches than in the British species. The cells in the young part are more prominent, and the apertures more elongated. But the chief difference is in the older part of the stem and branches, which

* "M. Fleming a décrit aussi sous le nom de *Cellepora cervicornis* ('British Animals,' p. 532) un Polypier qu'il a trouvé sur les côtes de l'Ecosse, et qu'il considère comme identique avec le *Porus cervinus* d'Imperato, etc.; mais d'après l'inspection d'un échantillon qu'il a envoyé sous ce nom au Musée de York, nous ne doutons pas que ce ne soit une espèce tout-à-fait distincte, et même un véritable Cellepore plutôt qu'un Eschare." —*Recherches sur les Eschares.*

is finely granulated, with the cells sunk and almost obliterated, very different from the heaped and prominent cells of our British species. M. Milne Edwards's specimens were from the Mediterranean. On turning to Pallas's 'Elenchus' for the original description of his Millepora cervicornis, we find it to agree more nearly with the species described by Milne Edwards than our own, while the locality, "*Mare Mediterraneum solum,*" shows that he had not the British species in view at the time. Indeed, I am inclined to think that his E. fascialis, *a*, from the Isle of Wight, was really a variety of our C. cervicornis, some of the forms of which approach very closely in general appearance to that species; and, as far as I am aware, Pallas's statement here alluded to is the only authority for including E. fascialis in the British Fauna. The "Italian coral" figured by Ellis was most likely from the Mediterranean.

With regard to the third point. Through the kindness of my friends, I have had the opportunity of examining numerous specimens of this species, both from Shetland and the coast of Cornwall; and I am led to the conclusion that, though considerable difference exists in the external form of examples from the two localities, their minute structure does not warrant the separation of them into two distinct species. Those from the south coast are generally more massive, especially in their basal portions, than specimens from the Shetland seas. On referring to the descriptions of British authors, I find most of them agree pretty well in the essential characters of the species; and though Mr. Busk considers his E. cervicornis ('Catal. Mar. Polyzoa') to be identical with that of Milne Edwards, it is evident, from the latter part of his remarks upon it, that it has the characters of a Cellepora, and a specimen he has kindly presented to me shows it to belong to our well-known British species. Mr. Richard Couch was of opinion that the figure given in Johnston's 'British Zoophytes' represented a different species from that described in the 'Cornish Fauna,' and Professor Busk was inclined to agree in this opinion. Professor Sars has also suggested that Dr. Johnston's figure was probably taken from a specimen of the *E. rosea* of Busk. Dr. Johnston's own opinion, however, was in favour of the specific identity of the British forms. I have taken some pains to ascertain if the specimen figured in 'British Zoophytes' was still preserved and could be referred to, and have at length been able to make out pretty satisfactorily, through the kind assistance of Mr. Norman and Dr. Baird, that this specimen is in the

British Museum. A broken fragment of it, lent me for examination, proves, as I had expected, that it is only an aberrant variety of the C. cervicornis of British authors.

Palmicellaria, nov. genus.

Polyzoary erect, calcareous, inarticulate, cylindrical, smooth, branching dichotomously. *Cells* disposed in four longitudinal alternate series, those in the two opposite series being on the same level. Apertures circular, opening vertically, within a slight concavity (Pl. III, fig. 4,) with a broad projecting, palmate expansion in front, bearing an avicularium.

This genus is somewhat intermediate between Cellepora and the Quadricellaria of Sars. With the former it agrees partially in the form of the aperture, but it differs in the simplicity of its general structure and the regular arrangement of its cells, which have not the heaped appearance more or less characteristic of that genus in its adult state. With Quadricellaria it agrees in the arrangement of the cells, but differs in the form and position of their apertures. No ovicells have yet been observed.

Palmicellaria elegans, n. sp. (Pl II, figs. 1—4.)

Polyzoary very slender, of ivory whiteness, two or three times dichotomously branched nearly on the same plane, and of equal thickness throughout, or expanding very slightly towards the top; composed of four longitudinal rows of cells alternately with each other, the opposite cells corresponding; they are oblong-ovate and smooth, young cells showing some minute perforations round their margins; the apertures are circular and sunk in a slight depression, with a long, curved, and expanded rostrum in front, bearing a circular avicularium on the centre of the upper surface. Height $\frac{6}{10}$ths of an inch; breadth of stem $\frac{1}{30}$th inch.

For the opportunity of describing this elegant and graceful little coral I am indebted to my friend Mr. Norman, who dredged it last summer in from eighty to ninety fathoms, eighteen to twenty-five miles north of Burraforth lighthouse, the most northern point in Shetland. Palmicellaria elegans is distinguished, not less by the simplicity of its structure than by the gracefulness of its form. It is of small size and very little branched, and is more slender than any other member of the family.

Mr. Norman had previously dredged a small piece of this polyzoon in Loch Fyne, but not sufficiently perfect to allow of its characters being recognised; and he has since ascertained that similar imperfect specimens are in the Johnstonian collection in the British Museum, labelled Pustulipora proboscidea, showing that the species erroneously so named in 'British Zoophytes' was described from much worn examples of this genus. The P. proboscidea of Milne Edwards is quite distinct, and belongs to a different order.

Genus Quadricellaria, Sars.

Polyzoary erect, calcareous, rigid, inarticulate, cylindrical, dichotomously branched. *Cells* disposed in four regular longitudinal alternate series, immersed; apertures slightly tubular (opening laterally), with the upper and lower margins a little projecting. *Polypides* with twelve to twenty tentacles, the lower ones shortest.

Professor Sars characterised a genus formed for a Polyzoon that he had formerly described as a Pustulipora. The same species has been referred by Prof. Busk to his new genus Onchopora, in the family Salicornariadæ. The latter comes nearer to its true affinities. The species, however, seems entitled to generic rank, and is now, I think, more correctly placed among the Escharidæ.*

Quadricellaria gracilis, Sars. (Pl. II, figs. 9—12.)

Polyzoary slender, white, much branched dichotomously, the branches cylindrical, nearly linear, and tapering a little towards the extremities. *Cells* arranged in four longitudinal rows, alternating with each other, so that the two cells on opposite side of the branches are on the same level. *Apertures* nearly circular, slightly tubular and bilabiate. There is a small tubular orifice below the mouth, and large oval radiating perforations surround the margins of the cells, the surface of which is finely striated in an undulating manner. Two, or sometimes four, small circular avicularia are seen at the sides of the cells, on a line with the perfora-

* Mr. Busk informs us that the name *Quadricellaria* has been already used by D'Orbigny for a genus of chalk fossils, and will have to be changed.

tious. The ovicells are few and very little raised. Height 1 to 1½ inches.

Pustulipora gracilis, Sars, 'Reise i Lof. og Finm.,' 1850, p. 26.

Onchopora borealis, Busk in 'Journ. Micros. Soc.,' p. 213, t. 28, figs. 6, 7.

Quadricellaria gracilis, Sars, 'Norske Polyz.,' p. 15.

This interesting Polyzoon has, until lately, been much misunderstood. The only notice of it as a British species is that of Mr. Busk, who described it under the name of Onchopora borealis, from a small and imperfect specimen in Mr. Barlee's collection. That so imperfect a scrap only should have come into Mr. Busk's hands for description must have been by some mistake, as Mr. Barlee brought several specimens from Shetland in 1858, where it was also obtained last summer by Mr. Norman. It is a deep-water species, and has not been found in any other locality in Britain, but appears to be not uncommon on the Norwegian coast.

Prof. Sars considers this genus to be without avicularia. None is seen in the usual position on the under lip of the cell aperture, nor does the small tubular orifice below it appear to possess that character, but two other circular orifices, slightly tubular, are generally present one on each side of the central orifice already named, and continuous with the marginal perforations: these are certainly avicularia, and bear a horn-coloured semicircular mandible. Two other similar avicularia are frequently seen below these last on the margin of the cell. There is an obscure, slightly raised ovicell, with a striated surface in the usual position above some of the cells, with an opening within the upper lip. M. Sars appears to doubt this being a true ovicell, but the coloured contents shining through its transparent wall, as in other species, show its ovigerous character.

Eschara lævis, Fleming. (Pl. III, figs. 8—11.)

Polyzoary white or yellowish, smooth and polished below, dichotomously branched; the branches cylindrical, rising from a short and stout stem, spreading much laterally, and slightly tapering to a blunt apex. *Cells* immersed, ovate, very obscurely granulated on the surface, and perforated at the sides. *Apertures* generally a little higher than broad, arched on the upper margin, slightly contracted at the side and straight below; upon or a little within the under lip is a slightly raised circular avicularium. *Oricells* smooth, prominent, hooded, or continued below into a projecting margin surrounding the mouth of the cell. Height, an inch and a quarter; lateral expansion, about an inch and a half; breadth of branches $\frac{1}{10}$th of an inch.

Cellepora lævis, Fleming, 'Brit. Anim.,' p. 532; Johns. 'Brit. Zoop.,' p. 299.

Eschara teres, Busk in 'Ann. Nat. Hist.,' 2nd series, vol. xviii, p. 33, t. 1, fig. 2.

Eschara lævis, Sars, 'Besk. over-nogle Polyz.,' p. 12.

This species was described by Dr. Fleming in 1828. from a single specimen got in deep water, Shetland. Since that time it does not appear to have been recognised by British authors, for the specimens got on the Cornish coast, which Mr. Richard Couch referred to this species, appear from his comparison of them with C. cervicornis to have been something else. Dr. Johnston did not know the species, and the supposed C. lævis, got by Mr. John Macgillioray, on the Aberdeenshire coast, was probably, as Dr. Johnston supposed, a worn variety of C. ramulosa. Professor Busk does not notice it in his 'Catalogue of Marine Polyzoa,' and in his 'Polyzoa of the Crag' quotes C. lævis as a synonym of C. ramulosa. The same naturalist has, however, described a species from the coast of Norway, brought home by Mr. McAndrew, under the name of E. teres, which proves identical with this. Mr. Barlee, in the mean time, had got several good specimens in Shetland, but probably considering it a variety of E. ramulosa, he had not placed it in Mr. Busk's hands for description. Prof. Sars finds this fine species pretty generally distributed on the coast of Norway, in deep water, from 36 to 150 fathoms, and has published an excellent description of it in his 'Beskrivelse overnogle Norske Polyzoer.' He very correctly recognises it as the C. lævis of Fleming. The species is perfectly distinct from the C. ramulosa; and I have great pleasure in vindicating the correctness of Dr. Fleming, and restoring it to its place in the British Fauna, from which there appeared some chance of its being expunged.

Eschara lævis is one of those species that form an intermediate link between Cellepora and Eschara; its rounded branches, with the cells ranged round an imaginary axis, agreeing with Cellepora, while the cells themselves bear the character of an Eschara. Occasionally, however, the branches assume a flattened shape. The lower parts of the branches are generally worn smooth, and the apertures often over-grown or nearly obliterated; but the upper portions are usually studded with prominent globular ovicells, giving them a knotted appearance. There is no authentic record of this species having been found south of Shetland. A smaller and more slender variety was also met with there by Mr. Norman.

Eschara lorea,* n. sp. (Pl. III, figs. 5, 6, 7.)

Polyzoary yellowish white, shining, compressed, and dichotomously branched, rising from a slender flattened stem; the branches are slender, much compressed, and strap-shaped, of nearly equal thickness throughout, expanding a little towards the ends, which are blunt, and generally bifid; the branches are pretty nearly on the same plane, and occasionally anastomose. *Cells* prominent, oval, nearly smooth, but appearing finely granulated under a magnifier, placed in quincunx, seldom more than two or three in a transverse row. *Apertures* large, rounded above, and nearly straight below, with a slightly projecting, blunt rostrum, bearing a circular avicularium on its upper and inner surface. A few small circular avicularia are also seen scattered on some of the cells, and there are punctures occasionally round the margin. *Ovicells* few, small, globose, slightly granulated, without perforations. Height, an inch to an inch and a half; breadth of branches, about $\frac{1}{15}$th of an inch.

One or two specimens of this new species were obtained in Shetland by Mr. Barlee, but being rather worn, they were passed over at the time as a variety of E. Skenei. Mr. Norman met with it at the same place in 1861, and again in 1863, when he dredged fine specimens in eighty to ninety fathoms, to the north of Burraforth lighthouse.

E. lorea is nearly allied to E. saccata of Busk, but it is a much more slender and delicate species, with the cells rather larger in proportion, less closely set, and fewer in a tranverse row. The cells in this species, too, have a distinct though blunt rostrum below the mouth, while those of E. saccata are not rostrated, but are uniformly cylindrical, with a much larger avicularium in front of the aperture. On the

* I had proposed to call this species E. ligulata, under which name it is mentioned (but not described) in the Report of the British Association; finding, however, that the Cellepora ligulata of Esper is also an Eschara, and synonymous with the E. fascialis of Pallas, I have thought it best to avoid a repetition of the name.

other hand, this species approaches very near to some of the more slender branched varieties of E. Skenei, from which it can readily be distinguished, in a fresh state, by its more smooth and slender appearance, and by the absence of the pointed rostra, that give a prickly character to the latter species.

ESCHARA LANDSBOROVII, Johnston. (Pl. IV, figs. 1—3.)

Polyzoary consisting of very thin and delicate foliaceous plates, anastomosing irregularly, and undulating on the upper margin, which is a little expanded. *Cells* in longitudinal rows, placed alternately or in quincunx. They are oblong, thin, and perforated with large punctures. *Apertures* with the margin slightly raised, nearly circular above, and produced into a point below, where there is a small, slightly prominent, circular avicularium, behind which is a truncated denticle. *Ovicells* prominent, globose, or ovate, silvery and perforated, produced below into a raised margin, surrounding the mouth of the cell, and giving it a triangular form. A rather large, spatulate avicularium is seen in some cells, placed transversely by the side of an ovicell, and raised a little from the surface (fig. 3). The two layers of cells are separable. Height, two inches: breadth, about two and a half inches.

Lepralia Landsborovii, Johns., 'Brit. Zooph.,' p. 310, t. 54, fig. 9; Busk, 'Catal.,' p. 66, t. 86, fig. 1, and t. 102, fig. 1; Hincks, in 'Journ. Micros. Soc.,' v. viii, p. 277 (young state).

Eschara foliacea, Alder, in 'Trans. Tynes. Club,' v. iii, p. 151.

This delicate and fragile species was obtained some time ago on the north coast of Northumberland, by Mr. Embleton, of Beaduel Cottage, but was passed at the time of the publication of my 'Catalogue of the Zoophytes of Northumberland and Durham,' as a variety of E. foliacea. A second and more careful examination, however, convinced me that it was a distinct and very characteristic species, hitherto undescribed as an Eschara, but not entirely unknown to science, as the L. Landsborovii of Johnston turns out to be an encrusting form of this species, which has not until now been seen in its perfect state. Mr. Bean, however, has lately sent me a small specimen for examination, got at Scarborough, in which a double layer of cells rises to about an inch in height; and Mr. Norman has dredged a variety of this species in Guernsey, consisting of a single layer, assuming the form of a hollow cylinder, with the edges slightly appressed at their junction. Mr. Hincks has also met with similar examples. It is rather singular that on this coast, where for the first time the species has been found in its perfect state, the Lepralian or rudimentary form is unknown. In its intermediate state this species has all the characters of the genus Hemeschara of Busk. At present, I am inclined to consider that genus as only a peculiar state of an Eschara, and which some species have more tendency to assume than others.

E. Landsbovorii differs from most of the other members of the genus, in having the two layers of cells readily separable—a character that has been considered generic by some authors, but which does not appear to be of any great importance.

Eschara pavonella, Alder.

Polyzoary foliaceous, yellowish, forming continuous flabelliform or undulating expansions, arising from an encrusting or clasping base. *Cells* oval or oblong, with large perforations generally radiating from the centre to the circumference. *Apertures* orbicular, large, with a thin, plain margin, and a small mucro below, having a flattened and truncated apex. An oval avicularium on each side of the mouth. No ovicells have been observed. Height, about an inch and a half; breadth variable, but generally exceeding the height.

E. cribraria, Busk, in 'Journ. Micros. Soc.,' v. iv, p. 311, t. 10, figs. 7, 9.

Excellent figures of this beautiful species were given by Mr. Busk in the 'Microscopical Journal,' from specimens I had the pleasure of sending him from Newcastle a few years ago. That gentleman then considered it to be the *E. cribraria* of Johnston, an opinion which now proves to be erroneous. I was first led to this conclusion from observing that Dr. Johnston mentions, in his account of E. cribraria,* having had a fragment of another native species sent him from Scarborough, by Mr. Bean, but too imperfect for description in so difficult a genus. Mr. Bean has favoured me with a sight of this fragment, which proves to belong to the present species, and which Dr. Johnston, therefore, evidently considered distinct from his E. cribraria. An examination of Dr. Johnston's specimen of the latter species in the British Museum, lately made for me by Mr. Norman, confirms this opinion,

* 'British Zoophytes,' 2nd Ed., p. 353.

and makes it necessary to give another name to the species now under consideration.

E. pavonella, like the foregoing species, is sometimes found assuming all the three forms of a Lepralia, a Hemeschara, and an Eschara, according to the substance on which it is developed, often clasping the stems of zoophytes in a single layer before rising into a double foliaceous expansion. It is a deep-water species, only yet found on the north-east coast of England, ranging from Cullercoats to Scarborough, and extending eastward to the Dogger Bank.

Family CELLULARIADÆ, Busk.

SCRUPOCELLARIA DELILII, Audouin. (Pl. III, figs. 4—8.)

Polyzoary slender, shining, dichotomously branched, conspicuously jointed, the internodes containing from five to ten cells each. *Cells* ovate, narrowed below; apertures oval, with smooth margins, bearing one stout spine (or sometimes two) on the upper and outer margins, and a smaller one on the inner margin. *Operculum* ovate, channelled with tubes, forming a lobated cavity. Marginal avicularia moderately prominent; there is also a tubular or conical avicularium in the centre, in front of each cell. Vibracular capsules (sinus of Busk) transversely wedge-shaped, stretching across the back of a cell and part of the adjoining one. *Vibracula* short, rising from the upper and outer angle of the capsule, below which is an aperture for one of the radical fibres, which are numerous and scattered over the whole of the branches. *Ovicells* small, smooth, and imperforate. Height half an inch.

Crisia Delilii, Aud., in Savigny's 'Egypt' (fide Busk).

Cellularia scrupea, Alder, in 'Trans. Tynes. Club,' v. iii, p. 148.

Scrupocellaria Delilii, Busk, in 'Journ. Micros. Soc.,' v. vii, p. 65, t. 22, figs. 1, 2, 3.

I obtained specimens of this delicate little Scrupocellaria a few years ago, from the deep-water fishing-boats on the Northumberland coast, but did not at the time observe its distinctness from S. scrupea, with which it agrees in having the cells operculated. It differs, however, in having an avicularium on the front of each cell, and in the peculiar shape of the vibracular capsule, which is transversely wedge-shaped, while in the other known species it is bilobed and erect. Another example of this species has lately been dredged on the Durham coast, by Mr. G. S. Brady and Mr. Hodge. It appears to be a Mediterranean species, and has also been found in Madeira by Mr. J. Y. Johnson. This is the first notice of its occurrence on the British coast.

Order Cyclostomata, Busk.

Family Idmoneidæ, Busk.

Genus HORNERA, Lamouroux.

Hornera borealis, Busk. (Pl. IV, figs. 1—6.)

Polyzoary white, much and irregularly branched; the branches commencing almost from the base, stout below, undulating, and gradually tapering to the extremities; they are cylindrical or a little compressed, curving slightly inwards below on the smooth side, and rather bent outwards towards their extremities; the cell-apertures are arranged nearly in quincunx on the outside of the branches; the central ones are orbicular and slightly tubular, with an even rim; those towards the sides are more produced, dilated and expanded obliquely towards their extremities, and sometimes ending in an acute point, but more frequently slightly rounded; there are three or four cells in each transverse row. The surface on this side is striated in an undulating manner, and there are numerous small, sub-tubular perforations (some of which appear to be avicularia), somewhat irregularly disposed, but generally following the margins of the cells. The inner or back part of the branches is smooth, without cells, but with faint undulating ridges, and a few very small punctures like sunken tubes. The *ovicells* are placed on this side, generally near the junction of a branch, forming yellowish, sub-globular protuberances, of a hard, calcareous nature, and appearing reticulated or coarsely punctured under a magnifier; a tubular aperture is seen at one side (Pl. V, fig. 6). Height, about three quarters of an inch; lateral expansion about the same; thickness of the branches, from $\frac{1}{10}$th to $\frac{1}{20}$th of an inch.

Hornera frondiculata, Busk, in 'Ann. Nat. Hist.,' 2nd Ser., v. xviii, p. 34, t. 1, fig. 7; Sars (Reise i Lof. og Finm.), 'Nyt Mag.,' v. vi, p. 146.

Hornera borealis, Busk, 'Crag Polyzoa,' p. 103 (without description).

This interesting Hornera, the first of the genus discovered in Britain, was got by Mr. Barlee in Shetland, in 1858, and recognised at the time, but, by some oversight, it has not hitherto been announced as British. It is stated by Professor Sars to be not uncommon on some parts of the Norwegian coast, in about forty fathoms. Professor Busk has recorded and figured it among the Polyzoa got by Mr. McAndrew on that coast, and in his 'Polyzoa of the Crag,' points out its distinctness from H. frondiculata, and proposes for it the name of borealis, which I now adopt. It differs from H. frondiculate, in being much smaller, less expanded, and more robust, in proportion to its size; the surface, too, is much less strongly striated; another difference will be found in the character of the marginal cells; these in the southern species are usually set in diagonal rows, which is not the case in H. borealis. But the most decided difference is in the ovicells. Those of H. frondiculata are oblong, strongly keeled along the top, and striated at the sides, with the aperture projecting above into a curved tube (Pl. V, fig. 7); but in H. borealis they are globose and reticulated, or punctured over the surface, with a tubular aperture at one side. The ovicells in this genus are very peculiar. They are large, and developed from the general polyzoary at the back of a branch, apparently unconnected with the individual polypides, thus showing a decided zoophytic character.

An ENDEAVOUR *to identify* PALMOGLŒA MACROCOCCA (Kütz.) *with* DESCRIPTION *of the* PLANT *believed to be meant, and of a* NEW SPECIES, *both, however, referable rather to the* GENUS MEOSTÆNIUM (Näg.). By WILLIAM ARCHER.

(Read before the Natural History Society of Dublin, January 9, 1863.)

BEFORE proceeding to the subject proper of this communication I shall call to mind the characters of the genus Palmoglœa (Kütz.) itself, thus defined by Kützing:*—"Stratum gelatinosum difforme indeterminatum, ex cellulis sparsis polygonimicis in substantia gelinea nidulantibus, compositum." Now, such a diagnosis of the genus, while it does not seem calculated to exclude all that it ought, appears to me to omit an additional important character pervading all the species intended to be included therein (if we except, as we ought, *Palmoglœa Roemeriana* Kütz.), and that is the elon-

* 'Species Algarum,' p. 227.

gate or oblong form of the cells. As I should be disposed to understand it, putting aside his *Palmoglœa Roemeriana*, Kützing must have established his genus Palmoglœa for the reception of, and meant it to include, all those Palmellaceous Algæ (except the one species forming his genus Trichodictyon, separated from his Palmoglœa with little reason) possessing oblong, cylindrical, or elliptic cells, with granular contents, each cell possessing only a single simple, special, mucous coat not persistently included coat within coat, the whole becoming confluent into an indeterminate gelatinous stratum of greater or less density or tenuity. It is true that, of course, in the specific characters and diagnosis of subgroups, the elongate form of the cells is alluded to, but I do not think a character so obviously generic should have been left to be sought for amongst the specific. But the fact of *Roemeriana* being included in the genus compelled him to omit this character from the diagnosis.

It is, indeed, with much diffidence that I venture to suggest that Kützing's three subdivisions of his genus are founded upon wholly unreliable distinctions. These distinctions in regard to the two principal subdivisions, *P. Roemeriana* forming the third, are based, so far, indeed, as I can judge, merely on the comparative density or tenuity of the gelatinous "matrix," or, in other words, the supposed greater or less readiness with which the special mucous investments of the cells remain individually defined, or become confluent with each other, thus rendering the "loculi" (Kütz.) more or less noticeable, or not at all perceptible. These distinctions seem to be by no means of the constancy requisite for usefully available characters; indeed, as A. Braun* well observes, of so little value are they as to render it doubtful in which section we are to seek a particular species. The remark was made especially in regard to a plant named by him, as most approaching to truth, *Palmoglœa macrococca* (Kütz.); but I venture to think that the plant meant by A. Braun was not that so named by Kützing, nor, indeed, probably any described by that celebrated author. Indeed, the degree of moisture of the situation in which these plants grow seems to exercise a considerable influence on the consistence of the common gelatinous stratum. A mass of one of these species in drying assumes a firmness and a somewhat elastic tenacity before shrivelling up. In those species which grow wholly in water the gelatine is of considerable tenuity, and the cells sometimes even live free.

* 'Rejuvenescence in Nature,' translated for the Ray Society, 1853, p. 327.

But in this genus Palmoglœa it will seem evident, I think, upon a careful examination of the living plants, that there are associated forms of readily distinguishable diverse generic types, the most obvious common character being the pervading elongate or oblong form of the cells. Amongst these Palmoglœa-forms, then, including therein the single one placed under Trichodictyon, and of which I have just endeavoured to convey a very general conception, I believe I see five types. It is true that Professor De Bary* alludes to but two, and also referring to those two, and to the genus Penium (Bréb.), while he conceives they are undoubtedly separated by distinct characters from each other, he thinks those characters seem to be of so slight value as that these three types may eventually have to be united in one genus.† But surely *Penium interruptum*, or *P. digitus*, or *P. closterioides*, or *P. cylindrus*, and others, have little in common with Kützing's Palmoglœa-forms; and, even admitting them all as belonging to the family Desmidiaceæ, if the generic types alluded to should prove constant—which, so far as we know, I should say they really seem to be, and as to which future research will be useful to decide—it would seem more advisable to retain them as representing three distinct genera.

I have said that Kützing's plants included in Palmoglœa seem to be separable into five types, and I shall now, one by one, endeavour to point them out.

(1) *Palmoglœa Roemeriana* (Kütz.) seems altogether distinct from any of the others. I have never seen it, but it seems to possess angulato-globose cells, combined into a flattened frond-like expansion, growing in water. Whatever it be, it will, I think, be admitted that it has little affinity indeed with any of the others, and that it should find no place here. Kützing himself, indeed, places it under one of his subgroups, under the subgeneric name of Limnodictyon.

(2) *Palmoglœa minococca*, var. *æruginea* (Kütz.), appears to me to be a form referable rather to Glœothece (Näg.)‡ than to this genus; but in Glœothece no conjugative or other generative process has been noticed, and I shall not dare to enter into any disquisition as to whether the forms included in that genus or their allies are or are not actually independent organisms—that is to say, whether they themselves represent the species or are merely the transitory intermediate phases in the development or "alternations," so to speak, of higher plants. Be that as it may, they are at least forms of more or

* Op. cit., p. 30.

† Ib., p. 74.

‡ 'Gattungen einzelliger Algen,' p. 57.

less frequent occurrence to those who seek for them; and, under any circumstances, Glœothece appears to have no immediate affinity with the remaining Palmoglœa-forms; and I may, besides, call to mind that the endochrome in Glœothece is "phycochrome." It would, therefore, be superfluous and beyond the object of this paper to enter into any description of them here.

(3.) *Palmoglœa endospira* (Kütz.) = *Cylindrocystis endospira* (Bréb.), and *P. closteridia* (Kütz.) = *Endospira closteridia* (Bréb.), with their distinctly well-marked, parietally wound, spiral band of endochrome, represent a type entirely distinct from the preceding or the following. I conceive they really and naturally belong to the genus Spirotænia (Bréb.), and, for my part, I see no grounds sufficient to separate them in a distinct genus from *S. condensata,* for instance; for surely that the former live on damp rocks, forming confluent gelatinous strata, and that the latter inhabit pools and live more or less isolated, can hardly be accounted such. It is true that in *S. condensata,* and some others, self-division appears to be oblique, whilst in *P. endospira* it is transverse. But I do not venture to express this opinion without having had an opportunity to examine living specimens of what I believe to be the former species (*P. endospira* (Kütz.) = *C. endospira et Endospira truncorum* (Bréb.), which I obtained in small quantity from a moist cleft in a rock near the road side in the "Rocky Valley," near Bray. But I make the statement with a great amount of deference; for I am here at variance with the original discoverer of the two forms, M. de Brébisson himself, who would still consider these as forming a genus of Palmellaceæ, and not as belonging to the genus Spirotænia. I submitted mounted specimens of my plant to him; and although, owing to the unavoidably altered state of the plant as compared with the fresh condition, he would not speak positively as to its being actually his *E. truncorum,* yet he believed it must be. I have myself little or no doubt but that so it was. But, on the other hand, I am fortified in the opinion of the actual identity of the genera Endospira and Spirotænia by that of Professor De Bary, who describes a species of the latter genus under the name of *Spirotænia muscicola,* of which he quotes *Palmoglœa endospira* (Kütz.) = *Endospira truncorum* (Bréb.), as synonymous, but with a note of interrogation appended, and this wisely, for the identity of De Bary's species with those of De Brébisson must, indeed, still remain a question. I should, indeed, be disposed to imagine that they are distinct species, but, as I have indicated, belonging to the same genus; *S. muscicola* is apparently a larger form. To enter into the characters of the genus Spirotænia, as already known, would be alike unnecessary and beyond the purpose of this communication; they are to be found set forth, as far as is known, by various writers. No reproductive process having been noticed in this genus, its position, indeed, remains unsettled; but there cannot be much doubt but that, when discovered, it will be found to be by conjugation. However, the before-indicated parietal, spirally wound band of endochrome abundantly separates the two forms mentioned, included in Palmoglœa by Kützing, from the forms I have previously adverted to, and from those included in the fourth and fifth types presently to be alluded to. There may, indeed, be some possibility that likewise the form called *Palmoglœa rupestris* (Kütz.), which is thus spoken of—" . . . cellulis ex substantia gonimica convoluta transverse hyalino-zonatis;" also *P. lurida*, thus described—"Substantia gonimica fasciæ-formi sub-convoluta," may belong here; but without seeing fresh specimens of the plants so named by Kützing, it would be impossible certainly to decide. Having thus eliminated *Palmoglœa Roemeriana*, *P. monococca*, *P. endospira*, and *P. closteridia*, and possibly *P. rupestris* and *P. lurida*, the remaining forms included in this genus by Kützing probably belong to one or other of two further apparently naturally distinguished generic types, and these, indeed, so far as I can see, are the only two alluded to by De Bary. These are—

(4) Cylindrocystis (Menegh.), and—

(5) Mesotænium (Näg.).

Both these, as previously indicated, agree with the foregoing (*P. Reomeriana* excepted), as well as with each other, in the elongate and elliptic or oblong form of the cells, but they are distinguished from them and from each other by the structure of the cell-contents. In Cylindrocystis the cells possess granular chlorophyll-green contents, and at the centre a paler or less dense region. This clear central space is described by De Bary, for *C. Brébissonii*, as rounded and four-cornered; to me it appears of extremely indefinite outline, if, indeed, it can with propriety be said to possess a proper outline at all. Within this occurs a nucleus, but not always evidently. Beyond it, at each side, occurs one, or, in longer cells, about to divide, occur two somewhat elongate, apparently dense bodies (starch-granules), from which radiate, in an irregular substellate manner, the general granular cell-contents. The arrangement of the cell-contents here reminds one very much of that in Zygnema. Reproduction is by conjugation, and evolution from the contents of the spore, in germination, of four young cells the same as the parent.*

* De Bary, op. cit., p. 37, t. vii E., 18 – 22.

To this genus belongs clearly *Palmoglœa Meneghinii* (Kütz.) = *Penium Brébissonii* (Ralfs) = *Cylindrocystis Brébissonii* (Menegh.), the last being, doubtless, the correct apellation. And not less certainly, I believe, does *Trichodictyon ruprestre* (Kütz.) belong here. The species so named by Kützing I believe to be identical with *Cylindrocytis crassa* (De Bary); the remarkable mode of growth pointed out by De Bary* not being constant, seems to decide that it is not of sufficient importance to suggest the separation of this species from Cylindrocystis, seeing that the external structure seems to coincide. It is true, assuming that I am right in my identification of this plant, that Kützing places it in a genus by itself, distinct from his Palmoglœa; but the reasons for this course are not founded on any essential peculiarities of the cells themselves, or their mode of growth, but upon external accidental circumstances, which, so far as I can see, are in no way connected with the plant itself or its growth, and consequently erroneously introduced into his conception and definition of his genus. To indicate the circumstances on which Kützing relies for his generic distinctions, I cannot do better than repeat here his generic characters for Trichodictyon:†—"Phycoma amorphum gelatinosum; substantia gelinea matricalis loculoso-vesiculosa; loculi fibris delicatulis reticulatim fasciculatis circumtexti celluliferi." It will be seen that Kützing relies here mainly for his generic characters on the filaments accompanying the cells being interlaced in a loosely reticulated manner, so as to leave white, roundish interspaces, in which occur the large ovato-elliptic cells, either singly or in one, two, or more pairs, surrounded by their broad and copious, finally confluent, gelatinous coatings. These filaments do not seem to differ from those frequently growing along with other Palmoglœan and other Palmellacean forms, nor do they seem organically connected with, or in any way belonging to, the plant in question. Similar filaments are by Kützing himself referred to Leptothrix, or perhaps to Hypheothrix. In fact, it would here seem as if it were only because these filaments often occur along with this plant in great quantity, penetrating through the mass, and because the cells themselves, during active vegetation, increase vigorously from numerous centres, and copiously giving rise to their gelatinous investments (this taking place pretty equably over the mass), that the filaments are forced to give room, and become obliged to assume more or less of a reticulated disposition. But that these filaments possess no importance, nor any organic relationship, so far as I can

* Op. cit., p. 37, t. vii, C., 4—6, 9.

† 'Species Algarum,' p. 230.

see, as regards the plant in question, is, I think, proved by it being met with, as I have often found it (always supposing that I am right in my identification of the species, of which, indeed, I have myself no doubt) unaccompanied by filaments, or these so sparing as to render Kützing's description of the plant as inappropriate as, so far as I can see, the introduction of these filaments into the generic character at all is erroneous. In regard to his *Cylindrocystis crassa*, De Bary omits any notice of such filaments altogether; yet, as I before indicated, I believe these plants are identical.

But, in order to explain the occasionally occurring peculiarity alluded to, in the mode of growth or self-division of the cells themselves in this plant, dwelt on by De Bary, I shall momentarily draw attention to that which prevails in the entire of its allies, and then advert to the variation sometimes met with in this species itself.

In the related species of Penium, Spirotænia, Cylindrocystis, and Mesotænium (as well as those elongate, but apparently not at all related, forms included in Glœothece (Näg.), Stichococcus (Näg.), &c. &c., the direction of self-division occurs always in a line at the middle, at right angles with the original longitudinal axis of the mother-cell. Now, in *Cylindrocystis Brébissonii*, along with the elongation of a cell, preparatory to self-division, a longitudinal extension and a transverse subdivision of the central corpuscles belonging to each of its halves take place, thus causing the now two corpuscles of each half to lie in the direction of, and on a line with, the longitudinal axis of the original mother-cell. Presently ensues a segmentation and division into two of the cell itself at the middle, in the transverse direction, and, as stated, in a line at right angles to the longitudinal axis, the original nucleus vanishing, and a new one for each half, that is, each daughter-cell, making its appearance, according to De Bary. In *C. crassa* (De Bary) = *Trichodictyon rupestre* (Kütz.), previous to division of the cell itself, there is no subdivision of the central corpuscle of each half, but on the formation of a septum it seems to ensue. Its subdivision may take place then, *either* after the manner of *C. Brébissonii*, in a transverse direction, causing the two new corpuscles to lie in the direction of the longitudinal axis of the mother-cell, that is, perpendicular to the new septum, *or* the subdivision of the central corpuscle of each half of the mother-cell may apparently take place in a direction on a line with the longitudinal axis of the mother-cell, causing, in this case, the two new corpuscles to lie in a direction perpendicular to the original axis of the mother-cell, that is, parallel to the new septum. Now, whichever of these cases holds good, the elongation of each new cell seems to take place in the direction of a line connecting the two new central corpuscles, which always thus lie in the direction of the longitudinal axis of every cell when about to divide, which always, as before stated, takes place transversely, or in the direction of the narrow diameter. Thus, in the former case, the repetition of the process of cell-division does not alter the relative positions of the (so to speak) north and south poles of the generations of cells, whilst in the latter case each alternate repetition of cell-division changes the longitudinal axis of each generation from running north and south to east and west, and *vice versâ*, in the following generation; that is to say, each repetition of the process presents a division of the cell-generations according to two directions alternating with each other at right angles. I do not imagine that these two modes of behaviour possess any specific importance; further observation may determine if they have. The latter mode seems, so far as my experience goes, to be the rarer; whilst I fancy also the plants presenting it seem to be larger usually than those which exhibit the former plan. The endochrome in this plant is very dense and opaque, rendering it a matter of great difficulty to discern a nucleus, or the arrangements of the contents. It is perfectly distinct as a species, and constant, and the remarkable peculiarities of which I have endeavoured to convey an idea strikingly distinguish it from any of its allies. The plant is by no means uncommon here, though Kützing gives but one locality —the Black Forest. De Bary does not say whether it is common or rare, but I should argue from the context that it is as common with him as here. So much, in passing, for the genus Cylindrocystis.

I shall now advert to the last genus, Mesotænium (Näg.). Plate VI, figs. 1 to 31. In this genus the structure of the cell-contents is different from any of the foregoing. Here there runs, either directly through the longitudinal axis of a cell or sometimes slightly excentrically, a more or less compressed, sharply defined, dense "chlorophyll-plate" (often, however, difficult to be detected, I believe, owing only to being hidden by the remainder of the contents), whose margin either touches the cell-wall or leaves a more or less wide intervening space. When the remaining contents are not too dense and abundant to permit its being readily perceived, this chlorophyll-plate, when its edge is towards the observer, appears either, in some species, like a narrow, vertical, axile, green band, swollen at the middle at each side, and reaching entirely from end to end of the cell, or, in others, as a somewhat lenticular body, thus, in this edge view, presenting a fusiform outline, and not reaching to the cell-wall at each end (figs. 2 to 6). In the middle of the chlorophyll-plate there is usually a starch-granule within the central projection or swelling-out. If a cell seen from the point of view showing thus the edge or lateral view of the chlorophyll-plate be caused to make a quarter of a revolution on its longitudinal axis, the chlorophyll-plate presents its broad or front surface to the observer, provided it be not obscured by the too dense remaining contents, when it is seen to be (of course less intensely, but) uniformly green. De Bary describes for *M. Braunii* this chlorophyll-plate to be minutely toothed at the margin; but, so far as I can see, if I be right in my identification of the plant, it would, perhaps, be more correctly described as irregularly crenate. Exceptionally and rarely, the chlorophyll-plate possesses three (or four, De Bary) planes, presenting in end view a triradiate (or quadriradiate) figure. The remainder of the cavity of the cell may be apparently entirely filled by a rather coarsely granular, peculiarly coloured endochrome, or it may be destitute of it, or nearly so, possessing then, besides, only watery or colourless contents. In the latter case, indeed, is the chlorophyll-plate best seen; and then only, or when the granular endochrome is but sparing, can it be discerned at all in front view. But in certain species an intermediate condition appears to be the most common; that is to say, the whole of the remaining cavity of the cell is not filled by the granular endochrome, but the latter forms only a parietal layer, sometimes somewhat sharply defined within, and leaving a clear intermediate space between it and each broad or front surface of the chlorophyll-plate. In *M. violascens* (De Bary), about the middle of the parietal layer, at one side, there may be often seen a little depression. This sometimes contains a little corpuscle or granule; but I have by no means always, or indeed often, been able to detect it. De Bary considers this a nucleus. In *M. Braunii*, and his *M. chlamydosporum*, this nuclear body seems to be in contact with the plate. In this genus, when a cell has attained the full length proper to the species, self-division sets in. As in all the elongate forms, here also the line of division takes place transversely, cutting the cell into two in a line at right angles to its longitudinal axis. A division of the chlorophyll-plate either precedes it or is apparently affected by it, according to the species. In young daughter-cells, immediately after division, when the central corpuscle is to be seen, it occupies in each a place near the septum; by and by, each is again found at the middle of its chlorophyll-plate, both as regards the *longitudinal* and transverse diameters. Reproduction in this genus, as in Cylindrocystis, is by conjugation and evolution from the spore-cell, in germination of four young cells identical with the parent.* In this genus, however, the foregoing characters are in some species often not easy of application, owing to the density of the granular cell-contents obscuring a proper view of the internal structure, and to the specimens not being in a conjugated state.

Such, as briefly as I can convey it, is some account of the genus Mesotænium (Näg.), the last of the genera into which Palmoglœa (Kütz.) seems capable of being divided. Undoubtedly the three principal, and those most nearly related to each other, are Spirotænia, Cylindrocystis, and Mesotænium; the two others above alluded to should, so far as I can judge, have never found a place in Palmoglœa. Of these three, Spirotænia may, I think, be said (as far, at least, as regards the forms themselves) to bear a relationship to Spirogyra similar to that which Cylindrocystis bears to Zygnema, and possibly Mesotænium may be considered to possess, in a great measure, a relatively similar relationship to Mesocarpus or to Leptocystinema (mihi).

The query with which I commenced this paper suggested itself to me after having searched for and having tried to examine our Dublin forms included in Kützing's genus, and upon a reperusal of Alex. Braun's remarks,* where that author observes that "the species of the genus Palmoglœa, as established by Kützing, cannot be certainly determined either by the characters given in 'Species Algarum,' or by the figures given in 'Tab. Phyc.'" And he goes on to say that in the species represented by himself, which, doubtfully, he calls *P. macrococca*, "the jelly-like envelopes are sometimes distinguishable singly, sometimes not, which renders doubtful even the section in which we are to seek the species;" and he afterwards expresses an opinion that several of the species (citing six) will have to be combined as forms of one and the same species. With that writer I must concur in admitting the difficulty of identifying Kützing's forms, as well as even the uncertainty, as I before indicated, in deciding the section in which we are to seek a particular species. But I think it must be admitted that, seizing upon other distinctions than those put forward by Kützing, abundantly distinguishable forms, even generically separated, here

* De Bary, op. cit., p. 34, t. vii, 20—29.
† Op. cit., p. 327.

present themselves, as I have endeavoured to show. It may indeed be quite probable that some of his forms are described as distinct upon characters too trivial; thus I would be disposed to suggest, altogether conjecturally, that his *P. vesiculosa* and *P. macrococca* may be possibly identical —*P. lurida* and *P. rupestris*—*P. protuberans* and *P. macrococca;* but in the main, so far as I can judge, the forms generally referred to by him to this genus seem to be distinct. On the other hand, I fancy that, as might be expected, a few forms appertaining to Mesotænium, described by Nägeli and De Bary, do not occur at all in 'Species Algarum.'

In thus expressing an opinion as to the actuality and distinctness of these species, which I would wish to do very far from dogmatically, I am not unmindful of the statements made by writers as to the diamorphosis of these forms—that is, as to their being more or less transitory conditions of higher plants. But it, indeed, appears to me, that anything as yet adduced in support of the transition of a true Palmoglœa—that is to say, of either a true Spirotænia, Cylindrocystis, or Mesotænium—into or from any other plant is by no means so conclusive as regards, an actual diamorphosis, as are De Bary's observations on their development from one generation to another, through germination of the spore formed by conjugation, apparently decisive as regards their perpetuated identity and constancy. Kützing, indeed, speaks of a transition of his *P. protuberans* into Scytonema,* and of his *P. vesiculosa* into a Zygogonium; but, very deferentially, I think his statements and figures are too meagre, in these cases, to prevent great doubt as to the correctness of his conclusions; besides, it is possible, indeed, that his plants thus called may not, strictly speaking, belong at all here. Again, Dr. Hicks † draws attention to an elongate form of cell noticed by him during the development of lichen-gonidia, and which he considers nothing but a "Palmoglœa;" consequently, he seems to come to the conclusion that all the Palmoglœa-forms are but conditions in the growth of the gonidia of lichens. Far be it from me to doubt the accuracy of Dr. Hicks' very valuable and remarkable observations; but, at least, so far as the forms of Cylindrocystis and Mesotænium (by whatever names they may pass) are concerned, I would suggestively put it, that here, as elsewhere, resemblance may by no means necessarily constitute identity. We are not now so much astonished as formerly at remarkable cases

* 'Phycologia Generalis,' p. 178.

† 'Quart. Journ. of Mic. Science,' vol. ii, n. s., pp. 17 and 20.

of homomorphism, even in organisms very high in the scale, and well know that such sometimes do not indicate even any affinity, not to speak of identity. And I should certainly be disposed to imagine that homomorphs are not less likely to occur in such simple plants as those under consideration than in regard to the more complicated and elaborate organs of higher existences, even in animal life. Dr. Hicks * speaks of "large oval cells precisely similar to Palmoglœa" (Kütz.) (Cylindrocystis, Menegh., Coccochloris, Hass.), as occurring during the development of certain lichen-gonidia, and he considers the oval cells represented in his figure † as "visually identical" with "*Palmoglœa Brébissonii.*" If he means by this *Palmoglœa Brébissonii* (Kütz.), which Kützing makes out to be identical with *Palmella cylindrospora* (Bréb.), which latter Ralfs considers identical with his *Penium Brébissonii,* then I am bound to say I cannot agree that Dr. Hicks' form is by any means "visually identical" with that indicated by the names just quoted. That alluded to (*Penium Brébissonii,* Ralfs) is undoubtedly a Cylindrocystis, and Hicks' figure suggests to one more the idea of a Mesotænium, with the broad side of the clorophyll-plate uppermost, but does not at all call to mind a species of the former genus. If it be assumed as presenting a form of Mesotænium, the granular endochrome, which so often obscures the view of the chlorophyll-plate, seems to be very deficient, for the central corpuscle is to be seen in all the cells figured. This central corpuscle is regarded by Hicks as a nucleus; it would seem far more probably to be merely a starch-granule, or a "chlorophyll-vesicle" (Näg.). In *Cylindrocystis Brébissonii* two such granules occur in ordinary cells, and four in cells about to divide, and they appear quite homologous and identical in nature with the similar bodies occurring in Closterium, &c. &c. If by *Palmoglœa Brébissonii* is meant by Hicks *Coccochloris Brébissonii* (Thwaites),‡ although Thwaites' description and figures hardly admit of a certain conclusion as to whether any species more recently described by Continental writers may be identical with it, yet Hicks' figures do not at all seem to me to be identical with, or even at all to resemble, those of Thwaites. The former represent a rather narrow, egg-shaped form, while the latter is described as "cellulis subsphæricis vel rotundato-ellipticis;" and, setting aside the scantiness of the accompanying filaments (which, as I before indicated, I conceive have no connection with the

* Loc. cit., p. 17.

† Ib., pl. ii, figs. 11, 12.

‡ 'Annals of Natural History,' n. s., vol. iii, p. 243.

cells), Thwaites' figures remind me more of *Trychodictyon rupestre* (Kütz.) = *Cylindrocystis crassa* (De Bary). But I put this latter surmise forward merely suggestively. In point of fact, Hicks' figures do not seem to me absolutely identical with any of the species described by De Bary, nor with any I have myself encountered; and if, as the former states, "the remainder of the British species of Palmoglœa or Coccochloris" (that is, exclusive of "*Palmoglœa Brébissonii*," of which, after all, he has doubts) "can certainly be produced from Cladonia," he has as least not figured them, nor explained the process. But I do not suppose that Palmoglœa and Coccochloris are synonymous, or at least they are only so in part. Itzigsohn,* I find likewise, makes the statement that he cannot at all regard the "so-called Palmoglœa as independent organisms," expressing a hope at some time, eventually, to publish the observation on which this assumption is founded. This promised communication I have not been able to hit upon. But surely the finding of "Palmoglœa" or other forms in company with various algæ is not—as I venture to fancy Itzigsohn, indeed, too frequently seems to assume—any proof of a genetic relationship. Again, I would beg to say that I put forward the foregoing opinions merely as those which have forced themselves on myself, and I trust I may not be thought to have expressed them too dogmatically or too confidently.

What, then, is *Palmoglœa macrococca* (Kütz.), as to the identity of which Alexander Braun expressed so much doubt? I certainly should consider that the plant figured by him † is not the species in question. The former, undoubtedly Braun's plant—for De Bary tells us he identified it from the fresh and authentic specimens—has been since described by the latter as *Mesotænium Braunii*. If *this* were Kützing's *macrococca*, I wonder how he could omit to notice the striking "chlorophyll-plate." *M. Braunii* differs from *Palmoglœa macrococca* (Kütz.) so far as Kützing's descriptions and figures permit us of judging, in its larger size, shorter length in proportion to its width, and its more broadly rounded extremities, and, if I be right in my identification of these plants, in several other more positive and decisive characters, although to the accustomed eye these external marks will distinguish sufficiently readily, at least, our Dublin forms. I do not think that *P. macrococca*, as Braun supposes, is the same thing as *Coccochloris Brébissonii*

* Itzigsohn, 'Skizzen zu einer Lebensgeschichte des *Hapalosiphon Braunii*,' p. 295. Weber, Bonn.

† Loc. cit., pl. i and ii.

(Thwaites). According to Kützing, in the former the cells are oblong-cylindrical, not, as in the latter, sub-spherical or rotundato-elliptic. I before indicated that the latter (*C. Brébissonii*, Thwaites) appears to me far more likely to be the same plant as *Trichodictyon rupestre* (Kütz.) = *Cylindrocystis crassa* (De Bary).

P. macrococca is not the state figured by Hicks of his lichen-gonidia; for in the former the cells are oblong-cylindrical, not ovate, setting aside the fact that the latter is nothing but what may be called a homomorphic representative of that which I am as yet forced to regard as a true species.

I feel satisfied that *P. macrococca* is not the plant so named by Grunow,* of which that writer describes "the cell-contents, in certain cases, as exactly like those of *Zygnema cruciatim*, or Desmidium;" also that a "nucleus, and in each cell-half a starch-vesicle, were to be observed." Moreover, we must infer from the context that his plant occurred submerged in water. These characters combine in indicating that it was not a Mesotænium, but a Cylindrocystis, which Grunow must have had under observation—possibly *C. Brébissonii;* but we are without any figure to assist in this determination. Now, I think there can be no doubt but that *Palmoglœa macrococca* is at all events a Mesotænium, and not a Cylindrocystis; for those known Palmoglœa-forms which actually appertain to Cylindrocystis can be best identified with forms separately described under other names by Kützing.

Since this paper was read I have obtained Rabenhorst's lately published 'Cryptogamic Flora of Saxony' (and adjacent countries). Now, I have here again to remark, with every deference, that I cannot concur in considering the plant *figured* by this author as truly *P. macrococca* (Kütz.).† Rabenhorst's figure certainly appears to represent the form named *Mesotænium violascens* by De Bary, and, if it really represented the species it is called (*P. macrococca*), De Bary would appear to be right in supposing their actual identity. But surely it will be admitted that the narrow cylindrical plant represented by Kützing is quite a different thing from this stout, broadly elliptic form? Yet Rabenhorst describes *P. violascens* separately,‡ and considers the former (*P.*

* 'Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien,' 1858, p. 489. Grunow, 'Die Desmidiaceen und Pediastreen einiger österreichischen Moore.'

† 'Kryptogamen-Flora von Sachsen,' &c., 150.

‡ Op. cit., p. 167.

macrococca) equivalent to *M. Braunii* (De Bary); but if the figures given by Rabenhorst be compared with those of *M. Braunii* given by De Bary, it will be seen that the former represent a broadly elliptic, the latter a cylindrical, form. Indeed, I consider that Rabenhorst's figures said to represent "*P. macrococca*" seem actually to be copied from De Bary's figures of *M. violascens.* As to Rabenhorst's description of "*P. macrococca,*" an objection to be made to it seems to be that it is not sufficiently in detail, as the characters given would as well apply to two or three apparently distinct species; nor do the characters agree with the figures (seeing that they represent *violascens*). And as to the validity of their distinctions, I would beg observers to suspend their judgment, at least until careful examination be made of the fresh specimens. In regard to the generic characters given by Rabenhorst for Palmoglœa, they are intended to include only, and to be restricted to, the forms appertaining to Mesotænium (Näg.), while Cylindrocystis (Menegh.) is included in Penium (Bréb.). But, as I have before pointed out, Cylindrocystis seems sufficiently well characterised as a distinct genus. The statement as to the constant incorporation of cell-wall and -contents in the act of conjugation must be modified as regards Mesotænium, as will be seen by the description in this paper.

Of the three species of Mesotænium described by De Bary, I have above indicated that I believe the *P. macrococca* could not have been *Mesotænium Braunii* (De Bary). The narrow-cylindrical cells with rounded ends seem quite to separate it from the broadly elliptic form, gradually diminishing towards both ends, of *M. violascens* (De Bary).

I believe, then, it is more probable with *M. chlamydosporum* (De Bary) of properly described species, that the identity of *P. macrococca* exists.

It is indeed to be regretted that in endeavouring to settle the identity of the plant in question, from the insufficiency of Kützing's description, we have little else to go upon but the external outline; yet the genus being known, I must hold to the opinion that this is by no means unimportant, and there can be no doubt but that the genus here is Mesotænium. After some search in our Dublin and Wicklow hills, I have succeeded in finding, and pretty certainly identifying by De Bary's description, his three species of that genus; and in my opinion *M. chlamydosporum* is the only one which suits Kützing's (indeed but vague) description of the debated plant. They are both cylindrical, with rounded ends, and coincide pretty nearly in the measurements, and are common, whilst the gelatinous mass is rather firm—thus agreeing with Kützing's character in that regard, upon which he lays so much importance. His *Palm. protuberans* and *Palm. macrococca* are much smaller plants. I believe I have found here one or both, but I have not as yet been at all able to satisfy myself as to their actual nature. It seems probable that the *Coccochloris protuberans* (Spreng., Hass.) may be identical with *P. macrococca.*

But here any further power of comparison of Kützing's and Braun's plants ceases, owing to the meagre description of the former. As to the possible identity of any other of Kützing's forms with *P. macrococca* or others, I have hereinbefore ventured to express a conjecture.

But the plant I identify as *M. chlamydosporum* (De Bary), or which, perhaps, I believe I might possibly be more correct in assuming as a variety thereof, I had at first thought to be a distinct species, and so, indeed, it may possibly still prove to be; and I had, when this paper was read, drawn up a description of it as such; but if I err in modifying my former opinion, it is at least an error on the right side. I shall, however, endeavour to put forward a general description of the plant which occurs here, reserving an allusion to the points in which it differs from De Bary's, until after a brief reference to the generally received views as to the affinities of the genus.

MESOTÆNIUM CHLAMYDOSPORUM (De Bary). *Var. β.*

General description.—Mass light green, gelatinous, rather firm; cells oblong, cylindrical, ends broadly rounded; chlorophyll-plate in edge view usually axile, narrow, fusiform, pointed at the ends, which do not reach the extremities of the cells, after division blunt at the ends towards the septum dividing the mother-cell; nucleus, when to be seen, forming a small rounded body, lying upon one of the front surfaces of the plate; granular contents very dense and abundant, often preventing the view of the chlorophyll-plate, which is therefore very rarely discernible in front view. Conjugation effected by the extension and protrusion of the entire contents, which touch and incorporate at any point, the parent cells uniting in many varieties of position, the original cell-membrane of each being thrown off, in its almost original form, each half often bent at an angle, as if due to a separation at a suture. Zygospore, at first shapeless or irregular, assuming finally an ovate or elliptic outline, and becoming surrounded by a comparatively thin, sharply defined mucous envelope the cell-contents, very dense and coarsely granular, the latter ultimately becoming considerably retracted from the outer wall and surrounded by an inner, finally yellowish or brownish coat, forming the actual spore, which presents to view a four-, five-, or six-sided, or a somewhat circular outline, sometimes somewhat flattened at certain sides, slightly enlarged or thickened at the angles, and often presenting on the general surface a slightly undulate or somewhat granular appearance, due to the presence of little superficial prominences. When showing four sides, I presume the inner spore may be of a cubical or prismatic figure, and when five- or six-sided, irregularly polygonal, but it appears sometimes of an irregularly rounded, very indefinite form. I have not seen, however, a triangular form.

Measurements.—Length of cell, $\frac{1}{1000}$ to $\frac{1}{770}$; breadth of cell, $\frac{1}{2150}$; length of zygospore, $\frac{1}{880}$ to $\frac{1}{630}$; breadth, $\frac{1}{1160}$ to $\frac{1}{875}$ of an inch.

Plate I, fig. 1, cell in which the chlorophyll-plate cannot be seen; either the remaining contents are too dense, or the edge view of the plate is not towards the observer. Fig. 2 shows edge view of chlorophyll-plate, with nucleus (?). Figs. 3, 4, accidental forms and positions of the chlorophyll-plate. Fig. 5, cell about to divide; the chlorophyll-plate divided; its inner ends bluntly rounded. Fig. 6, the cell divided. Fig. 7, two cells about to conjugate. Fig. 8, two such cells in contact, the parent-coats slipping off. Figs. 9 to 13, various degrees of advancement of conjugation. Fig. 14, zygospore formed, with mucous investment. Figs. 15 to 19, various mature zygospores.

Now, as regards the position of the genus to which this plant belongs, inasmuch as the mode in which the reproductive process is carried out in any organism is always—and doubtless rightly—regarded as of more importance than vegetative structure in deciding affinity, the fact that in these forms reproduction is by conjugation most strongly points to a close relationship with the Desmidiaceæ and with the Zygnemaceæ; and in this genus the process is essentially that which characterises those families. On the other hand, the gelatinous nature indicates considerable affinity with the Palmellaceæ; but, with the exception of Palmoglœa, I am not aware of conjugation having been found in any other genus of that family, though zoospores occur in some, while in regard to others Professor Kützing's * and Dr. Hicks' inte-

* Kützing's "Die Umwandlung niederer Algenformen in höhere,' &c., published in 'Natuurkundige Verhandelingen van de hollandsche Maatschappij der Wetenschappen an Haarlem,' 1841.

resting observations render their truly autonomous character doubtful, although I fancy each has been perhaps too hasty and too comprehensive in his generalisations.

Clearly this genus and Cylindrocystis are very closely related, and to whatever group one belongs so does the other. By Nägeli the genus Mesotænium is placed with the Desmidiaceæ, and by De Bary both those genera are classed in that family. By the latter writer the Conjugatæ are divided into three families—Mesocarpeæ, Zygnemeæ, and Desmidieæ—their distinctions drawn from the mode as to special details of the formation of the zygospore and of the development of the young plants originating therefrom, distinctions I need not more than allude to here. The distinctions based upon the fact as to whether all the daughter-cells originating from the germ-cell are again capable of self-division, or whether one of the daughter-cells remains as a "root-cell" incapable of further self-division—the former characterising the Desmidieæ, the latter the Zygnemaceæ—De Bary considers the only decided pervading features absolutely separating these two families. Mesocarpeæ are distinguished from both by peculiarities in the formation of the zygospore itself. Suffice it that the genera in question, as indicated by that author's original researches, in the mode of development, seem to accord with the characters in that regard as specially appertaining to the Desmidiaceæ.

There is a character, however, which seems to pervade the family Desmidiaceæ, and is certainly demonstrable in every undoubted member of the group. I allude to the well-known fact that the vegetative increase of a cell, or "frond," is effected by the formation of two new half-cells, which become interposed between the older, so that the two newly produced cells consist each of a new and old half-cell. Of course a figured outline cannot be assumed as an essential, though it is very frequent, and affords classificatory characters.

Is there any evidence of such a mode of cell-increase in Mesotænium? I fancy there is. I refer to fig. 6, in which the chlorophyll-plate is divided, and a division of the cell itself is taking place. Then the two portions of the chlorophyll-plate appertaining one to each daughter-cell, in place of presenting in side, *i.e.* edge view, the somewhat fusiform figure, pointed at both ends, which is seen in a fully grown cell, now show the end near the septum which halves the mother-cell to be bluntly rounded. I conclude, therefore, that its recovery of the fusiform and pointed outline at the blunt ends may be due to a new growth onwards in that direction, therefore accompanied by the growth of a new half-cell, the older halves of each remaining unchanged. But I imagine the probability of a new half to the chlorophyll-plate being formed in continuation of an old one is strengthened by the fact that in dividing cells, when discernible, the corpuscle therein imbedded is found near the end towards the septum, and in fully grown cells at the middle. I therefore suppose it must be inferred that this change of position of the imbedded corpuscle is not due to any inherent movement of its own, but to an elongation of plate *and cell* at the end nearest to which it at first lies, or that at which division has only recently taken place. A similar argument I before applied as some proof of the Desmidian nature of my *Leptocystinema Kinahani*.* Again, I have stated that in our present plant (figs. 9 to 14), in the act of conjugation, a shedding of the parent cell-wall takes place, accompanied by a splitting, as it were, through a suture, indicating, as in the Desmidiaceæ, the point of union of the half-cells. It may be worth noting, too, that in *Mesotænium chlamydosporum* the free inner spore, finally formed within the zygospore, seems to find a parallel in the similar occurrence in *Tetmemorus lævis*. All these characters point strongly to the Desmidiaceæ.

But on the other hand, *Mesotænium Braunii* and *M. violascens* (De Bary) seem to conjugate by complete participation of the parent-cell-membranes in the act; cases, too, in the present plant are not rare in which the parent-membrane cannot be detected, but it must, in such cases, have become either lost or dissolved. Al. Braun † seems to consider that the genus Palmoglœa (Kütz.) is more Palmellacean than Desmidian, but thinks that the greatest distinction between Cylindrocystis and Penium is the participation in the former of the outer cell-membrane in the act of conjugation. But our plant presents an example of a "Palmoglœa" in which the cell-membrane does not co-operate in the conjugative act.

But, except that they are Conjugatæ, exhibiting, according to De Bary's researches, the character, dwelt on by him, of capability of self-division in all the daughter-cells originating from the zygospore, I do not exactly see that the species of "Palmoglœa" which fall under Cylindrocystis rank themselves under the Desmidiaceæ with the same amount of probability as regards the mode of growth alluded to. In other words, I do not see that the same supposed evidence can be so readily drawn from internal sources as in Mesotænium of the addition of two new half-cells between the old ones in

* 'Natural History Review,' O. S., vol. v, p. 243.

† Op. cit. (English translation), p. 135.

vegetative growth. It might be assumed, indeed, in *Cylindrocystis Brébissonii*, as cell-division is preceded by a division of the central corpuscles belonging to each half of the parent-cell, which now, therefore, contains four such, each equal in size to each of the two former, and as those nearer the ends seem to occupy the same relative position in respect of, and distance from, the ends, as the original ones did at first—in fact, apparently precisely the same situation—that the new space provided for the accommodation of the two inner corpuscles is due to the addition at the centre of an extension of the cell-wall, which, after divisision, forms the new half-cells. But the central pale space is present throughout, and the division of the corpuscles is preceded by their elongation, the whole in the direction of the axis of the cell, as if this might be due to a gradual external extension all over of both corpuscles and external wall. Indeed, in *C. crassa* (De Bary), which, as hereinbefore spoken of, occasionally presents its young recently divided cells elongating in a direction at right angles to the longitudinal axis of the mother-cell, there apparently takes place an elongation equally at both ends of the nascent cells. Moreover, in this genus the parent-cells seem to incorporate during conjugation, and do not split as if at a suture, the zygospore finally free within the cavity formed by the parent cells. But, again, the plants themselves seem to have considerable affinity to the genus Penium (Bréb.); but, as it seems to me, as Spirotænia, Mesotænium, and Cylindrocystis, as I have above endeavoured to point out, are distinguished from each other by their internal structure, so I believe is Penium distinguished from those by its internal structure. In Penium the granular contents form an axile mass, sending out all round in some species more or less irregularly divided, or in other species quite uninterrupted, plates to the cell-wall, which appear outwardly as more or less interrupted, or irregular, or tolerably uniform longitudinal bands, in end view radiate; but in these and other respects, as regards the species, characteristically disposed, and of course often containing starch-granules, or "chlorophyll-vesicles." This is briefly the character distinguishing this from the three other genera we have been considering. It is undoubtedly Dismidian. Although Spirotænia has always also been so considered, as already said, conjugation has not been seen in it.

Such then is, so far as I can see, and as briefly as I can put it, the state of the case as regards the position of the Palmoglœan species. Whether they be regarded as Desmidians, or as connecting that family with the Palmellaceæ, or what place amongst the algæ near them they may be eventually thought to hold, they appear to me, at least, very well distinguished as genera and species.

Reverting now to the description of our plant given above, I would just compare it with that of De Bary's *M. chlamydosporum.* It will be seen that our plant disagrees with that alluded to, in that it seems to possess a more dense and more coarsely granular endochrome—that during division the parent-membrane does not seem to be cast off as a free pellicle, cap-like, from the ends of the old cells—that the zygospore is ovate, not quadrate—that it becomes surrounded by a definitely bounded mucous investment, and that, preliminary to the process of conjugation, the parent-cell-membrane is cast off (figs. 8 to 14). On the other hand, it agrees in the general form and dimensions of the cell, which in both are cylindrical with rounded ends, in the form of the chlorophyll-plate, and in the ultimate contraction of the contents of the zygospore within the primary external coat, and the formation of a new one of an angular figure closely investing the inner actual spore (figs. 15 to 19). This latter process does not take place for some time after conjugation and the formation of the external coat; hence I at first rather too hastily assumed that it did not occur in our plant. However, I have met with numerous specimens presenting this character, which is, perhaps, sufficient to establish the specific identity of the plants in question. This plant, then, seems to be most likely the *Palmoglœa macrococca* (Kütz.).

Perhaps it may not be unworthy mentioning, in case these forms may occupy the attention of observers elsewhere, that the only character which occasions doubt to myself as to the identity of the plant which occurs here, and which I conceive to be *M. Braunii* (De Bary), Braun's plant referred to in his 'Rejuvenescence' is that of the colour of the mass. De Bary describes it as dark green, and he afterwards speaks of the special definitely bounded gelatinous investments of the cells present before the whole mass becomes seemingly confluent into a homogeneous mucus, as being of an intense, often dark, gray-violet colour. Now, my plant is of a reddish-brownish hue in the mass, somewhat like that of an infusion of tea, but deeper and richer; the tint is deeper at the outside of the mass, and the colour is due to that of the gelatinous matter, and not to the cells themselves; but the form, structure, and appearance of the latter, under the microscope, seem, so far as I can judge, entirely to coincide with De Bary's figures and descriptions of his *M. Braunii.*

I now proceed to describe, as best I can, a form I consider a new and distinct species, though without the conjugative state, but which presented to me a very remarkable condition not before noticed in this genus. But although thus apparently rare, I cannot suppose it confined to the following form—in other words, I would not describe it as distinct on that account. I shall defer an account of the condition alluded to the general description of the species.

Mesotænium mirificum (mihi, sp. nov.).

Specific characters.—Cells broadly elliptic; chlorophyll-plate in edge view very narrow, often curved.

Habitat.—Like the former, wet rocks, but very rare.

Locality.—Between Loughs Luggelaw (or Tay) and Dan, near Ballinrush.

General description.—Mass pale yellowish-green, gelatinous; cells broadly elliptic; chlorophyll-plate in edge view very narrow, excentric, not rapidly attenuated to the extremities, which are not acute, and do not quite touch the cell-wall, often curved; endochrome dense.

I have observed the cell-contents bounded by the "primordial utricle" escape from the parent-cell without conjugation, through a lateral or terminal or intermediately disposed opening, effected by the raising up and often separation of a lid or valve-like portion of the parent-cell-membrane (figs. 22 to 31). During this operation the contents are often much constricted, by reason of the narrow orifice through which the mass makes an exit. After emergence it becomes rounded, and the contents of this resting-spore-like body (figs. 24, 25), which do not conjugate or combine with any other, become of a reddish-brown hue, with a dark corpuscle in the centre. The empty parent-cell-membrane lies hard by, the lid-like structure sometimes apparently still adherent by one point—sometimes wholly detached, and lying about in various positions, or lost altogether (figs. 22 to 31).

What may be the fate of these resting-spore-like bodies I cannot say; but to my mind they form an additional reason for dissenting from Hicks' conclusion, already referred to, that "Palmoglœa-forms" are any condition of developing gonidia of lichens. Somewhat similar spore-like bodies are sometimes formed in Zygnema—one such from the entire cell-contents of one cell—and they escape from the parent-cell through a lateral opening into the surrounding water;

but I have not observed in Zygnema that the opening by which they escape is produced by their raising up a portion of the cell-membrane as a lid or valve-like structure, which forms so remarkable a feature in this Mesotænium. Similar "resting cells," not resulting from conjugation, are described by De Bary in a Zygnema,* distinguishable from the "spores" by their more cylindrical figure, and which germinate into young plants. But in this Mesotænium this "lid" does not form a specially formed cap (so to speak), like that, for instance, in some species of Chytridium (Braun), there for the exit of zoospores, but seems to be merely a small portion of the cell-membrane pushed up from within at any point. This "lid," however, is of a somewhat sharply defined outline, and of a rounded figure, as it were cut out, and not produced by a rough bursting or tearing; and yet there can be no suture, the line of separation taking place in the most varied directions and positions, between transverse, oblique, and vertical. It is well known that somewhat similar spore-like bodies are formed by the individualization of the whole or a portion of the cell-contents in some Desmids, in Spirogyra (here beset with spine-like extensions), &c., but they do not seem to have been noticed as yet as being eventually set free; and if they are so, it must be by the breaking up of the original cells, for no special opening seems to occur, if, indeed, those alluded to be not possibly really internal parasitic growths. Therefore, so far as I know, the only apparent parallel for the curious phenomenon in this plant is the probably similar bodies which occur in Zygnema just alluded to. But they are possibly structures of an analogous nature.

I do not at all suppose that the apertures here left by the raising off of the lid-like portions of the cell-wall are by any means to be regarded as for the purpose of admission of spermatozoids—that is, these spore-like bodies have no resemblance to the germ-cell (oospore or *Befruchtungskugel*, Pringsheim) of Œdogonium. Nothing of the sort was apparent, nor is it to be looked for or expected. The true generative act, as I regard it, is found in these species in that of *conjugation*.

Measurements.—Length of cell, $\frac{1}{770}$ to $\frac{1}{880}$; breadth, $\frac{1}{1400}$ to $\frac{1}{1270}$; diameter of spore-like body averages about $\frac{1}{1000}$ of an inch.

Fig. 20, cell showing edge view of chlorophyll-plate; figs. 21, 22, 23, cell-contents emerging; figs. 24, 25, cell-contents emerged, and balled together into a spore-like

* Op. cit., p. 10, t. viii, 13.

body, of a reddish colour; figs. 26 to 31, various empty cell-membranes, showing the valve or lid-like portion detached.

Affinities and differences.—This is the only species I am acquainted with which reaches the size of *M. Braunii*, but it differs from that in the pale colour of the mass, in the broadly elliptic, not cylindrical cells, in the much narrower chlorophyll-plate in *edge* view, in this not being proportionately so much expanded at the ends or at the middle, in its not reaching the extremities of the cells, and in its being more frequently eccentric and somewhat curved. It more resembles *M. violascens* in figure; but it is of larger size and different colour, the chlorophyll-plate in *edge* view is narrower and more pointed, the cells are not so broadly rounded at the ends, the endochrome is less dense, but more scattered, and the parietal layer not so well marked. It is distinguished from *M. chlamydosporum* by its elliptic, not cylindrical, outline, by its greater width in proportion to its length, by its not shedding its coat during division. Its elliptic, not cylindrical, figure, and densely gelatinous habit, separate it from *M. Endlicherianum* (Näg.). I do not set any distinctive value on the remarkable phenomenon of the extrusion of the cell-contents through a valvular opening, as I conceive, whatever it portend, there may be nothing to prevent a similar occurence in any other species.

While I have to apologise for the discursive tendency and rather irregular arrangement of this paper, I am, at the same time, indeed, well aware that there is far more in it that is not new than that is so, and that the former has already been much better laid down by De Bary than I could ever hope or pretend to do; but the former was necessary to illustrate and elucidate the latter, and I know of no English work in which, as I imagine, these plants are properly described. Therefore I consider that the little that is new in these remarks will not be without its value as a contribution, small though it be, towards an eventually more correct acquaintance with these humble and obscure organisms, occupying so lowly a corner in the great domain of the vegetable kingdom.

REVIEWS.

Transactions of the Linnean Society.

In the last Part of the 'Linnean Transactions'* are several papers of considerable interest to the microscopical observer.

I. The first paper in the Part is one by A. Hancock and the Rev. Al. M. Norman, 'On *Splanchnotrophus,* an undescribed Genus of Crustacea, parasitic in Nudibranchiate Mollusca.'

In their 'Monograph of the British Nudibranchiate Mollusca,' Messrs. Alder and Hancock noticed three or four forms of Entomostraca found infesting the Nudibranchs; but partly from want of sufficient materials at the time and for other reasons the subject of these parasites was not pursued. Having recently, however, obtained a fresh supply of specimens of two of the forms, Mr. Hancock and Mr. Norman proceed to give as complete a description of them as they are able from the limited number of specimens at their command.

Some of these parasitic crustacea, one species of which is figured in the above monograph, in Pl. XLV, fig. 10, and which was taken in *Antiopa cristata,* and referred to the genus *Ergasilus,* though subsequently constituted by Leydig into a distinct genus *Doridicola,* are active little beings, "which flit about from place to place on the surface of the infested animals, or anchor themselves by their long prehensile antennæ amidst the gills of *Doris,* or the papillæ of *Eolis.*"

But the subjects of the present paper are not these agile, sprightly forms, but certain ill-formed and monstrous-looking creatures, which live constantly attached to one place, and are almost motionless.

"Two species of these curious animals have occurred.

* Vol. xxiv, Part 2. 1863.

Both are internal parasites, lying buried within the visceral chamber of their victims. The minute caudal extremity, and the ovigerous sacs of the female, however, appear at the surface."

One species was obtained in *Doris pilosa*, from the coast of Devonshire, and has since also occurred in *Idalia aspersa*, taken on the west coast of Ireland. The other species has been found in *Eolis rufibranchialis* and *Doto coronata*, captured on the shores of Northumberland. The characters of the genus *Splanchnotrophus* are thus given :—

Female.—Head and thorax either blended into a single segment, the thoracic portion of which is furnished on either side with unarticulated arm-like appendages or lobes, or the first part only of the thorax is united with the head, and the last part forms a second but comparatively minute segment. In this case, however, all the thoracic appendages are attached to the first segment. First antennæ minute and few jointed; second larger, in the form of prehensile hooks. Labrum large, overhanging the mandibles, which organs, together with the maxillæ and two pairs of foot-jaws, are minute and crowded round the mouth. Thoracic feet two pairs, minute, simple, or two-branched, terminating in hooks. Abdomen two-jointed, the last joint ending in two caudal appendages, which are furnished with one or two simple setæ. Ovigerous sacs elliptical.

Male.—Minute. Cephalothorax without lateral appendages, and divided into four segments, the first of which bears the two pairs of thoracic feet.

The genus belongs to the family Chondracanthidæ, and its most remarkable characteristic, as pointed out by the authors, is the "degree of development of the thorax in the male." Posterior to the two pair of foot-jaws, and, like them, attached to the cephalothoracic segment, we find two pairs of feet, the representative appendages of two thoracic segments; and posterior again to these, and between them and the first abdominal or genital segment, there are three distinct segments; and these constitute, therefore, the third, fourth, and fifth of the thorax. We search in vain throughout the whole order of the Pœcilopoda for an analogous instance of thoracic development.

Two species are then described, viz. :—

1. *Splanchnotrophus gracilis*. In *Doris pilosa* and *Idalia aspersa ;* and

2. *S. brevipes,* found in *Doto coronata,* and *E. rufibranchialis.*

Of the former species several females were obtained; but never more than one individual is found in the same "Nudibranch, and this invariably occupies the same position, resting upon the under surface of the liver-mass, and embracing two thirds of it with its long attenuated lateral processes. The under surface of the parasite is pressed to the liver; the anterior extremity forward, and the posterior extending as far back as the region of the branchial circle; here the two last segments of the body penetrate the skin of the Nudibranch to which they are firmly attached." "It is a remarkable fact, that this penetration and an attachment always takes place within the branchial circle; and consequently, the ovigerous sacs must float amidst the plumes, and be always exposed to the constant flow of water brought thither by the branchial cilia.

The males are more numerous and much smaller than the female, and generally several are associated with each female. "They always live immediately beneath the skin, either adhering to the viscera" or "the female." They are, curiously enough for an internal parasite, furnished with an eye; the reason for which is explained by the circumstance that, as they undoubtedly enjoy a limited degree of locomotion, they might lose themselves among the viscera, in the interior part of the body, had they not an organ which, however low in organisation, yet suffices to guide them towards the surface, immediately beneath the skin, where the female resides permanently attached. The habits of *S. brevipes* appear to be very similar.

Both species are "remarkable for their great size, in comparison with the animals they infest. *S. gracilis* is not very much shorter than the liver upon which it lies;" whilst *S. brevipes* occupies nearly one third of the visceral cavity of *D. coronata*. The Nudibranchs, however, seem perfectly unconscious of the presence of the insidious foe.

II. The second paper is by Mr. Lubbock, being the first part of an "Account of the Development of *Chloëon* (*Ephemera*) *dimidiatum*." This account is preceded by some "Introductory remarks with reference to the number and nature of the changes undergone by Insects in the course of development from the egg upwards."

After referring to the "opinion general among entomologists, that we may observe four distinct periods of existence in every insect, viz., those of the *egg*, the *larva*, the *pupa*, and the *imago*," he observes that "these differences relate only to what we see in insects after birth; while if we are to treat the question in a philosophical manner, we must examine the development as a whole, from the commencement of the changes in the egg up to the final completion of the animal, and not suffer ourselves to be misled by the circumstance that insects do not all leave the egg in the same stage of embryonal development."

After quitting the egg, the general opinion of entomologists is, that the life may be divided into three periods, each marked by a change of skin and an alteration of form.

Mr. Lubbock, however, wishes to show "that in several insects there is no such well-marked, threefold division; and that in Ephemeridæ at least the young insect gradually attains its perfect condition through a series of more than twenty moultings, each accompanied by a slight change of form."

He then proceeds to cite instances already observed of exceptional cases to the assumed uniformity, and says that we shall probably find that there are far more variations from it than most people are at present prepared to accept.

Amongst the Coleoptera are cited the curious and complicated metamorphoses of *Meloë* and *Sitaris*, described by Newport and by Fabre. Amongst the Diptera is noted the interesting case of "*Pupipara*" and *Lonchoptera*. In the Physapoda is noticed the case of *Thrips*. In the Homoptera he has satisfied himself of the existence of at least five well-defined stages in *Typhocyba*. Whilst in *Aphis* there are at any rate more than three.

"If," he says, "we now attempt to ascertain the secondary laws which regulate the form under which any given family of insects is hatched, we shall find that the whole development being, in a certain sense, in all cases the same, the rapidity with which the different organs are developed varies in different insects; and that the condition at birth depends partly on the group to which it belongs, but perhaps still more on the manner in which it is to live.

"Thus those larvæ which are internal parasites, whether in animals or plants, belong to the vermiform state; and the same is the case with those which are intended to live in cells, and to depend on their parents for food. On the other hand, those larvæ which are to burrow in wood have strong jaws and somewhat weak thoracic legs; those which are to feed on leaves have the thoracic legs more developed."

A remarkable instance of this kind of adaptation of organisation to habits is seen in the case of *Meloë* and *Sitaris*. among the Coleoptera. "The insects of this group are at first active, hexapod larvæ; but having introduced themselves into the cells of Hymenoptera, they undergo a retrograde metamorphosis, lose their legs, and emerge as grubs not altogether unlike those whose places they have usurped. When an insect is destined throughout life to exist in the same manner and to use the same food, then it leaves the egg with the principal organs constituted in the same manner as in the *imago*."

Several apparent exceptions to this are cited, and a satisfactory explanation of most of them is afforded.

Having thus described the *degree* of change which takes place after birth, the *manner* in which it is effected is next considered, and shown in great measure to depend upon the circumstance whether the organs undergoing change continue or not in a state of functional activity. It is rendered obvious that, in the former case, the changes must be slow and gradual, so as not to interfere too much with the performance of the functions; whilst in the latter they may be rapid, and accompanied with only one or two changes of skin, though necessarily accompanied with a period of quiescence. This is well exemplified in the instance of Lepidoptera, "in which a mouth originally mandibulate is destined to become suctorial. Any gradual change in such a case would be inconvenient or impossible; the insect might starve in the meantime. Here, therefore, it becomes desirable that the change should be rapid."

III. On the Hairs of *Carcinas mænas*. By W. C. M'Intosh.

This communication is an elaborate account of the appearance and structure, as seen under the microscope, of the hairs, or, more properly speaking, hair-like appendages found on different parts of the surface, both external and internal, of the common shore-crab, and as such will be interesting to the microscopist; more so, in fact, to him than to the physiologist, for there is no attempt made, which is much to be regretted, to conjoin with the morphology some account of the physiological peculiarities which they doubtless possess, of these appendages. The tactile or sentient property possessed at any rate by many of the hairs in the Crustacea has already, however, been the subject of various memoirs by M. Lavalle, Holland, Hæckel, and more especially of Mr. Campbell de Morgan, who has shown conclusively their intimate relation to the nervous system.

Dr. M'Intosh appears to entertain doubts as to the auditory functions of the peculiar organ at the base of the internal antennæ, but in this we think there is now but little room for dispute.

IV. The fourth paper in this rich part of the 'Linnean Transactions' is by Mr. H. C. Bastian, "On the Structure and Nature of the *Dracunculus* or Guinea-worm."

Notwithstanding the numerous attempts that have been made to clear up the minute structure of the Guinea-worm, some of the main points still remained in considerable obscurity. Mr. Bastian, in the paper before us, goes far to remove this, and has added greatly to the knowledge we previously possessed respecting the conformation and probable nature of this the most important of human parasites.

After a brief description of the well-known external characters, we have an account of the minute structure of the integuments, in which the author differs a good deal from previous writers on the integument of annelid animals.

In the Guinea-worm, he says, the integuments are composed of a transparent, almost structureless chitinous substance, arranged in a number of concentric lamellæ, presenting peculiar linear markings. He denies the existence of anything like a corium, though, with something like a contradiction in terms, he regards the integument as "composed of successive excreted epidermic layers." If there is no dermis, how can there be an epidermis? His further description of the structure of the integument in the Guinea-worm and some other Nematoidea, as *Ascaris lumbricoides* and *A. mystax*, is too long for extract, but is well worthy of attention.

With respect to the muscular system little is added to our previous knowledge, and what is said respecting the nervous system leaves it much where it was. The "water vascular system," he conceives, is represented by four equidistant, longitudinal vessels, which extend throughout the whole length of the body, situated, like the [supposed] nervous cords, in the midst of a pulpy substance beneath the peritoneal membrane. These canals, he thinks, have been mistaken by previous observers for nervous cords.

The mature Guinea-worm, as is well known, is crammed full of embryos in all stages of development, and it has thence by some been regarded as a sexual kind of "nurse." It was also known, from the observations of Leblond and others, that the worm contained a slender intestinal tube, terminating according to some, in an anus, but according to others, with whom we fully agree, without any such outlet. Mr. Bastian has, for the first time, shown the true relations which subsist betweeen the embryogenous part of the body and this intestine.

To all appearance the worm represents a simple tube filled with young, but Mr. Bastian has shown very satisfactorily that the tube is not a simple one, but that the interior is formed by an internal tube, formed of a distended *uterus*, coequal in size with the calibre of the integuments throughout nearly the entire length of the worm, but terminating at either end in a slender prolongation, which he regards as the ovaries. Like previous observers, he has been unable to detect any external genital opening. He further shows that the slender intestinal tube runs down between the wall of this distended uterus and that of the body.

He then goes on to describe the structure of the young Filariæ, and traces their development from the earliest stages. In these he has noticed two peculiar organs situated at the junction of the anterior three fifths with the posterior two fifths, and which seem to have altogether escaped the notice of previous observers. They consist of two minute, globular sacculi, embedded in the substance of the body behind the anal opening, and communicating with the exterior by narrow, short canals. Their nature is obscure, unless they represent the rudiment of a water-vascular system.

V. Our space will hardly allow us to do more than mention the title of a second communication from Mr. Lubbock, "On two Aquatic Hymenoptera, one of which uses its wings in Swimming."

"On one of the early days in August," he says, "I was enjoying myself by watching the animals in a basin of pond-water. It is customary to regard the inhabitants of fresh water as less beautiful and varied than those of the sea. But though our inland lakes and rivers can boast no sea-anemones, no star-fishes, Medusæ, shrimps, nor sea-urchins, they are still full of beauty and variety. Without counting the rarer forms, almost every weedy pool contains specimens of *Daphnia, Cyclops, Diaptomus,* and *Asellus* (and he might have added *Branchipus*), among Crustacea; the *Hydra* among Polypes; the lovely green *Volvox,* and many other Algæ, besides numerous Desmidiæ and Diatomaceæ; with insects almost innumerable. Besides the perfect insects, such as water-beetles, *Notonecta, Nepa,* and other Hemiptera, there are larvæ of dragon-flies, beetles, Phryganeas and Ephemeras, the beautifully transparent larvæ of *Corethra,* and many other species of Diptera. But though most of the great orders are more or less richly represented, no aquatic species of Hymenoptera or Orthoptera had till now been discovered." * *

"Great, therefore, was my astonishment on the occasion to which I allude, when I saw in the water a small, Hymenopterous insect, evidently quite at its ease, and actually *swimming* by means of its wings. At first I could hardly believe my eyes; but having found several specimens, and shown them to some of my friends, there can be no doubt about the fact. Moreover, the same insect was again observed, *within a week*, by another entomologist, Mr. Duchess, of Stepney." * * * "It is a curious coincidence that, after remaining so long unnoticed, this little insect should thus be found almost simultaneously by two independent observers." Mr. Walker at first considered the insect to be *Polynema fuscipes*, but though allied to that species, it is not identical with it, the male having twelve joints in the antennæ instead of thirteen. Though so completely aquatic in its habits as to be found almost always beneath the surface, it nevertheless requires to come to the surface at certain intervals to renew the air in its tracheæ. It seems, however, capable of remaining immersed for at least twelve hours.

It is uncertain whether *P. natans* can also use its wings in flight. They are at any rate not easily incited to do so.

The insect, like the rest of the genus, is doubtless parasitic in the larval condition; but nothing appears to be known of this part of its history, which therefore remains an interesting object of research.

It is a very minute species and well fitted for microscopic observation—the female measuring 0·38 inch, and the male 0·42. They were observed in a muddy pond from the beginning of August to the end of September.

Microscope Teachings. Descriptions of various Objects of especial Interest and Beauty, adapted for Microscopic observations, &c. By the Hon. Mrs. Ward. 8vo, pp. 219. London: Groombridge and Sons.

The demand for popular works on the microscope must be enormous, to judge from the numbers in which they are produced; scarcely a year passes without a new, little or big book on the microscope, or its new edition of an old and favourite author. And no wonder that it is so when we consider the enormous number of instruments yearly produced and sold. Every purchaser of a microscope, or nearly so, will want some instructions in its use, or some easily understood information about the various objects he sees through it. Books consequently are produced to suit all tastes, from the scientific enquirer to the most superficial observer, who uses the microscope simply for amusement. Among the numerous popular works on the subject, few have appeared more worthy of favour by the latter and very numerous class than the present.

In a short compass and in a few well chosen words, a considerable amount of information suited for beginners is conveyed on the mode of using the instrument itself, and of mounting the more common kind of objects. And the coloured illustrations, most if not all of which are stated to be by the hand of the authoress, are really excellent of their kind, and very well selected "to present," as she says in the preface, "these wonders successively to view in the manner of a panorama." "The utmost care," it is said, "has been taken to make the work strictly accurate in its statements and exact in its pictorial representations of the objects described," and our inspection of the book enables us to say that this care has been well and successfully applied. We have observed few or no errors, but a considerable amount of useful and instructive information, conveyed in a lively and pleasing style.

On the Preparation and Mounting of Microscopic Objects. By THOMAS DAVIES. London: Hardwicke.

"MUCH information," as the author remarks, "concerning the preparation and mounting of microscopic objects, has been already published, but mostly as supplementary chapters only, in books written professedly upon the microscope. From this," he says, "it is evident that it is necessary to consult a number of works in order to obtain anything like a complete knowledge of the subject." His own pages, he says, "will be found to comprise all the most approved methods of mounting, together with the results of the author's experience, and that of many of his friends, in every department of microscopic manipulation; and as it is intended to assist the beginner as well as the advanced student, the very rudiments of the art have not been omitted."

We will only observe, after carefully looking through Mr. Davies' work, that it appears to us a complete repertory of all that concerns the subject upon which it treats. The directions are given in a clear and precise manner, and the mode of manipulation required for different classes of objects is judiciously stated. Upon the whole, we may say that it is the best and most complete work on the subject with which we are acquainted, and one that will be found extremely useful to all engaged with the microscope.

NOTES AND CORRESPONDENCE.

Discussion on Spontaneous Generation at the French Academy.— We take for granted that our readers are aware of the present state of the controversy in France relative to the question of spontaneous generation. M. Pouchet, in his important work 'Hétérogénie,' had replied to all the objections which the antagonists of spontaneous generation had previously made, including those which were founded on the valuable researches of Schultze. Professor Wyman, of Boston (U.S.), arrived independently at the same conclusions as M. Pouchet, the general result of his experiments being that the boiled infusions of organic matter made use of, exposed only to air which had passed through tubes heated to redness, or enclosed with air in hermetically sealed vessels, and exposed to boiling water, became the seat of infusorial life. M. Pasteur has long been the leading opponent of this theory; and whilst a series of experiments which he submitted to the Paris Academy of Sciences some time ago met many of the arguments which Pouchet had brought forward, he furthermore stated that it was always possible to obtain, in a given locality, an appreciable but limited amount of atmospheric air not having undergone any sort of physical or chemical modification, and nevertheless entirely unfit to produce any alteration whatever in a liquid especially putrescible. MM. Pouchet, Joly, and Musset, in their desire to meet this objection, ascended the glaciers of La Maladetta, near Rencluse, in the Pyrenees, taking with them a certain number of flasks each filled one third with an infusion of hay filtered and boiled for more than an hour. No air was contained in the flasks, and care was taken that they were hermetically closed. Four of them were filled with air on the surface of the glacier and four in a crevasse. The examination of four of the flasks three days afterwards disclosed many specimens of *Bacteria*, *Monas*, *Vibrio*, *Mucedinea*, and *Amœba*. They state, however, in a note, that all the other retorts presented identical results. From this the three experimentalists conclude that the air of Maladetta, and, in general, the air of high mountains, does not fulfil the conditions which M. Pasteur predicted of it. At a recent meeting of the Paris Academy M. Pasteur, in vindication of his original theory, made the following remarks:—"The attentive reader will see that I do not make use in this discussion of the advantage which my opponents give me by not speaking of *Mucedineæ* and *Infusoria* in more than four of their eight flasks, a circumstance which proves that the results which are stated to be contradictory to my own in reality confirm them; and this remark would lead one to suppose that the four flasks alluded to contained neither *Mucedineæ* nor *Infusoria*.

At the meeting of the Academy on the 16th ult., a note was read from M. Joly, stating that these four flasks did contain organic matter, and that, if no mention of the circumstances was made in the note presented to the Academy, it was simply a mistake of M. Musset, who prepared the paper. "M. Pasteur," continues M. Joly, "is entirely mistaken; he has judged us without hearing us; after having asked for information respecting the four flasks, he did not allow himself time to receive an answer; if he had waited one day more, he would have been spared the contradiction we are forced to give him."

In announcing that M. Joly's letter would be inserted in the *Comptes-Rendus*, M. Flourens said—"Several newspapers have reproached me with not giving my opinion on spontaneous generation. As long as I had not formed an opinion I had nothing to say. My opinion is, however, now formed, and I will give it. M. Pasteur's experiments are decisive. What is necessary for the production of animalcules if spontaneous generation be a fact? Air and liquid susceptible of putrescence. But M. Pasteur puts air and liquids susceptible of putrescence together, and nothing happens. There is no such thing as spontaneous generation. To doubt any longer is to misunderstand the question."

M. de Quatrefages believed that, if the Academy were going to institute further experiments, it would be necessary that they should be carried on, not only in suitable localities, but in several places successively; for it followed from experiments formerly undertaken by himself that germs or sporules are so abundant in the atmosphere that it might very well happen that a hundred or more vessels open in the same place might all become the seat of microscopic products.

M. Henri Sainte-Claire Deville, who has repeated M. Pasteur's experiments before a numerous audience at his lectures on chemistry at the Sorbonne, and has always found them perfectly exact, insisted on the necessity of following with absolute accuracy the directions given by M. Pasteur, directions which cannot be deviated from with impunity.

M. Regnault entirely supported M. H. Sainte-Claire Deville's remark; he had seen in his countless experiments on the expansion of gas how, even in working with the mercury trough, it was difficult entirely to prevent the introduction of extraneous air; the *laisser aller* with which M. Pouchet had carried out his first experiments had greatly astonished him.

M. Pasteur reminded the Academy that he had formerly stated that the mercury trough was a receptacle of a multitude of germs which it caused to enter into all the bottles and tubes manipulated in it.

M. Milne-Edwards begged that an important experiment which he had previously referred to might not be forgotten. A small capsule containing germs derived from the atmosphere was floated on the surface of a liquid peculiarly susceptible of putrescence, and the liquid, even after many days, remained completely limpid and unaltered; afterwards, on overturning the capsule, the liquid became impregnated in some way or other, and at the end of a few days it was seen to be filled with a multitude of organized products.

M. Pasteur and other members took this opportunity of calling attention to the simpler and more decisive experiment —a real *experimentum crucis*—which consists in putting side by side two flask with necks drawn out to a point, and containing the same fermentable liquid, the open and slender neck of the one flasks remaining straight and vertical, whilst the slender and open neck of the other flask remained bent, with the opening downwards. The liquid of the first vessel was soon invaded by microscopic vegetation, although often, at least, the liquid of the second vessel remained entirely unaltered.

M. Pasteur had attended the meeting of the Academy for the purpose of exhibiting two flasks which he had filled with air on the Mer de Glace, without the contents having been in any way affected. After the meeting he met his colleague, M. Frémy, in the library, and the latter asked him what would happen if the neck of the vessel were broken. M. Pasteur did not hesitate to reply, that *Mucedineæ* would soon make their appearance. The neck of one of the flasks was accordingly broken, and the flask itself placed in a corner of the library. When M. Frémy and M. Pasteur returned eight hours later, the liquid, previously so clear, had lost its transparency, numerous living organisms were visible, and there was already a thin deposit of dead ones—thus brilliantly confirming the results of M. Pasteur's experiments.

We conclude our notice with an account of some experiments made by M. Pouchet with air collected on Mont Blanc by Dr. Kolb. Two vessels containing air, obtained at a height of 4810 mètres, were opened under the surface of a decoction of common clover, which had been boiled for an hour, and was still at almost the boiling-point. The rising of the liquid in the vessels showed that they had been hermetically closed, the air which they contained having preserved all its rarefaction. After having recorked the flasks in the hot liquid, the necks were put into mercury heated for an hour to 160°. The third day the decoction, which occupied about a third of the vessels, became clouded, and it was evident that *Infusoria* had been produced. Viewed under the microscope, the decoction was found to be filled with living monads of a size intermediate between *Monas lens* and *Monas corpusculum*, with *Spirillum*, and with *Bacterium*. Some *Amœbæ immobiles* were also observed. A flask of air obtained on the summit of the Buet, at a height of 3166 mètres, and partly filled with the same liquid, gave absolutely analogous results. In some centimètres of air obtained on Monte Rosa, monads and vibrios have also been produced. These experiments on the air of Mont Blanc, and some other of the higher peaks of the Alps, go to prove, as remarked by M. Pouchet, contrary to the assertion of M. Pasteur, that whatever be the place or height whence it is obtained, it is uniformly capable of producing living animalcules. M. Pouchet remarks that, at all these considerable latitudes, the air is almost entirely deprived of organic corpuscles. The examination both of air and snow proves it. Neither ova nor spores can be discovered. Thus it would seem that the question concerning the high air is at present undecided. We need, however, scarcely remark that the *experimentum crucis* alluded to by M. Pasteur is the real point of the controversy, and one, moreover, which renders journeys to distant mountain ranges unnecessary. Can M. Pouchet reply to it? It is simple—it requires no elaboration; the comparative skill of the experimenter, therefore, need no longer be any element in the inquiry. It is here that M. Pouchet must silence M. Pasteur, or in his turn hold his peace.—*Reader*, Dec. 12.

Anatomy of Helix aspersa.—In your numbers for January, 1863, and October, 1861, I observed two excellent papers by Dr. Lawson on the anatomy of *Limax maximus* and *Helix aspersa*.

Permit me to make a few observations on his interpretations of the generative organs of those animals. Having had occasion to dissect a specimen of *Helix aspersa,* I was struck with the immense number of zoosperms to be found in the gland which Dr. Lawson calls the ovary, and on further investigations on other specimens, as well as on *Arion empiricorum* and on specimens of the genera Limnæus and Planorbis, I find I can quite bear out the anatomy as given by Gegenbaur, as I have before me preparations of cæca of this gland, which show the zoosperms *in situ* in the centre, with ova in all stages of development towards the periphery, but I cannot make out any double membrane as described by Meckel and Siebold.

The presence of zoosperms in this gland is, I think, conclusive as to its being a testicle as well as ovary, for they are too numerous to have come in accidentally, and their presence in cæca in which all the ova are too young to be impregnated show that they are not derived from some exterior source for that purpose, which is also very improbable on other grounds; the duct is also stuffed full of zoosperms, and it seems strange that Carus should have taken them for ciliæ.

Dr. Lawson thinks that the prostate is the testis; but the fact that in the Planorbis the male duct separates from the uterus and, receiving the secretion of the prostate in its course, goes on to join the sac of the male opening, shows that the prostate is simply an accessory organ.

I shall be happy to show Dr. Lawson the preparations above referred to, and apologising for occupying your valuable space.—Alfred Sanders, M.R.C.S., F.L.S., 22, Beaufort Villas, Brixton.

PROCEEDINGS OF SOCIETIES.

Microscopical Society.

January 13*th*, 1864.

Charles Brooke, Esq., *President*, in the Chair.

W. H. Hall, Esq., 13, Victoria Street, Hackney, and Henry Lee, Esq., The Waldrons, Croydon, were balloted for, and duly elected members of the Society. Mr. Goddard read a paper "On an Improved Table for Mounting Objects." Dr. Beale read a paper "On the White Corpuscles of the Blood."

The thanks of the meeting were returned to these gentlemen for their communications.

February 10*th*, 1864.

Annual Meeting.

Charles Brooke, Esq., *President*, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Reports from the Council, on the progress of the Society, and from the Auditors of the Treasurer's accounts, were read.

The President delivered an address relative to the proceedings of the Society, and also showing the progress of microscopical science during the past year.

Resolved—"That the reports now read be printed and circulated in the usual manner with the President's Address."

J. M. Clabon, Esq., 4, St. George's Terrace, Regent's Park, John Frazer, junior, Esq., and James Howe, Esq., Foster Lane, were balloted for, and duly elected members of the Society.

The Society then proceeded to ballot for Officers and Council, when the following gentlemen were declared duly elected for the year ensuing:

As President—Charles Brooke, Esq.
As Treasurer—C. J. H. Allen, Esq.

As Secretaries { George E. Blenkins, Esq.
F. C. S. Roper, Esq.

Four Members of Council:—Dr. Beale, James Glaisher, Esq., E. G. Lobb, Esq., S. C. Whitbread, Esq.,

In the place of—T. W. Burr, Esq., J. R. Mummery, Esq., R. Warington, Esq., who retire in accordance with the regulations of the Society.

The Council of the Microscopical Society of London, being desirous of extending as far as possible the study of Microscopical Science, have determined to give their public approval, and grant a Quekett Medal, to that which shall be adjudged, after careful comparison, to be the best Microscope of each of the three following classes.

1. An Educational Microscope to be sold for Three Guineas.
2. A Student's Microscope „ Five Guineas.
3. A Student's Binocular Microscope „ Ten Guineas.

The Council consider that the talent and ingenuity of the Instrument makers should be restricted as little as possible in the specifications put forth; and in fixing on the following conditions for each Instrument, they confine themselves to what they will consider absolutely necessary to allow Instruments to compete on their merits.

1. The Three Guinea Educational must have good achromatic low powers, which may be made to act in combination or separately, to give a magnifying power ranging from 40 to 120 diameters. Fine adjustment may be made by the draw tube: good optical performance will be preferred to complexity of mechanism, but some means of inclining the Microscope will be desirable.

2. The Five Guinea Student's Microscope to have good achromatic powers, which may be made to act in combination or separately, ranging from 25 to 200 diameters. Two Eye-pieces, Bull's Eye Condensor, and Live Box; Camera Lucida, or some other apparatus for drawing. The stand to be capable of inclination.

3. The Ten Guinea Student's Binocular to be capable of being used as a Uniocular Instrument, to have powers which may be made to act in combination or separately, ranging from 25 to 200 diameters. One pair of Eye-pieces, Bull's Eye Condensor, Live Box, and Lieberkühn with dark stops, for the lower powers. The stand to be capable of inclination.

They are also prepared to offer a Certificate of Excellence for a Hand Achromatic Microscope for field or clinical purposes. The Instrument, with a Live Box, to be supplied for One Guinea.

Each Instrument to be fitted with the Society's screw, and with its apparatus to be packed in a case.

The Council, in stating the foregoing conditions to be necessary, without which Instruments will not be allowed to compete, do not wish to place any limit to the mechanism or to the apparatus supplied with each; at the same time, in comparing the merits of the Instruments sent in, they will consider good optical performance as the most essential point in determining which Instrument shall be selected for the Medal.

The Instrument of each class which obtains the Medal to remain the property of the Society, to be available as a standard of comparison, by which purchasers of corresponding instruments may be enabled to test them on application to the Curator of the Society.

The instruments intended for competition to be sent in to King's College, Somerset House, addressed to the Council of the Microscopical Society of London, on or before the 31st December, 1864. The Council do not undertake to grant a Medal or give a Testimonial in either of the classes, unless they consider the Instruments sent in to be worthy of their approval.

G. E. Blenkins, } *Hon. Secs.*
F. C. S. Roper. }

King's College, 25th March, 1864.

Hull Microscopical Society.

On Thursday evening a dress soirée, under the auspices of the above Society, took place in the Museum of the Royal Institution. About 250 ladies and gentlemen were present, and seldom has the cause of science in Hull been graced by so gay an assemblage. Every provision was made by the members of the Society for the entertainment and comfort of their guests. Upwards of twenty microscopes, including several "binoculars," occupied the tables, and among the objects exhibited were the following:—By Dr. Bell, microscopic shells and wing of butterfly (*Morpha Menelaus*); F. W. Casson, sections of fossil wood; Sir H. Cooper, vegetable tissues; R. M. Craven, bones of the mastodon and iguanodon; Hy. Gibson, acarus from the human face (*Demodex folliculorum*), sporules or spawn of mushrooms, section of tooth of sawfish, tick of sow; J. M. Gibson, claws of spider, gastric teeth of cricket (*gizzard*); R. Harrison, circulation of blood in a fish, living infusoria, water spider (Trombidium), diatom from guano (*Aulacodiscus formosus*), chambered shells (Foraminifera), pollen of mallow under binocular microscope; B. Jacobs, crystallization of salts, crystallization of salts with polarized light; Rev. H. W. Kemp, spicula of sponge, spicula of Gorgonia; Dr. Kelburne King, sections of coal; J. Malam, micro-photographs; S. Mosely, sections of spines of Echinus; Dr. Munro, hyperstein, crystallized silver, scales of a fern, spines from a leaf (polarized); Wm. Parker, micro-photograph £5 note, tongue of a fly; J. D. Sollitt, microscopic writing (2nd chapter of St. John in the 2000th part of an inch, the Lord's Prayer in the 2500th part of an inch), acarus of the wood-cutting bee (Zylocope), acarus of the hare. In the course of the evening the company adjourned to the Lecture Hall, where Sir H. Cooper offered a few explanatory remarks on the objects exhibited. To add to the pleasures of the evening, a miscellaneous selection of music was performed at intervals, several accomplished local amateurs being assisted by Fraulein Anna Eyserbeck and Fraulein Reichmann. The first mentioned of these ladies sang exquisitely, and the latter also displayed great skill as a pianist; and the applause which followed their performances showed how highly their talent was appreciated by, we should say, as critical an audience as it would be possible to bring together in Hull. We have only to add that, in addition to science and music, there was an ample supply of creature comforts, and that at a timely hour terminated one of the most delightful reunions the Hull Microscopical Society has ever had.

West Kent Natural History, Microscopical, and Photographic Society.

We have but just received the annual report of this useful and active association, containing the President's (F. Currey, Esq.) address and reports for the year 1863. The address consists mainly of notices of many of the "principal books and papers on natural history which have recently appeared," and it forms an excellent summary, in very brief compass, of most of the more important contributions to botany and zoology which have been published within the last twelvemonth.

If every society of this kind were favoured with a similar address, associations of the kind would certainly become one of the most important means of distributing scientific knowledge throughout the community. Mr. Currey's example in this respect is one well worthy of being held up for imitation by all presidents of scientific societies. We much regret that the President's excellent address should be too long for our pages, but subjoin the "Report of the Council" upon the general state of the Society.

Report of the Council.

The Council of the West Kent Natural History and Microscopical Society have again the pleasure of congratulating the members upon the prosperity of the Society. The number of members, which at the last annual meeting was 113, has increased to 132; 12 having withdrawn, and 31 having been elected.

Since the last general meeting the objects of the Society have been extended by an amalgamation with the Blackheath Photographic Society. The amalgamation has rendered it necessary to change the name of the Society, and the change proposed, as well as some slight modifications of the existing rules, will be submitted for your approval this evening.

The meetings of the past year have been well attended, and the following papers read:—1. On the dimorphic condition of the genus *Primula*, by J. Jenner Weir, Esq. 2. On the blow-pipe or air-gun of Macoushie Indians, with some remarks on the

Wourali poison, by the Rev. J. G. Wood. 3. On a new, quick, dry collodion process, by Arthur R. Marten, Esq.

One field meeting was held, devoted chiefly to Cryptogamic Botany, and to an inspection of the fossils of the drift period, as shown in the excavations belonging to Mr. Bazley White, near Erith, and in the collection of Flaxman Spurrell, Esq.

The annual soirée was unavoidably postponed until the month of November, and was then highly successful. More than sixty microscopes were provided, all belonging to members of the Society, and a variety of interesting objects, consisting of fossils, shells, ferns, algæ, insects, &c., were exhibited, besides a large collection of photographic (including stereographic) pictures. The room was decorated with choice plants, supplied by the liberality of John Penn, Esq.

The Library has been much increased during the past year, the funds having been sufficient to enable the Council to devote a considerable sum to this object, and it is hoped that before long the Society will possess a really valuable collection of standard works on subjects connected with natural history and photography.

The additions to the Library consist of the following works:—Huxley's 'Man's Place in Nature.' (Presented by L. M. Simon, Esq.) 'Photographic News,' 6 vols. 'Photographic Journal,' 4 vols. 'Journal of the Photographic Society,' 4 vols. (Transferred from the Blackheath Photographic Society.) 'Microscopical Journal,' 1863. 'Popular Science Review,' 1863. 'Natural History Review,' 1863. 'The Micrographic Dictionary.' Badham's 'Esculent Funguses:' Lovell Reeve's 'British Land and Freshwater Mollusks.' Harvey's 'Phycologia Britannica,' 4 vols. Johnston's 'History of British Zoophytes,' 2 vols.

Besides the above, two volumes are due from the Ray Society, viz., Blackwall's 'British Spiders,' vol. ii, and Günther 'On Indian Reptiles,' both of which may shortly be expected.

The auditors' report for the year 1863 shows the satisfactory condition of the Society's funds.

ORIGINAL COMMUNICATIONS.

A few Words *on the* Choice *of a* Microscope.

By J. J. Plumer, Esq., M.A.

There are, perhaps, few instruments of the present day in which theoretical perfection has been so nearly reached in its practical results as in the modern microscope. In saying this, I am of course speaking of it in its most perfect form, in which the highest optical skill is combined with the most consummate mechanical contrivance. A large number of works have been published on the microscope,* on its history and manner of using it, on its manufacture by our chief opticians, and lastly, on the countless variety of objects which nature and art present for its investigation.† Dr.

* The following are amongst the principal standard works on the microscope and the wonders it reveals.—Dr. Carpenter, 'The Microscope and its Revelations,' third edition; Mr. Quekett, 'Treatise on the Microscope,' third edition; Quekett, 'Lectures on Histology,' 2 vols.; Hogg on 'The 'Microscope, its history, construction, and application;' Beale's 'How to work with the Microscope;' Beale's, 'The Microscope and its application to Clinical Medicine;' Gosse's 'Evenings at the Microscope;' Lankester's 'Half-hours with the Microscope,' illustrated by Tuffen West; Lewis on 'Seaside Studies;' Pritchard's 'History of Infusoria,' 4th edit.; Smith on 'British Diatomaceæ;' Hassall's 'British Freshwater Algæ;' Hassall's 'Microscopic Anatomy of the Human Body;' Wythe on the 'Microscope;' Griffith and Henfrey's 'Micrographic Dictionary;' Woodward on 'Polarized Light;' Dr. Lardner on the 'Microscope.'

† Without giving a formal classified list of such objects, which would be misplaced here, let us select three classes merely of the most ordinary, each of which would stock a large cabinet, each of which has engaged the attentive study of some of the principal naturalists of the day, and given birth to valuable publications concerning their habits and character. 1st. Insects, their heads, eyes, antennæ, trunks, mouths, tongues, stings, wings, legs, feet, and breathing-organs; particularly the scales of beetles, butterflies, and moths. 2nd. The Marine Algæ, those vast families of Seaweed, together with the infinite number of creatures living and fossil attached to them. 3rd. The Pollen or Farina of every wild and cultivated flower or weed that the earth produces. See Dr. Hicks on "The Eyes and Peculiar Organs of Sense

Carpenter's great work, 'The Microscope and its Revelations,' is, in fact, a complete Cyclopædia of itself, in which the above subjects are most ably and fully discussed. The choice, therefore, of a microscope, about which so much has been, and we may safely add is being written, which has become so important an instrument in the hands of the medical student and physiologist, and which opens to the general observer the secrets of minute Nature with a clearness and ease till of late unexampled—the choice at the outset of the most efficient instrument that can be procured by the lover of microscopic research according to his means and requirements is a point of some consequence, and about which I propose now to say a few words. And in doing this, I am merely going to give my own experience in the matter, with such positive and direct advice as may help to guide the inexperienced purchaser in his choice. And firstly, my observations shall be addressed to those who can afford to possess themselves of the most perfect and expensive instruments. I would say, then, to such, what I shall probably have occasion to repeat more than once—*Begin by procuring the best microscope stand that the best optician can give you.* To explain the optical principles and somewhat complicated mechanism of the compound achromatic microscope with such books as Dr. Carpenter's, and Mr. Quekett's, and others before the public, would be altogether superfluous in a little paper like the present. Nor is it necessary to enter into the details of its elementary construction, now that illustrated catalogues within the reach of all are issued by some of our first opticians, with all the various parts figured and described. Besides, it may be taken for granted that a person about to invest a large sum in the purchase of a microscope has a general notion of its form and build. He may fairly be supposed to know the eye-piece from the object-glass, why they are so called, and that on the union of both depends the magnifying power. He may be supposed to know that the stand of the microscope

in Insects," 'Trans. Linn. Soc.' vol. 28, p. 189; and Mr. Tuffen West's "Memoir on the Foot of a Fly," 'Trans. Linn. Soc.' vol. 22, p. 393; also M. Bernard Deschamps on "The Organization of the Wings of Lepidopterous Insects," 'Ann. Nat. Science,' 2nd Zoolog. Series, vol. iii, p. 111; and Mr. R. Beck, on "The Podurn Scale," 'Trans. Micr. Soc.' N.S. vol. x, 1862, p. 83. See again Dr. Bowerbank, Mr. Huxley, Mr. Rainey, and Professor Williamson's 'Treatises on Sponges' and the 'Structure of Shells.' And lastly Mr. Henfrey on "The Development of Pollen-grains," in the 'Micrographic Dictionary,' second edition, p. 558. The above three classes of objects will be sufficient to give some idea of the wide field over which others extend, and those yet unexplored.

usually consists of two supports, which carry the body into which the glasses fit, together with the stage on which the object rests, and the apparatus necessary for illuminating the object.

But it may not be amiss, before giving our reasons for the above advice, to name what constitute the recent improvements of the modern microscope. They may be not unfitly classed under eight heads, the inventions or contrivances having successively come into vogue between the years 1850-60, in about the order in which they are placed. They are as follows:— 1st. The circular rack movement; 2nd. The clamping arc;* 3rd. The sub-stage; 4th. The dark-ground illuminator; 5th. The double nose-piece; 6th. The double arm to mirror; 7th. The separation of the inner and outer lenses of the lower object-glasses; 8th. Wenham's binocular arrangement. The increase of the angular aperture,† which of late years has been so greatly extended throughout all the powers of the microscope, and by which so much additional light is gained for the clearer resolution of the minute details of objects, immense as that improvement is, has not been included in the preceding list, because the advance in that direction, through Mr. Jackson Lister's able and zealous promotion of that branch of optical science, coupled with the exquisite skill of our great opticians, has been carried on steadily since the first construction of an effective achromatic object-glass in 1824 to the present time. The principle is the same now as then, only applied more largely, so that the angles in the deepest lenses have been widened at length to the very last degree that they can advantageously receive. Again, considerable improvement has been effected in the achromatic condenser by Mr. Andrew and Mr. Thomas Ross, and by Mr. Gillett. Its application has lately been simplified and enlarged by Mr. Thomas Ross, so as to be capable of use with the lower powers of the microscope; and its angular aperture has been also greatly increased to improve still further the performance of the deeper powers, while the light that passes through it has been modified through Mr. Gillet's ingenuity by a series of revolving steps to an almost infinitesimal extent. But the principle is pretty nearly the same as it was when M. Dujardin first introduced it.

The eye-piece also for giving double the usual field, which

* This contrivance seems to be peculiar to Mr. Ross's instruments, at all events as to the manner by which the result is obtained.

† For a clear explanation of the term angular aperture, see Mr. Pritchard's, given in Mr. Quekett's 'Treatise on the Microscope' (p. 426, first edition).

has been long in use, has lately been achromatised by Mr. Kelner making it a more efficient eye-glass for the popular exhibition of coarse objects, such as micrographs, insects entire, and transparent sections of wood and stone. The same may be said of the traversing motions of the stage which have received a range of late years by some opticians to the extent of 1½ inches in rectangular directions, but the movements are on the same plan as those in use many years ago. And so likewise with the selenite stage, which has been improved by the late Mr. Darker; as also with Dujardin's prism for reflecting oblique light on transparent objects, which has been modified in various ways by M. Nachet and Amici. I think, then, the recent improvements of the modern microscope may not unreasonably be restricted to the eight ones named above, and the several objects of which are, in short, as follows:

1st. The circular rack, which is immediately beneath the object stage and is capable of carrying it round in Mr. Powell's instrument the entire revolution of a circle, and in Mr. Ross' ¾ of a revolution, is a very convenient movement for altering the angle at which an object is being viewed without putting it out of field or focus, and that even under the deepest powers. This circular rack, moreover, being graduated, can be used as a goneometer for measuring crystals; and it may be altogether considered as the crowning perfection of the rectangular stage motion.

2nd. The clamping arc is a simple but effective contrivance of Mr. Ross's, by which the microscope can be firmly fixed at any inclination, and is a point of consequence after the instrument has been long in use, and the suspension joint has become too supple at that angle of inclination to which it is commonly adjusted.

3rd. The advantage of the sub-stage "for holding and adjusting by universal motions all the illuminating and polarising apparatus placed beneath the object" can scarcely be overrated, its applications are so various and convenient. This sub-stage, besides, can be instantly racked off and detached from the instrument when it is wanted to illuminate opaque objects with the mirror and Lieberkuhn; nothing is then left to intercept the light between the mirror and the objects, a very large space being given within the object stage through which an extremely oblique light can be thrown upon them.

4th. The dark ground illuminator, whether by means of the spotted lens for the lower, or of the paraboloid for the higher powers, is an admirable contrivance, by which a brilliant light is thrown to appearance on semi-opaque objects, though really coming beneath them, but so obliquely, that none of it enters the object-glass but that which is interrupted by the object.

5th. Mr. Brookes' double nose-piece is a most useful piece of mechanism attached to the end of the microscope body, by which any two object-glasses can be screwed on to it at once, and rapidly changed with each other.

6th. The double arm to the plano-concave mirror is a great improvement on the old method of supporting it, since it allows it to be so extended as to cast a very oblique light on objects, as well as to be raised near them without any preparatory movement.

7th. The separation of the outer and inner lenses of the lower powers was a happy idea first carried out by Mr. T. Ross, by which the greatest flatness of field and penetration are secured, and which has been adopted with signal success in his recently invented 3-inch distinct combination object-glass, which embraces in one field of view comparatively large-sized objects, such as flowers, ferns, flower-seeds, and mosses.

8th. Mr. Wenham's binocular arrangement, with double eye-pieces and prism, through which objects under low and medium powers are seen to stand out with solid stereoscopic effect, is the greatest recent invention of the modern microscope. This striking result is effected by means of a prism placed immediately over the object-glass, and which reflects one-half of the rays that proceed up the ordinary body of the microscope into another body attached at a certain inclination to it. The practical benefit of this new arrangement is, that it affords not a mere claptrap exhibition of the objects submitted to it, but gives real relief to the eyes by calling both into exercise, and allows the details of an object in their relation one to another to be far more clearly distinguished, than they could possibly be when the single body and eye-piece alone are employed. The prism above the object-glasses can be drawn aside whenever it is required to exclude the light from passing up the slanting body, and to use the perpendicular one as an ordinary microscope, and which of course will often be the case in the examination of flat objects by low, and of test objects by the highest powers.

Now I have been particular, even at the risk of being tedious, in drawing attention to these various improvements which have been effected during the last few years in the achromatic microscope, because they are just those which make all the difference in the world in the pleasure of using it, and constitute it quite another instrument from what it was fifteen years ago. Fortunately, the binocular body, the dark-ground illuminator, and the 3-inch distinct combination object-glass, can be applied to most microscopes of tolerable size; but the wide range of rectangular stage motion, the circular rack movement, and, in Mr. Ross's instrument, the clamping arc, belong to the largest microscope only, and cannot be applied to any other. I repeat, then, again, with great feeling, the advice already proffered to those about to possess themselves of a superior instrument: *Be satisfied with nothing short of No.* 1; for that microscope alone includes or has power to include *all* the eight above-mentioned advantages. The convenient mechanical contrivances, moreover, of the double nose-piece, the sub-stage, and the double arm to the plano-concave mirror, are managed with far greater ease and efficiency when attached to the largest microscope, because of its great solidity and steadiness; and I am here reminded to speak of the pleasant sense of security with which this steadiness of a first-class microscope stand inspires you; the complete control thereby afforded over the adjustments and various apparatus connected with the instrument, without a chance of disturbing it from its given position, must be realised to be properly appreciated.

And as to the loss in such a microscope of that portability which is so much prized by many, this is a want which can easily be supplied by one of those small stands of trifling cost (about which I shall have to speak again presently), with such limited apparatus as is required for travelling and seaside excursions, reserving the large instrument exclusively for home use.

I was seduced myself for many a year into the error of sacrificing the great advantages of steadiness and mechanical contrivance to the charms of portability and the possession of a complete set of object-glasses; but I now at length see how great was my mistake. If, then, any of my readers require a portable microscope, and will kindly receive a lesson from my failures, I would say to them, *Have* it by all means, but *besides,* not *instead of,* a large one. And as to your object-glasses, I would say, most decidedly, if you cannot afford to have everything, sacrifice even these in a measure to your microscope stand. Better secure the very best stand that can be got, with a couple of good useful object-glasses, than a second best with a dozen, patiently waiting to increase your stock of these as your means will allow you. It is wonderful what can now be done, with such an instrument and apparatus as I am advocating, with large aperture 1-inch and $\frac{1}{2}$-inch object-glasses of modern construction!*

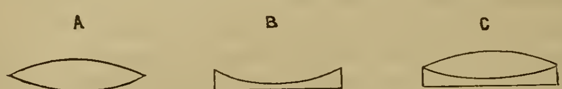
* The cost of this instrument, by Mr. Ross, called in his catalogue No. 1A, with bull's eye condenser, achromatic condenser, parabolic reflector, double

Now, with regard to the comparative advantages in the first-class microscope stands by our chief makers, it must of course be borne in mind that one advantage cannot be gained to the utmost degree without the sacrifice of some other convenience. Thus to take the example of the traversing stage movement, $\frac{3}{4}$-inch motion in rectangular directions, is not nearly sufficient for the purpose intended, though many first-class instruments are made only with that. You will find yourself continually baulked by unexpectedly coming to the end of your tether. So much does Mr. Pillischer value great range of motion in this part of the instrument, that his No. 1 stand is constructed with nearly $1\frac{1}{2}$ inches of motion in each direction; but if you wish for that luxury you must make up your mind to the inconvenience of a bulky microscope, and to the loss of the circular rack. Again, so much does Mr. Powell prize the advantage of the circular rack movement, that his great instrument is so constructed as to enable it to make an entire revolution of a circle when required, not only $\frac{3}{4}$ of a revolution, as is the case in Mr. Ross's instrument; but then if you covet that convenience, you must make up your mind to put up with a limited range of stage motion, and a somewhat unwieldy stand. Mr. Ross, however, striking the balance between these two advantages and disadvantages, secures a 1-inch motion in rectangular directions to the traversing stage; a $\frac{3}{4}$ revolution of a circle to the circular rack, which are sufficient for all practical purposes; while the entire instrument is not too heavy to be carried in one hand, though immoveably firm when once placed on its pedestal. Messrs. Smith, Beck, and Beck's large microscope possesses many excellent qualities. Its double body and stage are supported by a solid brass limb, with the rack movement attached to the body itself, giving great strength and security to that part of the instrument, but the power is lost thereby of turning the body, when required, out of its axis altogether away from the stage—a convenience belonging to the first-class microscopes of our other great makers. At the sacrifice of this and some other advantages, Mr. Smith's instrument, though of exquisite workmanship, is less costly, and lighter in its general build than theirs—merits that are sure to be appreciated by a large class of purchasers. Where, however, expense need not

nosepiece, polariscope, and mahogany box, is £60. The addition to the 1-inch and $\frac{1}{2}$-inch object-glasses, of a 2-inch glass, and which would make the instrument quite complete would raise the cost to 60 guineas. A similar microscope of Mr. Powell's would be about the same price, those of Messrs. Smith and Pillischer, some few pounds less.

be considered, I on the whole incline to the opinion that the greatcst number of advantages are secured in Mr. Ross's instrument that are compatible one with another.*

Thus much with respect to the mechanical department of microscopes. I must now say a few words on the optical part, and especially that most important part—achromatic object-glasses. The object-glass may in truth be regarded as the eye of the microscope; that which is termed the eye-glass standing in about the same relation to it in *importance* that a hand magnifier does to the unassisted eyesight. As the hand-glass would be useless if we had no eyes, so would be the microscope eye-piece but for the object-glass. Of what consequence, then, is it that the object-glass should be as perfect as possible! It is this perfecting of the achromatic object-glass that has engaged for the last forty years so many sagacious heads, mathematicians and opticians in England and abroad, and in the final accomplishment of which they have justly earned a lasting reputation. For, to quote Mr. Quekett's words in his treatise on the microscope, "Of all the triumphs of science that have been achieved by a combination of the labour of the mathematician and the workman, no one can outvie, in delicacy of construction and importance, a well-made achromatic combination." Thus, Franenhofer, Selligues, Chevalier, Aimici, on the continent; Herschell, Airy, Barlow, Coddington, Lister, Ross, of our own country; and the eminent opticians Messrs. Thomas Ross, Powell, and Smith, now resident in London, are all names that will be ever gratefully remembered by the lovers of microscopic research in their connection more or less directly with the achromatic object-glass. And perhaps foremost amongst these, for the tangible results at least that they have actually worked out and effected, may be placed, without any partiality, those of Mr. Joseph Jackson Lister and Mr. Andrew Ross. Mr. Lister's, for his suggestion, that *of* the double convex lens, A, which, with the plano-concave



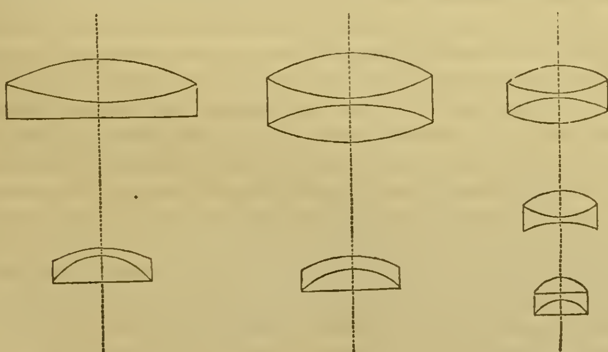
lens, B, go to make up an achromatic combination, *the latter*

* Dr. Carpenter strongly recommends either of the three great microscopes by Messrs. Powell, Smith, and Ross ('The Microscope,' p. 96) as the most desirable for any one, who, according to his means and requirements, wishes to possess a first-class instrument; but he gives the first place to Mr. Ross', though for reasons not precisely the same as those that have been here advanced.

should be of flint glass; and secondly, for his happy conception of uniting these lenses, already identical as at c, still more perfectly by a transparent and colourless cement; thus greatly diminishing the loss of light by reflection, and which is considerable at the numerous surfaces of an achromatic combination. Mr. Ross's, for being the first to notice that however perfect the correction of an object-glass might be, "the circumstance of covering the object," to use his own words, "with a piece of thinnest glass or talc, disturbed the corrections if they had been adapted to an uncovered object, and rendered an object-glass which was perfect under one condition seriously defective under the other." It was to correct this defect that he devised the well-known contrivance called the adjustment of object-glasses, by which they are rendered equally correct whether for covered or uncovered objects; and for the particulars of which, and further improvements in its mechanism by Messrs. Powell and Smith, the reader is referred to Mr. Quekett on the 'Microscope,' and to Mr. Andrew Ross's invaluable paper in the 'Penny Cyclopædia,' the substance of which is embodied in both Dr. Carpenter's and Mr. Quekett's works.

I have deemed it proper to allude thus far to the history and make of the achromatic object-glass,* not only because

* The following diagrams of the different object-glasses will help to explain the complex structure and consequent costliness of an achromatic combination to those who are unacquainted with it.



3 in., 2 in., 1½ in. — 1 in., ⅔. — ½, $\frac{4}{10}$, ¼, ⅕, ⅙, ⅛, $\frac{1}{12}$, $\frac{1}{16}$, $\frac{1}{25}$.

All the double convex and plano-convex lenses are of crown glass, the plano and double concave and meniscus lenses being of flint glass. It will be seen, therefore, that each of the object-glasses, from the ½ to the $\frac{1}{25}$th, are made up of as many as eight distinct lenses: the back combination being a triplet composed of two double convex lenses of crown, with a double concave lens of flint glass between them; the intermediate combination it occupies so prominent a place in the structure of the microscope, but also because the preceding discoveries, though many years prior to the eight recent improvements spoken of in the earlier part of this paper, are of by far the greatest importance. And now, before making any further remark, it will be necessary to give some explanation of the four terms used to denote the qualities of an object-glass; namely, Resolution, Penetration, Definition, and Flatness of field. 1st. The term Resolution is used to signify the power of an object-glass to show clearly the minute details on the surface of objects such as dots or lines, and which is effected, not so much by increase of magnifying power, as by increase of light transmitted through the object-glass to the eye by the enlargement of its angular aperture. 2nd. The term Penetration, according to its modern acceptation, denotes that quality of an object-glass which enables the observer to see deep into the structure of objects, not merely any delicate markings on their surface, but what is below them as well, without any alteration of focus; to show with perfect distinctness such parts as are in focus, and with tolerable clearness those parts that are a little out of focus besides. 3rd. The term Definition is used to signify the capabilities of an object-glass for showing the various details of an object, especially its boundaries, with the most perfect and exquisite sharpness. 4th. The expression marginal and central definition, in other words, Flatness of field, is used to denote the capacity of an object-glass for showing the plane surface of an object as sharply defined at the margin of the field of view as it is in its centre. It would be well for a person about to buy a microscope to have these four terms and their definition clearly in his mind—at his fingers' ends, so to say; because it is on the union of the above qualities in the highest degree, as far as they are consistent one with another, that the goodness of an object-glass mainly depends. Anyhow, I trust the preceding explanation will help to clear up the meaning of the very few remarks which I proceed now to make. Dr. Carpenter in his work on the microscope observes that some opticians, in their zeal to increase the resolving power of object-glasses by the excessive enlargement of their angular aperture, unduly sacrifice the still more important qualities

being a doublet composed of a double convex lens of crown, with a double concave of flint glass; and the front combination being another triplet composed of two plano-convex lenses of crown, with a plano-concave lens of flint between them. This will explain the composition of the shallow object-glasses, the distance between the different combinations throughout all the objectives and their size depending on the amount of magnifying power required.

of penetration and definition. Now, although this may be quite true in many cases, the following instance may serve to show that the largest angle that a medium object-glass can be made to bear, may be obtained when truly corrected without any injury to the perfection of its penetrating and defining qualities. And if this be true with medium object-glasses, it is still more so with deep ones, in which not penetrating, but resolving power is the principal requisite. Mr. T. Ross, for example, has enlarged the angles of his objectives altogether as much, and of his medium object-glasses beyond those of other opticians; and yet on carefully testing some recent medium object-glasses, by a very eminent maker, whose angular apertures were considerably less than his, I found their penetration and marginal definition greatly inferior to them, so that their performance on opaque objects was altogether indifferent; and this conclusion has been confirmed by other microscopists of far greater scientific knowledge than I possess. Each of our principal makers will of course always have their special advocates. There will always be in the microscopic world Powellites, Rossites, Smithites, Pillischerites. To undervalue, therefore, in the slightest degree the undoubted excellences in the glasses manufactured by other opticians, is far from my thoughts; I only say that, as far as the preceding experiment goes, from the large angular aperture, and consequently great resolving power which Mr. Ross obtains throughout his object-glasses, it is only natural to argue that their spherical and chromatic aberrations must be exquisitely corrected to ensure along with it so great an amount of penetrating and defining power. The object-glasses manufactured by Messrs. Smith and Beck justly bear a high character both for the optical skill displayed in them, and for the great excellence of their workmanship. Too high praise, again, can scarcely be accorded to Messrs. Powell and Lealand for their untiring efforts in producing with such success the deepest power for resolving the delicate points or lines of very minute structures, namely, their $\frac{1}{16}$th and $\frac{1}{25}$th objectives, though their sphere of usefulness, owing to their great expensiveness and extremely short focal lengths, becomes somewhat limited; especially too, as the angular aperture of such glasses cannot be increased with advantage, beyond that which the $\frac{1}{12}$th already possesses. It must be remembered, moreover, that the principal work of the microscope is effected with low and medium powers. How often do we find ourselves using, I will not say a $\frac{1}{25}$th, or $\frac{1}{16}$th, or $\frac{1}{12}$th object-glass, but even a $\frac{1}{8}$th, compared with the powers below them? Besides, the peculiar attribute, after all, of the compound achromatic microscope, which exalts it so far above the simple, is its capacity for exhibiting *opaque objects* with brilliancy and sharpness. And this is the special province of low and medium object-glasses—opaque objects, too, being (as old Dr. Goring truly said) severer tests than transparent ones of the penetration and definition of these powers of a microscope.

When the achromatic object-glass was in its infancy, the best test object *now*, as then, of the goodness of a deep objective, the lines on the Podura scale, could be resolved by transmitted light under a fine triplet, with a sharpness at least approaching the modern one eighth; but what glass, save the achromatic, was then capable of showing the commonest opaque objects satisfactorily? The old compound microscope was incapable of showing them with any distinctness, owing to the aberrations of its uncorrected object-glass, which, together with the eye-piece, broke up the light into red and blue colours, and if these were corrected by limiting the aperture of the object-glass, the light was insufficient for any satisfactory result. If, on the other hand, the simple microscope was employed even in its best form of doublet or triplet, though its aberrations were nearly got rid of, and sufficient angular aperture was obtained to resolve the ordinary test objects, yet, as they were not so totally destroyed as to allow the employment of an eye-piece to increase the magnifying power of the object-glass, the amplification of the objects submitted to it was too trifling for any practical purposes. And if, again, a deeper triplet lens was used to raise the magnifying power to the proper point, the focus between the object and object-glass was so short, that no reflected light could be interposed between them. So that now, in fact, the lowest achromatic object-glass, combined with the lowest eye-piece, gives more excellent results in the examination of opaque objects than the deepest single lens that could be effectually employed upon them. And if this be so with the shallowest powers, it may readily be anticipated how splendid are the achievements on such objects of the less shallow and medium object-glasses. Thus, the recently adopted $\frac{2}{3}$rd in. is a charming power for many opaque objects, and $\frac{4}{10}$th in. even for such as are extremely minute, while the $\frac{1}{2}$ in., especially that of 90° aperture,* will, probably, always maintain its

* So much difference of opinion exists as to the advantage of small and large angular apertures, especially for the purposes of scientific investigation, that it is with diffidence that I avow my decided preference for large apertures, presupposing, of course, the most perfect corrections on the object-glasses possessing them. Presupposing, then, these essential conditions,

ground as one of the most useful of glasses; for the same reason that the parabolic reflector ranks as one of the greatest inventions of the modern microscope—the $\frac{1}{2}$ in. as being the highest power that can be used on opaque objects with the best results; the paraboloid as enabling us to obtain even under a $\frac{1}{5}$th in. objective the effect of a brilliantly reflected light. And I am glad to see that Dr. Carpenter, in his work, 'The Microscope,' though he does not lay so much stress on the advantage of medium powers for opaque objects as is here insisted on, nevertheless intimates his satisfaction at the marked attention lately paid by our first opticians to the construction of such glasses as are capable of showing, in the most perfect manner, that fascinating class of objects.

And with respect to transparent objects (not to speak of the advantage of the achromatic microscope over the simple, accruing from the luxury of a large and well-defined field, causing infinitely less strain upon the eyes), the circumstance of obtaining with the medium glasses of the achromatic instrument this high magnifying power combined with considerable length of focus is so great a convenience in the examination of organised structures, and of living actions, whether vegetable or animal, when covered with a thick medium of glass or water, that this alone constitutes a benefit almost as striking as that which is derived from such glasses when employed upon opaque objects.

But it is time now to leave this part of our subject, and say a few words to those whose tastes lead them or means oblige them to confine themselves to the less expensive class of micro-

the utmost amount of light that can be transmitted through an object-glass, by the increase of its angular aperture is of so much consequence for exhibiting the details of objects in their *truthfulness*, that it is difficult to understand how so many scientific people should adhere thus pertinaciously to small angular apertures. Put a $\frac{1}{2}$-inch objective of large, and a $\frac{4}{10}$th of small angular aperture, but both equal in other respects, on some transparent object, say one of the common rotifera: the former glass will show with wonderful precision the forms of its digestive system, which the latter, though a higher magnifying power, will only show as comparatively confused with one another. Again, put the same glasses on the green scales (as seen by reflected light) of the wing of the papilio Paris butterfly, the large aperture $\frac{1}{2}$-inch will exhibit their lines and striæ, as clearly and sharply as a $\frac{1}{8}$th glass would by transmitted light, with a reality in fact that the most careful management of the Bull's-eye condenser, or the mirror and Lieberkuhn would in vain enable the small aperture $\frac{4}{10}$th to equal. It is for this reason, then, that I prefer well corrected object-glasses of large angular aperture, and feel that the trouble of adjusting them and managing the illumination as skilfully as may be, is well bestowed, if only the result is ensured at last of seeing objects *faithfully* represented—as they *are* in short —and not as they are *not*.

scopes, as they necessarily form by far the largest class of purchasers. Those, then, who, for the preceding reasons, do not aspire to the possession of first-class instruments, but such as rank midway between the most and the least expensive, will find all that they can desire in great variety at any of our principal makers, called students', medical or educational microscopes, and by Mr. Ross, "the bases of complete instruments." These microscopes are of a very high order, both as regards the mechanical and the optical parts. They are generally furnished with two best object-glasses, and all necessary apparatus, at a cost varying from £20 to £40. And I must here beg to reiterate the advice already given with respect to first-class instruments. It is better, having secured the object-glasses, to purchase at once the most complete microscope stand, with its usual appliances that the highest price here mentioned will procure. It is far better than having additions made to it on some future occasion, which may necessitate the return of the instrument to the maker, and by far the cheapest plan in the long run. For those, again, who are restricted to the least expensive form of microscopes, the market now-a-days is happily as extensive and fruitful as it is excellent. I would recommend such persons to procure a catalogue of microscopes from Messrs. Smith and Beck, or Mr. Pillischer, or, indeed, any of the opticians whose names are given below, and where they will find the description of a class of instruments called universal, or hospital, *small* students' or third-class educational, which have useful mechanical movements and object-glasses at the moderate cost of from £5 to £15.

I have often thought how fortunate I should have considered myself, when a boy, could I have bought for £10 such a microscope as Messrs. Smith and Beck, or Mr. Pillischer, now offer to the public at £5. The price, indeed, of the instrument by Mr. Field, of Birmingham, with similar apparatus to the above, and for the satisfactory working of which I can vouch myself, is as low as £3.

Such microscopes, though with eye-pieces and all necessary appliances to the stand, are, of course, in their most simple forms, and are rather suited for instruction and amusement than for scientific research; nor would it be reasonable to expect from them what can only be found in far higher-priced instruments. But those which run as high as £15 are provided with the binocular arrangement, fine and coarse adjustments to the optical part, moveable stage, parabolic reflector, polariscope, and all necessary apparatus, with such object-glasses as are usually supplied with these instruments;

and if the moveable stage can be dispensed with for the ordinary one, object-glasses of moderate aperture are sold with it at the same price, which are sufficiently well corrected for scientific investigation. The possessor, therefore, of a first-class microscope can thus obtain a portable one, if he pleases, at a very trifling cost, even when fitted with the binocular body, since all that he requires is the stand,—for as, by a general consent amongst the best opticians, the screws of every modern microscope and object-glass are so constructed as to fit each other alike, he will find his own objectives equally well adapted both to his large and small instrument.

Mr. Thomas Ross and Messrs. Powell and Lealand have justly earned the gratitude of the public for their unceasing energy in perfecting the various departments of microscopic art. But surely, with equal justice, those who have done their utmost to bring really efficient instruments within the reach of ordinary purchasers. Amongst this latter class of opticians may be named Mr. Dancer, of Manchester; Mr. King, of Bristol; Messrs. Field and Parkes, of Birmingham; and Messrs. Amadio, Baker, Crouch, Highley, Horne, Ladd, Warrington, and Wood, of London; but especially Messrs. Smith, Beck, and Beck, who, descending from the high ground they occupy as the manufacturers of first-class microscopes, have taken such pains to effect this desirable object. Nor can, indeed, such an object be too warmly promoted; for the microscope, owing to the perfection of its present construction, is becoming every day more and more popular. It is as necessary almost to the surgeon as his surgical instruments. It is hourly enlarging our view of the astonishing products of an invisible world, unmistakeably revealing the Finger of God, and transforming the commonest things cast aside as worthless by the careless and unobservant, into treasures truly wonderful and precious.

I must now bring these remarks to a close; and which have been written with the sincere desire that those who would set up a microscope for themselves may not fall into the same snare that I did myself, but may reap, by a short and royal road, all the benefits from that engaging instrument that it has cost me many years to acquire.

On Teichmann's Blood-crystals.

By William Hendry, Esq.

Having an impression that the nature of Teichmann's blood-crystals, supposed to be that of pure hæmatine or of the colouring matter of blood, and hence termed hematin-crystals, may not be so generally understood as the subject seems to merit; believing also that but very few individuals amongst those whom their production may chiefly interest have hitherto undertaken manipulations with respect to them, and the subject at large possessing a general microscopical value, as well as being of some interest in medical jurisprudence, I have deemed it worth while to awaken the attention of your readers to it, with the earnest hope of inducing some to undertake enlarged experiments, and of eliciting additional facts, which may tend to still greater utility.

How much it still exists a desideratum to determine conclusively the character of certain supposed blood-stains can only be evinced by the recent contributions to scientific journals and in various other publications, mostly relating to some modifications of the usual chemical measures applicable to the question ('Chemical News,' June, 1861) as contained in an article by Guibourt, also (idem, November, 1861) another on the subject by Thomas D. Toase, of Jamaica, who quotes Fowne, Müller, and Taylor; but if we refer on the other hand to Kölliker (edit. 1860, p. 526), and also to Virchow, translated by F. Chance (1860, p. 145), we find therein a value put upon Teichmann's crystals by these authors, as also by Brücke and others, perhaps not hitherto sufficiently regarded by the leading authorities in our own country.

Now I think, in all justice, the subject is well worthy of every consideration, for satisfactory as may be the ordinary chemical means of determining the nature of supposed blood-stains or spots, as taught by Taylor and others, consisting in steeping, boiling, the application of ammonia, the production of a coagulum or precipitate, then filtering, drying, boiling in caustic potash, and the further productions of solubility and colour, occasions still may arise when in the case of stains or spots of very minute size, or occurring under various circumstances, the production of Teichmann's crystals might afford the most available and conclusive evidence in the matter.

My own hitherto limited experience would induce me to place as much reliance upon the one method as the other (English as Continental), as regards ordinary quantities, but we have the authority of Virchow to the purport that, "in cases in which the ordinary chemical tests would necessarily fail *on account of the smallness of the quantity*, we are still able to obtain hæmatine." Again, "These forms (crystalline) have proved of very great importance in forensic medicine on account of their having been employed as one of the surest tests for the examination of blood-stains." I myself, says Virchow, have been in a position to make experiments of this sort in forensic cases; and he further asserts that in the case of a murdered man, on the sleeve of whose coat "blood had spurted, and where some of the drops were only a line in diameter, he had been able from these minute specks to produce innumerable crystals of hæmatine—of course microscopical ones."

Now, it appears to me that Virchow himself is unfortunately rather loose in the expressions, "some of the drops," "from these minute specks," &c., where it is intended to imply a minimum quantity of material under manipulation, for a multiplicity of drops, of each a line in diameter, might afford a quantity amply sufficient for comparison. However, I am myself willing to suppose that a quantity of material covering a space not exceeding about $\frac{1}{10}$th or $\frac{1}{12}$th of an English inch in length as well as in breadth, may furnish ample means of producing abundance of the crystals in question, as readily as a number of drops or even an indefinite continuous line of blood-deposit.

Kölliker likewise states, "the interest of these crystals has recently been greatly enhanced, from their having been used by Brücke in the diagnosis of blood spots."

So far, therefore, as authority goes, as to the importance of Teichmann's crystals, there is nothing wanting, yet there are a few matters to be understood concerning the distinctions necessary to be observed between the crystals obtained from the colouring matter of blood, whether produced spontaneously or artificially, or whether formed in or out of the body.

Jones and Sieveking figure crystals of *hæmatine* as elongated rectangular tablets, which vary very much in size, and are coloured more or less deeply by red matter (edit. 1854, p. 91) such are of pathological import.

Hæmatoidine crystals are formed *in the body* out of hæmatine, in the form of oblique rhombic columns or plates, sometimes resembling uric acid crystals, common to apoplectic effusions, coagula or extravasations, thrombi, &c., and presenting the usual play of colours by chemical treatment similar to the colouring matter of bile; being also insoluble in water, alcohol, ether, or acetic acid. (See Virchow, p. 145; Kölliker, p. 526.)

Hæmin crystals of Teichmann, on the other hand, are not of pathological import, do not occur spontaneously, but are produced artificially and out of the body.

Another form of crystal is designated *hæmato-crystalline* of Lehmann. These differ in different classes of animals, are very destructible, and readily perish, are found in normal perfectly fresh blood outside the body only, are soluble in acetic and nitric acids, and also in caustic alkalies; they are red or colourless crystals, assuming the form of needles, columns or plates, probably belonging to the rhombic system, but also occur as tetrahedra, octohedra (guinea pig, rat, mouse), or as hexagonal plates (squirrel), &c.

It may now be desirable to enter upon the subject of manipulation—recording the several brief methods for the production of Teichmann's crystals, as set forth by authors, and furnishing also such details as I have found myself the most advantageous in the course of my own investigations.

A blood-stain is treated with distilled water, and the solution, to which is added a little common salt, is evaporated in vacuo over sulphuric acid, then wetted with glacial acetic acid and evaporated on the water-bath, a few drops of distilled water being added to the product. Teichmann's crystals may thus be examined ('Kölliker,' 1860, p. 526).

Again, the best mode of proceeding is to mix dried blood in as compact form as possible with dry crystallized powdered common salt, and then to add to this mixture glacial acetic acid, and evaporate at a boiling heat; this is a reaction which must be ranked among the most certain and reliable ones with which we are acquainted ('Virchow,' 1860, p. 146).

M. Brücke directs to "wash the spots with cold distilled water to the reddish solution obtained, add a solution of sea-salt, and evaporate to dryness in vacuo over a vessel containing sulphuric acid; examine the dry residue well by the microscope, to verify whether it contains airy matter which might be mistaken for Teichmann's crystals; then add a little glacial acetic acid, evaporate to dryness, moisten the residue with water, when crystals of hæmatine will be formed if blood exists in the spots."

One might reasonably suppose, after the above several quotations, that nothing could remain to be added, and yet in experiment sources of failure may still exist. The 'Micrographical Dictionary' fortunately supplies the deficiency, although I had myself accidentally stumbled upon its recommendations prior to my consulting it. Under the head of Hæmatoidine, which appears therein to embody the several kinds of blood-crystals, the author states, "If recently dried blood be treated with a vegetable acid (acetic, oxalic), and a drop of the solution be placed upon a slide COVERED WITH THIN GLASS, and kept at a temperature of 80° to 100°, Fahr., the crystals may also be obtained, the addition of water and a little alcohol or ether to the blood sometimes favours the separation of the crystals—*their preservation is difficult.*"

My own experiments have been conducted thus:—A drop or two of fluid blood, or if dry, with an addition of distilled water, may be placed upon a slide, and a small quantity of dried common salt be mixed with it, and spread through a disc of about the size of a shilling; lightly cover over to protect from dust, and set aside for a day or two for spontaneous evaporation, then scrape off the hardened material with a knife edge, break up and spread loosely, moisten with glacial acetic acid, and *apply a thin glass cover* (square), filling up with the acid by means of a glass rod; place now upon the water-bath (a temporary apparatus, such as two tea-cake tins placed upon a tripod and heated with the spirit, may suffice), and when dry apply in like manner a few drops of distilled water with the glass rod, the cover not being disturbed; continue the heat to dryness, examine under the microscope both slide and cover, reversing that which is most approved; then moisten with spirits of turpentine or chloroform, and mount in Canada balsam, in which will be found an admirable medium of preservation notwithstanding the difficulties asserted elsewhere. The $\frac{4}{10}$ths objective will constitute a power best adapted for observation, the crystals, although deviating much in size, yet for the most part are very characteristic.

I have myself experimented several times very successfully upon a much less quantity than the usually estimated bulk of a drop of human blood.

On Homœcladia *in* Fresh Water. By F. L. Eulenstein, of Stuttgart.

The majority of frond-bearing diatoms, constituting the Tribe II of Professor Smith, the *status involucratus* of Kützing, are marine; still nearly every generic type of the tribe is found represented by a fresh-water form, and the cymbelloid type of frustule is even exclusively such. The fresh-water genus, Frustulia, Ehr., characterised by naviculoid frustules in a gelatinous stratum, may be said to prepare the way for the higher marine forms with definite fronds. *Berkeleyia, Drokreia,* and several species of that genus, are common on the continent. The higher Schizonemata are all strictly marine; but Colletonema affords a good fresh-water illustration on a lower scale, the latter genus being, however, much less known on the continent. Only this spring I have discovered *C. vulgare,* Thu., to be pretty frequent in the environs of Stuttgart, and it may have been often overlooked from its uncommon habitat, which, as far as my experience goes, is confined to deep mud, where it creeps below the films of *Pleurosigma attenuatum, Pinnularia viridula,* etc. Another species, *C. viridulum,* Bréb., has been found in Silesia by M. Bleisch, who has accurately followed up its development. At first the frustules aggregate into small dark-brown compact heaps on a soft gelatinous stratum. From the latter, at the points where the frustules aggregate, tubes are evolved which penetrate into the mud like the roots of a plant, and thus a Colletomena results which before any judge would have pronounced a Frustulia. From a series of specimens in his possession, M. Bleisch believes these genera to pass into each other without a definite line of demarcation.

Passing over the genus Mastigloia, being distributed over both mediums, there only remains Homœcladia (with Raphdoglœa, Kg.) possessing the nitzschoid type, which has not hitherto been observed in fresh water. From the great abundance of free Nitzschiæ in almost every aquatic gathering, the absence of a fresh-water Homœcladia appeared the more striking, and it was with much gratification that a short time ago I succeeded in finding out the coveted plant.

On examining cushions of *Gomphonema curvatum* from a waterfall in the neighbourhood of Stuttgart, I was struck by the appearnce of what seemed a Colletonema entangled between the stripes of the Gomphonema. Having placed a filament on a thin cover in a drop of distilled water, I submitted it to heat, and now readily observed undoubted Nitzschiæ lying within the scorched tube. At a point where the latter was ruptured some frustules had escaped and allowed the closest examination, from which I am inclined to consider the new fresh-water form a near ally to *H. fiifililiformis*, W. Sm. β minor, and to pronounce it even a mere variety of the latter species. The frustules are somewhat smaller and the front view broader; their arrangement is rather crowded than fasciculate, the filaments observed were undivided—characters either not sufficiently important, or not sufficiently established for the present, to warrant a separation on these grounds. A figure was thought to be unnecessary, the more as I shall take pleasure in presenting the original specimen described to the collection of the London Microscopical Society, and I shall be glad to communicate a few left to those especially interested.*

I may, with propriety, conclude this account with an allusion to the fact that the above instance of the apparent occurrence of a marine species in fresh water is not an isolated one in the class Algæ. I only mention at present another diatom, *Nitzschia dubia*, W. Sm., which being indigenous to brackish water, seemingly occurs in several localities on the continent in springs and ditches. As I am preparing, for insertion in the present publication, a full report on such cases, I shall be thankful to receive any opinions bearing on the subject, from British diatomists, who, from their ready access to the seashore, are well enabled to form a correct judgment on the following practical question which has often occurred to me in connection with the facts mentioned, and which seems worth while discussing at a future opportunity:—"Are forms apparently identical, but living in opposite mediums, to be regarded as one species, or does the medium constitute the limit in such cases?"

* The author will moreover be happy to exchange rare Continental species and deposits for British, marine, and brackwater gatherings, or foreign deposits.

DESCRIPTION *of* TWO NEW SPECIES *of* COSMARIUM (Corda) *of* PENIUM (Bréb.) *and of* ARTHRODESMUS (Ehr.). By WILLIAM ARCHER.

(Read before the Natural History Society of Dublin.)

Family DESMIDIACEÆ.

Genus COSMARIUM, Corda.

COSMARIUM PYGMŒUM, mihi, sp. nov.

Specific characters.—Frond very minute, smooth, segments sub-quadrilateral; end view sub-elliptic, somewhat inflated at each side at the centre.

Locality.—Featherbed Bog and elsewhere in pools in Dublin mountains; not very rare; on submerged plants, and in Sphagnum pools, coating the moss.

General description.—Frond very minute, smooth, rather broader than long; constriction a minute linear acute notch; segments in front view rather more than twice as broad as long, subquadrilateral, outline sometimes slightly irregular, ends straight or slightly curved; side view scarcely twice as long as broad, constriction a triangular emargination on each side, segments orbicular; end view sub-elliptic, with a gentle gradual central protuberance at each side, extremities subconical, rather abruptly rounded. Zygospore orbicular, smooth (*without spines*), placed between the shortly deciduous empty parent fronds.

Measurements.—Length of frond, $\frac{1}{2750}$ to $\frac{1}{2350}$; breadth, $\frac{1}{2350}$ to $\frac{1}{2000}$; depth (thickness), $\frac{1}{4700}$ to $\frac{1}{4300}$ of an inch.

Pl. VI, Figs. 45, 46, front view; 47, side view; 48, end view of frond; 49, zygospore.

Affinities and differences.—There is no danger of mistaking this for any other species, except, perhaps, *C. tinctum;* but from it, this form is at once distinguished by its subquadrilateral, not broadly and regularly elliptic, segments, and by its colourless, not faintly reddish, cell-wall. I have met this form for two or three years, and I consider it is perfectly distinct, nor is there any other species with which it need be contrasted. There is a slight variation as to size within the limits above mentioned. I might remark that the general contour of the segments seems to me to resemble in some degree those of *Cosmarium biretum* (Bréb.), and which to those acquainted with that species may serve to help out my description; but it would be simply absurd to institute any further comparison between them.

The orbicular smooth zygospore *without spines* seems further to indicate an affinity with *C. tinctum*. This latter I have moreover found to possess orbicular, *not* quadrate zygospores—thus, perhaps, pointing to an affinity between these species more strongly. But the parent forms are readily distinguished by the characteristics alluded to above; and I cannot fancy the possibility of their being confounded. Thus this distinct little species forms an additional exception to the generally pervading rule, that in this family the deeply constricted short forms possess spinous zygospores. But I shall take a future opportunity to draw attention to a few cases of exceptional form as regards the presence or absence of spines in the zygospores of the Desmidiaceæ.

Genus ARTHRODESMUS, Ehr.

ARTHRODESMUS TENUISSIMUS, mihi, sp. nov.

Specific characters.—Frond extremely minute; segments subhexagonal, opposite lateral extremities acutely cuspidate, each upper angle furnished on each front with a minute acute mucro, which four in the fusiform end view stand out divergently.

Locality.—Featherbed Bog, in Sphagnum pools, coating the moss.

General description.—Frond very minute, smooth, somewhat broader than long; constriction, a rounded or bluntly triangular sinus; segments in front view about twice as broad as long, sub-hexagonal, the sides somewhat concave, the opposite lateral extremities projecting horizontally, acutely cuspidate, ends truncate or slightly concave, the two upper angles at each front view furnished with a minute spine or mucro, but which, in this view, being turned rather towards the observer than divergent, each appears as a minute somewhat opaque thickening at the angles; frond in side view about twice as long as broad, oblong; constriction, a shallow emargination, ends broadly rounded, each furnished at each opposite side with a single short acute divergent mucro; end view broadly fusiform, about twice as long as broad, the body bearing on each side, near the acutely cuspidate extremities, two short acute divergent mucrones. Zygospore unknown.

Measurements.—Length of frond, $\frac{1}{2800}$; breadth, $\frac{1}{2300}$; at constriction, $\frac{1}{5000}$; depth (thickness), $\frac{1}{4000}$ of an inch.

Plate VI, fig. 50, front view; 51, side view; 52, end view of frond; 53, 54, dividing fronds; 55, abnormal frond.

Affinities and differences.—As to the *specific* distinctness of this minute form, there seems to me not the smallest doubt or difficulty. There might, however, in the opinion of some, be a question as to its *generic* position; for it seems possible that the same conflicting views which have been held by different observers as regards *Arthrodesmus octocornis* might also be held with respect to this new form. *Arthrodesmus octocornis,* Ehr., Hass., Bréb., &c., was at one time placed in the genus of Xanthidium and Ehrenberg—Meneghini and Kützing considered it a Micrasterias—Ralfs looks upon it as doubtfully a Xanthidium—but whatever be the proper position of that species, there can be little doubt, I think, but that the present form belongs to the same genus, and I should undoubtedly be disposed to consider that to be Arthrodesmus. Indeed, the only question, as it appears to me, is whether it be Xanthidium or Arthrodesmus. Taking *Arthrodesmus incus* or *A. convergens* as typical of the genus, there does, indeed, appear some dissimilarity between them and such as *A. bifidus,* Bréb., *A. octocornis,* and the present form, but I imagine the former are more closely related to certain Staurastra than are the latter to Xanthidium. For *A. convergens* and *A. octocornis* may, I imagine, be almost looked on as Staurastra, two-sided, not three—or more—sided, in end view—the first having most affinity to such forms as *Staurastrum Dickiei,* or *S. dejectum,* or *S. brevispina,* the latter having greatest relationship to *S. glabrum* or *S. O'Mearii.* Three or more in number of sides (or angles) in end view, in Staurastrum, is quite well known not to be of any generic or even specific value, therefore two only may be of as little import. But in giving expression to such a view, whatever might be the difference of opinion as to the generic position in the case of the species just mentioned, there cannot, I should think, be the smallest doubt as to their specific distinctness; but that is not the question at present. *Arthrodesmus octocornis,* on the other hand, seems to possess (especially through a plant I myself described as *Xanthidium Smithii*) considerable affinity to Xanthidium, in which genus it was hesitatingly placed by Ralfs. But it differs therefrom in having its marginal spines disposed in a single, not a double, series, nor scattered; and secondly, and, as I think, in a more important circumstance, in its wanting the prominences occupying the centre of both front surfaces of each segment characteristic of Xanthidium. Again, *Arthrodesmus bifidus,* Bréb., cannot at all be said to be spinous, but its sub-reniform quadrangular segments are at each opposite lateral extremity simply bicuspidate, and it could not, therefore, be placed in the genus Xanthidium, of which an essential and marked character is to be distinctly spinous, besides the central protuberances. Nor could, as I conceive, these two species (*A. octocornis* and *A. bifidus*) be placed otherwise than in the same genus, and I should be disposed to take them as typical of Arthrodesmus rather than those forms whose segments have a single spine only on each side. Now, notwithstanding that (unlike *A. octocornis*) my new form has its mucrones not arranged in a single series, but, as above described, possesses four at the ends of the segments, as seen in end view convergent and equidistantly disposed, there is yet too much generic similarity in front view, combined with the absence of the central protuberances, to regard *A. octocornis*, my new form, and *A. bifidus*, as belonging otherwise than to the same genus, and that genus not Xanthidium, but Arthrodesmus—unless, indeed, Mr. Jenner's original suggestion should be carried out, and they be made into a new genus, connecting such forms as *A. incus* and *A. convergens*, &c., with Staurastrum; but I am disposed to imagine, as above indicated, that the forms in question belong properly to Arthrodesmus, Ehr., whilst their allies, such as *A. incus*, &c., are more likely in reality *two-sided* Staurastra.

This species, like others of this family, is subject to an abnormal mode of growth, by which the intervening new portions, instead of becoming shut off, remain confluent, forming, with the old segments, but one uninterrupted cavity (Fig. 55). This irregularity I have myself noticed in many species, and it has been figured and described by several observers; it is simply a monstrosity.*

Supposing the question of the genus determined, but quite irrespective of it, this new form is quite distinct as a species, and cannot be mistaken for any other. Its size alone would almost distinguish it from any other Desmid; for, notwithstanding that the measurements of *Cosmarium tinctum*, and of the Cosmarium I have just described above (*C. pygmæum*), are not much greater, the present species probably enjoys the distinction, so far as I am aware, of being the *very smallest*

* See Mrs. H. Thomas, 'Quart. Journ. Mic. Sci.,' Vol. III, Pl. V, figs. 17, 18; Hofmeister, 'Bericht der K. Sächs. Ges der Wissench. zu Leipzig,' 1857, Heft I; De Brébisson, 'Listes des Desmidiées observées en Basse-Normandie," tab. i, fig. 15; De Bary, 'Untersuchungen über die Fam. d. Conjugaten," p. 47, t. vi, fig. 53; W. Archer, 'Proc. Nat. Hist. Soc. Dublin,' vol. ii, p. 207, figs. 10—15; also 'Nat. Hist. Review,' O. S., vol. vi, p. 469, pl. xxxiii, figs. 10--15; and again, 'Proc. Nat. Hist. Soc. Dublin,' vol. iii, p. 37, pl. i, fig. 7; and 'Nat. Hist. Review,' O. S., vol. vii, p. 391, pl. xiii, fig. 7.

of the free species of the family, for the concavities of the form under consideration render its actual bulk or volume very appreciably less. It is, therefore, considerably smaller than any other Arthrodesmus. From *Arthrodesmus bifidus*, Bréb., its straight, not curved and bicuspidate, segments and its four terminal mucrones in end view, abundantly distinguish it. From *Arthrodesmus octocornis* it is distinguished by its much less elongate and less acute lateral extremities, which in the latter are, as well as the upper angles, prolonged into single or double spines, all divergent in front view—while in the new form the four external spines are well seen only in the edge views, and are not in a single series. From *A. octocornis, var.* β, as well as from *Xanthidium Smithii*, (mihi) this species is distinguished by its not having a double spine at each angle, and from the latter also, by the want of the central protuberances. But, besides these more tangible and prominent diagnostic distinctions, I need hardly remind those who are thoroughly acquainted with this elegant family of Algæ, that each of them—these new ones included—presents to the familiarised a special *tout ensemble* of its own, difficult, perhaps, to define in words, but, in my mind, not the less actual, constant, distinctive, and characteristic.

Note.—I have in the foregoing made use of, and shall for the future employ, the more apt term "Zygospore," as suggested by Professor De Bary in his work "Untersuchungen über die Familie der Conjugaten," in preference to the seemingly inappropriate and inaccurate term "Sporangium" of most other authors.

Genus—Cosmarium, Corda.

Cosmarium exiguum, sp. nov.

Specific characters.—Frond very minute, smooth, oblong, rather more than twice as long as broad; segments subquadrate; starch granule single, central.

Locality.—Dublin mountains; not very rare.

General Description.—Frond very minute, smooth; in front view, rather more than twice as long as broad, constriction deep, linear, acute; segments in front view very slightly longer than broad, sub-quadrate, sides sometimes very slightly tapering, angles somewhat rounded, ends rotundato-truncate, with a very gentle, often nearly imperceptible, minute central depression; starch granule single, central; in side view the constriction acute within, widening outwards, segments some what longer than broad, broadly elliptic, ends rounded; end view broadly elliptic; empty frond colourless, not punctate. Zygospore unknown.

Measurements. — Length, $\frac{1}{930}$; breadth, $\frac{1}{2000}$; depth, $\frac{1}{2330}$ of an inch.

Fig. 32, front view; fig. 33, side view.

Affinities and differences.—The oblong non-crenate figure and smooth surface of this little form will readily distinguish it from every other at all agreeing with it in dimensions, such as *Cosmarium Meneghinii;* its size is, besides, in every way maller than that of that species. It is, indeed, amongst the largest species that a similarity of figure is to be found; and indeed, as far as concerns outward form alone, it is difficult to define in a diagnosis the characters which separate this little species from *C. cucumis*, Corda. In both the frond is oblong and smooth, deeply constricted; the segments subquadrate. But the linear dimensions of this new form are some three or four times less than those of the latter; moreover, the former is sometimes more than twice as long as broad—the latter is less than twice as long as broad; and, leaving the dimensions out of view, this character, apparently slight, would help to an identification. But as concerns dimensions, it would be as little necessary to compare *Docidium minutum* with *D. nodulusum* or *D. truncatum*, or *Euastrum elegans* with *E. oblongum* or *E. crassum*, or *Closterium Cornu* with *C. acerosum*, &c. This new form differs, too, almost as greatly in size from *Cosmarium quadratum*, Ralfs, and moreover wants the protuberance at each side near the base of each segment present in that species. Thus, though the agreement in figure of this new form with the species referred to it is considerable, I cannot fancy their being mistaken. But, moreover, the endochrome in this new form has embedded in it in each segment but one central large starch-granule. From *C. cucurbita*, Bréb., this form is quite distinguished by its deep linear constriction and non-punctate cell-wall, besides dimensions and other special points at once recognisable by those acquainted with these species; and, besides those mentioned, there are none others with which it is in the least necessary to be contrasted.

Genus—Penium, Bréb.

Penium Mooreanum, sp. nov.

Specific characters.—Frond very minute, about one third longer than broad, sides somewhat barrel-shaped, ends truncato-rotund; no clear space with moving granules at the extremities; zygospore quadrangular, oblong, compressed, angles mamillate, extremities nipple-like.

Locality.—Featherbed Bog, and near Lough Bray, conjugated.

General Description. — Frond very minute, about one third longer than broad, sub-elliptic, sides somewhat barrel-shaped, ends truncato-rotund; endochrome dense, a single large (amylaceous) granule in each half, and showing two or three indistinct longitudinal "fillets," and an instinct, pale central band; no moving granules at the extremities; end view, orbicular or very broadly elliptic; empty cell-wall colourless, without markings. Zygospore in front-view quadrangular, oblong, about 10 : 6 longer than broad, compressed, margins somewhat concave at the centre, angles produced, mamillate, nipple-like at the extremities; contents sparing, scattered; in side view elongate, often with a slight concavity at each side, ends rounded, extremities nipple-like; in end view, ovate, accuminate, extremities nipple-like. The empty parent-cell-membranes persistent at each end of the zygospore. If, as is mostly the case, the parent-cells conjugate in a parallel position, the zygospore possesses a regular cushion-like figure, all its angles lying in the same plane (Fig. 39). But if, during the conjugation, the parent-cells lie at right angles to each other, there is then a corresponding twist in the form of the zygospore, and in this case the angles at one of its ends lie in a plane at right angles to those of the other. Apparently from a similar cause, any intermediate degree of relationship in this regard may thus take place. Misshapen or irregularly contorted zygospores occasionally, but exceptionally occur, in which one of the corners may be inordinately drawn out, or the usual relative proportions of length, breadth, and depth become partially or locally interfered with. The mamillate form of the angles, and their nipple-like extremities, are maintained, however, in all cases (figs. 39—44). The conjugating, as well as dividing, cells are surrounded by a distinctly bounded gelatinous investment, which afterwards disappears.

Measurements.—Length, $\frac{1}{1333}$; breadth, $\frac{1}{2000}$; depth, $\frac{1}{1750}$ of an inch.

Length of zygospore, $\frac{1}{700}$ to $\frac{1}{600}$; breadth, $\frac{1}{1000}$.

Pl. VI, Fig. 34, frond with endochrome; 35, dividing frond; 36—38, commencing conjugation; 39, front view of zygospore; 40, side view of same; 41, end view of same; 42—44, variously twisted zygospores.

Affinities and differences.—I do not doubt but there might be some who, on looking at the mature unconjugated condition only of this little plant, on account of its simple form and minute size, would be disposed to regard it merely as an indescribable nonentity—perhaps a dwindled or starved example of some other form—or, at best, as only a transitional or gradational variety. It is true that, like many of its immediate allies, it is only a minute, elliptic, or, as I have tried to describe it, barrel-shaped cell; nevertheless, the first moment I noticed it, even in its unconjugated state, I thought not so, but felt that it was indeed a new form, which I had never seen before.

It is distinctly a species of Penium, Bréb., the structure of its cell-contents removing it from Cylindrocystis, Menegh., or Mesotænium, Näg.,—the entire want of a central constriction separating it from certain species of Cosmarium, Corda,—the same, as well as the want of a terminal notch, placing it apart from Tetmemorus, Ralfs. I do not believe that it can be mistaken for any other species in the genus Penium, its minute size alone readily distinguishing it. Irrespective of its minuteness, there is no other species of Penium in which the length of the cell is so short in proportion to its width, all other species, with the exception of *P.* (*Dysphinctium*) *annulatum*, Näg., being several times longer than broad, while the species just referred to is about twice as long as broad. And this relationship of comparative length and breadth I believe to be in this family a by no means unimportant character, though undoubtedly of so little value in others. Nor would I wish to be understood that here even this character is decisive; but when it is found that a pretty constant steadiness of relative length and breadth of most species is associated with other characters, it becomes, I think, a useful and readily applied diagnostic distinction, ancillary but subservient to other more special ones. From *Penium annulatum*, Näg., then, besides its less comparative length, this species is distinguished by its non-cylindrical outline and smooth cell-membrane. From *P. Navicula*, Bréb., this species is distinguished by its less comparative length, and by its broadly elliptic or barrel-shaped, not navicular, cells, and by the want of a terminal clear space with moving granules. There is no other Penium for which it could possibly be mistaken.

From *Cosmarium curtum*, Bréb., it is distinguished by its shorter comparative length, and the entire want of a constriction, by its broadly elliptic, not attenuated, ovate outline, and by the "fillets" of the endochrome being far less decidedly marked. From *Cosmarium cucurbita*, Bréb., it is separated by its much smaller size, by the entire absence of a constriction, by its elliptic form, and by its smooth, not punctate, cell-membrane.

From all these, and every other member of the family, it is, moreover, further distinguished by the remarkable form of its zygospore. It is possible that this may in some measure agree in nature with that of *Tetmemorus lævis*, Ralfs; but even if found isolated, it could not be mistaken for that of that species, differing, as it does, in form and size therefrom. But, as before stated, this plant is no Tetmemorus, wanting, as it does, a terminal notch and central constriction. I say it is possible that the quadrate, or cruciately-lobed zygospore of this species, may agree in nature with that of *T. lævis;* but although there is in all my specimens of the new Penium a tendency in the cell-contents of the zygospore to become collected towards the middle, I have not once noticed the formation of an inner coat, as happens in *T. lævis.* Yet it may have been that my specimens were not sufficiently matured. We are here, too, reminded of the zygospore in *Closterium Cornu* and others, Stauroceras, Kütz.; but even if found isolated, the zygospores never could by possibility be mistaken the one for the other. There is the common circumstance, however, that the parent cell-membranes remain persistently attached to the zygospore. Thus this little Penium possibly points out new cross affinities, to Tetmemorus on the one hand (although, as is well known, in that genus two forms of zygospore occur, as indeed this new form proves for the genus Penium), and to certain species of Closterium on the other.

It affords me great pleasure indeed to avail myself of the opportunity to name so distinct a species after David Moore, Ph.D., F.L.S., M.R.I.A., &c., of the Glasnevin Botanic Garden, not only as a token, inadequate though it be, of respect for that gentleman's high scientific attainments and of my personal esteem for himself, but also as commemorative of a very agreeable little excursion, when we had each the pleasure to be of the party, on which occasion I first gathered *Penium Mooreanum.*

On "CONTRACTILITY" *as distinguished from* PURELY VITAL MOVEMENTS. By LIONEL S. BEALE, M.B., F.R.S.

THERE are probably few actions more different than the contraction of a muscle or the vibration of cilia, and the movements which occur in a living Amœba, in a living mucus-corpuscle, or young epithelial cell; but it is generally considered that all these movements depend on a property which has long been known as *contractility*. And yet one would hardly conceive it possible that even a casual observer, who had attentively watched ciliary or muscular action, and the movements of an Amœba, for example, would fail to discern a remarkable difference in the movements he observed, although he might be quite unable to define in what essential points the movements differed. Not only are there essential differences between these (at least) two classes of movements, both of which occur in all the higher organisms, but I think it can be shown that the matter which is the seat of the observed motion is not of the same nature in each case. I have endeavoured to prove that the so-called moving matter (sarcode) of an Amœba or of a mucus-corpuscle, white blood or pus-corpuscle, corresponds to, or is homologous with, the so-called "nucleus," and not with *contractile material of muscle*. The *moving matter* of the former and the so-called "nucleus" of the latter correspond, and I have termed this *living or germinal matter*, while the latter I consider to be formed matter, and therefore no longer the seat of vital changes.

In a paper published in the last number of my "Archives," I have adduced facts in favour of the view that masses of germinal matter not only alter their form, but move from place to place. The movements which affect the germinal matter of muscle are of a nature essentially different from the contraction of the muscular tissue; but the movements observed in all kinds of germinal matter are, I believe, the same in their essential nature. Thus the movements in the Tradescantia, and many vegetable cells, the movements of the pseudopodia of the Foraminifera, those of the Amœba, &c., are undoubtedly of the same nature as those which occur in the mucus- and pus-corpuscles, young epithelial cells, germinal matter of the 'corpuscles' of the cornea, and every other kind of germinal matter.

For the sake of discussion it is only necessary to take one example of the two classes of movements which have been included under the head of Contractility, and I will, therefore, contrast the movements of the mucus-corpuscle and the contraction of muscle.

With regard to the muscle:—When contraction occurs it diminishes in length, and increases in width and thickness. The matter of which it is composed, for the most part, moves alternately in two directions, at right angles to one another. Each particle of contractile material retains the same relation with respect to neighbouring particles during the relaxed and contracted state. It is impossible that a particle could move from its position at one or other end of the muscle, for instance, and take up a position amongst the particles in its central part. Shortening and elongating, thinning and thickening, widening and narrowing, relaxing and contracting, convey an idea of what occurs in the contractile tissue of muscle, and each action is a repetition of the last. Although the actions may differ in degree, still the changes which occur in the relative position of the particles are the same for every action.

Now with reference to the mucus-corpuscle, no language could convey an idea of the changes which take place in form; every part of the surface of a corpuscle may be seen to change within a few seconds. The material which was in one part may move to another part. Not only does the position of the component particles alter with respect to one another, but it never remains the same. There is no alternation of movement. Were it possible to take hundreds of photographs, at the briefest intervals, with the utmost rapidity, no two would be exactly alike, nor would they exhibit different gradations of the same change, nor is it possible to represent the movements with any degree of accuracy by drawings, because the outline is changing in many parts at the same moment. The varying stages of contraction and relaxation of a muscular fibre may be represented with great accuracy, because the changes occur with regularity, and they are repeated, but it is impossible to premise the successive alterations in form of a mass of living matter, for it never assumes the same form twice.

And now to account for these movements,—the component particles evidently alter their positions in a most remarkable manner. One particle may move in advance of another, or round another. A portion may move *into* or *out* of another portion. A bulging may occur at one point of the circumference, or at ten or twenty different points at the same moment. The moving power evidently resides in every particle, of a very transparent, invariably colourless, and structureless material. By the very highest powers, only an indication of minute spherical particles can be discerned. Because "*molecules*" have been seen in some of the masses of moving matter, the motion has been attributed to these. It is true the particles do move, but the living transparent material in which the molecules are placed *moves first*, and these flow into the extended portion. The movements cannot, therefore, be ordinary *molecular movements*. It has been said that the movements may result from diffusion, but what diffusion or other movement with which we are acquainted at all resembles these? Observers have ascribed them to a different density in different parts, but who has ever been able to produce such movements by preparing fluids of different density; but further, these fluids of different density must make themselves and retain themselves of different density. We may certainly imitate, to some extent, the process of contraction of muscular tissue; but apart from living things nothing has ever been obtained which exhibits phenomena resembling those which are so familiar to us in the movements of a common Amœba.

Next as to the matter which is the seat of these two classes of movements. I have endeavoured to prove that every elementary part consists of matter which is living, and matter which is formed, of *germinal matter* and *formed material.* Now the contractile tissue of muscle is formed material. It is homologous with the so-called *intercellular substance* of *tendon, cartilage,* the *cornea,* and other *connective tissues,* with the *outer part* of the *epithelial cell,* with the "*cell-wall*" of the *vegetable cell,* &c. The "nucleus" of the muscle bears the same relation to the *contractile tissue* as the "*nucleus*" of the *white fibrous tissues* bears to *that substance,—that of an epithelial cell* to its *outer part, the primordial utricle* to the *cell-wall of the vegetable cell,* and the so-called mucus-corpuscle to the mucus in which it lies, the "pus-corpuscle" to the "liquor puris," &c. It is germinal matter.

Now, every kind of formed material was once in the state of germinal matter. Formed material in no case produces formed material, nor is formed material simply deposited from the nutrient fluids as crystalline matter is deposited from its solution; but formed material results from changes occurring in germinal matter. Muscular tissue which *contracts* is continuous with the nuclei or masses of germinal matter of muscle, and was produced from germinal matter. This germinal matter produces contractile tissue just as the germinal matter of tendon produces tendon, that of cartilage, cartilage, and so on. Hence the mucus-corpuscle, white blood-corpuscle, Amœba, &c., correspond to the so-called "nucleus" of a muscle only, *not to its formed material;* and any changes occurring in the latter must needs be essentially different from those taking place in the former. It is clear that muscle, which is formed material, must be formed before it can contract; but movements occur in germinal matter from the very moment of its first production. The movements of the matter in the first or germinal state are distinct from the movements which are incidental to its second or formed state. But let it not be supposed that these are the only differences that can be demonstrated between germinal matter and formed material.

The mass of germinal matter may move from place to place. A portion of muscular tissue moves within a given space, but does not move itself away from the position it occupied. The muscle cannot extend a portion of itself from any part of its surface to some distance from the general mass and draw it back again, nor can it detach a portion from itself from every part of which protrusions may occur after it has been detached. Again, if a part of the mucus-corpuscles dies, that which still lives moves away from the altered portion. Now, a part of muscle which still possesses contractile power, does not move away from that which has ceased to contract. But the movements of the mucus-corpuscle and of other forms of germinal matter form but a small part of the characteristics which distinguish it from every kind of formed material. It absorbs matter, effects its decomposition, and converts certain of its elements into matter having the same properties as it possesses itself.

Many observers in the present day seem to think that all motion is essentially the same, and argue that because there are reasons for thinking that muscular motion, and even certain forms of nervous action, like heat, electricity, &c., are merely different modes of primary motion, therefore we must admit that every kind of movement occurring in living organisms is of the same order. But the vital actions of living matter are very different from the phenomena occurring in any kind of formed material. The formed material may be arranged so as to form a mechanism which, however elaborate, may be governed by the same laws as other mechanisms; but what of the matter which produced the formed mechanism? It is this that the physicist should study before he discards *vital* as distinguished from every other force or power, and assumes that life is but another form of ordinary force, heat, or motion. So far, the *movement of living matter, the modifying power exerted by living upon lifeless matter, the converting and forming power of living matter*, have utterly baffled all attempts at explanation, and the more minutely the phenomena, which are open to the observation of all are studied, the more marvellous and inscrutable do they appear.

Dr. Carpenter has drawn attention to the manifest absurdity of supposing that all the *force* manifested in the fully formed organism existed in the germ in a concentrated form, and adopts the opinion that fresh *organizing force* is constantly being supplied from without. This organizing force is in fact heat.* Another writer goes the length of asserting that different quantities of force are absorbed in the formation of different cells. One equivalent of a high form of force corresponds to many equivalents of an inferior kind of force. Thus a single nerve-cell, in its formation, consumes an equivalent of force which would suffice for the production of a large quantity of cabbage! It only remains for this philosopher to demonstrate the vast amount of force set free at the moment of the death of the nerve-cell as compared with that which emanates from the cells of the dying cabbage, and his demonstration will be complete;—thus the identity of vital force with heat and primary motion will be established, and the exact amount of force liberated by the blood-cell, the epithelial-cell, and the nerve-cell, as they return to undergo the retrograde metamorphosis, will be quantitatively estimated.

In these views it will be observed that the action of tissue is not sufficiently distinguished from its production. Its formation and construction are not distinguished from the effects of its destruction. Doubtless, in the disintegration and chemical decomposition of the matter of a nerve-cell, force is set free, as in other forms of chemical decomposition; but this is not *vital action* at all. It is simply the decomposition of matter which is already formed, and has perhaps long ceased to *live*. What we want to know is, the condition of the force which is in relation with the matter of which the living or germinal matter consists. The action of a muscle, and the formation of a muscle, are two very different processes. The consideration of the one may belong to physics, but the other has nothing whatever to do with physics. The life of the muscle is not identical with the action of the muscle. The living part of muscle can move, but it does not *contract* like the muscle. It can produce more muscle, but the contracted tissue possesses no such power.

The view which I have been led to take upon this question is very easily expressed in a few words. I think that every tissue or organism consists of matter *that lives* and matter that is *formed*. The first is the seat of peculiar change *sui generis*, which never occurs in things inanimate. The second manifests phenomena which are, properly considered, physical and chemical. The movements, the decomposing and the formative, the analytical and synthetical power, of the living matter, are due to the operation of a power or force or energy which is not to be measured by the work achieved, nor

* On the application of the principle of "Conservation of Force to Physiology," by Dr. Carpenter.—'Quarterly Journal of Science,' vol. i, p. 82.

to be altered or converted into other forms of force. It is a power that may be transmitted from particle to particle, or that may cease its manifestation for ever. How it originated we have not the slightest knowledge. We only know that now it is always propagated from particle to particle, and that it cannot be transferred to particles at a distance. Heat is but one of the conditions under which this wonderful power manifests itself, not the power itself.

Contractility is a property of muscle. Contraction and elasticity are properties of fibrin, just as hardness is a property of horn, or nail, or bone, &c.; but *motion, increase, formation,* as manifested in germinal matter, are transmitted from particles that possess them, to particles of matter that do not. Muscle does not transmit its contractile property nor yellow elastic tissue, its elasticity, to matter which is devoid of these characteristics. Hence, I distinguish the movements of germinal or *living* matter from the movements of muscular tissue; and, surely, I may correctly term them *vital* movements until some one proves that similar movements occur in matter which is not alive.

CONCLUSIONS.

1. The *movements* of a mass of germinal or living matter, and *muscular contraction,* are phenomena essentially different.

2. The contractile material of the muscle does not correspond to the *moving matter* of a mucus-corpuscle, white blood-corpuscle, amœba, &c.; but the so-called *nucleus* of the muscle alone corresponds to this moving matter.

3. The movements in living or germinal matter are *vital movements,* for no movements like them occur in any form of matter which is not *alive,* and which has not been obtained from a *living organism.*

4. Muscular and nervous action are accompanied by chemical change, and correspond to a certain definite amount of *work,* which may be represented as heat, motion, &c., but there is no evidence to show that the *vital movements* described, perform work, are accompanied by chemical change, or can be converted into any form or mode of ordinary force.

It will be noticed, that in this paper, I have discussed simply the vital actions of *germinal* or *living matter.* I have not spoken of the "life" of man, of an animal, or of an entire plant. The phenomena of which such "life" is made up, make it very different from the "life" of germinal matter.

TRANSLATION.

On MOTILE PHENOMENA *in* SPONGES. By N. LIEBERKÜHN. (Abstracted from 'Reichert and Du Bois-Reymond's Archiv.), 1863, p. 717).

THE motile phenomena hitherto observed in sponges are connected with larger or smaller portions of the external integument and of the exhalent tubules, or with isolated cells. When the exhalent tubules of *Spongilla* contract, their walls become shortened and thickened, and the previously smooth surface uneven, from the presence of the spherical contracted cells, whose outlines at the same time are rendered very distinct, whilst they were before invisible, or, at most, here and there indistinctly perceptible. This contraction may proceed so far as to give the entire tubule the appearance of a mass of cells. The external membrane with which the sponge is covered exhibits its contractile property most clearly when separated to some distance from the substance of the body; on contracting, it either approaches nearer, or applies itself closely to, the subjacent parts, whilst the inhalent orifices open and close. Other motile phenomena are witnessed when a Spongilla with external membrane and exhalent canals is produced from a cut-off portion. The fragment thus cut off may be so thin as to consist of only a single layer of reticular parenchymatous fibres. The interstitial rounded, oval, or irregular spaces, under these circumstances, become for the most part closed, owing to the gradual increase in breadth of the trabeculæ; or cavities may be left when their membranes are stretched over them only from the upper and under sides of the trabeculæ, which enclose a space between them, and may become portions of the outer membrane, with exhalent canals. It cannot be determined with certainty to what extent this change of form is connected with any multiplication of cells. Lastly, movements in the individual cells have been noticed, the globular cells having been described as assuming a stellate figure, the stellate ones in turn becoming globular, but also this without any locomotion. This phenomenon occurs, not only in the cells of the uninjured substance, but also in those which have been detached. But locomotion has not as yet been described, and it is to this point that the following observations relate.

In all specimens of *Spongillæ*, whether developed from *ova* or from gemmules, or from separated portions, the most varied arrangement of the parenchymatous tissues may be seen, whilst the siliceous skeleton in the different species retains the same characteristic form. When the external membrane is quite transparent, we may observe, in many instances, a cavernous structure, consisting of more or less completely closed cavities, of irregular form, and of which the superficial ones are bounded by the external membrane, and admit the water which flows in through the inhalent orifices. Occasionally, however, they are not furnished with these external orifices, but have others communicating with the exhalent canals. Instead of these cavities, wider canals may also be seen, ramifying over a large portion of the sponge, and which open directly into the exhalent passages; in this way a considerable extent of the external membranes may be unfurnished with inhalent orifices. In other cases, however, these orifices exist over almost the entire surface of the sponge, and usually lead directly into a large cavity belonging to the inhalent system. The irregular septa, by which these cavities are bounded, contain in their walls the ciliary apparatus. All these cavities, whether belonging to the in- or exhalent system, may be traversed by parenchymatous trabeculæ of the most various thickness, and similar trabeculæ may sometimes even be seen crossing the exhalent canals. These trabeculæ are sometimes very closely approximated, and, at the same time, are so broad and thin, that an observer might suppose that he was looking at a portion of the outer membrane with inhalent orifices.

In other instances no membraniform septa of this kind are to be seen; but, instead of them, nearly the whole body is pervaded by slenderer or thicker trabeculæ, which are connected at numerous points with the external membrane, and are continued beneath it to great lengths. They exhibit a great variety of aspect; sometimes no indication whatever of a cellular structure is apparent in them, and they appear to be bounded by a smooth, transparent fine contour, whilst in the interior may be seen numerous strongly refracting granules, more or less closely crowded together. In the finest of these filaments, even when viewed by a stronger magnifying power, even these granules cannot be perceived. Within the thicker trabeculæ are placed the ciliated organs, which, like the trabeculæ themselves, are also situated immediately beneath the external membrane, and in contact with it.

In other cases the trabeculæ have a totally different aspect, becoming moniliform or beaded, the constituent cells of which they are composed being distinctly defined. Moreover, several rows of cells of this kind may be seen in contact, and the cells in such close contiguity that the whole appears like an epithelium detached from its substratum. At the same time the cells may be globular or depressed, and may assume a stellate or polyhedral shape. In other cases, again, they are separated by a transparent substance, so that the whole filament appears even on the surface, globular or irregular masses being seen only in the interior, and which are also surrounded by a transparent substance. In these granular masses may frequently be observed *nuclei*, with *nucleoli*, which, in any case, belong to the cell-contents, whilst the transparent substance may be referred both to this as well as to the membrane.

All the above-described conditions of the parenchyma may be witnessed in succession in one and the same specimen of *Spongilla*, and this even within so short a time that they must be regarded as *motile phenomena*. The observation may be very readily made under a low power in a suitable specimen, placed in a watch-glass filled with water. In this way the author observed the smooth, homogeneous septa become thick trabeculæ, which presented a cellular structure and assumed the moniliform appearance. He also noticed how two filaments in contact with the external membrane, and each consisting of a single series of cells, and separated from each other by more than the diameter of a cell, became so conjoined as to constitute an apparently homogeneous septum. Within the space of half an hour this process extended over a great part of the sponge; whilst, again, in other places smooth fibres became moniliform. At the same time cavities, having a diameter equal to the length of a spicule, closed up, new ones making their appearance at other points, and visibly enlarging whilst the observation was going on. Sometimes two cavities, separated from each other by a delicate septum, coalesced into a single one, by the enlargement of one of them, whilst the filaments became slenderer and slenderer, and ultimately united with the walls of the other cavity, which was all the while diminishing in size. In another instance the inhalent orifices of the outer membrane enlarged in such a manner and to such a degree that at last nothing but a network of filaments remained, exactly like that constituting the internal parenchyma, with which, in the course of the day, it became so united that the whole structure completely lost the usual appearance of a sponge, since even the exhalent canal had disappeared. In this condition the sponge resembled a gigantic Rhizopod lodged in a siliceous skeleton. Even with the naked eye the stronger filaments might be seen, constituting a network of whitish filaments within the skeleton. These, however, did not long retain their form, but became thicker or slenderer in the most various degrees; but so slowly, nevertheless, that the change could not be directly witnessed, though its reality could be concluded upon from the alteration in form. In the interior of some of the trabeculæ were enclosed large balls of detritus, but whence derived could not usually be determined; in only a few cases could the author recognise in them traces of decomposed cells of *Algæ*. The cells of the outer membrane precisely resemble those of the internal parenchyma; in the state of contraction above described they coalesce as readily with the latter as those do with each other. It appears, even in Spongillæ which have originated in detached portions, that the external membrane may be formed in a few hours from the cells of any part of the tissue. Nor are the inhalent orifices by any means characteristic of the outer membrane, since orifices of exactly the same kind may be observed in the internal membraniform septa. Besides this, in the so-termed process of "conjugation" the cells of the outer membrane unite, not only with the same cells of the other individual, but equally well with those of the rest of the parenchyma.

Very remarkable are the changes of place witnessed in the individual cells in the transparent exhalent passages. The latter, especially in their deeper parts, frequently consist of several layers of cells; the outermost of these layers is a continuation of the outer membrane of the sponge, whilst the inner ones are continuous with the rest of the parenchymatous tissue. These cells may occasionally be seen, whilst undergoing a continual change of form, to move slowly upwards and downwards. Sometimes, also, an individual cell may be seen to penetrate between two which retain their position, and afterwards follow the other, whilst the form of the canal retains its general form unaltered. In some points of the outer membrane globular or conical protrusions not unfrequently arise, which acquire the diameter and length of exhalent tubes, and which may become annularly constricted, and contract just like the latter, but without ever exhibiting any opening. In a similar way, in detached portions of *Spongilla* several exhalent tubes are occasionally formed. Both in these protrusions as well as in other parts of the outer membrane vacuoles of the size of a cell-nucleus, or even larger, may, not unfrequently, be seen to arise, which project above the surface, like the contractile receptacles in *Actinophrys Eichhornii*.

The remainder of the paper relates more especially to the multiplication of sponges by scission; but we are unable to perceive that it contains anything novel of importance on that subject.

REVIEWS.

The Utilization of Minute Life; being Practical Studies on Insects, Crustacea, Mollusca, Worms, Polypes, Infusoria, and Sponges. By Dr. T. L. Phipson, F.C.S. London, Groombridge and Sons.

We cannot give a better idea of the scope and intention of this work than is conveyed in the author's preface:

"Zoology and Botany have been looked upon as constituting less *practical* branches of Science than Chemistry or Astronomy, for instance. The zoological works placed in the hands of students are necessarily so full of anatomical details, details of classification, and observations upon the habits and instincts of animals, that very little space has (or could have) been afforded to notice the wonderful manner in which certain animals contribute *directly* to the welfare of mankind, and the methods by which they may be *cultivated.*

"This remark is especially applicable to the lower classes of animals, to the *Invertebrata*, and to these I have devoted the following pages. Their investigation in a *practical* point of view has led, and will still lead, to very profitable and interesting results. It has been rendered more interesting of late years by numerous experiments, having for object the *culture and artificial propagation* of several of the more valuable species.

"It is not sufficient to know that such an insect or such a polype is utilized for certain purposes in the Arts and Manufactures; we must acquire at the same time a correct idea of the animal itself, and the position it occupies in the animal kingdom; moreover, we must ascertain by experiment whether any species already valuable in its natural state cannot be rendered more so—cannot be submitted to *culture*, and *propagated* more extensively by artificial means, and thereby increase the benefits we derive from it.

"To exhibit the actual state of this interesting question is the task I have imposed upon myself in the present work, which embraces the practical history of a great number of animals, and from which I find it impossible to exclude even the microscopic Infusoria.

"When opportunity has been afforded I have mentioned a few peculiarities observable in several species, for it has been my endeavour to render the following pages interesting to the general student, as well as to the practical zoologist."

The idea is not a bad one, and Dr. Phipson appears to have carried it out with considerable care and success. It sounds at first strange to hear grubs, insects, animalculæ, &c., spoken of as "domestic animals." "But," says the author—

"But do we not rear our *silkworms* with as much care as our *sheep* or our *cows?* Do we not construct houses for our *bees, cochineals, snails, oysters*, &c., as we do for our *rabbits*, our *chickens*, or our *horses?* Are not large fortunes realised by the cultivation of a worm such as the *leech*, or a grub such as the *silkworm*, as readily as by the aid of the *camel* of the desert or the Indian *elephant?* Have we not seen a thimbleful of some new insect or its eggs fetch as high a price in the market as the choicest Cochin-China fowl?

"It is too true that these inferior beings are comparatively new to us in this light. But their study affords far greater interest, and, in many cases, undoubtedly more profit, than that of superior animals.

"Imagine a man in difficult circumstances endeavouring to gain a livelihood by rearing some new variety of dog, cow, horse, ass, or pig. He would have greater chance of success were he to extract some new colouring matter from the insect world, or discover a means of doubling the produce of the *bee* or the *silkworm*, or a method by which *sponges* and *corals* might be cultivated with as much ease as a *lettuce* or a *cauliflower*.

"My endeavour in this volume is to treat of *inferior animals* useful to man, from *insects* downwards to *infusoria* and *sponges*. I leave it to others to write the useful novelties that may concern *quadrupeds*, *birds*, *reptiles*, and *fishes*. My observations treat of *Invertebrata* only.

"Our readers have doubtless heard of a new species of culture which has lately taken a very extensive development. It is called *pisciculture*, or the breeding of fish, in which many eminent naturalists have met with astonishing success. Their secret was, however, known long ago to the Chinese. When a Chinaman wished to stock a pool with fish, he repaired to some stream where the latter were known to abound, and placed in it bundles of straw, which were soon covered with spawn. After a certain time the straw was withdrawn and placed in his pool, where the eggs were hatched, and the young fish soon became large enough to satisfy their master's appetite.

"The writings of Coste, Millet, Géhin, Milne-Edwards, De Quatrefages, Remy, and others, have not only taught us how to stock our streams with magnificent salmon, trout, grayling, &c., but lead us to expect that there will soon exist as many different varieties of trout, salmon, perch, tench, &c., as we have actually of dogs or horses. For certain closely allied species have been crossed so as to produce new varieties or races of fish never before seen.

"Similar experiments are being made with inferior animals. The attention of philosophers and practical men is now directed to the latter. We speak now of the *amelioration* of some *insect* species, of the cultivation of a *mollusc* or a *polype*. We begin to see how we can profit by *infusoria* or some other animalculæ."

He might also have adverted to the cultivation of the oyster, which, when fully carried out, promises, according to Mr. Buckland, to render a single breeding oyster a sufficient legacy for a man to leave to his family.

The classes of animals more especially considered by Dr. Phipson as objects of cultivation, or, as he terms it of domestication, are—1. Silk-producing insects—treated of in Chapter II. Many curious and interesting facts concerning this useful class of insects will here be found; and amongst these one which strongly exemplifies the enormous voracity and capability of assimilation and consequent rapid growth to which animal organisms may attain, and which may be nearly said to equal what is witnessed among some of the fungi, whose growth can almost be seen:

"The larvæ born from one ounce of eggs require during their first age, which lasts five days, about 7 lbs. weight of mulberry leaves. After the first moulting, and during the second age, which lasts only four days, they require 21 lbs. of leaf. During the third stage, which lasts a week, they devour 70 lbs. of mulberry leaf; in the fourth stage (also a week), 210 lbs.; and during the fifth stage, from 1200 to 1300 lbs. of leaf. On the sixth day of this last period, they devour as much as 200 lbs. weight of leaf, with a noise resembling the fall of a heavy shower of rain. On the tenth day they cease eating, and are about to undergo their first metamorphosis."

Another curious and important circumstance here noticed is the apparent success that has attended the endeavours to improve the breed of the common silkworm (*Bombyx mori*) by M. André Jean, of Neuilly. This gentleman has proceeded upon the principle of selection so extensively adopted in the breeding of other animals of larger growth. And he has thus been very successful in creating a valuable race of silkworms, simply by causing the largest and finest male and female moths to breed together. The larvæ developed from these eggs are of very large size when compared with the common silkworm.

He next speaks of colour-producing insects—of insects producing wax, resin, honey, manna, &c. With reference to the latter substance, or rather to the various substances included under the term, although he mentions the production of an edible manna from the *Eucalyptus resinifera*, he omits to notice that it is, in fact, the produce of an insect; of which an account will be found in the fifth volume of this Journal, under the head of "Laap or Lerp." The substance so termed is one highly worthy of the attention of chemists, more especially as it seems to afford an instance of the occurrence of a substance similar to that of which starch-grains are composed, but which is amorphous, and produced, as it would appear, in a semifluid form by an insect which spins it into a beautiful conical habitation, presenting, under the microscope, very much the appearance of a Chantilly basket composed of spun sugar.

Then we have an account of insects employed in medicine, food, &c. Amongst the latter are some which, in any case, show to what extremities necessity will compel mankind.

Not to mention locusts, which are doubtless good and palatable food, what can be said of the natives of New Caledonia, who devour roasted spiders about an inch long; or of the Indian children mentioned by Humboldt, who delight in centipedes eighteen inches long; or of the Mexicans, who consume in large quantities an aliment composed wholly of the eggs of a *Notonecta*, &c. &c.

We have no space to notice the chapters on the *Crustacea* and *Mollusca*. Connected with the latter will be found some interesting observations on the Tyrian purple, which, however, would have been perhaps of more importance in an economical point of view before the introduction of the beautiful aniline colours. The chapter devoted to "Infusoria and other Animalculæ" will be found to contain much matter highly interesting to microscopists.

"The antiquarian, in bringing the microscope to bear in his researches, and by the discovery of these siliceous shells of Infusoria in various ancient articles of pottery, and the remains of similar species in the clay of the vicinity in which they occur, has proved that these vases were made upon the spot, and not imported from the higher civilised nations of that day, as had been previously supposed. In like manner thieves have been tracked and robberies discovered by means of the fossil Infusoria adhering to the boots of the suspected persons, though the latter had travelled many miles from the spot where the act was committed."

And again—

"In the lakes of Sweden there are vast layers of iron oxide almost exclusively built up by animalcules. This kind of iron-stone is called lake-ore. In winter the Swedish peasant, who has but little to do in that season, makes holes in the ice of lake, and with a long pole brings up mud, &c., until he comes upon an iron bank. A kind of sieve is then let down to extract the ore. One man can raise in this manner about one ton per diem.

"Besides the excellent polishing material furnished by these infusorial deposits, Liebig has recently drawn attention to another application of which they are susceptible. His observations were made upon an infusorial deposit which constitutes the under soil of the commons or plains of Lünebourg, in Germany; and he has shown that these microscopic remains, as well as those taken from several other localities, can be very easily converted into *silicate of potash* or *silicate of soda*, sometimes known as '*soluble glass.*'"

The work concludes with a short account of sponges.

It will be seen, from the length of this notice, that we regard Dr. Phipson's work as one well deserving of attention, and containing, if not novel, at any rate useful and interesting information.

Conspectus Criticus, Diatomacearum Danicarum. By Dr. PHIL. P. A. C. HEIBERG. Copenhagen, 1863.

THIS work, which is, unfortunately for its ready perusal, written in the Danish language, professes to give a general review of the Danish species of diatoms.

It commences with a general account of the natural history and structure of these organisms, and with a definition of the terms employed in their description, in which, so far as we are able to make it out, there does not appear to be anything new, though it contains a good deal of useful historical information with respect to the species noticed by Otto Müller, Lyngbye, and other Danish writers.

The second part is systematic, and the following table will serve to show the arrangement followed by the author in the classification of Danish diatoms :

I. Valves equal (eensdannede).

A. "Front view" symmetrical in the longitudinal axis.

(*a*) "Side view" circular.

Fam. 1. MELOSIREÆ, Grunow.

1. *Melosira*, Ag.
2. *Lysigonium*, Link.
3. *Orthosira*, Thwaites.
4. *Paralia*, n. gen.
(5.) *Pyxidicula*, Ehr.
(6.) *Coscinodiscus*, Ehr.
7. *Actinocyclus*, Ehr.
8. *Eupodiscus*, Ehr.
9. *Auliscus*, Ehr.

(*b.*) "Side view" not circular.

a. "Side view" symmetrical longitudinally.

Fam. 2. BIDDULPHIEÆ, Kutz.

Tribus 1. *Biddulphieæ genuinæ.*

10. *Cerataulus*, Ehr.
11. *Biddulphia*, Gray.
12. *Triceratium*, Ehr.
13. *Amphitetras*, Ehr.

Tribus 2. *Biddulphieæ cuneatæ.*

(*Eucampia,* Ehr.)

Fam. 3. HEMIAULIDÆ, n. fam.

Tribus 1. *Hemiaulidæ genuinæ.*

14. *Hemiaulus,* Ehr.
15. *Trinacria,* n. gen.
16. *Solium,* n. gen.

Tribus 2. *Hemiaulidæ cuneatæ.*

17. *Corinna,* n. gen.

Fam. 4. FRAGILARIEÆ, Kutz.

Tribus 1. *Fragilarieæ genuinæ.*

18. *Plagiogramma,* Greville.
19. *Diatoma,* Decand.
20. *Fragilaria,* Lyngb.
(21.) *Synedra,* Ehr.

Tribus 2. *Fragilarieæ cuneatæ.*

22. *Meridion,* Ag.
23. *Asterionella,* Hassall.

Fam. 5. STRIATELLEÆ, Kutz.

Tribus 1. *Striatelleæ genuinæ.*

24. *Rhabdonema,* Kutz.
25. *Tabellaria,* Ehr.
26. *Grammatophora,* Ehr.
27. *Striatella,* Ag.

Tribus 2. *Striatelleæ cuneatæ.*

28. *Podosphenia,* Ehr.

Fam. 6. NAVICULEÆ, Kutz.

Tribus 1. *Naviculeæ genuinæ.*

29. *Navicula,* Borg.
30. *Stauroneis,* Ehr.
31. *Pleurosigma,* Sm.
32. *Scoliopleura,* Grun.
33. *Amphiprora,* Ehr.
34. *Mastogloia,* Thwaites.

Tribus 2. *Naviculeæ cuneatæ.*

35. *Gomphonema,* Ag.
36. *Cocconeis,* Ehr.

Fam. 7. SURIRELLEÆ, Grun.

Tribus 1. *Surirelleæ genuinæ.*

37. *Surirella,* Turpin.
38. *Campylodiscus,* Ehr.

Tribus 2. *Surirelleæ cuneatæ.*

39. *Novilla,* n. gen.

β. "Side view" unsymmetrical longitudinally.

Fam. 8. EPITHEMIEÆ, Grün.

40. *Epithemia,* Bréb.
41. *Himantidium,* Ehr.

Fam. 9. CYMBELLEÆ, Pritch.

42. *Cymbella,* Ag.
43. *Amphora,* Ehr.

B. "Front view" unsymmetrical in the longitudinal axis.

Fam. 10. NITZSCHIEÆ, Grun.

44. *Nitzschia,* Hassall.
45. *Tryblionella,* Sm.
46. *Amphipleura,* Kutz.

II. Valves unequal (uensdannede).

Fam. 11. ACNANTHEÆ, Grun.

Tribus 1. *Achnantheæ genuinæ.*

47. *Achnanthes,* Borg.
48. *Achnanthidium,* Kutz.

Tribus 2. *Achnantheæ cuneatæ.*

49. *Rheicosphenia,* Grun.

An Elementary Text-Book of the Microscope, including a description of the methods of Preparing and Mounting Objects, &c. By J. W. Griffith, M.D., F.L.S., &c. London: Van Voorst.

Dr. Griffith is too well known to microscopists not to ensure us that any work from his pen will be interest and value, and in the present one he has certainly given a very useful addition to his former labours.

Its object "is to furnish an elementary course of instruction in the use of the microscope, and in its application to the examination of the structure of plants and animals." But, in addition to this, it also includes figures and descriptions of the "principal structures and more minute forms of both the vegetable and the animal kingdom, which are common and readily procurable." A chapter is also given upon the optical principles of the microscope, and a sketch of the subject of polarized light.

Intended, as it is, for beginners or novices in the use of the microscope, the work, of course, contains much already well known to those in the habit of making microscopic observations, and does not enter very deeply into many points; but what it does contain is well and clearly expressed, and, so far as we can perceive, all that is really likely to be of use to the class for whom it is intended is given in it. The numerous and beautiful coloured plates, which appear to be most carefully and correctly executed, give the work a special character, and we have no doubt that it will be found to supply the place of numerous larger and more expensive books to a large class of readers, and to all beginners who may not have determined to devote themselves to any special subject of research, but may employ their instruments in a discursive way through all the realms of nature.

We cannot give a better idea of the book than by going over the chapter of contents. In the first chapter we have an account of the structure of the microscope, with details of the various forms of apparatus which are intended to assist its use. In the second chapter the beginner will find a good description of how he is to proceed in the mounting of objects. This is a subject which deserves more attention than it has yet received. The best possible way of noting the progress of observation with the microscope is to make preparations of the objects seen. This is one great advantage of microscopic inquiries—that their results may be kept in museums of small size. All other inquirers are obliged to arrange their specimens in extended cases, but the microscopist can exhibit all his treasures in a very small space.

Following the old systematic view, Dr. Griffith begins with vegetable structures, and passes on to those of animals. In his third chapter he speaks of vegetable tissues and elements; and if he were a professed botanist instead of a microscopist, we might join issue with him in regard to the result of his observations. From vegetable elements he passes to vegetable organs. Here we find a very good account of the various organs of plants. From the higher plants in the fourth chapter, we pass, in the fifth, sixth, seventh, eighth and ninth chapters, to an account of the various structures found amongst ferns, mosses, algæ, lichens and fungi. It is impossible to criticise all the information here given. Dr. Griffith has, with a respectful regard to the memory of his distinguished colleague and co-editor in 'The Micrographic Dictionary,' reproduced here in a more elementary form what was recorded there. The late Professor Henfrey had studied with more than ordinary diligence the structure of the Cryptogamic forms of plants, and he has left in his researches amongst these humble forms of the vegetable kingdom a permanent record of his love of natural objects and powers of observation.

Passing down the vegetable scale of existence, we diverge from plants into animals at the Fungi. Animal elements and tissues follow the Fungi in a tenth chapter. It would be invidious to criticise what is done so well; yet we cannot but feel that in these elementary chapters Dr. Griffith has opinions with which we do not wholly agree. At any rate, we freely admit he may be as right as ourselves, and we commend his observations to our friends who are beginning to study minute structures. Starting from the great broad basis of universal animal structure, we have, following, particular accounts of animal families. We have no particular microscopic account of the Mollusca; but why they have offended Dr. Griffith we are at a loss to discern. We feel inclined at once to supply a chapter on the microscopic interest of Mollusca. The teeth of the Gastropoda, &c., the glands of the Lamellibranchiata, and a host of other phenomena, occur to us. But we must follow Dr. Griffith. Chapter XI is devoted to Articulata. Chapter XII to Radiata; and as this tribe has been given the go-by of late, we may as well say the whole family is treated by Dr. Griffith with great contempt, and dashed off in two pages. The Protozoa, being especially microscopic, are treated at length. Here we have an account of that very heterogeneous and doubtful family, the Infusoria. Of course in catering for juniors, Dr. Griffith does not indulge in speculating as to the animal or vegetable nature of these organisms. He gives descriptions of various forms, which his plates display in all their proportions and colours. Wisely reserved to the latter part of the book is a chapter on "optical principles." We advise all readers to skip this chapter if they please. A dinner is not the less pleasant that you are ignorant of the structure and functions of the nerves of teeth. The wonders of the microscope may be enjoyed without a knowledge of "optical principles." What we commend is the use of the microscope, and when observation has gone to its furthest point, the desire for a knowledge of the principles on which we have proceeded may undoubtedly lead to yet further discoveries.

In conclusion, we would commend Dr. Griffith's work to our readers, believing they will find it all that is necessary for the commencement of observations with the microscope. Should they ever become masters of its details, we can rejoice with them in the power they possess of diving deeper into the great secrets which the Creator of All has yet to reveal to those who diligently study and take delight in His works.

NOTES AND CORRESPONDENCE.

Zoosperms in the Ovaria of Pulmoniferous Gastropods.—In the April number of your Journal I find a communication regarding the above subject, from one of your correspondents. In this communication the writer impugns the accuracy of my assertion, that the zoosperms are not secreted in the ovary properly so called. It is stated that, because the structures in question are to be seen in a fully developed condition in the saccules of the ovary, the latter organ is that which gives them birth. Now, without desiring to dwell upon the fact that the *petitio principii* is hardly a fair mode of reasoning, allow me to indicate to your correspondent a few of the difficulties which his assumption involves.

1st.—The zoosperms being found fully developed in the ovary and imperfectly formed [spermatophora] in the sperm-sac, they must, according to his hypothesis, have undergone a species of retrograde development.

2nd.—There being but one oviduct, the zoosperms must pass out with the ova, and, therefore, be utterly valueless so far as reciprocal fecundation is concerned.

3rd.—The *testis* [mihi] which is *tout entier* of greater volume than the ovarium, would have but a subordinate function attached to it.

4th.—It would be impossible to show how the zoosperms pass into the spermatheca.—Henry Lawson, M.D., Professor of Physiology in Queen's College, Birmingham.

Stereoscopic Photographs of Diatoms.—At the recent soirée of the Microscopic Society were exhibited a series of photographs, by Dr. Maddox, of various forms of *Diatomaceæ*, in which the markings were defined with great distinctness, and the peculiar appearances produced with differences of illumination were illustrated. These attracted considerable notice.

Some of the most interesting were taken in pairs, so as to be shown in the stereoscope, the negatives of which were obtained with a $\frac{1}{12}$th of 172° of aperture.* As it is impossible to see these objects stereoscopically with the *full* aperture, by any form of binocular microscope, it may be stated that the pair of negatives were impressed by two different exposures, slightly shifting the objects sideways and altering the focus for each time. In fact, it is difficult to obtain two negatives, taken at different times, closely alike. With a large-aperture objective, even a difference of illumination will give a stereoscopic effect in the combined pictures.

Some of the diatoms photographed by Dr. Maddox, when viewed in the stereoscope, appeared disk-shaped, or with the surface of the valve curiously contorted, and the markings standing in bold relief, like the seeds of a pomegranate.

Those who take an interest in the structure of the markings on the Diatomaceæ may, perhaps, find that a careful scrutiny of these photographs (which we believe are now in the hands of Mr. How, Foster Lane, Cheapside) will materially assist in determining their character, or whether they are in the form of projections or depressions.—F. H. WENHAM.

Notes on Raphides, by George Gulliver, Esq.—We have already seen ('Annals' for April and July, 1863), how well this order is characterised by raphides, so that not only can a plant belonging to it be henceforth truly distinguished from others of nearly allied orders by these acicular crystals alone, but a minute fragment of the leaf or its modifications may be sufficient for the diagnosis; nay, that even a seed-leaf would be so was proved in *Œnothera* and *Epilobium*.

This last fact appeared so remarkable that I have lately made it the subject of experiments with other plants, when a careful examination of numerous species showed that those belonging to orders previously ascertained to be regularly destitute, in the adult leaves, of raphides, are also equally devoid of them in the seed-leaves. Then the seeds of such Onagraceæ as were easily procurable (to wit, *Circæa lutetiana*, *Eucharidium grandiflorum*, *Clarkia elegans*, *C. pulchella*, and *Godetia vinosa*) were sown in pots; and as soon as the seed-leaves were well developed above the soil, they were all examined, and found in every instance to contain raphides. These could be seen both scattered in bundles throughout the parenchyma and floating freely and singly

* The $\frac{1}{12}$th used was constructed by Mr. Wenham, and lent for the occasion.

in the water wherein the part had been broken by pressure and friction between the glass object-plate and cover. The raphides in the green cotyledons were somewhat smaller and less plentiful than in the plumule and fully developed stem and leaves.

The difference in question between Onagraceæ and their nearest allies of other orders is not only very curious, but is one of those numerous phenomena which remind us of how little we know of the recondite operations of vegetation. Take, for example, two plants, as *Epilobium hirsutum* and *Lythrum salicaria*, similar in habit and growing closely together in the same soil of the river-bank, and observe the signal difference of their products—the one plant, as a regular part of its healthy structure, abounding during its whole existence in raphides, the other as regularly destitute of them, and affording sphæraphides instead, differing as much in form as they probably do in chemical composition from raphides. Supposing, then, as there is some reason to do, these crystals respectively are phosphate and oxalate or some other salt of lime, a leading and constant function of the Onagraceæ would be the formation of the phosphate, while the Lythraceæ would be a laboratory of a different salt—the performance of each of these diverse operations being a regular and special design of the plant-life in such cases.

But though we know so little of this subject that its significance remains a mystery to us, we may now make good use of the facts already revealed as botanical characters, provided we distinguish truly, as proposed in the last number of the 'Annals,'* raphides from sphæraphides, so as not to confound such different things under one and the same term, taking care also to observe how far the sphæraphid tissue (of which an engraving† was given in the same number of the 'Annals') may be characteristic of certain orders. If we confine the word raphides to the needle-like crystals commonly occurring in bundles, it may be the expression of a more universal diagnosis between such orders as Ona-

* Without some such definition as therein proposed be used, there will be, as there has long been, great confusion. It is merely perplexing to say that such a plant, or order of plants, affords raphides, unless it be defined what is meant by this term. It should be confined, as I have lately confined it, to the acicular forms occurring so commonly in bundles; and all the conglomerate forms provisionally, should be called sphæraphides. These last are much more common and widely diffused than true raphides.—G. G.

† The outlines of the crystals are often more or less rounded or granular, not so sharp and distinct as there represented. In that number of the 'Annals,' p. 228, for *Cucurbitaceæ*, read *Dioscoreaceæ*.

graceæ and their next allies, and yet less simple and sure, than any single character hitherto employed. Thus, too, we could determine the affinities and contrasts of certain plants by a method at once easy, novel, and practical, and all this in the absence of those parts heretofore exclusively used for the descriptive distinctions. And there would be another advantage in enlisting these crystals into the service of systematic botany; for we should not be thus employing merely an empirical formula, but methodically recognising some really fundamental results of plant-life, well fitted to keep before us such interesting and important phenomena in the economy of vegetation as must be especially valuable in a natural system of classification.—*Annals of Nat. Hist.*, Oct., 1863.

Onagraceæ.—This order, as shown in former papers, is so well and truly characterised in this manner, that the raphides even in the seed-leaves may be sufficient for the diagnosis; and I know not that it had ever before been suspected that this rudimental part of the plant of one order would thus be adequate to distinguish it from the other plants of the nearest allied orders.

Further, I have now to observe that the same difference may be demonstrated in the ovule. In its sacs and in the placenta the raphides abound, whilst they do not exist there or elsewhere in plants of cognate orders. Though I have made a few observations to this effect in other raphidiferous plants, I have chiefly studied the facts in Onagraceæ, because these are easily obtained, germinate freely, abound so much in raphides, and stand in the natural system between orders not thus producing raphides.

Thus, taking the order Onagraceæ as a typical raphidiferous one, we have shown the presence regularly of raphides through every part and period of growth of the vigorous plant, from the ovule, cotyledons, axis, leaves and their modifications, to the parts of fructification, and, finally, to the pulp of the berry. In most, if not all, species of the order, the raphides occur more or less in the anthers, filaments, style, and stigma, and, less plentifully, in the petals.

Discoreaceæ.—The raphides are sometimes so very distinct and beautiful in this order, that they would be excellent examples for demonstration at lectures. By simply drying on glass some of the juice of the berry of *Tamus communis*, the raphides may be preserved for an indefinite time; and, as they are about $\frac{1}{124}$th of an inch long and $\frac{1}{5000}$th inch thick, they may be seen merely with the aid of a common hand lens. In the ripe berry the raphides generally occur naked, either singly or in the characteristic bundles, destitute of a cell-wall.

Araceæ.—But the raphis-cells are so large and plain in the berry of *Arum maculatum,* and thus continue for a long while in its ripe state, as to afford as good an example for the study of the development, form, and relations of the raphis-cells as the berry of the *Tamus* is for the examination of the separate raphides. And, in this point of view, these very common berries are well worthy of the attention of teachers and pupils. In the woodcut, fig. 3, it will be seen that some of the raphis-cells of *Arum* are nearly $\frac{1}{50}$th of an inch in length and $\frac{1}{100}$th in breadth.

Asparagaceæ.—This is propably a true raphidiferous order; for, though I have not examined the exotic species, I have found raphides in all the British plants (except *Maianthemum,* which I have not seen). In *Asparagus officinalis* raphides occur throughout the plant, and at all periods of its growth, from the first leaf-bud to the ripe berry.—*Annals of Nat. Hist.,* Nov., 1863.

Orchidaceæ.—We have already seen raphides abounding generally throughout these plants in the only four British species examined. Hence it appeared interesting to extend the inquiry to the exotic species, and especially to the epiphytes of the order, which I have been enabled to do through the courtesy of Dr. Hooker and Mr. J. De Carle Sowerby. The following are notes of parts of fresh plants received on January 26th and February 6th:—*Isochilus linearis:* raphides very scanty in leaves and stem, but very plentiful in bundles in the fleshy root, without starch; dotted chains of cells in stem. *Sobralia macrantha:* raphides rather numerous in stem, leaves, and the parts of fructification. *Calanthe vestita:* raphides abundant in scape, bracts, petals, and other parts of fructification (no leaf examined); hairs of scape jointless, and not glandular. *Dendrobrium nobile:* raphides abundant in very young leaves, less so in old leaves and stem, and very rare in the root. *D. pulchellum:* bundles of raphides in the stem and fleshy leaves, and very rare in the root. Leaf of another *Dendrobium:* raphides rather scanty, but large. Leaf of *Aërides odorata:* several bundles of raphides, but not abounding. Bit of leaf of *Trichotosia* (a section of *Eria*): bundles of large raphides abundant in cells, and numberless smaller raphides in the field of vision; hairs of leaf red, smooth, jointless, swollen at base, and not glandular. *Schomburghia crispa:* bundles of raphides abundant in swollen part of stem, scarcer in its thin part and leaf; woody part of stem made up of dotted vessels. *Cattleya Mossiæ* (leaf and swollen part of stem): raphides abundant. *Phaius grandifolius:* bundles of raphides swarming in the leaves, bulb, and root-fibres; in the bulb, raphis-cells very large and hyaline, also a profusion of beautiful, conical, large starch-granules, average length $\frac{1}{266}$th, and breadth $\frac{1}{400}$ of an inch. *Brassia* (a bit of the leaf, as also in all the following): raphides, but not very plentiful. *Oncidium:* very few bundles of raphides. *Megaclinium*: raphides abundant, and a beautiful subcuticular sphæraphid tissue ('Annals,' Sept., 1863, pl. iv., fig. 13); the diameter of each of the shæraphides regularly about $\frac{1}{3200}$th of an inch. *Ansellia*: raphides rather numerous. *Bolbophyllum*: raphides pretty numerous.

Araceæ.—Among some fragments of plants to aid this inquiry, which were obligingly supplied by Mr. Cox, the excellent superintendent of the Redleaf Gardens, is part of the leaf of *Richardia æthiopica,* which I find abounding in biforines, the raphides escaping, under gentle pressure, regularly from both ends of the oval cells.—*Annals Nat. Hist.*, March, 1864.

PROCEEDINGS OF SOCIETIES.

Microscopical Society of London,

March 30th, 1864.

The Annual Dress Soirée of the Society was held this evening in the great Hall and adjacent rooms of King's College. The very fine weather, and especially as the soirée was not held as before in Easter-week, enabled near 800 ladies and gentlemen to attend this interesting and scientific meeting. The number of microscopes exhibited was over 200, the chief of which were from the various instrument makers, most of whom are now members of the Society. The predominance of the binocular arrangement of Mr. Wenham, the beauty of construction, and costly adaptations of the several instruments, were subjects general admiration. The following were among the exhibitors :—

Mr. Baker.—*Twenty-four microscopes*, fifteen of which were made with his new binocular stand. These latter were arranged so as to display in an effective manner the advantages of this construction. All the objects were of a popular character, and among those which attracted most attention should be mentioned—artistically arranged groups of diatoms, opaque and transparent, the former showing well by the soft light of the Lieberkuhn: spicules of Synapta, consisting of seventy-four plates and anchors, similarly arranged; a fine specimen of the Myriapod, "Millipede," and its exuviæ; a new polarizing crystal *Aspartic acid;* transparent injections of the toe and brain of the mouse; head of large tiger beetle, shown entire by the 3-inch objective. Among the living objects were several specimens of the parasite (*Argalus foliaceus*) of the stickle-back and other fresh-water fish. This forms an interesting study under the binocular, the respiratory action, sucker, and entire structure being well displayed.

Dr. Carpenter exhibited a new binocular microscope by Nachet, in which the principle (introduced by Mr. Wenham) of allowing one-half of the cone of rays to pass on without interruption is applied in such a manner that, by a change in the position of the prism, a conversion of relief is produced; a *pseudoscopic* effect being substituted for the proper *stereoscopic* projectien. Various objects were exhibited, showing this phenomenon in a very remarkable manner; thus the effect of the conversion upon the eggs of a small Lepidopterous insect was to make them appear as if laid open and seen from their interior face; the same was the case with the spherical and bell-shaped polycystina, and with such diatoms as Isthmia; whilst the convex and concave faces of Arachnodiscus were mutually interchanged. Dr. Carpenter also exhibited a (true) half-inch objective, constructed for him by Messrs. Powell and Lealand, specially adapted, by the limitation of its angle of aperture to 40°, for use with the binocular. The *focal depth* or *penetration* of this objective, combined with entire freedom from that *exaggeration of relief* which is necessarily produced when objectives of an angle of aperture much exceeding 40° are used with the binocular, were displayed in such a manner as to satisfy the most critical judges, upon a beautiful slide of polycystina prepared for Dr. Carpenter by Mr. Freestone.

Messrs. Crouch.—*Fourteen microscopes*, including several of their "cheap binocular microscopes." This instrument is of a very superior construction, and optically as perfect as the most complete and expensive, and fully bears out the testimony of Dr. Carpenter and other eminent microscopists as to the great superiority of this binocular as a "cheap" instrument.

Messrs. Gould and Porter.—*Eleven microscopes*, including their portable sea-side microscope, admired for its cheapness and compactness; it has coarse and fine adjustment mechanical rack-stage, three sets of achromatic powers, best condenser on stand, with sliding, centre motion for inclining it to any angle, and fits into a case $5\frac{3}{4}$ in. by $5\frac{1}{4}$ in., and 3 in. deep.

Mr. J. How.—*Ten microscopes.* Among the objects exhibited by reflected light, were curculio of hazel, small intestine, human, lung of boa constrictor, foraminifera, polycystina; by transmitted light, female gnat, head of crane fly, gizzard of cricket, foraminifera, Mediterranean diatoms (assorted); by polarized light, platino-cyanide of magnesium, salicine, and chlorate of potash.

Mr. Ladd.—*Seven microscopes* of different construction. One fine mounted specimen of the itch insect, one live specimen of the *Conochilus Volvox*, two polarized objects, especially one of the coral from the mountain lime-stone, forming a most brilliant object.

Messrs. Murray and Heath.—*Eight microscopes.* Among others their new model, combining perfect steadiness with large range of adjustment, at a small cost. The objects were Vorticella, Ophiura, *Ætea dilatata*, S. Australia, peristoma of Bryum, spiral vessels of rhubarb, polycystina, diatomaceæ, guano, &c.

Messrs. Newton and Co.—*Twelve microscopes.* The objects were diatoms, polarizing objects, and injections; also a series of large preparations 3 inches in diameter, for gas. Microscopes, including scorpions, tarantulas, crabs, locusts, butterflies, &c.

Mr. Norman.—*Nine microscopes.* Some of the objects displayed were of great beauty, and a few worthy of particular notice, such as the wheel-shaped spicula of Chirodota figured by Dr. Carpenter in his work on the microscope; also a section of agate, brought by Dr. Murie from the Nubian desert, consisting of an aggregation of regular formed crystals, beautifully shown by polarized light; likewise a mineral called sunstone, as an opaque object rivalling in iridescence and colour the elytron of the diamond beetle; also spicula of a synapta more than four times the size of those generally met with.

Messrs. POWELL and LEALAND.—*Seven* of their splendid first-class instruments, and the following objects:—Circulation of the valisneria (with their new $\frac{1}{25}$th objective), *Volvox globator*, peristoma of moss, gastric teeth of cricket, leaf insect, circulation in young of trout, and tail of fish, &c., &c.

Mr. ROSS.—A magnificent display of twenty-four of his first-class instruments. Although the objects presented no novelty, the brilliant illumination and definition were very remarkable, We particularly noticed a slide of "*Heliopelta*," mounted as an opaque object, shown in a binocular with the $\frac{1}{2}$-inch of 90°, and its Lieberkuhn.

Messrs. SMITH and BECK.—*Twenty-four microscopes;* also two instruments connected with the early history of the compound achromatic microscope.

The one was a microscope stand, designed by Mr. Lister in March, 1826. The work was executed by James Smith, under Mr. Lister's superintendence, and was finished in 1827. This instrument is the basis from which has been built up all the improvements in the achromatic microscope which have taken place in this country. The object-glass was worked by Mr. Lister's own hands in 1830, and its aperture was at that time larger than any other glass made either before or for some time after.

The other was the first complete microscope made by James Smith on his own account. It was ordered by the late Mr. R. L. Beck, and delivered to him May 29th, 1839.

In connection with microscopic objects, the same firm also exhibited the "life history" of an acarus, identical in appearance with the *Acarus Crossii.* The various stages from the egg to the mature male and female were separately shown, in a living state, by six instruments, accompanied with drawings at the side of each. The construction of these microscope stands, intended for purposes of demonstration, was entirely novel, and besides being of very moderate cost, the arrangements entirely prevented any interference with the object—a precaution which so many find to be necessary on such occasions.

In one of their ordinary best microscopes a Podura scale was shown, under a $\frac{1}{20}$th. This particular specimen exhibited in a striking manner the continuity of the markings—a subject which was still further illustrated by drawings of the scales from five different species, magnified 1300 linear. Under some of their other microscopes Smith, Beck, and Beck also showed some entirely new and exceedingly fine carmine injections.

The SOCIETY. — *Five microscopes*, including that splendid "binocular," with the objectives and other necessary apparatus, lately presented to the Society by Mr. Thomas Ross, were in the charge of Mr. Searson, the curator, who exhibited some fine injections of the dorsal and palmar surfaces of the hand, villi, and follicles of the intestine; sections of human scalp, with the hairs, glands, and vessels *in situ;* also, under several powers, the action of the cilia on the fibrillæ of the common mussel, the isolated portions floating by means of the cilia across the field of the microscope in a remarkable manner, as so many infusorial animalculæ.

Mr. WHEELER.—*Twenty-one microscopes*, and an elaborate display of objects, with some light well-made cases for the convenience of carrying a quantity of objects with safety. These comprised some respectable instruments at a very low cost, with others of higher pretensions; and his first-class binocular, with his improved achromatic objectives, made expressly for binocular use, a new goniometer stage, and the modern appliances for special illumination. The objects were elegantly displayed, embracing an extensive series in almost every branch of microscopy; the most enviable, perhaps, being his grouped and symmetrical selections of diatoms, both opaque and transparent; whole insects, orchidaceous and other vegetable structures, and anatomical preparations.

There was an interesting exhibition of early microscopes, the property of the Society, of Mr. Roper, and of the Assistant Secretary, Mr. Williams. Those belonging to the Society were the Martin microscope, of which there is a description in No. VI, new series, of the Journal. An early specimen of the compound microscope known as Culpepper's, and a silver mounted specimen of Wilson's pocket microscope. These were from the Quekett collection. Those of Mr. Roper were Lyonet's anatomical microscope, and one of Martin's early compound hand microscopes. Mr. Williams exhibited a lucernal microscope in operation. The double constructed microscope, two specimens of Wilson's pocket microscope, Withering's botanical microscope, two specimens of microscopes for opaque objects, a solar microscope, and a very minute microscope contained in a case the size of a small acorn.

The following gentlemen also exhibited microscopes with well selected and interesting objects:—Messrs. Pillischer, ten; Highley, six, with beautiful photographs of diatoms for the magic lanthorn; Mummery, two; Gray, one; J. Smith, one; Morley, one; Horne and Thornthwaite, three, and two polariscopes; and Topping, two.

Around the walls of the great hall were displayed a large series of elaborate and instructive diagrams, kindly contributed by Dr. Carpenter, Dr. Beale, Mr. Mummery, and a very interesting series of the "anemonæ" executed by Mr. T. Suffolk, a member of the Society, were greatly admired. The generality of the objects far surpassed all former attempts, especially the diatoms, the clearness of mounting, and the geometrical arrangement of the several groups on the slides, showed a great advance in the preparation of these beautiful, instructive, and elaborative structures.

The whole of the proceedings passed off with the greatest *éclat*, and thus ended one of the most successful soirées of this Society, mainly due to the untiring exertions of Mr Blenkins, Mr. Roper, Mr. Lobb, and the other members of the soirée committee.

April 13*th*, 1864.

Charles Brooke, Esq., F.R.S., *President*, in the Chair.

Blandford Nugintour, Esq., 23, Ely Place, Holborn, was balloted for, and duly elected a member of the Society.

A paper by Dr. Vogel was read on Trichina spiralis, illustrated by four slides of specimens.

A letter was read from W. H. Hull, Esq., requesting information on the scab of sheep, now prevalent in Australia.

May 11*th*, 1864.

Charles Brooke, Esq., F.R.S., *President*, in the Chair.

Edmund Wheeler, Esq., Holloway, Benjamin Fox Watkins, Esq., Fern House, Conholt Place, Brighton, Rev. R. H. N. Brown, 12, Oakley Square, Alfred Lapone, Esq., Denmark Hill, and William Wright, Esq., 12, College Terrace, St. John's Wood, were balloted for, and duly elected members of the Society.

A short paper by W. Hendry, Esq., on Glass Crystals, was read.

A paper by Dr. Greville, on Diatomaceæ, was read.

Mr. Beck made some remarks on certain peculiarities in spiders.

June 8*th*, 1864.

Charles Brooke, Esq., F.R.S., *President*, in the Chair.

Joseph Spawforth, Esq., Sandall Cottage, Hornsey Rise, George H. Fryer, Esq., 70, Portsdown Road, Maida Vale, were balloted for, and duly elected members of the Society.

The following papers were read:

"*On* Vulcanite Cells," by W. H. Hall, Esq.

Believing that vulcanite would make good cells for mounting microscopic objects, Messrs. Silva and Co. kindly supplied me with some tubing of this material. I had some doubt as to the action of glycerine upon it, but this has been removed, for after soaking a thin piece in pure glycerine for the last two months, I cannot perceive the slightest alteration in it: the ring experimented upon is on the table. The cells which I now exhibit were cut with a lathe and an ordinary chisel, of a thickness of a little more than the microscopic thin glass and upwards, and cemented by heat with marine glue to the glass slide. It will be perceived that the thinnest has not altered its shape in the slightest degree.

Mr. Bailey, of No. 162, Fenchurch Street, City, has undertaken to supply these rings from 6*d.* to 8*d.* per dozen, according to size and thickness.

In examining a slide of Polycystina a few days ago with oblique light thrown by the mirror, my attention was attracted by seeing the black ground more intense and the object better brought out while my hand was employed in moving the reflector; I found this to proceed from the shadow—the hand cast across the plane of the object-glass. This suggested placing a piece of dead black paper on the table beneath the objective, or still better, at the bottom of a pill-box mounted on the stem carrying the mirror, which gave an increased improvement in the back ground. I subsequently substituted for the sombre colour papers stained with green, blue, yellow, red, pink, orange, &c., with a pleasing and I think instructive effect—very grateful to the eye, especially so in respect to the greens and the blues. I propose to try if the spot lens can be used with a like result; in the mean time, if not already observed and recorded, it may be interesting to your readers.

Lee's Card-board Cells *for* Mounting dry Objects.

Mr. Henry Lee introduces to the Society specimens of cells cut from tubes of card-board, which being cheap to purchase, 1*s.* per gross, and easily made, will be found very useful in the mounting of dry and opaque objects. As these are now much in favour for the binocular microscope, it is hoped that cheap cells adapted to them will prove acceptable to both amateur and professional mounters. They are made in the same manner as the sides of pill-boxes, by rolling gummed paper on a wooden mandril, and cutting rings from the tube thus formed when dry and hard. It will be seen that they can readily be made of any required depth, diameter, or thickness.

"On the use of black and coloured paper as a background for objects," by Mr. Hall.

"On a new Achromatic Condenser," by Mr. J. Webster.

"On the structure and formation of the Sarcolemma of Striped Muscle, and of the exact relation of the nerves, vessels, and air-tubes in the case of Insects to the contractile Tissue of Muscle," by Dr. Lionel S. Beale.

PRESENTATIONS TO THE MICROSCOPICAL SOCIETY.

January 13*th*, 1864.

	Presented by
Canadian Journal, No. 48 . . .	The Editor.
Intellectual Observer, No. 24 . . .	Ditto.
Journal of Photography, No. 205 . . .	Ditto.
Photographic Journal, No. 140 . . .	Ditto.
Astronomical Register, 1864 . . .	Ditto.
Historia e memorias da Academia réal das sciencias de Lisboa, 1863 . . .	Academie.
Annals and Magazine of Natural History, No. 73 .	Purchased.
30 Slides of Diatoms (*America*). . . .	Prof. Jones.
12 Slides of Algæ	Mr. Goddard.
6 Slides of Coal	Mr. Tupholme.

February 10*th*.

Quarterly Journal of Science, No. 1 . .	The Editor.
Intellectual Observer, No. 25 . . .	Ditto.
Quarterly Geological Journal, No. 77 . .	The Society.
Annals and Magazine of Natural History, No. 74 .	Purchased.
On Cephalization, and on Megasthenes and Microsthenes in Classification, by J. D. Dana . .	The Author.
Photograph of Leaf Insect . . .	Mr. T. Ross.

April 13*th*.

On the Structure and Formation of the so-called Apolar, Unipolar, and Bipolar Nerve-cells of the Frog. By Dr. Lionel S. Beale	The Author.
Observations on the Genus Unio By. Dr. Isaac Lee .	Ditto.
Archiv des Vereins für wissenschaftliche Heilkunde, Leipzig	Dr. Vogel.
Proceedings of the Academy of Natural Sciences of Philadelphia, Nos. 3 to 7, 1863 . . .	The Society.
Transactions of the Linnean Society, vol. xxiv, part 2 .	Ditto.
Journal of the Proceedings of the Linnean Society, No. 28	Ditto.
List of Linnean Society, 1863 . . .	Ditto.
Intellectual Observer, Nos. 26 and 27 . .	The Editor.
Journal of Photography, Nos. 208 to 211 . .	Ditto.
Photographic Journal, Nos. 141 and 142 . .	Ditto.
Annals and Magazine of Natural History, Nos. 75 and 76	Purchased.
Four Slides of *Trichina spiralis* . . .	Dr. Vogel.

May 11*th*.

Quarterly Journal of the Geological Society, No. 78 .	The Society.
Canadian Journal of Industry, Science, and Art, No. 50 .	Ditto.
Intellectual Observer, No. 28 . . .	The Editor.
Photographic Journal, No. 142 . . .	Ditto.
Journal of Photography, Nos. 212, 213 . .	Ditto.

	Presented by
Annals and Magazine of Natural History, No. 77 .	Purchased.
Fifty Slides of various Woods, with the List of the Names thereof	H. Black. Esq.

June 8th.

Blackwall's Spiders of Great Britain and Ireland, Part II, Ray Society, 1864	The Society.
Intellectual Observer, No. 29 . .	The Editor.
Journal of Photography, Nos. 214 and 215 . .	Ditto.
Photographic Journal, Nos. 144 and 145 . .	Ditto.
Verhandlungen der kaiserlichköniglichen Zooligisch-botanischen-Gesellschaft in Wien, 1863 . .	Ditto.
Monographie der oestriden von Friedrich Brauer .	The Author.
The Annals and Magazine of Natural History, No. 78 .	Purchased.

W. G. Searson, *Curator.*

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Manchester Literary and Philosophical Society.

MICROSCOPICAL SECTION.

Extract *from* Proceedings *of the* Microscopical Section *of the* Literary *and* Philosophical Society, 19*th October*.

A letter dated 15th May, 1863, was read from Captain J. Mitchell, of Madras, addressed to the President, presenting copies of Report published by the Madras Government, and stating that the almost universal opinion, that the cotton fibre is of a flattened form consisting almost entirely of membrane, is one founded on error as far as the general form of well-nourished cotton fibre is concerned.

Captain Mitchell further stated that an examination of many varieties of cotton had led him to believe that in those cottons which find most favour in the English market there is a very large proportion of hairs that are entirely or nearly filled with secondary deposits, and on the contrary in the low-priced cottons, the flat fibre consisting of hardly anything but membrane, in fact, an apparently undernourished cell predominates, the knotty portion considered as refuse consisting almost entirely of those flat fibres, the absence of secondary deposits being an indication of careless culture, or, what is much the same thing, of a poor soil.

Mr. J. G. Dale in a note to the paper on carmine injection stated that, as a blue injection, that of Turnbull's leaves nothing to be desired. He could not find the formula for it published, and therefore appended a copy, as follows:—

10 grains sulphate of iron,
2 oz. water;
Dissolve cold: then take—
32 grains ferrocyanide of potassium,
2 oz. water;
Dissolve cold: mix the two together and shake well for some time, then add—
1 oz. glycerine,
$1\frac{1}{2}$ drachm pyroacetic spirit,
1 oz. alcohol.

The following is the Report referred to at the above Meeting.

REVENUE DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Read the following letter:—

From Captain J. MITCHELL, Officer in charge of the Government Central Museum, to J. W. BREEKS, Esq., Private Secretary to His Excellency the Governor, dated Madras, 21st April, 1862.

MY DEAR SIR,

1. On the 4th instant I had the honour to acknowledge the receipt of certain samples of cotton that were forwarded with your letter of the 3rd April, 1862.

2. The examination of these samples has occupied all the time I could command since that date, and it is now my duty to report the result. I fear His Excellency Sir W. Denison will consider it a very inadequate return for the time devoted to it. It certainly appears so to me.

3. I have considered it advisable to send *in full* all the measurements that I have made of the *diameter* of the fibre, because it seems to me that a mere average is calculated to give a very erroneous idea of cotton as it really is. With the whole of the measurements before him His Excellency will be able to see the ta on which the averages are founded.

4. The measurements were made with a cobweb micrometer, the divisions of which (with the object glass used) have a value of $\frac{1}{133,833}$ of an inch; this quantity, 133,833, therefore, is the common denominator of fractions, of which the micrometer read-

ings entered in the several columns of the table are the numerators.

5. As it would have been obviously unsatisfactory to select any particular kind of fibres for measurement, the plan I adopted was to tease out a pinch of the cotton until it lay pretty smooth; from this I detached as thin a stratum as possible of about half an inch in width, which was placed on the compressorium in water. Then, commencing at one end, I passed the different parts in succession across the field of the microscope, and measured those that lay flattest and best situated for that purpose, without reference to their size or form. I did not at first note in the table the form of the fibres, but after a time it occurred to me to do so, as it is evident that the diameter of a flat thin fibre will, as a rule, be greater than a cylindrical one; indeed, it follows as a matter of course that if one portion of a hollow cylinder be pressed flat, it must measure half as much more than the cylindrical portion, *i. e.*, in the ratio of the semi-circumference to the diameter.

6. You will observe that I have used the terms round, roundish, flat, and flattish, in the table. I apply the term "round" to a fibre that is *apparently* round and solid, with considerable opacity, somewhat like a stout hair; but I do not mean to assert that such are in reality solid cylinders, they are possibly flattish fibres rolled up in such a way as to appear solid, and I reserve that point for further examination.

7. Those termed "roundish" have a light line along their axis when seen at the upper focus, an effect often seen with hairs, and which led to the idea of hairs being tubular.

8. The "flattish" fibres have this line wider, and, a more or less, broad, opaque margin, which is rounded off so as to give the idea that a transverse section would be an ellipse of greater or less eccentricity.

9. The "flat thin" fibres are exceedingly thin, flattened tubes, like pieces of ribbon, and without any appearance of internal thickening from secondary deposits.

10. You will see by the following quotations that the use of some terms to describe the nature of the fibre was a necessity. Whether there be any kind of cotton in which a riband-like band is the common form I have yet to learn, but in the samples that I have examined, a flat riband-like fibre is *not* the rule, and in some varieties it is *almost a rare* exception;—to proceed.

11. The late Professor John Quekett in the 1st volume of his Lectures on Histology, speaking of cotton fibres, says they "are recognised as flattened and more or less twisted bands," and his figure represents, as well as a wood engraving can be expected to do, what I call "thin flat fibres." The writer of the article "Cotton" in the English Cyclopædia (A.D. 1854), says, "They (*i. e.* the fibres) are long, weak tubes, which, when immersed in water and examined under the microscope by transmitted light, look like flat, narrow, transparent ribands, all entirely distinct from each other and with a perfectly even surface and uniform

breadth. Professor Henfrey, 'Micrographical Dictionary,' is nearly as bad; he says, "From the absence of the regular thickening layers the cells of the cotton hairs become collapsed when dry, appearing like a thin band with thickened borders."

12. I have said that I have not found the above descriptions to apply otherwise than exceptionally, but I should mention here, that in some of the samples small knots remained after the cotton was teased out with the fingers, and that I examined several of these knots and found them composed (almost entirely) of very thin, weak, flat fibres, much entangled.

13. Although it seems probable that the quality of cloth produced and the facility of working must depend materially upon the *form* of the fibre, yet great stress is laid upon its length. It is therefore with much regret that I am obliged to say I have not been able to devise any easy and practical method of measuring *single* fibres. The exceeding tenuity of the fibre, say as a mean $\frac{1}{1200}$th of an inch in diameter, renders it impossible to apply it to an ordinary scale, and the only method I can see is to cement them to a glass slide, which can then be applied to a scale ruled on glass for the purpose. This is exceedingly tedious and very trying to both eyes and head from the impossibility of seeing the fibres without a lens; I therefore abandoned it for the method adopted (I believe) by the broker and manufacturer, of repeatedly drawing a small portion through the fingers until it appears to be nearly all in a line, and then measuring these small tufts.

14. It is necessary also to observe that there is no equality of form or diameter in the individual fibres, which are in one part round, in another flattish and twisted, appearing varicose; spreading out into a flat, thin fibre for some distance, to become again contracted, &c. This variation of form seems to render anything like a standard of measurement next to impossible.

15. I have sent herewith the small tufts of cotton from which the lengths entered in the table were obtained. His Excellency's proposition to draw lines on paper exhibiting the average length of the several staples is, I think, a very good one. I would, however, suggest that a broad black line on white paper, while quite as well seen as a white line on black paper, would be more readily executed, the latter method, I fear, would require wooden blocks engraved for the purpose. It should be accompanied by a short description of the way in which a small tuft is to be prepared for measurement. The photo-lithograph sent by the Cotton Supply Association is not very plain, and unaccompanied by any explanation it seems likely to be misunderstood; for a friend of mine who has taken some interest in cotton cultivation told me he thought it was intended to represent seeds with the adhering fibres simply stretched out. If an educated man could fall into this error, it would not be strange if the native cultivator should find it hard to understand.

16. I will not detain this report longer, but will endeavour to

prepare a memorandum on the subject of measurement, to be forwarded hereafter.

P.S.—1. In a note dated 22nd instant, with which I was favoured, His Excellency Sir W. Denison was good enough to suggest the possibility of obtaining a better knowledge of the structure of cotton fibres by means of transverse sections.

2. The subject is a very difficult one, as the sections require to be so exceedingly thin, less than one-thousandth of an inch. I am not, therefore, surprised that I did not succeed. But my failure to obtain transverse sections, properly so called, led me to cut as obliquely as possible through the fibres, and this method has revealed all I wanted to know, for the sloping extremities of the fibres thus obtained show beyond a doubt that in all, except the very thinnest, there is a greater or less amount of secondary deposit, which in the round, roundish, and flattish ones is carried to such an extent as to form (?) homogeneous solid body, instead of a hollow cell or tube, but in the flattish fibres the deposit appears thickest at the margins. The same result was subsequently arrived at by examining the cut extremities of other portions with a half-inch object glass and Lieberkuhus' reflector. This method of examination not only confirmed the results of the other, but exhibited also the very irregular form of the transverse section.

3. I have also examined the fibres by polarised light, upon which I find the thin flat fibres have little or no action, being nearly, sometimes altogether, invisible when the axes of the Nicol's prisms are crossed. But they become visible when a film of selenite is interposed between them and the polarising prism.

25*th April*, 1862.

Progressive numbers.	Form and Character of the fibre in the several samples.
No. 1	The majority of the fibres flattish with thickened walls, a few flat and very thin, still fewer round and solid looking.
" 2	The flat thin fibres and those with thickened walls in about equal proportions, a few round solid looking.
" 3	Fibres chiefly flattish with thickened walls, some round and roundish solid looking; but very few of the very thin kind.
" 4	Many flat and very thin fibres: others flattish with the walls but moderately thickened, a few round solid looking ones.
" 5	The thin flat fibres present in considerable number, fibres generally but little thickened and having a delicate appearance.

Progressive numbers.	Form and Character of the fibre in the several samples.
,, 6	Much like No. 5. The thickness of the wall of a fibre that measured $\frac{1}{1,408}''$ was $\frac{1}{13,786}$th of an inch.
,, 7	The flat thin fibres were the predominating character of this sample.
,, 8	Some flat thin fibres, but not in great numbers, the roundish and flattish predominating.
,, 9	The flat thin fibres formed about (?) $\frac{1}{3}$rd; the remainder chiefly flattish with thickened walls.
,, 10	Thin flat fibres in considerable numbers, perhaps one half.
,, 11	Consists chiefly of flattish and roundish fibres, the very thin flat ones being proportionately few.
,, 12	Fibres roundish and flattish with thick walls; very few of the thin flat kind.
,, 13	A few thin flat fibres: some of the fibres have a ragged or torn appearance.
,, 14	Chiefly round, roundish and flattish fibres with thick walls; but few of the thin flat kind.
,, 15	Flat fibres present, but not in great number; chiefly flattish hairs with thick walls.
,, 16	Flat fibres in moderate quntity; the remainder roundish and flattish fibres with thickened walls, but somewhat uneven.
,, 17	Like No. 16. This is marked "saw-ginned." I have not seen any indications of the injury said to be done by the saw-gin to Indian cottons, the fibre is as sound as any I have looked at.
,, 18	Consists of roundish, flattish, and round fibres; the broad, thin, and flat kind being very rare. This seems a very even cotton.

(Signed) J. Mitchell, Captain.

Order thereon, 5th May, 1862, No. 977.

1. Resolved that Captain Mitchell's report of his microscopical examination of various specimens of cotton be printed and circulated. The samples numbered 10 to 18 were received from the Manchester Cotton Association.

2. Captain Mitchell is requested to prepare the drawings and descriptions referred to in paragraph 15.

(True Extract.)

(Signed) J. D. Sim,
Secretary to Government.

To the Officer in charge of the Central Museum.

Exd. T. McMootry.

REVENUE DEPARTMENT.

PROCEEDINGS OF THE MADRAS GOVERNMENT.

Read the letter from Captain J. MITCHELL, Officer in charge of the Government Central Museum, to J. W. BREEKS, Esq., Private Secretary to His Excellency the Governor, dated Madras, 29th April, 1862 :—

MY DEAR SIR,

With reference to the 16th paragraph of my letter of the 21st April, 1862, to your address, I have now the honour to forward a table exhibiting the prices of the various samples of cotton sent out by the Cotton Supply Association, opposite to which are black lines to show the average length of staple, which lengths are also given in inches and decimal parts. To this I have added a short memorandum to show why the table has been prepared, and containing a few remarks having reference to some points to which it appears desirable to attract attention

Will you do me the favour to ascertain whether this paper will meet the wishes of his Excelleney the Governor, as conveyed to me in paragraph seven of your letter of the 3rd April, 1862.

The white lines on this paper are intended to show, without having recourse to a scale, the average length of fibre in the several samples of cotton sent by the Cotton Supply Association, being those in the greatest demand in the English market.

The plan of measurement adopted was to tease out repeatedly a small quantity of cotton until a tuft was obtained with both extremities of the fibres as nearly as possible in line. It was then tied round the middle with a thread, and applied to a one-inch diagonal scale.

But as, notwithstanding every care, there will remain a few fibres which project beyond the others, it is proper to note that the lines represent the length of the *principal body* of the tuft, and not that of these few extreme fibres.

There is a perceptible difference both to *sight* and *touch* in different cottons; some are *very* soft and *silky*-looking, others feel somewhat crisp and look less brilliant. But it is probable that considerable experience is requisite before cotton can be judged of in this way; therefore no attempt has been made to lay down rules on that subject here. It must, however, be observed that in cottons of Indian growth the microscope shows a greater proportion of thin flat fibres than is found in the American grown cottons, and it is possible that much of the beautiful glossy appearance of the better class of long cloths and cambrics depends upon the comparative absence of these thin flat fibres from the cotton of which they are made; and it may be a question for scientific agriculturists whether any alteration of the time of sowing or by some other means of which they will be the best judges, more time cannot be obtained for the accumulation of secondary deposits in the hairs of cotton seeds. Its absence, and perhaps the shortness of the fibre also, may be due to the too rapid ripening of the pods, or is it owing to the poverty of the soil?

Some cottons present a considerable number of "specks," or "knots;" these are found to consist of fibres in which the secondary deposit is absent, that is, of the thin flat fibres, consisting of the cell-wall only.

The points to which the cotton spinner attaches the greatest importance is "LENGTH OF FIBRE" and "ABSENCE OF FOREIGN MATTERS," or in plain words "DIRT;" *uniformity* of length also is of course assumed; a reference to the prices also will show that they are in proportion to the *length* of *staple.* Thus on the 18th December, 1861, SeaIsland cotton, which measured about one inch and two thirds, was worth 21*d.*, say 14 annas per lb., while saw-ginned Surat, which measured one inch and one fifth, say half an inch less, brought only 7¼*d.*, or a trifle more than one third of the price of the former.

The point therefore to which the attention of the grower should be directed is, by improved cultivation to increase the length of staple, for we see that when the staple was one half longer, the price was three times greater or increased from a trifle under five annas, to fourteen annas per lb. It is true the *fibre* was also *better in other ways*, but it is likely that more careful cultivation would improve the cotton in every way.

The cotton (No. 1) placed at the head of the list is that in greatest demand, and it will be seen that its length does not much exceed the Broach cotton. Knowing what careful agriculture has effected in Europe, Europeans have a right to expect that the same cause should produce the same effect in India, and in addition to one-half or 50 per cent. to the price should be an inducement sufficient to the cotton grower to endeavour to effect such an improvement as would give India that command of the cotton market which is now held by America.

Length and Price on the 18th December, 1861, of the following Samples of Cotton.

No.	Description.	Price per lb.	Length.	Inches.
1	American Medium Cotton	12*d.* or 8 Annas* ...		1·4 to 1·25
10	Sea Island Cotton	21*d.* „ 14 „ ...		65
11	Sea Island Cotton, stained	12*d.* „ 8 „ ...		1·7 to 1·6
12	Egyptian Cotton .	12*d.* „ 8 „ ...		1·6 to 1·55
13	Pernambuco Cotton	11½*d.* „ 7 „ 8 Pie.		1·45 to 1·4
14	Fair Orleans Cotton	11½*d.* „ 7 „ 8 „		1·35 to 1·23
15	Middling Orleans Cotton	10¾*d.* „ 7 „ 2 „		1·33 to 1·25
16	Broach Surat......	8*d.* „ 5 „ 4 „		1·25 to 1·15
17	Saw-ginned Surat.	7¼*d.* „ 4 „10 „		1·2 to 1·1

* On the 20th November, 1861, for this sample only.

ORDER THEREON, 10th June, 1862. No. 1276.

1. The Government are much obliged to Captain Mitchell for the Table, &c., submitted with this letter.

2. As the Table cannot be of much use, the Government direct that copies of it and of the Memorandum annexed, as also of the papers recorded in the Order of 5th May, 1862, No. 977, be furnished to the Board of Revenue for distribution to the several Collectors of this Presidency, and to such other persons as are interested in cotton cultivation.

(True Extract)

(Signed) J. D. SIM,

Secretary to Government.

To Captain J. Mitchell.

To the Board of Revenue.

Exd. S. T. Augustin.

Ordinary Meeting, March 22nd, 1864.

E. W. BINNEY, F.R.S., F.G.S., President, in the Chair.

Mr. HURST communicated the following letter from Capt. John Mitchell, Superintendent of the Madras Museum :—

Madras, 13*th January*, 1864.

To H. A. HURST, Esq., 61, George Street, Manchester.

DEAR SIR,—I have the pleasure to acknowledge the receipt of your letter of the 10th November, 1863.

There are very few microscopists here, and as I do not know any person who is likely to undertake the examination of cotton fibre in the various stages of its growth, I have resolved to do so myself, in the belief that the subject is one of sufficient importance to justify me in devoting one day in the week to the inquiry so long as may be found necessary.

I have accordingly made arrangements with Dr. Hunter, Honorary Secretary of the Madras Agrihorticultural Society (who at once promised me every assistance), to receive weekly on Saturday a few pods from the Society's grounds, where cotton of all kinds is growing.

I have already given four days to this inquiry, and although it is still in its infancy, I have obtained some interesting results, which I will at once briefly communicate.

I began the examination with pods that were supposed to have been just formed. In this, the earliest stage, I found the cotton hairs just becoming visible upon the surface of the seed as minute transparent hemispheres containing a few motionless granules—

I should perhaps say translucent, for the cotton hairs do not seem ever to be transparent.

In a more advanced stage the seeds were covered with hairs which contained numerous minute granules floating in a very fluid and colourless mucus. An active rotation of the cell contents, exactly like that in Nitella, was seen in all the hairs that had not been injured by pressure, and continued for a considerable time, at least half an hour. I found it could be seen with Ross's half-inch and the higher eyepieces, but I used chiefly a $\frac{1}{12}$th.

In a pod apparently somewhat older the appearances only differed by the cell contents, which I have called colourless mucus above, becoming thickened, and the granules somewhat smaller, so that we had a fine granular mucus of a pale buff colour.

As the pod becomes older the cell contents appear to increase in density and rotation to cease; at least I have not seen rotation unless in the hairs of young seeds, *i.e.*, seeds from young pods of perhaps from two or three to ten or twelve days' growth. I have not, unfortunately, been able to learn the exact age of the pods.

On Saturday last I plucked a fine pod of Queensland cotton (growing in the garden of a friend) that was supposed to be nearly full grown, and was upwards of two inches in vertical diameter. In the hairs of this I found generally, but not always, a considerable amount of secondary deposit, made evident by the thickening of the walls and by its action on polarized light. But in the hairs of younger pods there was nothing of the kind, and the walls were so thin as scarcely to afford evidence of their presence, it requiring considerable power to bring out the usual double contour line, and they had no action, singly, on polarized light, although they became a little luminous in a mass of many.

The growing cotton fibre is an elongated cone with a hemispherical apex, and, of course, a circular transverse section. Each hair is a single cell. I have sought in vain, with all powers and every kind of illumination that I thought likely to render it visible, for any section or transverse division in the hairs, and I have been equally unsuccessful in my search for spiral fibres, which Mr. O'Neill says he found in cotton by means of re-agents, and I believe I am justified in saying that spiral fibre did not exist in any cotton hairs hitherto examined by me. But I have yet to examine pods of a later growth, and spiral fibre may yet appear, but I must confess I do not expect it.

I have not seen any twist in growing fibre, and, notwithstanding the pressure to which the hairs are probably exposed, I have seen no flattening from this cause, but the hairs of course collapse and become flat when from any cause the cell contents are absent. From sections I have made and examined I believe that in the younger pods the hairs wind round the seeds; in the more advanced stages the hairs of neighbouring seeds intermingle, and this may account for the bent and twisted appearance of dry cotton, that is, in some degree; but the principal cause will doubtless be found in the desiccation of the cotton after it is exposed to the sun by the bursting of the capsule.

I must not omit to mention that when by pressure a portion of the contents is expelled from the cotton hairs, it frequently appears in the form of small spheres, in which an active molecular movement of granules is seen, just as in the mucous corpuscles from the mouth, from which, in appearance, they only differ in their larger size.

I have seen in some dry Sea Island cotton, with a $\frac{1}{12}$th and polarized light, what Mr. Sidebotham (was it he ?) took for spiral fibres, I presume; but they are only visible in places and not in all hairs. I confess that at present I am a sceptic on this point.

With apologies for this hasty letter,

I am, dear Sir,

Your most obedient servant,

J. Mitchell, Captain,
Superintendent Madras Museum.

May 9th, 1864.

Officers elected 9th May, 1864:—President, Joseph Sidebotham; Vice Presidents, Arthur G. Latham, Thomas Allcock, M.D., John B. Dancer; Secretary, Henry Alexander Hurst.

Of the Council:—Joseph Baxendell, F.R.A.S., Thomas H. Nevill, John Parry, W. H. Heys, W. Roberts, M.D., W. C. Williamson, F.R.S., &c., Murray Gladstone, L. H. Grindon.

ANNUAL REPORT, 1864.

The Council of your Section in presenting this, their sixth annual report, have to regret the loss of their late Secretary, Mr. George Mosley, whose untiring industry and zeal in promoting the progress of the Society can hardly be over estimated. One of the first members, he was from its very commencement an indefatigable worker in its cause, and the Council believe that to him, in a great measure, may be attributed the marked success and increasing usefulness of this Section. His place has been very ably filled by Mr. H. A. Hurst, one of the original suggestors of a Microscopical Society in Manchester, and also one of our oldest members, who has without hesitation very kindly acceded to the request of the Council to take upon himself the duties of Honorary Secretary of the Society.

Your Council have only to record the accession of one new member during the past Session, which has been one of comparative quietude in the history of Microscopical science.

The following papers and communications have been laid before you at the meetings held this Session:—

Two communications "On the structure of the Cotton Fibre at various stages of its growth," by Captain J. Mitchell, of Madras.

A paper by Messrs. Thomas Davies and J. D. Dale, "On Transparent Injections."

A paper by W. H. Hyslop, "On mounting Microscopic preparations in Canada balsam and chloroform."

"Description of an instrument for collecting soundings free from tallow," by Captain Baker, ship "Niphon."

A paper by Mr. Sidebotham, "On mounting objects for the Microscope in fluids," illustrated by specimens mounted in 1842 and subsequent years.

"Suggestions as to the use of mica slips and covers instead of glass, when employing high object-glasses," by Mr. Sidebotham.

Addresses "On the present state and aims of Microscopic Investigation," by Professor Williamson and Mr. Sidebotham.

The Society have also been favoured, by Mr. Dancer, with the exhibition of a new and improved *oxy-calcuim* Microscope.

Abstracts of most of the above communications have been printed in the proceedings of the Society, and in the 'London Quarterly Journal of Microscopical Science.'

Many discussions have taken place regarding the structure of the cotton fibre.

Your Council would remind the members that ample supplies of cotton plants are being raised for their use, and trust the structure of cotton fibre will be fully investigated during the recess, the members having at their command better object-glasses and instruments than have been hitherto applied to these investigations. Mr. Grindon has kindly promised to supply pods to members who apply for them.

Supplies of soundings have continued to arrive from various quarters of the world, and it is to be hoped another year will not elapse ere some attempt be made to examine and classify the fine collection now in the possession of the Section. The addition to your microscopical objects has not been important, excepting twenty-four beautiful slides of scales of diurnal lepidoptera, illustrating Mr. John Watson's paper on the subject, read at our previous Session; a fine specimen of Microscopic writing on glass presented by Mr. W. J. Rideout, and some fine sections of cotton from Mr. Crum, illustrating his pamphlet on the subject.

Your Council would earnestly solict the donation of good illustrative slides, which would always be accessible to the members, and hope that in time a valuable collection of authentic specimens may be brought together to serve for reference.

The attention of the Section is respectfully called to a new rule of the Parent Society admitting associates to the Section on their paying half a guinea yearly subscription to the Section and a similar sum to the Parent Society. These associates enjoy the privileges of attending the meetings of the Section to which they belong, and also the use of the reading room, with access to the valuable library of the Parent Society. It is to be hoped that this measure will add to the number and efficiency of the Section.

The Treasurer submits the following account of receipts and expenditure of the past year:

J. G. Lynde, Treasurer, in account with the Microscopical Section of the Literary and Philosophical Society of Manchester, from May 18th, 1863, *to May 9th,* 1864.

Dr	£	*s.*	*d.*	*Cr.*	£	*s.*	*d.*
To Balance of last Account	4	15	2	By Microscopical Journal	0	10	0
Subscriptions received	16	5	0	Printing and Stationery	1	1	0
				Album	0	16	0
				Literary and Philosophical Society for attendance	2	2	0
				Tea and Coffee	2	16	0
				Postages	0	7	11
				Balance	13	6	9
	£21	0	2		£21	0	2

Examined and found correct,

John Slagg, Jun.,
Robert Worthington, } *Auditors.*

In conclusion, your Council would earnestly beg members to avail themselves of the ensuing recess to work up some of the many mysteries still existing in Microscopic Science. The movements of Diatomaceæ,—reported Amœba in the interior of Plants, —Sexuality of Infusoria,—are all subjects which will amply repay careful thought and investigation. The doubt existing as to the cause of the first, may be considered almost a reproach to Microscopic workers.

Your Council would also express a hope that the next Session may be as fruitful (if not more so) than the last.

The Report of the Committee appointed to consider the best means of mounting objects belonging to the Section, was read and received.

COPY OF THE REPORT.

The Committee appointed to consider the best means of mounting the objects belonging to the Section have now to report, that several meetings have been held to fix upon the method to be pursued to carry out the views of the members.

The following resolutions and recommendations have been passed:

1. It is desirable that the soundings be first attended to, and that a specimen of each be mounted dry for the cabinet, to show the sand and the general character of the sea-bottom or harbour from whence it was obtained.

2. Those soundings containing interesting specimens may be afterwards mounted on a slide of Nevill's cells, each description separate.

3. That it may be desirable to request certain members to prepare cells, others to mount the specimens, and others to examine and report upon them when mounted.

4. That any of the members of the Section who may desire to assist in the work can do so; and that a register be kept of specimens delivered to members and the time of return.

5. That the Section shall provide glass slides and thin glass for the purpose of mounting the specimens.

6. Duplicate slides of interesting objects from soundings may be exchanged for other objects not in the cabinet.

7. The specimens of Indian woods may be mounted for distribution amongst the members by any member who may wish to take charge of them, and who will at the same time mount one slide of each for the cabinet; the blocks to be returned to the Section when done with.

8. That a catalogue of the objects now in the cabinet be made as soon as convenient.

9. The Committee recommends that three curators be annually appointed, who shall have charge of the management of the specimens belonging to the Section.

Linnean Society.

On the Spiral Markings *of the* Flocci *in the* Genus Trichia. By the Rev. M. J. Berkley, M.A., F.L.S.

A good deal of controversy has arisen respecting the real nature of the spiral markings in the genus *Trichia*, which were first observed by Schmidel and the younger Hedwig, and afterwards more exactly, on modern improvements in the microscope, by Klotzch and Corda, who were probably, at the time they made their observations, unaware of the earlier notices. The accuracy of Corda's drawings has, however, been called in question; and mycologists, a few months back, were pretty equally divided on either side, the one regarding the threads as real spiral vessels, the other insisting that the spiral lines were due to torsion, while Mr. Currie advocated a third opinion, in which he has been followed by De Bary and Wigand, viz., that the markings were due to elevations in the threads assuming a spiral direction.

The question has again been brought immediately under my notice by some observations of Mr. Knight, sent in a letter to Dr. Hooker from New Zealand, an extract of which I shall beg to lay before the Society.

"I notice," writes Mr. Knight, "in the review of Mr. Berkeley's 'Outline of British Fungology' in the 'Natural History

Review' of January, 1861, p. 8, that the reviewer states, in respect of spiral vessels, that it is true that all the species of *Trichia* contains threads, all of which bear spiral markings, but the nature of the markings is still a subject of controversy.

"That these threads are true spiral threads I cannot doubt. I should, three or four years ago, have drawn your attention to the observations I had made on the subject, had I not been under the impression that the controversy had ceased, and the spiral nature of those cells been admitted.

"I send you now a tracing of a sketch which I made several years ago. You will see that there are three distinct continuous spirals—not asperities, nor what the reviewer terms arcuate elevations of the cell-wall following a spiral direction. That there may be no doubt of the correctness of the observation, I enclose for Mr. Berkeley a few specimens of a *Trichia* collected here. I have had them some time, and they may not be so well adapted for observation as when in a living state. With a good microscope and a $\frac{1}{5}$th object-glass the spirals are brought out quite distinct, but a $\frac{1}{8}$th may be necessary to enable one to count the number of spirals.

"Previous to observation, the specimen should be placed for a few hours in cold water, and then in boiling water. A shallow eye-glass would be best to use with the $\frac{1}{5}$th; otherwise, from the age of the specimen, the crossing of the threads will give the appearance of asperities. The size of the spores is at least four times too great to admit of their being a spore attached to each asperity."

Just after the receipt of Mr. Knight's communication, a very learned paper, by Herr Wigand, appeared in Pringsheim's "Jahrbücher für wissenschaftliche Botanik," (published at the end of November, 1861) on the genus *Trichia* and the nearly allied genus *Arcyria*, which differs principally from *Trichia* in the absence of spiral markings, or rather in the frequent substitution of rings instead of spirals. The memoir is accompanied by numerous and most careful figures; and while it is quite convincing as to the threads bearing a very close relation to the spiral vessels of higher plants, it shows at the same time that they cannot be considered (at least, so far as herbarium specimens show) as vessels containing a free spiral thread, or even a raised spiral thread attached to the inner walls, but rather as having an elevation of their walls from within in a spiral direction, so as to leave a groove externally between each volution of the spiral,—the hollow of the spiral itself being filled up afterwards, it should seem, by the deposition of new matter, though never in such a degree as to produce a raised spiral thread within the tube; they resemble, in fact, if I may be allowed to use the illustration, a male screw rather than a female. As a proof of the deposit being subsequent to the spiral elevations, he adduces the fact that when first formed they are colourless, and that they only become opaque at a later period of development. In certain states of *Trichia furcata*, as in *Arcyra punicea*, he finds rings instead of spirals, and, in some threads of the former, rings and spirals at the same time, with the addition of bladder-like swellings or beads towards the extremities. In *Trichia abietina* the spiral branches, and after two or three volutions become simple again, then running in a horizontal detection so as to form imperfect rings, and then again becoming oblique, exactly after the fashion of the mixed vessels of Phænogams. Such phases, it is clear, could never be presented by any twisting of a flat thread, even where there is one spiral alone—not to mention the fact that the threads are, from their earliest growth, not flat, but cylindrical—much less where the threads themselves are branched and, at the same time, irregular in outline, as is frequently the case. Till a thin vertical slice from a thread can be obtained, it may be impossible to say, so positively as to convince all gainsayers, notwithstanding the deeper tint, whether there is really any deposit in the inside of the threads corresponding to the spiral markings, though in any case the elevations are due simply to some action *within*, which take place in a spiral or circular direction, passing occasionally from one into the other.

I have examined Mr. Knight's specimens, prepared precisely according to his directions, and with an object-glass of one-fifth I see, clearly enough to satisfy myself, that there is a depression in the membrane of the thread between each spiral exactly as the structure is figured by Wigand, and, indeed, previously by Mr. Currey,* though, at the same time, it seems clear to me that there is no twisting of the thread, and that the appearance could never have been brought about by mere torsion. In *Battarea* I have seen the vessels more closely approaching the type in Phænogams; and, unless I am greatly deceived, I have on former occasions, in individuals of *Trichia* which had just passed from the milky stage, seen nearer approaches to this than any which are figured in Wigand's plates. Be this, however, as it may, whether the difference be greater or less, it is pretty certain that the spiral marking of the threads is a case rather of affinity than analogy; and we cannot entirely deny the existence of spiral vessels in fungi, though they may exhibit a somewhat different type from that to which we are accustomed. I have seen precisely the same arcuate elevations in the cells of *Sphagnum*, respecting the spiral threads of which I believe there is no doubt.—*Journal of Lin. Soc.*, Vol. VII, p. 54.

On the Spicula *contained in the* Wood *of the* Welwitschia, *and the* Crystals *pertaining to them.* By Colonel Philip Yorke, F.R.S.

When the spicula were immersed in dilute hydrochloric acid, even though they remained in the liquid several hours, there was no action on the crystals.

* 'Quart. Journ. Mic. Sci.,' Vol. III, Pl. II, fig 4.

Also when the spicula were placed in a platinum spoon with hydrofluoric acid and heated, and when the same was done with a solution of caustic soda, there was no apparent action on the crystals.

On the other hand, when the spicula were boiled in nitric acid, the crystals disappeared.

When a few spicula were carefully burned by heating them on platinum foil over a small spirit-flame, a white ash remained of the form of the spicula; and when this ash, moistened with water, was examined by the microscope, it was found to be made up of a congeries of the crystals unaltered in form, and acting on polarized light.

When a drop of dilute hydrochloric acid was added, the crystals disappeared, apparently with effervescence.

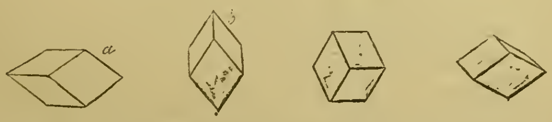
A quantity of the spicula was collected which weighed 0·105 gr.; this was carefully burned as before; the ash weighed 0·010 gr., or just 10 per cent.: water added to the ash, the liquid slightly restored the blue of reddened litmus; a drop of hydrochloric acid added, the ash dissolved with brisk effervescence; and when this, neutralized by ammonia, was tested by oxalate of ammonia, a considerable precipitate formed.

The supernatant liquid was removed, and tested by phosphate of soda; but a very minute, if any, precipitate was thus formed.

This experiment shows that the substance examined is essentially carbonate of lime, possibly with a little carbonate of magnesia.

The form of the crystals also supports this view, though their minuteness renders the examination difficult. By far the greater

Sketches of the crystals.



number of the crystals presented a rhombic outline, the largest measuring in their longer diagonal $\frac{1}{2000}$th of an inch. Some approximation to the measure of the angles was obtained by means of a doubly refracting prism fitting on to the eye-piece of the microscope; the mean of several measures gave 106° nearly as the value of the obtuse angle (that of calc-spar being 105°5′). With regard to the prismatic-looking crystals occasionally seen, several, examined by favorable light, presented the figure *a*, *b*.

This form of rhomboid resembles that which was called by Haüy the "inverse," a peculiarity of which is, that its plane angles measure the same as the dihedral angles of the primary rhomboid.

The crystals of the so-called crystallized sandstone of Fontainebleau (which are carbonate of lime containing sand) are instances of this form.

As it appears, therefore, that these crystals consist of carbonate of lime, the question remains, What is it that protects them from the action of acids?

Some light is thrown on this question by the following observations:

Alcohol and ether, even when heated, had not the power of removing the protecting substance; but if, after digesting with ether, the spicula were boiled in solution of caustic soda and subsequently immersed in dilute hydrochloric acid, the crystals disappeared, and their places were occupied by amorphous patches.

There is one objection that may perhaps be taken to the view here adopted as to the nature of the crystals, which may as well be noticed. It may be thought that in the plant the lime was united to some organic acid, say the oxalic. But it will be admitted that, putting aside the agreement in form with carbonate of lime, the fact of the crystals being unaltered in form by burning, and retaining the power of acting on polarized light, is fatal to such an hypothesis.—*Journal of Linn. Soc.*, Vol. VII, p. 106.

Royal Society.

"*A Contribution to the* Minute Anatomy *of the* Retina *of* Amphibia *and* Reptiles. By J. W. Hulke, F.R.C.S. Assistant-Surgeon to the Middlesex and the Royal London Ophthalmic Hospitals. Communicated by W. Bowman, Esq Received February 4, 1864.

(Abstract.)

The animals of which the retina was examined were the frog, the black and yellow salamander, the edible turtle, the water- and the land-tortoise, the Spanish Gecko, the blindworm, and the common snake. The method adopted was to examine the retina (where possible) immediately after decapitation of the animal, alone and with chemical agents; and to make sections of the retina hardened in alcohol or in an aqueous solution of chromic acid, staining them with iodine or carmine, and adding glycerine, pure and diluted, to make them transparent. The following is a summary of the results of the examination:

1. The rods and cones consist of two segments, the union of which is marked by a bright transverse line.

2. Each segment consists of a membranous sheath and contents.

3. The outer segment, or *shaft*, is a long narrow rectangle (by inference, a prism or cylinder). It refracts more highly than the inner segment. Its contents are structureless, and of an albuminous nature. It is that part which is commonly known as "*the rod*." It is smaller in the cones than in the rods, and in the cones narrows slightly outwards.

4. The outer ends of the shafts rest upon the inner surface of

the choroid, and their sides are separated by pigmented processes, prolonged from the inner surface of the choroid between them to the line that marks the union of the shaft with the inner segment. The effect of this is that the shafts are completely insulated, and rays entering one shaft are prevented passing out of it into neighbouring shafts.

5. The inner segment of the rods and cones, or body (the appendage of some microscopists), has a generally flask-shaped form, longer and more tapering in the rods, shorter and stouter in the cones. It is much paler and less conspicuous than the shaft. It fits in an aperture in the membrana limitans externa.

Its inner end always encloses, or is connected by an intermediate band with an outer granule which lies in or below the level of the membrana limitans externa. Its outer end, in cones only, contains a spherical bead nearly colourless in the frog and blindworm, brilliantly coloured in the turtle and water- and land-tortoises, and absent from the common snake and Spanish Gecko. In addition to this bead, where present, and the outer granule, the body contains an albuminous substance which in chromic acid preparations retires as an opaque granular mass towards the outer end of the body. The inner end of the body is prolonged inwards, in the form of a pale, delicate fibre, which was sometimes followed through the layer of inner granules into the granular layer. It does not appear to be structurally connected with the inner granules. It is essentially distinct from Müller's radial fibres, and bears a considerable resemblance to the axis-cylinder of nerve. That it *ever* proceeds from the outer granule associated with the rod- or cone-body is doubtful, from the consideration (α) that where the body is large, and the granule lies within at some distance from its contour, the fibre is seen to leave the inner end of the body distinct from the granule, and (β) that the fibre appears to proceed from the outer granule only where the body is small, as in the frog, and where the granule does not lie within the body, but is joined to this by a band. Ritter's axial fibres are artificial products.

6. The "outer granules" are large, circular, nucleated cells. Each cell is so intimately associated with a rod- or cone-body that it forms an integral part of it.

7. The intergranular layer is a web of connective fibre. It contains nuclei.

8. The inner granules are roundish, in chromic acid preparations polygonal cells. They differ from the outer granules by their higher refraction, by the absence of a nucleus, and by receiving a deeper stain from carmine. They lie in areolæ of connective tissue derived from Müller's radial fibres, and from the intergranular and granular layer. They are more numerous than the outer granules, and consequently than the rods and cones.

9. The granular layer is a very close fibrous web derived in part from Müller's radial fibres, and from other fibres proceeding from

the connective frame of the layer of inner granules. It transmits (α) the radial fibres, (β) fibres proceeding radially outwards from the ganglion-cells and bundles of optic nerve-fibres, and (γ) fibres passing inwards from the rod- and cone-bodies.

10. The ganglion-cells communicate by axis-cylinder-like fibres with the bundles of optic nerve-fibres, and send similar fibres outwards, which have been traced some distance in the granular layer.

11. In the frog and Spanish Gecko the author has a few times traced fibres proceeding from the bundles of optic nerve-fibres for some distance in a radial direction in the granular layer.

12. Müller's radial fibres arise by expanded roots at the outer surface of the membrana limitans interna, pass radially through the layers, contributing in their course to the granular layer, to the areolar frame of the layer of inner granules, and end in the intergranular layer and at the inner surface of the membrana limitans externa. They are a connective and not a nervous tissue, and do not communicate between the basilary element and ganglion-cells.

13. The orderly arrangement of the several layers and their elementary parts is maintained by a frame of connective tissue which consists of—1, an unbroken homogeneous membrane bounding the inner surface of the retina, the membrana limitans interna; 2, a fenestrated membrane which holds the rods and cone-bodies, the membrana limitans externa, first correctly described by Schultze; 3, an intermediate system of tie-fibres—Müller's radial fibres—connected with which in the layer of inner granules are certain oblong and fusiform bodies of uncertain nature; 4, the intergranular layer; 5, an areolated tissue, open in the layers of outer and inner granules, and very closely woven in the granular layer.

14. No blood-vessels occur in the reptilian retina.—'Proc. of Royal Soc.,' Vol. XIII, p. 138.

Hull Micro-philosophical Society.

The fifth winter sessional course of this Society, comprising twelve meetings (bi-monthly), for the purpose of delivering papers, with discussions thereupon, terminated on the 11th day of March last; the attendances were generally good, and a lively interest in microscopical research duly maintained.

George Norman, Esq., the President, gave the opening subject, "On Cleaning Diatomaceous Deposits," stating that the first important point to be ascertained is, the nature of the material which binds the mass together. In the generality of deposits, this seems to be aluminous earthy matter, often mixed with some siliceous material which renders the action of acids of little avail.

When the bulk of the deposit is clayey matter, the best plan is to place the lumps broken quite small into a vessel, and pour on a few ounces of water, hot, and rendered thoroughly alkaline with common washing soda; this plan frequently answers, causing the lumps to swell, gradually separating into layers, and finally falling asunder into a pulpy mass. The strong soda ley must now be removed by frequent washing, and afterwards boiled in a florence flask with pure nitric acid; the whole must afterwards be transferred to a large stoppered vessel and violently shaken, in order to break up the minute fragments of dirt, and thus to free the siliceous diatoms. After shaking, allow the vessel to stand for a space of time, varying from half to one hour or more, according to the size and density of the valves; the diatoms having subsided, the dirty water is drawn off with a syphon, fresh water added, and the shaking repeated. The whole secret indeed depends upon getting rid of the impurities by this violent shaking and washing; when quite free from all impurities the material may be transferred to a test-tube, washed in distilled water, and finially mounted.

Sometimes the binding material may be siliceous, in which case the only plan is to adopt Professor Bailey's caustic soda method, viz., boiling the material very slightly in a strong solution of caustic soda or potash, and suddenly pouring it into a large quantity of cold water to check the action of the alkali on the siliceous diatoms; the after process of boiling in nitric acid and shaking up is nearly similar to that already described.

Some of the Barbadoes and Oregon deposits were mentioned as being alike unacted upon by either acids or alkalies, in which case Mr. Norman had found a plan of long-continued boiling in plain water as the only adoptable method to break the lumps down. The gentle abrasion of the small particles during the boiling freed many of the valves which would have been destroyed had more force have been used. The finely abraded powder is to be boiled in acid as before mentioned; a previous boiling in soda or liquid ammonia had in some cases been found beneficial.

Should oxide of iron be present, which is shown by its red or yellow colour, muriatic acid must be used; the employment of sulphuric acid is always to be avoided should the presence of any lime be suspected. Gypsum or sulphate of lime in small quantities may be removed, by boiling in a solution of soda and then with nitric acid.

Should vegetable matter exist, it must be charred by boiling in strong sulphuric acid, and afterwards adding with caution finely powdered chlorate of potash.

When after careful boiling in acids there remains much flocculent matter, which falls with the diatoms and is difficult to get rid of, a few drops of liquid ammonia shaken up with the material causes the filth to remain a long time suspended, and may thus be drawn off with the water.

Mr. Hanwell's paper on the "Gastric Teeth of Insects" was illustrated by numerous slides of his own preparing, including those of the wasp, bee, cricket, cockroach, Dysticus, Staphylinus, ant, and flea, the last named of which provoked discussion, some members questioning the existence of gastric teeth, the flea being non-mandibulate; but several slides exhibiting the teeth *in situ*, as well as being separate also, the fact was generally admitted. Mr. Hanwell recommends the teeth of the cricket to be mounted in spirit and water, and then viewed as an opaque object.

Mr. Hendry upon one occasion displayed involuntary muscular fibre tinted with carmine obtained from the umbilicus and other parts, and contrasted these with the ordinary striped fibres. Upon a second occasion Teichmann's blood-crystals were produced in the presence of the members, and these were contrasted with the ordinary chemical evidences of blood in stains, spots, &c. And upon a third occasion Mr. Hendry exhibited as a novelty his newly obtained microscopical crystals in thin glass, through the agency of the blowpipe alone, probably a new arrangement by fusion of the ordinary constituents of glass, exhibiting uniformity in figure and nothing wanting either in number or beauty; specimens have already been forwarded to some members of the Metropolitan Society.

Mr. Prescott read a paper on the larger stinging nettle (*Urtica dioica*), in which he embodied the result of his hitherto unfinished researches on this much neglected order, observing that plants bearing perfect hermaphrodite flowers are far more common than are usually suspected, and in the male flowers are constantly found minute organs representing rudimentary pistils.

With respect to the stinging hairs on the leaves and stem of the plant, they do not, as stated by some botanical authority, collapse at the base when the point is touched, but a slight discharge of an irritating fluid is caused by the removal of the button at the extremity of the hair, and much of the irritation known as the sting is probably due to the pointed button remaining in the flesh when detached from the hair.

This interesting paper was amply illustrated by numerous well-mounted slides of microscopic sections of the plant, affording ready comparison with various excellent drawings of the same laid upon the table.

Dr. Kelbourne King in the course of the session delivered two excellent demonstrations, one upon the "Microscopical Structure of the Kidney," with mounted and fresh specimens, and another "On the Development of the Ovum," in illustration of the views of modern authors.

Mr. Hunter exhibited polarization as a test in analysis whereby distinguishing soda and potash and other salts.

Mr. Ball, of Brigg, exhibited in very great variety and beauty slides of his own mounting of the tongues of snails, &c., with comment thereupon.

Mr. James Young, one of the earliest of the Hull microscopists, and zealous labourer in the field of natural history, gave an interesting paper on the roots of plants, &c., with illustrations, under the following heads:—Source of plants, trees, &c. Fructification—peculiar forms of pollen—mysterious cause of species—power of germ—absorbing power of roots—effects of destroying fibres of roots—increase of stems downwards—increase of roots upwards. Roots in stems, leaves, &c. Law of nature in producing variety—variety how continued. Rule of growth from seed, contrary by roots, bulbs, &c.—power of roots in penetrating through dense clay, &c. Neglected valuable roots—stems changing into roots in autumn—changing annuals into biennials and perennials. Error of cropping perennial grasses in autumn—sap not descending. Torpidity of roots according to temperature—why the absence of sap-supply—how to produce monster masses of shoots—transpiration of sap—valve of roots—a dozen different names for roots according to manner of growth, form, &c.—sceptical opinions with regard to roots and plants—Creator's provision to perpetuate them against destruction—not the same provision for man and animals, being confined to seed, and by seed only can they continue their species. A leg, arm, finger, &c., can never produce or continue a similar creature.

WILLIAM HENDRY, *Hon. Sec.*

On HENDRY'S CRYSTALS. By WILLIAM HENDRY, Esq., Secretary of the Hull Microphilosophical Society.

(Read May 11th, 1863.)

(ABSTRACT.)

The author stated that four years since, in attempting to substitute fusion by the blowpipe for cement, in fixing their glass covers to slides, he noticed masses of crystals produced in the covers after the treatment, and believing them to be unkown, he named them after himself. To obtain the crytals he heats a thin glass cover on a piece of mica, over a spirit-lamp, holding both with forceps; then quickly turning them to the side of the flame, applies a blowpipe, withdrawing the cover to the apex of the flame for a few moments. An examination with a 1 or $\frac{1}{2}$-inch objective will then show the crystals. Similar results were observed in a thin glass slide, after a similar treatment, when examined with a $\frac{1}{12}$th objective. Specimens were sent with the paper, and the author suggests that it would be desirable to ascertain the chemical nature of the crystals, whether a silicate of lead or soda.

BOSTON NATURAL HISTORY SOCIETY.

AT a meeting of the above Society, March, 1864, Mr. C. Stodder exhibited a specimen of diatomaceous earth, with a slide of the same under the microscope. The specimen was from the land of

Mr. D. Faxon, in Randolph, Mass., found under the following conditions:—

The surface of the country is generally undulating. There is slight depression, with a level tract in the centre, nearly circular, of about one hundred feet diameter, apparently like any ordinary New England meadow, flooded with water: but, on walking ono to it, it is found, unlike flooded meadow lands, to be not soft and miry, but nearly as firm and hard as the surrounding dry land. The surface is covered with grasses and turf two to three inches thick. Immediately below that is found the material exhibited, which has in one spot been excavated to the depth of ten feet without finding the bottom of it. It contains vegetable matter, a few fibres, to the amount of five or ten *per cent.;* the remainder is entirely organic, nearly all whole or broken frustules of diatoms, with some spicules of sponges. Not one particle of sand or other inorganic matter has been discovered after the strictest search with the microscope.

The diatoms as yet have presented no species of particular interest. The genus *Himantidium* is most abundant; next, *Pinnularia* and *Stauroneis.* No attempt has been made to make any list of species found, as all are common in thousands of sub-peat deposits in New England. It would be a matter of interest to know if the species are the same at different depths from the surface; but no opportunity has yet been afforded for that, nor is it known from what depth the specimen examined was taken.

Under what conditions could this enormous accumulation of diatoms have been deposited? An examination of land in the immediate vicinity has given the clue to a probable explanation. As already stated, the locality is a slight depression from the general surface around. There is a very small stream of water running into and through it. The outlet is through a ridge of drift gravel, and has been artificially deepened some five feet since the settlement of the country. Before this lowering of the outlet, the place must have been a pond, with some four to five feet of water above the present surface. The small stream running into it comes from some twenty or thirty acres of meadow, from a hundred yards to a quarter of a mile distant, and a few feet (less than ten apparently) higher level. Now the pond, when it existed, was too deep for the growth of peat-forming plants, and not favorable for the growth of diatoms in any large quantity. But the meadows above were, particularly before the cultivation of the country and the introduction of artificial drainage, most favorable for the growth of diatoms. The sluggish stream draining the meadows would have force enough, especially in floods, to wash out the diatoms, and not enough to move sand: neither could the meadows supply sand. When the diatoms reached the pond they would of course settle to the bottom; for the mass of water in the pond being so great in proportion to the supply, there would be no perceptible current in it. In fact, it was a perfect natural trap for the diatoms, in principle exactly like the process used for separating diatoms from sand and other coarse material, in mounting for the microscope. The course of the little stream running into the pond is for a few rods through a ridge of drift material. This undoubtedly furnished some sand and coarse material, but it would be deposited almost immediately on entering the quiet water of the pond, and undoubtedly it will now be found directly against the entrance of the stream.

After the examination of this place, the conclusion must be that this deposit has been forming ever since the close of the drift period, when the surface of the earth received its present conformation.

Apothecaries' Society.

On Tuesday, the 31st of May, the Master and Wardens of the Society of Apothecaries opened their ancient hall in Blackfriars to receive a large party of scientific men and their friends. As at this *conversazione* the chief objects of interest that were exhibited were microscopes, microscopic objects, and enlarged diagrams, we select from the accounts in the papers and journals a few extracts, as a record of an interesting event, and an expression of our gratitude to the liberal hosts who so munificently catered for the intellectual benefit of their friends. The 'Medical Times and Gazette,' describing the entertainment, says, "Very seldom in this country has such a magnificent collection of microscopes and microscopical objects been brought together. All the great manufacturers of microscopes contributed instruments. It would be impossible to give anything like a full list of the varied and beautiful objects displayed. We may notice, however, a few of them. Amongst those exhibited by Messrs. Powell and Lealand was the circulation of the sap in the Valisneria, shown by a $\frac{1}{25}$th inch object-glass. Mr. Warrington exhibited, in a small aquarium, *Phoronis Hippocrepia*, the Annelidan homomorph of the *Hippocrepian Polyzoa*. The Hippocrepian tentacular plume, with the œsophagus and the vessels conveying the blood to and from the ciliated tentaculæ, were beautifully shown. Mr. Ross exhibited some objects under Kelner's large field eyepieces. A number of binocular microscopes were shown by Messrs. Crouch, Murray and Heath, Edmund Wheeler, Gould, Smith and Beck, and others. Mr. Jabez Hogg contributed a beautiful specimen of *Trichina spiralis*. But, besides microscopes and microscopical objects, there were many other things exhibited of great scientific interest. Dr. King and Dr. Stephen Ward showed a series of very interesting ethnological water-colour sketches taken from life by Mr. Say, Mr. Stephen Ward, Miss F. Corbaux, &c. We were especially struck with the 'Study of head of young Bushman,' by

Mrs. Ward. Mr. Carruthers exhibited some of the first original sun-pictures on metal plates, with etchings from the same, executed by M. Niepce in 1827. The Messrs. Wheeler showed various experiments illustrating the allotropic conditions of several elements. They also electrolysed water, making use of carbon poles; and showed that when these were employed carbonic acid was obtained at the negative pole in place of oxygen. Another experiment illustrated the bleaching effects of nascent hydrogen, the gas, at the moment of disengagement, decolorising a solution of indigo, but having no effect on the same solution when passed into a wash bottle containing it. On Wednesday morning, when the microscopical exhibition was visited by a large number of ladies, the same gentlemen made a series of brilliant experiments with twenty-four cells of a carbon battery of their own construction. With this battery they produced a powerful electric light, and showed the arc of the thallium flame on the screen. Iron and zinc were burnt with ease by means of the battery. They also exhibited the magnesium light, and showed beautiful experiments illustrating the fluorescent property of a solution of sulphate of quinine. There was a very large attendance both on the Tuesday and Wednesday; on the latter day of ladies."

A less learned critic, writing in one of the daily papers, says, "It was a pleasant change from the darkness, rain, and mud of Bridge Street, and its dismal sub-ways, when at 8·15 p.m. we reached the entrance of the hall, made warm and cheerful with lights, hot-house plants, and a profusion of flowers. At the hall door we were welcomed by Master Saunders, and found ourselves in the principal apartment, a handsome oblong chamber, adorned with portraits of a few of our English sovereigns, commencing with those of James I. and his ill-starred son, with the likenesses of many past masters, beginning with John Lorimer, Magister, 1654. This large room was well filled with students and professors of science, and on long ranges of tables were displayed, under an almost painful blaze of light, a truly wonderful collection of microscopes, hardly to be equalled in any of the museums of the world.

"Aquatic vegetables, globes inclosing smaller globes, and in perpetual motion, fairy baloons inflated by a subtle fluid consistent with transparency; a white human hair, shown in polarized light, and rich in the most brilliant colours; the scalp of a negro presenting, under the lens a rich, dotted surface; section of a cat's tongue, of a rich amber tint, with pearly points; tadpoles of a newt; animated minute dark bodies moving with great velocity; marine polyzoa, shown with remarkable clearness; crystals of borax, and oxalate of ammonia, exceeding in beauty and splendour the most perfect assemblage of gems; the injected lung of a sheep, a brilliant field of vivid scarlet varied with dazzling crystal points; muscle of a mouse, injected; toe of the same animal; spine of echinus; intestine of a frog; and the tongue of a drome fly—each of these minute objects including a little world of wonders. The sides of the hall were hung with a collection of surpassingly perfect diagrams, illustrative of all the kingdoms of nature, especially the various departments of physiology, and an endless variety of beautiful botanical studies. They were no doubt contributed for the occasion by the chief professors of those fascinating sciences. In a smaller side room was displayed a large collection of specimen chemicals, metals, and curious products of human industry; a miniature ancient catalogue of plants, copiously annotated by Ray, the great naturalist, and used by him while travelling; some extremely correct botanical drawings, coloured after nature, by Hindoo artists; a case of gold coins from a Japanese mint; some original photographic etchings, the first attempts in an art now so prodigiously improved, and abundance of other noteworthy objects too 'numerous to mention.' At the upper end of the hall there were three stereoscopes on an unusually large scale, representing the grounds of a chateau, and various phases of rocky and mountainous scenery.

"We spent two very agreeable hours in the rooms of the company, surrounded on all sides by gentlemen of no common acquirements, some of whom are of European fame. A few of the victors in science commanded universal attention, their gray hair and thoughtful faces challenging that silent reverence which is so much more valuable than vulgar applause. No better proof of the progress of scientific education amongst us could be brought forward than the presence of such an assemblage. The company had not forgotten the comfort of their guests, for whom a liberal supply of tea, coffee, cake, and delicately thin slices of roll and butter was provided. Every visitor must have left the hall with a deep sense of the courtesy and liberality of his entertainers. When so much precious time is sacrificed to mere amusement, which too often leaves nothing behind but a sense of weariness, it is highly desirable to attract thinking men of all ages, and especially the young, to such banquets of science, which afford far more genuine gratification than the showy spectacles which are addressed merely to the senses, and have no enduring charm for the mind. Some, doubtless, who availed themselves of the liberality of the compay on this occasion, will commence therefrom a life-long pursuit of wisdom in its more recondite forms, and become themselves, as years advance, the instructors of a new generation. Perhaps, however, these meetings would admit of an improvement: it would instructively and agreeably diversify the evening if, at intervals, men of acknowledged talent would read or deliver short addresses (each not occupying above ten minutes) on subjects illustrative of the specimens exhibited. After an hour or two, the continued inspection of microscopical objects exhausts attention, and becomes wearisome from its monotony. Besides, this would help more completely to carry out the true notion of a *conversazione*. The suggestions of new ideas by the speakers or readers would afford profitable themes for discussion, and all would carry away with them for home use intellectual gleanings of no ordinary value; not merely the recollection of curious or suggestive objects, but hints at interpretation and teachings too precious to be soon forgotten."

Amongst other objects of interest not referred to in the above extracts was an ophthalmic microscope exhibited by Mr. Ernest Hart, and constructed in such a manner that he was enabled to demonstrate by its aid the beautiful vascular structure of the eye of a living rabbit. A series of drawings also by Mr. Mummery, of Actiniæ and other marine animals, excited great admiration, on account of the accuracy with which minute points of structure were delineated, and their beautiful execution.

Birmingham Natural History Association.

Microscopical Section.

A Microscopical Section has just been added to the Birmingham Natural History Society, and promises to take an important rank among the educational institutions of that large town. The movement originated in a letter by Mr. Fiddian, which appeared in one of the Birmingham newspapers, advocating the formation of a Society devoted to microscopical research. The meetings are held in a large room at the Midland Institute on the second Tuesday in every month.

April 12*th*.—The first paper was read by Mr. Fiddian, subject, "The History of the Microscope." The varied forms of the instrument were described in a progressive order from the earliest rude lenses of the ancients to the introduction of the modern achromatic combination; a full description of the latter being reserved for a future occasion. The paper was illustrated by well-executed diagrams, a number of old microscopes, and a remarkable collection of old and rare books on the microscope.

May 10*th*.—A paper by Mr. T. Morris on "The Simple Microscope," with practical illustrations of the method of mounting and using small spheres of glass, Canada balsam, water, and other transparent media. A collection of insects mounted in a new style for the microscope was exhibited; also one of Adams's variable microscopes made in 1170.

June 14*th*.—An exhibition of living infusoria and some of the larger aquatic animals. Among these the *Volvox globator*, and the circulation in the branchiæ of the larva of the newt, excited the greatest amount of attention.

ORIGINAL COMMUNICATIONS.

CRYSTALLIZATION *and the* MICROSCOPE.

By THOMAS DAVIES.

In no branch of science does the microscope prove more useful than in the study of the numerous forms of the crystallization of salts. The exceeding minuteness of these forms constitutes no difficulty in their study; and where their tenuity renders them so transparent as to become literally invisible, polarized light generally lays them open to observation, with the addition of every beauty that colour can bestow. Without this aid, who would have suspected the rings and cross of nitre, or the gorgeous appearance of salicine? Even more than this may be asserted when we remember how many valuable facts there are which would still remain unknown without the aid of polarized light and the microscope.

But before the subject is entered into, the question may be asked, what is crystallization? This may be briefly described as the formation of certain substances in shapes according to fixed laws, which shapes are always the same except under interfering causes. The most frequent examples of crystallization occur when a solution of some salt has been made, and the liquid is again driven off by the aid of heat. If this process is repeatedly performed, on examination the crystals will always be found of the same shape, provided that no chemical change has taken place. But it is not by solution and evaporation alone that this phenomenon is displayed. From other causes crystals are formed, of which the three following may be termed the principal:

1st. Simple evaporation (as above), where water is driven off by heat, or where the salt is soluble to a greater extent in hot water than cold. A saturated solution being made in this case in hot water, a certain portion of the salt becomes crystallized on the liquor cooling.

2nd. Driving off by heat all or part of the water which is necessary to the formation of the crystal, and afterwards allowing it to reabsorb the same from the atmosphere, &c., as copper and magnesia (described in Vol. II, p. 128, of this Journal).

3rd. Fusion, and again allowing to cool.

From the second part of the first cause above mentioned it might appear that at a certain temperature the formation of crystals must inevitably take place; but this is not the case. Crystals do not readily form in any solution, even if "supersaturated," without some disturbance or interference. This, perhaps, explains the difference in the shape of many crystals, as the same accidental causes which aid their formation necessarily act more or less upon the form finally assumed. But it must not be understood that the regulations required to ensure fine and well-shaped crystals are by any means arbitrary or useless. When crystallization commences at a high temperature, and the mother-liquor is allowed to cool slowly and uniformly, the crystals are better developed than those obtained by a different mode of proceeding. As an instance of this may be mentioned the following:—Mr. Jno. G. Dale has frequently shown me the vats in which he crystallizes certain of his salts. These are not only made warm before the solutions are allowed to flow into them, but are deeply imbedded in sawdust, which is an imperfect conductor of heat, and thereby the cooling is rendered much more gradual. Thus the "accumulation" of crystalline forms receives no more interference from brother crystals than is absolutely necessary. This accumulation is often distinctly visible in large crystals, particularly in alum. One which I have lately obtained from the vats of my friend Mr. Dale shows each superimposed plate very clearly, though the transparency is almost perfect.

In cases where crystals are formed in masses their shapes are necessarily rendered invisible. Thick ice might be supposed to show no crystalline structure. It is, however, by no means "structureless," in proof of which may be quoted the authority of Professor Tyndall:—"Crystallization during freezing, takes place very similarly to snow crystals, even in thick blocks of ice from Norway or Wenham Lake, and the constitution of these masses is easily revealed by reversing the process which formed them. A large converging lens was placed in the sunbeams passing through a room, and the piece put into such a position that the point of convergence fell within it. Along the course of sunlight the ice became studded with lustrous spots. On examining the cube afterwards each spot was surrounded by a liquid flower of six petals. At first the leaves were unbroken curves, but when the flowers expanded under a long-continued action the edges became serrated. . . . . No matter in what direction a solar beam is sent through lake ice, the liquid flowers are all formed parallel to the surface of freezing." Thus, not only are the crystals perfect, but all these forms lie in successive parallel planes. This fact is clearly shown in many examples of microscopic crystals. The surface alone is first crystallized, the lower part becoming gradually assimilated in form to the higher; though, in certain instances, a conflicting arrangement becomes visible, and the two separate layers of crystals are unlike in some respects.

It is above stated that crystallization requires "disturbance or interference." It may be asked, what are these disturbances or interferences? In the present state of our knowledge of this science it would be impossible to give anything like a satisfactory answer to the question. A few of these causes, however, are known, two of which may be mentioned as the principal:

1st. Sudden change in temperature of certain parts of the substance, which cause contraction or expansion, and so give rise to the formation of crystals. Wherever the substance varies in thickness this action would be materially aided.

2nd. Insoluble atoms, dust, impurities, &c.

As instances of the first cause may be mentioned the formation of crystals, which is visible when produced on the microscopic slide. Those at the edge are almost invariably first formed, however equally the slide is heated. Of the second, the examples are so numerous that they frequently prove a great annoyance when a large surface of uniform crystallization is wanted. A small atom of undissolved salt proves a nucleus for the accumulation of other portions, and thus commences a circular growth of crystals, which materially interferes with the particular arrangement which might be desired. Dust, which is always floating about in the air, or fine impurities in the solution, produce important modifications, just as strings are suspended in the syrup-pans to serve as nuclei for the formation of sugar-candy.

It may be here remarked that most fused salts are governed by the same laws as those which are dissolved.

I. Santonine.

I have chosen santonine as the first to be considered. This substance is procured by boiling seeds of the artemisia and dry lime in alcohol; the decoction is then distilled, filtered, evaporated to one half, and afterwards boiled in an acid solution. When cold the santonine crystallizes in feathery forms, and after washing in alcohol is redissolved, and again crystallized. This salt is but sparingly soluble in water; but at 338° Fahr. it melts, and if the heat is not raised much higher than this point, and is carefully applied, no decomposition or change of colour occurs.

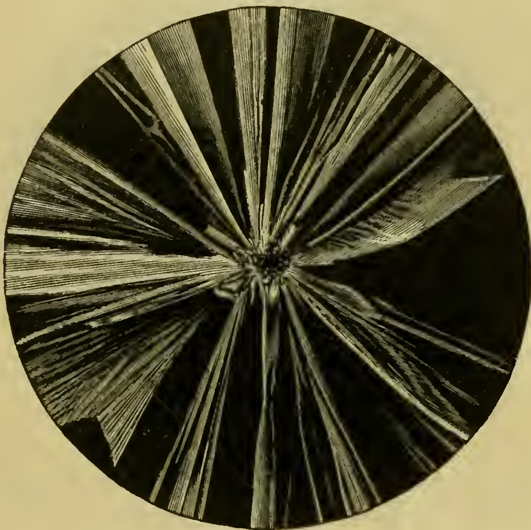
To prepare microscopic slides of this beautiful salt a saturated solution may be made in alcohol, then spread upon the slide, and the liquid evaporated. But this mode of proceeding is very inferior in the uniformity of its results to *fusion,* which may be effected as follows:—A small portion of the salt must be placed upon the centre of the slide, and the whole of the slide heated until the santonine is fused. By the aid of a hot needle the substance must then be evenly and thinly spread upon the surface required. As the temperature is lowered the formation of crystals, in various parts of the plate, takes place until the whole fused mass is covered. These crystals should be then mounted in castor oil, as santonine is slightly soluble in the Canada balsam which is ordinarily met with. Should, however, the difficulty in using oil prevent the operator from attempting it, he may safely use balsam if the film of santonine be a thick one, and the balsam be no deeper upon the salt than is absolutely necessary. Thus, the coating of balsam will become saturated with the salt without seriously damaging the crystal, provided the balsam be pure. But it may be here mentioned that, as it is usually obtained, it is not unfrequently adulterated, turpentine and other solvents being added to the stock lest it should become hard and useless. These solvents readily dissolve many substances which remain uninjured in pure balsam, and thus crystals and other objects are frequently lost, and the true action of balsam mistaken.

In form the aggregated crystals of santonine differ according to the temperature at which formation takes place; but the salt is not really *dimorphous.* The changes are produced by relative position and size of crystals alone. The temperature at which the salt is *fused,* however, has no influence in this particular, but too high a degree of heat during fusion frequently gives it a brown colour.

These changes of form according to temperature during crystallization may be divided into three very distinct classes:

1st. Very hot; when the crystals run from the centre in rays expanding without any undulations, thus (see Photog. No. 1).

Photograph No. 1.



2nd. Medium heat; when the crystals show concentric waves of very decided form, thus (see Photog. No. 2).

3rd. Cool; when the crystals are exceedingly minute, thus (see Photog. No. 3).

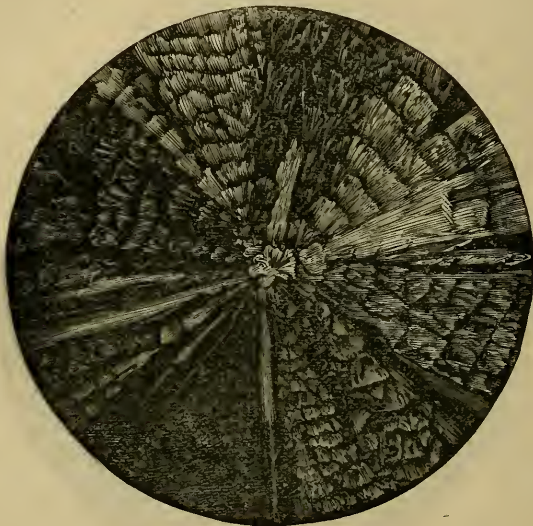
The first-mentioned crystals are so formed because some powerfully acting cause has produced crystallization whilst the mass of salt was in a very soft state. The growth of the crystal is then uninterrupted for a comparatively long period, and the surface unbroken.

The second crystals are produced by the whole matter becoming so cool that the progress of formation is stayed at certain points by hardness, and immediately a fresh formation started from these points.

The third are simply the results of the same action as those of the second class of crystals, rendered more powerful by a still greater degree of cold.

To produce the most beautiful microscopic crystals for the polariscope, it is necessary that they should be formed at a temperature betwixt the second and third above mentioned, as the minute and flowing forms are then combined, and long feathery crystals are the result. But to produce cer-

Photograph No. 2.



Photograph No. 3.

tain forms requires much knowledge of the substance employed, and some patience, as there are many interfering causes to combat. Of these the weather is by no means an inactive one, as it is frequently found almost impossible to obtain the above-named feathery crystals when the place in which crystallization takes place is cold and damp. When the temperature is low, and yet too dry, santonine will frequently assume the form of a uniform semi-transparent mass after fusion, showing no crystalline shape; yet the same portion will crystallize beautifully when again fused, interfering means being employed. This is also the case with many other salts.

I myself was long under the impression that it was merely the thickness of the salt which caused the various formations; but on closer inspection found that, though thickness certainly did influence the forms, I did not find it difficult to procure the same class of crystals with either thick or thin coverings of the fused salt by recalling the before-mentioned facts.

Remarks *on* Mr. Archer's Paper *on* Algæ. By J. Braxton Hicks, M.D., F.R.S., F.L.S. &c.

It was with much pleasure I read Mr. Archer's paper in your Journal of April, 1864, read before the Natural History Society of Dublin, inasmuch as it opens up a question of much interest in many points of view, but more particularly bearing deeply on the validity of the classification of the unicellular forms of vegetable life. And as he in many places refers to my observations on these growths set forth in former numbers of your Journal, I may, perhaps, be allowed to occupy a further space on the same subject.

The title and the whole of this paper, coming as it does from so able and indefatigable an observer, proves more than any remarks I could have made the very unsatisfactory condition in which our knowledge remains, and also the great difficulty (may I say impossibility?) of fixing the separate species or genus to which the majority of the Palmellaceæ belong.

When, after all Mr. Archer's careful and earnest researches on the subject, the title of this paper is called an "Endeavour to Identify the *Palmoglœa Macrococca* of Kützing" with a plant which he (Mr. Archer) thinks is meant, but which, with another new species, he thinks is referable rather to another genus, it would seem almost a hopeless task to assist in the work. If Kützing, Naegele, De Bary, and other equally celebrated algologists, are unable to decide the position of the various Palmellaceæ, and are further unable to agree upon what are the essential characters by which to settle these points, what can be better proof of the intrinsic difficulty of the whole question? If by one observer the envelope of mucoid matter be taken as a specific or even generic sign—if the mode of segmentation be taken by another as of specific or generic value—if the size of the cell, or the position of the nucleus, or the mode of diffusion of the endochrome within the cell, be sufficient in the eyes of another to separate genera—if, as Mr. Archer contends, the oval shape is another important distinction—it seems to me no wonder that the difficulty, acknowledged by all, has arisen.

If, again, inability after careful research to determine what is meant by Kützing's character of the genus Palmoglœa be admitted by Mr. Archer and Braun; and if Mr. Archer thinks that this genus is separable into five types, two of which he thinks do not at all belong to it; when, in fact, no one algologist can tell distinctly what is a Palmoglœa, so as to be understood by any other algologist; then, I must confess, it seems difficult to understand how Mr. Archer can find sufficient ground to state that a Macrococca is not the state figured by me as similar to Palmoglœa amongst the forms produced by the lichen-gonidia. Mr. Archer is by no means certain of what I mean by *Palmoglœa Brébissonii,* for he questions whether it be the same as that which Kützing makes identical with *Palmella cylindrospora,* which Ralf considers identical with *Penium Brébissonii,* and which Mr. Archer places with Cylindrocystis; and which, as far as can be ascertained, Mr. Thwaites calls *Coccochloris Brébissonii,* although Mr. Archer thinks he means the *Trichodictyon rupestro.* The exact characters of this form, it will thus be seen, are by no means settled by any one of these observers. The exceeding confusion prevailing in this species extends similarly throughout the whole group, and leaves it in such a state of uncertainty that it would be well if the whole of these forms were to undergo complete remodelling.

But the question first of all arises, how is a single cell to be distinguished from another single cell? What reliable characters are to be fixed upon which can be considered as of generic value? When we consider through what various forms those cells pass whose life-history has been carefully watched, as for example, *Protococcus pluvialis,* the very species with which Mr. Archer illustrated his paper, how are we to tell to what genus any single cell belongs? how can we tell whether it be a fixed form, a separate entity, or merely a transitional form of some other growth? When, again, we find, as I have shown in this Journal, and in the 'Transactions of the Linnean Society,' that cells quite similar in all respects are produced during the segmentation of the gonidia of the lichens, mosses, Lycopodia, Prasiola, &c., in what manner, may it be asked, are we to tell to what group it belongs, and how can we say that it is certainly a separate Palmellaceous plant?

It is clear that the whole question must be gone over completely, not with the distinct intent of dividing each of these forms into genera and species, but for the purpose of tracing their history as far as practicable, in order to find out through what various forms they can pass, and more especially to inquire how many homomorphous forms can spring from different structures.

The whole case resolves itself into this heavy task, a subject which will require the combined efforts of many observers, and one which I am fully aware will hold out little attraction for those whose love of distinctness and definiteness draws them rather to analysis than to synthesis. It is one to which, if Mr. Archer will apply his patient and careful habits of observation, he will find it repay his pains far more amply than endeavouring to unravel the confusion of authors. These views I have already expressed in the papers above quoted, and I may repeat that I consider that, till the life-history is traced out, it is impossible to tell whether the growth before one be a distinct form or not.

The principal point which must be first determined is, what are the characters to the differences of which we can assign a generic or specific value? Is size to be taken as a guide? The size of any cell depends on many circumstances, as, for instance, upon the rate of segmentation compared with individual growth. This is well seen by observing continuously the process of the gonidia of lichens or mosses. The size depends also upon the temperature and other external circumstances affecting the activity of its vital powers. There is no doubt the subdivision of a cell may extend to almost an invisible point, and in that state it may so remain for an indefinite period; and that it may begin at any time to grow, till it reach the size of the parent, and probably to a still larger, provided, however, segmentation does not commence.

Does the position of the nucleus help us? How, then, can those states be classified in which there is no nucleus? I think few will consider that the position of the nucleus, of a starch-granule, or of a vescicle, can be considered of any assistance whatever.

Can the disposition of the chlorophyll? How, then, are we to arrange those forms where the whole contents are homogeneous? How are we to place those whose contents are without any definite arrangement? It seems that but little value can be placed upon this in the majority of cases, to which any one who has observed the various arrangements of the contents in the same plant I think will agree. It is true that in some there are peculiar dispositions, as in Zygonema and its allies, and, when present, no doubt is of certain value; but even in this case the contents may become homogeneous, as in conjugating; and then, supposing subdivision to take place, the contents of the resulting cells would become more or less homogeneous, and thus the spiral character lost.

Can the mode of subdivision assist us? Before this can be answered we must find out in how many modes, and in what varieties of forms, this process can take place. Here is a vast field. Let us therefore inquire of nature in every stage of the life of a cell—in its active spring growth, during and after its period of conjugating, in its zoospore stage, and in the forms the zoospore may ultimately assume, in the autumn growth, and in the various stages the winter-resting spore may pass through before it reach again the parent form. Let nature be fully inquired of here, and I have no doubt an ample harvest will be the reward. Can the form of the cell be of any help? If it is found that the subdivisions of a generally round form assume an oval, at any stage, and then revert to the round shape, what value can we put upon the form? That this can be constantly observed is palpable to any one who will watch the segmenting gonidia of lichens and other plants. I need only refer again to the plate illustrating Mr. Archer's paper. The varying forms of the divisions show that their form changes very strangely. This is observable in almost every Converfa, and the Desmidiæ are good examples. Supposing Mr. Archer had carried his observations as Cohn has done in *Protococcus pluvialis*, it is highly probable that as diverse forms would have been found.

Upon what, then, are we to fix? No other answer seems practicable but that which I have already indicated, namely, upon the gradations assumed during its whole life-history. If it be asked, how can this be attained? it must be honestly answered, with much labour and careful observation; better trace one form out well than endeavour to attain an apparently large result by that which cannot be relied upon, although it may have the attraction of being definite.

In this particular subject especially algologists have generally endeavoured to restrict nature into the narrowest compass; they have made orders, genera, and species innumerable, out of the simple physiological process of cell-growth, and have used even the ordinary variations of subdivision as a means to classification.

Had a tithe of the labour bestowed upon the classification of the Palmellaceæ been devoted to their life-history, some progress by this time would have been made in the herculean task.

One point, I think, will tend to shake our confidence in the certainty of the separate existence of these forms, to which I have also formerly alluded; it is this, that when we consider the multitudes of mosses and lichens to be found everywhere capable of producing gonidia, and from them Palmellaceous forms to an indefinite extent, and varying probably according to the species, what absolute proof can we possibly have of the separate existence of any similar form unless we know its history? I am sorry to give utterance to so much scepticism, and to cause such perturbations in the minds of those devoted to the subject; but I am certain the sooner misgivings occur on the validity of the mode hitherto adopted, the sooner we shall attain a more satisfactory knowledge of what I am certain will prove to be a wide page in the book of nature.

Mr. Archer has rather misunderstood me in concluding that I consider *all* species of British Palmoglœa can arise from the lichen Cladonia. I mean that all forms similar to those hitherto described can certainly arise from it, but I do not mean to affirm that no other forms of vegetable life do not also give origin to similar cells. I have little doubt but that a more extended knowledge of the matter will show that segmenting gonidia of other orders will also produce similar forms, as I have already shown in the mosses. At the same time I do not mean to say there are *no* such forms as distinct Palmellaceæ. I admit it is possible; but I ask, how are we to be sure the specimen before us is so? For this reason I cannot agree with thinking with Mr. Archer that I have been hasty or comprehensive in my generalizations.

What value in classifying can be attributed to that peculiar action called conjugation? I think we can hardly judge at present. That it is but a process of vegetative, as distinguished from sexual action, is clear; but whether it is to be considered as a sign belonging only to the Confervoid group-section, it is impossible to say; at any rate, for ought we know to the contrary, it may be also formed during the growth of the gonidium of lichens, and it would seem rash at our present state of information to confine it within any limits. Further observations are wanting before we can consider it peculiar to the Confervæ.

The same remark may be applied to the zoospores, the formation of which is also asexual process. We have evidence which shows that the formation of zoospores extends over a wider range than had formerly been believed. There, again, is a fine field here for observation. It is very possible that some of the Volvocinææ may have an origin in some other form of life, especially since Cohn has shown forms of zoospores of *Protococcus pluvialis,* united in such a manner as to partake of many of the features of that tribe. No finer field than the one I have above pointed out is open for the patient observer, who will carefully trace, and as carefully portray, every step of the form in which he is interested.

The Anatomy *of the* Earthworm.

By E. Ray Lankester.

Part I.

Being desirous of publishing a notice of certain new points of structure which I have detected in the earthworm, I thought that it might be well to accompany it with a description of the general anatomy of that Annelid, especially since the later and more accurate observations on this subject have been published as papers in foreign journals, and are scattered about in various French, Belgian, and German periodicals. The appearance too, of a paper in the 'Philosophical Transactions' for 1858, by Dr. Williams, in which the anatomy of the reproductive organs of *Lumbricus* is treated of, has been a further inducement to me to publish my observations on this point. The separate researches of two Continental naturalists, M. Jules d'Udekem and Dr. Ewald Hering, had placed our knowledge of the generative system of the earthworm in a so far satisfactory state that little more remained to be done than to explain a few minor discrepancies between the results arrived at by these authors. Dr. Williams, however, having failed to observe that which is recorded by Dr. Hering and M. d'Udekem, asserts that those authors' observations are "confused and contradictory," and proceeds to give a description of ovaries and testes, which he does not confirm by adequate figures, and which, certainly as far as my observations have gone, do not exist. It is therefore necessary, in justice to these two continental observers, to show, if possible, that their observations are not "confused and contradictory," but that they (more especially Dr. Hering) have given, on the whole, a truthful and accurate account of the reproductive organs of *Lumbricus*; that it is Dr. Williams's observations which are incorrect, and that consequently that author's views as to the modification of the ciliated tubuli into reproductive organs are, at any rate, as far as *Lumbricus* is concerned, untenable.

The frequent use of the microscope, which is necessary in the elucidation of the anatomy of the Annelida, and without which no accurate knowledge of their organization can be arrived at, must be my apology for the publication of a paper of this nature in the pages of a microscopical journal.

From the time of Willis* and Redi† the structure and habits of the earthworm have received much attention from naturalists. Montegre,‡ Sir Everard Home,§ Dufour,|| Dugès,¶ Meckel,** Stein,†† D'Udekem,‡‡ and Hering,§§ are amongst those who have written on the subject, the only author, however, who professes to deal with it as a whole, and who has treated of the entire anatomy of the worm, is Morren,|||| the other writers named having devoted their researches almost exclusively to the reproductive organs. The work of this author was published many years since, but is still remarkable for the amount of labour displayed in it, and the profusion of engravings. The nervous system has formed the subject of papers by M. de Quatrefages and Mr. Lockhart Clarke, to which reference will be made hereafter. I propose to describe the organization of the earthworm under the following heads:—Tegumentary system, Muscular system, Digestive

* 'De Animâ Brutorum.'

† 'De animalibus vivis quæ in corporibus animalium vivorum pariuntur.'

‡ 'Annales du Museum d'Hist. Nat.,' 1825.

§ 'Phil. Trans.,' 1823, p. 11.

|| 'Ann. des Sciences Nat.,' 1825.

¶ Ibid., 1828.

** Müller's 'Archiv,' 1844.

†† Ibid., 1842.

‡‡ 'Memoires de l'Acad. Roy. de Bruxelles,' 1857.

§§ Siebold and Kölliker, 'Zeitschrift,' 1858.

|||| 'De Lumbrici terrestris Historia naturali necnon anatomia tractatus.'

system, Circulatory and Respiratory systems, Nervous system, Secernary system, and Reproductive system. I may here mention that the majority of my observations have been made on the *Lumbricus terrestris*, though I have also dissected many individuals of *L. agricola*.

Tegumentary system.—The tegumentary and muscular systems of the earthworm are so intimately united that it is somewhat difficult to describe the one apart from the other. If a vertical section be made of a portion of the integument of Lumbricus, three distinct strata or layers will be distinguished. The external one is the epidermis, the middle the pigmentary layer, and the internal the muscular layer. If a very thin section of this description be made and placed beneath the microscope, the appearances drawn in Pl. VII, fig. 12, are seen. The epidermis (*e*) appears to be almost structureless and transparent, having, however, a certain finely granular, striated aspect. The pigmentary layer (*d*) contains numerous dark-brown cells, irregularly disposed in a semi-transparent homogeneous matrix, in which also ramify very numerous blood-vessels. The disposition of these capillaries is towards the exterior, the larger branches from which they are derived being situated in and above the muscular layer. The muscular layer (*c*), which varies in size in various parts of the integument, is generally by far the thickest, composed of minute fibres, crossing and intercrossing in various directions, the more superficial ones having a direction parallel with the longitudinal axis of the body, whilst the deep-seated fibres run exactly at right angles to these. Within the muscular [layer a small species of nematoid (*b*) may be frequently detected. They are very abundant in all parts of the earthworm, but do not appear to do much harm. I shall have occasion hereafter to refer to this parasite (the *Anguillula Lumbrici* of Dujardin) in speaking of the generative organs, where its existence has given rise to many errors. A delicate layer of cells is perceptible beyond the muscular coat (*a*), which probably belong merely to the corpusculated perivisceral fluid.

The tunic thus formed is constricted into various rings, or annulated, at short intervals throughout the length of the body, which is of a cylindrical tapering form anteriorly, but broad and flat as the posterior region is approached, terminating at length very suddenly by a rapid diminution in the size of the annuli. If a worm be drawn through the hand, from head to tail, no perceptible impediment to its passage is felt; but if the reverse operation is tried and the worm be held by the posterior extremity, a considerable amount of resistance is experienced, in consequence of a roughness of the worm's skin. This roughness is owing to the presence of minute setæ, of which there are four pairs on nearly every ring of the worm's body, those only comprised by the cingulum and the smallest anal segments being free from them. Two pairs of the setæ have a ventral aspect, and a pair on either side are disposed laterally (fig. 8). One of these setæ placed beneath the microscope shows a slightly curved form, is transparent, of a yellow colour and fibrous structure (fig. 7). The broader portion is fixed in the integument, and is softer than the exposed portion.

The setæ are secreted by very minute glands, of which there are four in every segment, each situated in connection with the inserted portions of a pair of setæ. These setigerous glands may be seen in fig. 11, *b*, *d*. In a certain part of the body the setigerous glands often acquire a large size, and their normal function appears to become subservient to some other. Large semi-developed setæ are thus found in them, as also a viscid secretion, the function of which must be discussed in connection with the reproductive system. The setæ are very frequently lost or injured in use by the earthworm, and their place left unsupplied. From this we may conclude that the process of their formation is not rapid, nor adapted to supplying a vacancy immediately on its being required; but, rather, a regular and slow development, which takes place equally, whether injury has been sustained or not, and irrespective of wear. Another feature of the integument which will be noticed by the most casual observer is its enlargement into the "cingulum," extending from the twenty-ninth to the thirty-sixth segment. The cingulum, which, though a tegumentary appendage, is strictly an accessory organ of reproduction, is of a paler colour than the rest of the integument, encloses the dorsal and lateral surfaces of the rings over which it extends, but is not developed from the ventral surface. The structure of this body is glandular, being composed of a great number of minute pyriform papillæ, which secrete a fluid, and also act as adhesive organs during the congress of two individuals. The epidermis covering the papillæ is remarkably thin, and appears to be ruptured when coition occurs. In examining the ventral surface of the worm various minute apertures will be discovered in the anterior segments of the body; but as they are intimately connected with certain of the organs of reproduction, I defer describing them for the present.

Muscular system.—The various modifications of the muscular layer of the integument constitute the principal part of the muscular system in the earthworm. There are but few special developments of muscular tissue in such organisms at all; the various functions which are entailed on special muscles in higher animals being here performed by a simple contractile tunic or membrane. The muscular coat succeeding the pigmentary layer of the integument (the cutis being inseparable, and not easily distinguished from those structures) consist of fibres which run transversely to the longitudinal axis of the body, and by their contractions cause the rings to diminish their diameter; the succeeding layer to this is formed of intercrossing and oblique fibres, whilst the innermost fibres are arranged longitudinally. These last are by far the most numerous, and are largely developed on the ventral surface. They form the straight muscles of Morren. Two lateral muscles, a ventral, and a dorsal, may be distinguished (fig. 11). The setigerous glands occupy a position between the dorsal and lateral and the lateral and ventral muscles on either side. Morren has carefully described an arrangement of minute muscular fibres in connection with the setæ, which he considers as the protractors and retractors of these appendages. Cuvier has also described these.

The object of the muscular attachment appears to be to keep the seta in position rather than to withdraw or extend it, so that the hooklet may yield to pressure from the quarter towards which the worm is progressing, but offer resistance to similar force in the opposite direction. The remaining muscles of the earthworm are the transverse or intraseptal muscles, or modifications of these. Between every segment or ring a very delicate, tenacious, pellucid, muscular membrane exists, loosely connected with the internal viscera, but firmly attached to the walls of the body. These transverse muscles do not entirely close the various rings from each other, but allow the contents of the perivisceral cavity free movement from one end of the body to the other. The fibres of the transverse muscles are very fine, and take a direction from the walls of the splanchnic cavity towards the central viscera. In the first eight or nine rings of the body oblique radiating muscular fibres diverge from the transverse muscles, and become attached to the muscular pharynx to be described hereafter. A somewhat similar arrangement occurs in the terminal rings of the body, where these radiating fibres assist in the expulsion of the fæces from the anal aperture.

Digestive system.—Before proceeding any further in the description of the anatomy of the earthworm, it is necessary to explain the method which has been adopted in dissecting. The best way of killing the worm, which should be of as large a size as can be obtained, is with chloroform, though spirits of wine can be made to answer the same purpose. The advantage of chloroform is that it leaves the subject lax and pliable, whereas in spirits of wine rigidity often occurs, which renders careful dissection impossible. A pin being inserted in the first or labial segment, and the worm pinned firmly in a gutta-percha trough, the dissection may be commenced by a dorsal, lateral, or ventral incision, which should extend from the first to the thirtieth segment. This being done, the cut edges must be separated and pinned out, as much longitudinal tension being used as possible. The organs of the body will then present a very beautiful sight. Many, though, are concealed because of their transparency, and great difficulty will be found in manipulating certain organs on account of their tenuity and the fluid nature of their contents. These difficulties will be entirely obviated by filling the trough with pure spirits of wine.* A most marvellous change then comes over the appearance of the extended annelid; numerous little fibres display themselves, running from the pharynx to the transverse muscles, which also become more evident; the ciliated tubules in each segment make their appearance, and, what is most important, the reproductive organs become so hardened as to admit of careful dissection. I cannot but attribute some of the errors which have been made by the older and certain recent observers to the want of some such method of dissection as this. Fig 5 represents a worm opened by a dorsal incision, and treated in this way.

Mouth.—The mouth in the earthworm is formed by the incomplete structure of the first segment of the body (fig 9). The incomplete ring is a conical or nipple-shaped projection, of a very fleshy, muscular nature, forming what may well be called an upper lip. The mucous membrane of the mouth is reflected inwards, and lines a large oral cavity, considered as the pharynx (fig. 5, *b*, fig. 6). The mouth forms the subject of several figures and a good deal of letter-press in Morren's memoir; but it appears to be a very simply formed orifice,

* Mr. George Busk, who has for many years made the earthworm a favorite study, and who very kindly assisted me when first commencing its dissection, was, I believe, the first to use chloroform and spirits of wine in this way; I regret very much not having had the benefit of his advice in preparing this paper.

the movements of the labial segment, which can be retracted so as to close the oral aperture, being dependent on muscles similar to those existing in each segment of the body, and already described.

The *pharynx* is a broad somewhat flattened and very muscular organ, immediately succeeding the oral aperture; it extends from the second to the seventh ring of the body. The upper surface, exposed when a dorsal incision is made, is very muscular, numerous radiating digital fibres connecting it with the transverse septal muscles; its lateral attachments appear to be the strongest, though numerous radiating fibres may be also detected on the ventral surface of the organ. The outer thick and muscular coat, which thus gives to the pharynx its principal muscular power, is of a yellowish-white colour, and very vascular. If this be opened and carefully examined it will be found to project anteriorly into the hollow cavity which it forms, and gives rise to a sort of disc or sucker by the action of which, no doubt, the earthy food of the worm is drawn into the mouth. A second, much finer muscular coat will also be found underlying this denser one, and intimately connected with the loose folds of mucous membrane which line the pharyngeal cavity. In fig. 3 a small bundle of muscular fibres from the pharynx is drawn; they present the same simple structure and appearance as the muscular tissue from all parts of the body.

Salivary glands.—Opening into the mouth and pharyngeal cavity are three pairs of glands, which must be considered as salivary organs. Morren appears to have figured these, and Mr. Lockhart Clarke briefly mentions their existence. They are in the form of convoluted tubules, situated near the oral aperture in connection with the dense exterior coat of the pharynx, and require a little examination to be detected.

Passing down the alimentary canal, we come to the *œsophagus*. This commences in the eighth segment of the body, (fig. 5, *c*, fig. 6), and is directly continuous with the muscular pharynx. The latter organ contracts very considerably in the seventh ring, and then is followed by this narrow, delicate, but highly elastic tube. The œsophagus extends to the fifteenth or sixteenth ring; throughout it is composed of a more or less delicate muscular coat and an inner mucous lining. In its passage through the septal muscles it becomes slightly constricted, and the fibres of the one organ appear to become interwoven with those of the other; this is more particularly the case in the eighth, ninth, and tenth rings. The large dorsal vessel which runs all along the alimentary canal attains its greatest development in the region of the œsophagus; it passes directly along the median line of the body, in close connection with the digestive tube, and, with its contractions and dilatations, the œsophagus also performs certain peristaltic movements, the object of which may be connected with the circulatory system. The large lateral vessels, described as hearts, are given off from the dorsal vessel in the region of the œsophagus, and the reproductive organs closely surround it; we have therefore in this region the most vascular and active part of the body. Although the œsophagus itself consists merely of a muscular and a mucous membrane, possessing no special secernary powers, yet the dorsal blood-vessel, throughout its connection with the œsophagus, is more or less invested with a yellowish-brown mass of cellular matter, which sometimes extends to the lateral vessels and hides the true walls of the blood-vessels from view. If a portion of this yellow mass be placed under the microscope with a high power, it will be found to consist of minute cells, the contents of which are still finer granular particles (fig. 13). They exactly resemble the cells which, in connection with the blood-vessels, invest the whole of the intestine, yet to be described, and which have always been considered as performing a secernary function similar to that of the liver. This yellow mass may therefore be regarded as an organ of secretion in connection with the œsophagus, of similar nature to the hepatic membrane of the intestine.

Œsophageal glands.—Situated in the twelfth and thirteenth rings, and nearly or entirely concealed by the testicular masses, are three pairs of very remarkable glands, which have never yet been described. In fig. 5 the reproductive organs have been turned back, so as to expose these (*h*). The dorsal blood-vessel is in close connection with them, and two of the great lateral vessels lie in contact with their surfaces. Morren, indeed, in pl. xxxi of his memoir, gives a rough figure of two of these glands, but does not add any accurate description of them. Dr. Williams, in his paper in the 'Philosophical Transactions,' describes a figure in his pl. vi as the reproductive organs of the earthworm, and denominates a certain mulberry-like mass "calciferous glands." No description of these glands is given in his memoir, and the figure is so utterly unlike *anything* existing in the earthworm that I cannot say whether the œsophageal glands are meant, although no other calciferous bodies are to be met with in *Lumbricus*. In fig. 4 the three pairs of œsophageal glands and part of the œsophagus are seen removed from the attached blood-vessels and septal muscles, considerably enlarged. The most anterior pair, which exists in the twelfth ring, are somewhat round and full, pale in colour, and with an immensely vascular surface, the vessels running parallel to one another, and frequently so numerous as to give the organs a bright-red colour. They are firmly attached to the walls of the œsophagus, but do not appear to have any communication with its interior. When opened they are found to contain either a single hard crystalline mass or numerous smaller bodies of a similar appearance, when placed under the microscope, to that drawn in fig. 10. The wall of the pair of pouches is thin, and the presence of the hard bodies beneath can be detected by simply pressing the glands. When a portion of the crystalline substance is treated with acetic acid, it dissolves with great effervescence. It is therefore probable that the substance is carbonate of lime. These glands do not always contain crystalline bodies, and occasionally a worm is found in which all three pairs of œsophageal appendages have lost their vascularity and size. I am not able to give any clue as to the function of this first pair of glands; it may be connected with the formation of the egg-capsule, which is said to contain carbonate of lime; on the other hand, it may be a provision for disposing of any superabundance of mineral matter in the blood. I have frequently found the crystalline bodies passed into the œsophagus and lodged in the capacious crop. The second and third pairs of œsophageal glands are situated in the thirteenth ring, and have a form and appearance differing from the first. They are a little smaller, and their walls are much thicker, but no less vascular, than the first pair. They contain a milky fluid, which, when examined with the microscope, is found to consist of very minute granules, somewhat similar to those of the hepatic membrane of the intestine. A very thin section, made vertically through one of these glands, shows the structure drawn in fig. 2, an inner epithelial coat, a vascular region in which the blood-vessels are arranged in loops as seen in the figure, and an outer more delicate membrane, forming the sheath of the organ on which the externally visible vessels extend; these, as in the anterior pair of glands, are very numerous, and run parallel to one another.

The arrangement of the vessels interiorly in loops is very remarkable, and may be easily observed when the vessels are naturally injected. All three pairs of glands present this structure. The use of the milky secretion contained in the second and third pairs may be in the process of digestion;

indeed, this appears most probable, but the properties of the secretion cannot be determined. That these three pairs of glands are of very vast importance in the economy of the worm cannot be doubted, when their proximity to, and connection with, the great vessels of the body is considered, and it is somewhat surprising that they should have escaped the notice of previous observers.

Crop or stomach.—Leaving the œsophageal glands, we may follow the course of the alimentary canal, closely adhered to by the dorsal vessel and its surrounding granular mass, to the sixteenth or seventeenth ring. Here the œsophagus terminates, and the digestive tube expands into a voluminous heart-shaped sac, which may be regarded as a species of stomach. Sometimes this organ commences in the fifteenth ring of the body, and at other times it occupies only the sixteenth segment; this appears to be a matter of indifference, depending merely on the growth of the septal muscles. The muscular wall is here well developed, and the continual contractions, which it performs even after the worm is pinned out for observation, show that one of the principal functions it performs is the propelling of food on its course through the alimentary canal. Very numerous blood-vessels are distributed to its surface, whilst the interior is lined by a loose, largely developed mucous membrane.

Gizzard.—The eighteenth and nineteenth rings of the body are occupied by a hard cartilaginous-looking ring, which is attached to the muscular sac just described. Its walls are very thick, and composed of fibrous tissue much resembling the muscular fibre, but they do not appear to be contractile. The blood-vessels, which are very freely distributed to the surface, are disposed in a transverse direction, and are very minute. This organ has been called the gizzard by previous writers, though whether its functions are those of a gizzard does not appear at all certain.

Intestine.—Immediately attached to the remarkable fibrous ring just described is the intestine, which passes throughout the rest of the body with very little change in its structure. It is a loosely and much plicated tube, with very delicate elastic walls, which are so disposed as to occupy a small space whilst possessing a large amount of surface. The wall is composed of three distinct coats, of which the interior one is mucous membrane, with a finely ciliated epithelium; the middle, delicate muscular tissue; and the exterior, a mass of yellow cells, forming an olive-brown-coloured investment for the whole intestine, which is of the most tender nature, and very easily ruptured. The cells, possessing granular contents, are exactly similar to those found in the yellow tissue surrounding the dorsal blood-vessel by the œsophagus, and they appear to perform the same offices. It is almost universally admitted that this yellow tunic of the intestine should be considered as discharging the functions which are distributed to various organs in the higher animals, viz., those of the gall-bladder, the pancreas, and the gastric glands. And it may therefore be conveniently called the hepatic membrane.

The very numerous blood-vessels which ramify in this portion of the digestive tube, and around which the development of the hepatic cells is greatest, is connected, of course, with the elimination of nutriment from the contents, and it is probably in this part of the viscera that the chief amount of absorption takes place.

The muscular coat of the intestine is very delicate, but exercises considerable force in the propulsion of food. The transverse septal muscles, which are intimately connected with the folds of the intestine, also assist in causing those movements of the digestive cavity by which the passage of aliment is effected.

Anus.—After passing through three hundred and fifty rings in a well-grown worm, or less, the alimentary canal terminates in the last segment of the body. The modifications of the septal muscles, which by Morren were described as peculiar muscles of the anus, and the contractility of the muscular membranes of the intestine and of the integument, effect the discharge of the fæces. The ciliated epithelium of the mucous membrane may be best observed near the anal aperture, where it appears to have its greatest development.

Recapitulation.—The digestive organs of the earthworm consist of a mouth, situated in the first anterior segment of the body; of an oval muscular pharynx, extending to the eighth segment; of a narrow contractile œsophagus, expanding in the fifteenth or sixteenth ring into a muscular crop, followed by a hard fibrous ring occupying the seventeenth and eighteenth segments. The rest of the body is traversed by the intestine, a plicated, delicate, elastic tube, invested in a membrane of granular cells, and terminating in the last ring of the body. Connected with the pharynx are three convoluted bodies, considered as salivary organs, and attached to the œsophagus are three pairs of glands in the twelfth and thirteenth segments, the two posterior pairs of which secrete a milky fluid, probably to assist in digestion.

The food of the worm is such vegetable matter as is contained in the rich loamy soils which it selects for habitation.

(*To be continued.*)

Notes *on* Organic Structure *as* illustrated *by means of* Dyes. By Walter Abbey, M.R.C.S.

This Journal has of late presented to its readers a remarkable series of papers by Dr. Lionel Beale, embodying the results obtained from the investigation of organic structures into a doctrine that is likely to give the *coup de grâce* to the already staggering cell-theory of Schwann.

Dr. Beale, having conceived the happy idea of staining the tissues with carmine, found that a permanent stain was acquired by certain portions only of the tissue, including all those which are generally supposed not to have reached their ultimate grade of development, and excluding those which have evidently undergone a structural process.

This new and conspicuous fact suggested the division of all organized matter into the two easily determined sections of "germinal matter" and "formed matter," the former being dyed, the latter unaffected, by carmine. The "germinal matter" is well represented by the nucleus and nucleolus; the "formed matter," by the cell-wall and spiral fibre.

Dr. Beale also inferred, from the presence of gradated colour in the stained "germinal matter," that it lost its proclivity for the dye in the course of its gradual transition into the "formed matter."

It is very obvious that this selective staining power of carmine is of great value to the physiologist, and that still further advantage would be derived from the possession of one or more dyes capable of staining the whole or part of that which is not coloured by the carmine; also, that the one colour ought sufficiently to contrast with the other.

Iodine has long and deservedly been in use and repute; but, apart from its value as a test for starch and cellulose, it does not avail much as a dye, the cell and the cell-contents usually differing only in the intensity of the uniform and fugitive brownish-yellow conferred upon them.

Substances largely possessed of the desired properties are, however, easy to obtain, and easy to use. They are most abundant among the compounds of aniline.

Magenta, one of the most brilliant of these, has already been used by the microscopist, but its distinctive qualities seem to have escaped suspicion. This dye, like most of its congeners, has selective staining power as great as that of carmine, and still more limited. Altogether unattracted by pure cellulose, it at once seizes those portions of "formed matter" which come under the head of "secondary layers."

A dye for the structures left uncoloured both by magenta and carmine is still a desideratum.

Although a second characteristic colouring agent thus presented itself to me, it did not give a satisfactory contrast of colour. Mauve, Hoffmann's violet, aniline brown, picrate of aniline, and turmeric, all dye as magenta, but the purples alone approximated to the desired contrast. Aniline green, which I subsequently tried, accorded with these, but its results hitherto have been capricious and unsatisfactory. It seemed probable that a substitute for magenta, if found at all, would be found among the aniline colours, and I became indebted to my friends Mr. J. G. Dale, F.C.S., and Dr. Martius, who have all along most liberally furnished me with dyes not otherwise readily obtained—for two blue salts; the one almost identical with magenta, the other belonging to a different though closely allied series of compounds.

I naturally looked to the former, the ordinary aniline blue of commerce, for the accomplishment of the sought-for contrast, but it proved a lamentable yet instructive failure. The tissue, plunged into its alcoholic solution, came out magnificently coloured, and remained so when immersed either in water or glycerine. Under the microscope, however, the colour was seen to be merely mechanically and impartially distributed; and, by the action of alcohol, its proper solvent, it was entirely discharged. This surprise was outrivalled by the one which the second blue afforded. The desired contrast was now effected, but at the expense of the carmine, instead of the magenta. Nothing could be more satisfactory than this result, inasmuch as the blue substitute for carmine has intense and splendid colouring power, and is even more brilliant by artificial light than by daylight. It is also freely soluble in water, thus incidentally refuting Dr. Beale's somewhat rash explanation of the limited dyeing power of carmine, which he refers to the acid reaction of the "germinal matter" on the alkaline solution of the dye. I feel justified in calling this assumption "rash," because Dr. Beale had probably employed no other than an alkaline solution; carmine being only soluble in ammonia, or in a neutral solution of oxalate of ammonia, the solvent power of which is not generally known. Moreover, such an explanation should be based on the reaction, not of the solvent, but of the carmine, which, in a good sample, would most likely be acid, owing to the presence of free carminic acid.

The "formed matter" is equally affected by acid, alkaline, and neutral solutions of the dyeing agent.

Having thus drawn attention to the merits of the blue dye, I shall henceforth, in order to avoid risk of confusion, speak only of carmine and magenta.

Since magenta is incapable of dyeing either cellulose or "germinal matter," unless with the aid of mordants, but has a special affinity for the secondary layers, such as those constituting spiral fibre and woody tissue, it is evident that the components of the typical cell may be made to present three conditions of colour, viz., enumerating from without inwards, (1) unstained—cell-wall; (2) stained with magenta—spiral fibre; (3) stained with carmine—"germinal matter." It is also seen that the generally accepted statement, to the effect that the secondary layers consist of cellulose, as does the cell-wall, requires, to say the least, considerable modification. It is, perhaps, strange that this statement should have passed with so little question, seeing that, as a rule, the cellulose reaction with sulphuric acid and iodine is confessedly only to be obtained from such structures by means of a "preliminary treatment," such as boiling with nitric acid or caustic potash. Surely this is much akin to saying that the reactions of sulphate of copper can only be procured from metallic copper by means of a "preliminary" treatment with sulphuric acid. If, by an extravagant figure of speech, sulphate of copper may be said to be a mode of the metal, then perhaps the secondary layer may be said to be a mode of cellulose.

Before proceeding further, I ought to premise that this article should be looked upon as based on phenomena observed in the vegetable kingdom, my very incomplete researches having only reached so far over the frontier as to attain the probability of the universality of the deductions resulting from them. It will, of course, be borne in mind that, in the animal kingdom, similar investigations have been much more fully carried out by Dr. Beale.

Placing our matter before us in the form of the ideal cell already spoken of, it will be proper to leave the consideration of the secondary layer until we have worked up to it from the *fons et origo*, which, so far as we are concerned, is the "germinal matter."

With all diffidence, I venture to suggest that the term "primordial utricle" should be discontinued. Its meaning has evidently become so capricious as to render it perhaps worse than useless as the sign of a precise idea. I am not prepared to accept the equivalent offered by Dr. Beale, inasmuch as I believe that his "germinal matter" consists, not of one substance only, dyed by carmine, but of two—the one of which is dyed and the other is not. While agreeing with him that the nuclear mass of stained "germinal matter" is shaded off from that darkest point which represents the nucleolus, I am convinced that this shading consists of *stippling*, and not of *tinting*. Nor is this distinction so frivolous as it may seem at first sight. It is opposed to two of Dr. Beale's conclusions — first, that the gradation of colour is due to the gradual transition of "germinal matter" into "formed matter;" secondly, to use his own words, "As it is a fact that the colouring matter passes through all the outer layers, and is deposited in the greatest quantity in that central part which is at the greatest distance from the solution, it seems only reasonable to infer that pabulum takes the same course during life."

It is not a light matter to differ, even as to minor facts, from so experienced a microscopist and acute a physiologist; nevertheless, I must give precedence to the evidence of my own eyes, aided by good and sufficient object-glasses. My own conclusions, as differing from those of Dr. Beale, may be thus summed up:

1. The germinal matter, so called, consists of two parts—the one dyed by carmine, the other not so.

2. It is not possible to demonstrate by means of dyeing agents the gradual transition of living matter into dead matter.

3. The varying tints of the dyed nucleus are due to the greater or less dispersion of coloured molecules through the uncoloured substance; their close aggregation forming the nucleolus.

4. The uncoloured portion of the "germinal matter" is the product of the coloured portion.

5. Nutrition is least active in the most deeply coloured part of the "germinal matter."

After this declaration of belief we must, for the remainder of the paper, take leave of the phrase "germinal matter," its original definition conveying a meaning different to that which the actual substance seems to me to warrant. I propose to substitute the term '*nuclear matter*,' consisting of '*germinal molecules*' and '*germinal plasma*.'

The nucleus proper is formed by the carmine-stained "germinal molecules" dispersed through the mass of unstained germinal plasma, which they have produced. The nucleus may or may not contain the nucleolus, composed of germinal molecules whose functional powers are in abeyance, and which, therefore, are closely aggregated into a deeply coloured mass, which seems capable of forming a circumferential deposit or areola of plasma, whose quantity is proportionate to the size and age of this composite molecule.

Here, then, we have the condensed nucleolus active only at its outer surface, and surrounded by the colourless plasma resulting from that activity; this, again, having a granular envelope, composed of similar plasma, and strewed with what are, in fact, fragmentary nucleoli.

As the outlying molecules become insufficient, demands for reinforcement are made upon the nucleolus, and this demand is answered in various ways. Frequently, successive molecules seem to be detached from the surface of the nucleolus, becoming more and more widely separated from each other as the produced plasma increases. Sometimes the whole mass of the nucleolus is at once called into action, and thus arises the phenomenon of a new granular nucleus contained within the original and paler one.

At other times, the nucleolus having divided, the one part remains in *statu quo;* while the other, sphered in its share of the plasma, goes off to form a new nucleus, nucleolated or otherwise.

Other varieties of fission might be referred to, but it does not seem necessary to do so in this place.

The vital processes of the unimpregnated animal ovum correspond very closely with those exhibited by the nuclear matter of the vegetable-cell.

A good general illustration of my proposition is shown by that pretty little organism *Volvox globator,* which may very well be looked upon as a sort of glorified mass of nuclear matter. It will be remembered that it consists of a hollow hyaline globe, studded at regular intervals with little green masses of endochrome. This represents the nucleus. Contained within the globe is a variable number of solid masses of endochrome, each with a viscid transparent envelope. These represent the nucleoli. When the time comes for one of these latter to assume independent activity, it divides and subdivides within its envelope or areola up to a certain point, without undergoing other change. Each of the resulting globules—with the exception of a portion which, like some part of the yolk of certain eggs, has escaped segmentation—secretes around itself the 'germinal plasma,' until the globe of the Volvox, with its contained nucleoli, is reproduced; the plasma-envelope of the original nucleolus now forming the containing sac of the whole organism.

If my interpretation of microscopical appearances is correct, it seems impossible to avoid the conclusion, that the deep and uniform colour of the nucleolus is so far from indicating the maximum of nutritional activity, that it is actually the sign of its minimum, if not, indeed, of its absence.

As I have illustrated the nucleus, with its nucleolus, by reference to a higher grade of life, so may I illustrate the individual nucleolus.

We find its analogue in the resting spores of algæ, with their dark, condensed mass of inactive endochrome contained in a self-secreted coat; also in one of the older cells of a Conferva (*Cladophora glomerata*), whose crowded contents become ever paler and less dense with the progress of renewed growth.

The phenomena of cell-growth are so conveniently epitomised in the short career of the annual stems of herbaceous plants, that we may advantageously take a transverse section of such a stem for the purposes of illustration.

Such a section, by-the-bye, dyed with magenta and blue or with orange and blue, and viewed with a 1-inch objective and C Kelner eye-piece, is, from its intrinsic beauty, a striking object for the unphysiological eye.

The common dock (Rumex) sufficiently serves the purpose. In the cambium-layer, where growth is actively progressing, we observe that the young cells, as yet very small, are quite full of darkly stained nuclear matter, usually, if not always, in the form of a hollow nucleolated nucleus.

In the older tissue, as represented by the central parenchyma, we find, if the plant be young, that the nuclei are very distinct, the germinal molecules being so thickly grouped as to need the use of a $\frac{1}{12}''$ object-glass for their satisfactory optical separation. The seemingly homogeneous nucleolus has, in this case, little or no areola. In the corresponding parenchyma of an older plant the nuclei are often more numerous; they are absolutely larger, but smaller in proportion to the containing-cell; the germinal molecules are distinctly isolated, and there is a very apparent areola round the nucleolus.

Not unfrequently may be noticed a series of three nuclei with their nucleoli, each smaller and more deeply coloured than its predecessor, the presumptive common parent being but the ghost of its former self. Many nuclei have *two* areolated nucleoli. Here and there may be seen, clinging, as it were, to the nucleus, a smaller mass, consisting solely of large molecules separated by plasma, which seems to be the result of fission of the nucleolus, followed by assumption of vital energy by all the component molecules of the liberated portion.

In the tissue of a fast-growing plant, destined to die as soon as it has arrived at maturity, and which is already far advanced—as in the case of a cereal whose ear has now burst from the sheath—is seen a somewhat different and very instructive condition. Within the limits of a very large nucleus, so blanched and undefined as to be hardly visible, is conspicuous the quondam nucleolus taking upon itself the dignity of a nucleus; occasionally presenting zones of colour paling from within outwards, as the result of want of synchronism in development; and only rarely possessing, by way of nucleolus, one, two, or more granules, somewhat larger than their compeers, and therefore invested with a tolerably distinct areola, yet scarcely deserving a special title.

From these appearances I conclude that the germinal plasma is produced from the germinal molecules, as they are successively brought into action to supply the exigencies of the tissue. This plasma, though vitiating Dr. Beale's definition of "germinal matter" as distinct from "formed matter," cannot be classed under the latter head, inasmuch as it is undoubtedly endowed with vital powers. On this matter, however, I must not now expatiate, but proceed to those more nearly akin to the professed subject of this paper.

In most of the cells of the dyed and mounted section that we have been considering we see that the nuclei are enveloped by the loose folds of a transparent colourless pellicle, manifestly detached from close apposition to the cell-wall, and more or less flecked with coloured germinal molecules. This would seem to consist of the skirting portion of the nuclear matter in a condensed condition, answering to the coating (ectosarc) of a Rhizopod. Very apparent in the younger cells, it is seldom, if ever, seen in those that have exhausted their nutritive capacity. In no case does it receive colour.

External to this, and, normally, in contact with it, are the "secondary layers," constituting spiral cells and spiral vessels; ducts of all kinds, whether spiral, annular, scalariform or dotted; liber, laticiferous, woody, and epidermal tissue. None of these are stained by carmine; most of them are stained by magenta. Their susceptibility to the influence of the dye is the more valuable because it varies with their age, and thus enables us to decide their relative priority of formation.

If the transverse section of *Rumex* be taken from a plant sufficiently young, we find that all its parts are, as it were, gorged with nuclear matter, and that the fibro-vascular bundles seem perfectly formed, but that the spiral vessels are the only parts so much as tinged by the magenta. This accords with the fact, familiar to botanists, that these vesssels are the forerunners of the "bundles."

If, on the other hand, we take a second year's shoot from some shrub, we see that the new deposit of woody tissue is much more intensely coloured than that of the preceding year. Returning to our *Rumex*, and taking a slice from an older stem, we observe that the cells of the medullary rays and of the peripheral portion of the central parenchyma have become thickened by woody deposits, and that these latest productions are more deeply magenta-stained than the previously lignified pleurenchyma of the fibro-vascular bundles.

This useful peculiarity of behaviour may readily induce error on the part of a careless observer. To illustrate this, I must for the moment digress into the animal kingdom. If a section of bone-cartilage be dyed with magenta alone, it will present the "cartilage-corpuscles" (nuclear matter) as bright pink upon a very much paler ground. Reference to a similar section dyed with magenta and the aniline-blue substitute for carmine will explain the apparent inconsistency, by showing that the nuclear matter is enclosed in a film of recent "formed matter," which takes a deeper stain from the magenta.

Useful indications might probably be derived from the fact that the magenta is often more or less deoxidized by the tissues which it dyes, becoming more purple. The liber seems to be exempted from this action, and to be always pinker and less deeply coloured than the spiral fibre or the woody tissue. There is a peculiar form of cell-thickening, corresponding, perhaps, to the variety of liber stated by Mohl to consist of cellulose, which, during some part of its existence, at least, takes no colour. I am not, however, able to give its history.

Some one—I forget who—has proposed the contents of a rhubarb-tart as a ready means for obtaining spiral vessels. If these, thus obtained, be dyed with magenta and carmine, well washed, and mounted in balsam, the microscopist will find himself in possession of a preparation that is both instructive and beautiful. The fully formed vessels will be found to vary as to the degree of juxtaposition of the successive coils of fibre. In some the spiral will suddenly break up into rings, or divide to form a second spiral winding in the same direction; but in all these a cell-wall of the most limpid transparency encloses a crimson spiral, and nothing more. But other vessels will be seen, where the spiral fibre is but faintly mapped out; and these contain nuclear matter—the scaffolding of the unfinished structure. This is also seen, though not to such advantage, in the transverse section. Does not this suggest a compromise between opposing opinions as to the function of the spiral vessels? It is evident that they cannot convey air when young and filled with nuclear matter; but this objection disappears with age.

If I might venture to suggest yet another hypothesis, it would be, bearing in mind the early appearance of the spiral fibre, that it serves the simple mechanical purpose of giving that elasticity to the whole structure, which must necessarily be given in some way or other.

In the 'Micrographic Dictionary' we are told, apropos of the epidermis of plants, that "the walls of the cells next the external surface are found much thicker than the rest, this thickening extending more or less down over the contiguous side walls. When such sections are treated with sulphuric acid and iodine, the greater part of the thickness, from without inward, of this outer wall is stained yellow, while the rest of the walls assume the blue colour ordinarily taken by cellulose with these reagents."

Magenta gives a beautiful and instructive variation of this experiment, dyeing only that part which iodine colours yellow. Probably this state of things is not so universal as inferred by the 'Micrographic Dictionary,' for, in some plants, *e.g.* asparagus, the epidermal cells are altogether uncoloured, while the superjacent cuticle is deeply stained. These facts have an important bearing on the cellulose question, on which I would fain have touched, but must for the present forbear.

Before coming to the final full-stop, some notice seems to be demanded by a paper by Mr. Walter Crum, which appeared in the 'Chemical Society's Journal' for 1863, and is entitled "On the manner in which Cotton unites with Colouring Matter." This only by accident; for, since the paper is principally concerned with the actions of mordants, it would hardly have been available in this place, were it not that one of the substances quoted as a mordant is, as it seems to me, no mordant at all. The dye principally spoken of in Mr. Crum's elaborate and carefully illustrated essay is madder, and the so-called mordant in question is the mono-muriate of alumina. My own experiments have shown me that the colouring principle of madder has the same powers as carmine; that is to say, it is capable, without the aid of mordants, of dyeing the nuclear matter. Now, Mr. Crum's figures show the youngest fibres of cotton—in which the nuclear matter is most abundant—wholly undyed as regards the cell-wall, but with a beautifully coloured mass in the interior. This coloured substance very naturally puzzled Mr. Crum, who looked upon it as a mere precipitate of colouring matter, and he says, with reference to its shrinking, "It is remarkable that the alumina should adhere so slightly to the membrane which contains it, as thus to shift without difficulty from one part of it to another in the act of shrinking."

The fact is that the colour wholly depended on the presence of the nuclear matter, and that the mono-muriate of alumina was simply thrown away.

Wrong conclusions will certainly be drawn from the examination of preparations dyed with magenta unless they be washed until every trace of soluble colour is removed; and this should be done with alcohol. In the unwashed preparation the nuclear matter is seen deeply coloured by the magenta. This operation should be followed by immersion in glycerine, which will remove any lingering trace of unattached colour, and which is also the best preservative fluid. If several vegetable sections of different kinds are steeped in the same colour-bath, care must be taken that none of them contain tannin, the mordanting power of which would altogether disguise the proper differentiating appearances conferred by the dye.

I have omitted to remark, in the proper place, that secondary products, such as starch, are not coloured either by carmine or magenta.

TRANSLATION.

On the Development *of the* Eggs *of* Floscularia ornata, Ehr. By Dr. J. F. Weisse, of St. Petersburg.

('Zeitschrift f. wiss. Zool.,' xiv, p. 107, pl. xiv, A.)

Whilst the author, in the course of last summer, was pursuing his investigations on the eggs of the Rotatoria, he noticed on the 15th of August a beautiful example of *Floscularia ornata,* together with four minute ova, which had been already deposited in the aquarium. A fifth ovum, which was still contained within the maternal body, was expelled under his eyes on the following morning, by a forcible contraction of the animal. The germinal vesicle was still present, and it differed, moreover, from the other ova in the circumstance that the embryo, whose motions became more and more lively, remained in this condition the whole of the following day, exhibiting at times movement of the difficultly seen pharynx. It was not till the 20th that the egg was ruptured at the end where the ciliary motion had been perceived. The little animal crept slowly about with a worm-like movement, and now exhibited very distinctly the circle of cilia at its anterior extremity. When completely liberated, it might be about twice the length of the egg, but it had not the slightest resemblance to the parent, so that any one accidentally coming across such an animalcule under the microscope might readily mistake it for a newly discovered species. The author, therefore, gives a figure of the contents, which were slightly separated from the shell at either end (fig. 1).

Up to the 17th of August he was unable to perceive any striking change in any of the ova, except that in one of them there appeared in the course of the day a minute red point, which seemed to change its place, although he was unable actually to witness any movement in it. But, on the following day (the 18th), early in the morning, he perceived in this egg two distinct bright-red eye-spots, which, owing to the visible movements of the already developed embryo, were continually changing their relative positions towards each other; and, at the same time, he noticed a faint ciliary movement at one end of the embryo young *Floscularia,* in this condition, since none is given by Ehrenberg, who had only obtained a sight of the embryo by artificially rupturing the egg.

Whilst his whole attention was directed to this ovum, two others in the meanwhile had so far advanced in their development that the eggs were already visible in them. They both gave exit to the embryos on the 22nd, one at eight o'clock in the morning, and the other two hours later; in both the ciliary movements, at the anterior end, were distinctly visible whilst the embryos were still within the shell. In a fourth egg the embryo had died, as was evident from the circumstance that its contents, even before the appearance of the eye-spots, had contracted from each end into the middle of the egg into an irregular mass. The fifth egg, lastly, that, viz., which the author had seen escape from the parent on the 16th, presented as early as on the 20th, in the morning, both eyes in the actively moving embryo, but it did not rupture before the morning of the 23rd, so that the complete development of the embryo was effected within seven days. In conclusion, he remarks that the first egg had probably been deposited on the 13th August.

The foregoing observation stands in striking contrast to Ehrenberg's statements respecting the rapid propagation of *Hydatina senta.** But, since, from the author's previous researches,† as well as from many later observations on the subject of the ova of the Rotatoria, it is evident that their development proceeds with tolerable slowness, *Hydatina senta* must probably be regarded as an exception to the general rule.

Lastly, the author cannot refrain from adverting to the erroneous statements of M. Pesty respecting Floscularia. That writer, at p. 47 of his 'Memoir on the Knowledge of the Smallest Living Forms' (1852), states, "At the foot 2—3 ova, each two thirds as big as the body of the parent animal. Vitellus brown, and set round with short hairs," &c. But the eggs of this Rotifer are so small as hardly to equal

* 'Zur Erkenntniss der Organisation in der Richtung des Kleinsten Raumes.' 2nd part, 1832.

† "Zur Oologie der Räderthiere." In 'Mémoires de l'Académie impériale des Sciences de St. Petersbourg,' VII série, tome iv, 1862.

in length one sixth of the maternal body; and then to think of a "vitellus set round with short hairs"! It is a pity that M. Pesty, among the overwhelming multitude of his often-unused figures, has not given us one of his supposed *Floscularia.*

REVIEW.

Principles of Human Physiology, by WILLIAM B. CARPENTER, M.D. Sixth Edition, edited by HENRY POWER, M.B. London: Churchill.

THE sixth edition of a work of nearly one thousand pages is no mean testimony to its worth. We shall not, therefore, attempt to criticise this work, but simply afford our readers the means of judging whether the new edition has kept up with its predecessors in those departments where the use of the microscope is necessary. We are not sure that this is a work of supererogation. Researches with the microscope in this country do not at all command the attention which their importance demands, and if we examine the records of our own societies compared with those of other countries of Europe, it is very manifest that the easier methods of observation with the naked eye are favourites with the scientific men of Great Britain. As a physiologist, no microscopist could complain that Dr. Carpenter has neglected to chronicle and estimate those researches which alone could be carried on with the microscope. He has everywhere recognised research by the aid of this instrument, and in his work on the use of the microscope has shown how thoroughly he understands the facts that can alone be brought into consideration in the science of physiology by its aid. At the same time we cannot but regard a certain tendency to speculation in the direction of physical and chemical forces, as fraught with danger to physiology, unless accompanied with the sound observation of facts which the microscope alone supplies. On this ground we felt anxious lest Dr. Carpenter, in committing his work to the editorship of another, should diminish its value in relation to all those facts bearing on human physiology which can alone be properly understood by the use of the microscope. We are glad to say that, as far as our examination of this new edition of Dr. Carpenter's work has gone, we observe no indication on the part of Dr. Power of attaching less importance to microsopical researches than his author.

But whilst congratulating Dr. Carpenter and our readers on this fact, we cannot but regret that he has been compelled to resign the superintendence of another edition of his own book. And why? Because, "having long since relinquished, on his appointment to the post he at present occupies, the duties of a Teacher of Physiology, and having consequently ceased to feel it incumbent upon him to keep up with the science in detail, he found that the mass of new material which had been accumulated by the industry of inquiries in every one of its departments, was far greater than lay within his capacity to systematise; the time and working power left at his disposal, by the requirements of his official position, being extremely limited." We can hardly imagine any Englishman reading this passage without blushing for the honour and reputation of his country. Here is a man of great ability, and blessed with special endowments for the prosecution of a particular branch of science, coming forward and saying, the only reward my countrymen have been able to bestow on me for all my scientific work is a clerkship, the nature of which occupation renders me utterly incapable of pursuing my scientific work. Dr. Carpenter is not a solitary case. There are other appointments we could name, which the Government of this country, in its utter ignorance of the nature of science or its aims, have made, which have been attended with the like disastrous results. As a reward of science men are put into a position where their means of prosecuting science are absolutely cut off. We are honestly of opinion that unless our ruling authorities are prepared to repudiate the notion that they are in earnest about the advancement of science, they had better make no such appointments as those of Dr. Carpenter at all. Let us have our men of science to ourselves. Let us live and die despised and in poverty, with at least the comforting thought that we have accepted no "mess of pottage" that has interrupted us in the glorious career of advancing true knowledge and lifting the dark veil which hangs between man and a knowledge of his Creator's laws.

We turn over the pages of this new volume of Dr. Carpenter, and we feel that it is a disgrace to us as a nation that we are doing so little for the advancement of the knowledge of the science of physiology. We cannot conceal from ourselves that whatever may be the satisfaction with which England regards her educational system, that it is from the universities of Germany that the light is streaming which gives to physiology its interest, and supplies the facts that make it a progressive science. We hope we may be excused from alluding to this subject, but it is vital to us. We cannot expect to keep pace either with Germany or France in physiology, or any other branch of natural science, unless a greater effort is made to place these sciences in a proper position in our Universities. Our statesmen, our clergy, and our lawyers, educated in our universities, are all more or less infected with the heresy that human thought, character, and action, are little influenced by the culture of the natural sciences; the consequence is, that they are everywhere snubbed and ignored in our courses of education, and their cultivators rewarded in the same manner as persons of diligent habits who occupy menial and official positions in society. When England treats her great men of science as they ought to be treated, she will find that there is no want of genius and power amongst her sons; but as long as the men who cultivate natural science are regarded as on a level with those who cultivate the meaner arts of life, so long must she submit to the degradation of holding a second-rate position amongst the nations that cultivate science.

It was the burthen of the life of the late Prof. Edward Forbes, who occupied a professedly scientific position, that he was always treated as a clerk and not as a man of science. Throughout the whole of the so-called science and art department there is one universal feeling among men of science—that they are treated as clerks, and the objects and aims of the officers criticised and judged of by the mere clerk-intellect which the Government places over them. In these posts scientific men are insulted, degraded, and discharged, and there is no help for them anywhere.

But we must still be thankful for our privileges. We do not think there is a better text-book of Human Physiology than Dr. Carpenter's extant. All honour to our young men who, for little thanks and scant reward, can be found to aid in the work of making known what has been done in foreign countries in the great work of scientific progress. The present edition of the 'Human Physiology' is different from the last. Much is omitted and much is added. The great feature of all four editions of Dr. Carpenter's work—the sections on the functions of the cerebrum—are now omitted. In the chapters on food and digestion, considerable additions have been made to the section treating of the saliva, whilst the experiments of recent continental observers on the effect of the nervous system in this quarter are fully detailed. The experiments of Brüche on the influence of the gastric acid on the fibrine and albumen, and the formation of peptones and parapeptones by Meissner, are given in detail. A great deal has been recently done with regard to the nature and action of the pancreatic juice and the bile, and the sections devoted to these subjects are full of new and interesting matter. There is an interesting account of the structure of the villi, and as this subject is entirely microscopical, we are induced to give an extract from this part of the work to show, in the first place, how well the editor has kept up with his time, and, in the second place, to show in what a bold and instructive manner microscopic illustrations may be produced in wood.

106. The *villi* are extensions of the mucous lining of the intestinal canal, which thickly beset its surface from the pyloric orifice to the cæcum, that is, through the entire length of the small intestine, to which they are limited in man. They have usually somewhat the form of the finger of a glove, being sometimes nearly cylindrical sometimes rather conical, whilst they not unfrequently become flattened and extended at the base, so that two or more coalesce. Their length varies from 1-4th to 1-3rd of a line, or even more; and the broad flattened kinds are about 1-6th to 1-8th of a line in breadth. In the upper part of the small intestine, where they are most numerous, it has been calculated by Krause that there are not less than from 50 to 90 in a square line; and in the lower part, from 40 to 70 in the same area. The details of their structure are of extreme interest in reference to the mechanism of absorption. If the plan pursued by Teichmann, that of injection, be adopted, the appearances presented are those shown in Figs. 19, 20, and 21, taken from the beautiful plates which accompany his work on the Lymphatic System.* From these it appears that the lacteals commence either by a simple closed extremity, or by a loop, though in broad villi a network is sometimes visible. The tube or tubes occupying the centre of the villus appear to possess perfectly definite walls, and are larger than the numerous capillary blood-vessels which surround and are external to them. Their average diameter is about 1-800th or 1-1000th of an inch; but they present here and there slight dilatations and contractions, and at the base of the villus terminate in a network of lacteal vessels immediately subjacent to the Lieberkühnian follicles (Fig. 20 *b*), termed by Teichmann, from the closeness of the meshes, the *Reta angustum*. This plexus communicates with another possessing larger vessels, which are supplied with valves, are more deeply situated in the submucous areolar

Fig. 18

Villi of the Human Intestine, with their capillary plexus injected.

* Ludwig Teichmann, 'Das Saugader System,' Leipzig, 1861.

tissue (Fig. 20 *c*), and constitute the so-called *Reta amplum.* Besides the central lacteal, the villus is composed of a matrix of areolar tissue,* without any intermixture of elastic fibres, containing in its interstices numerous branched and communicating cells with nuclei, and frequently also fat-granules in their interior. No nervous elements have been traced into the villi; but a layer of muscular fibre-cells has been shown by Kölliker and others to surround the

Fig. 19.

A. Villi of Man, showing the blood-vessels and the lacteals.
B. Villus of a Sheep.

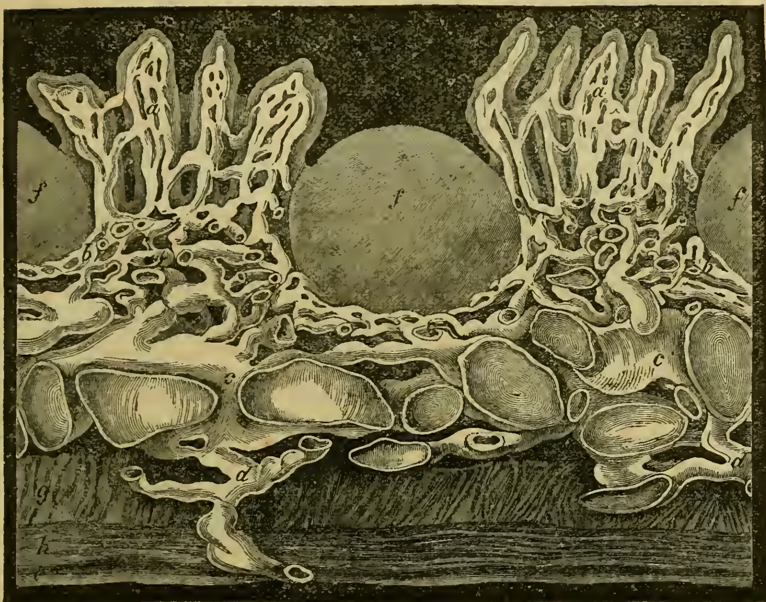
lacteal tubes, the contraction of which has been frequently observed whilst absorption is going on, and has an important influence on the propulsion of the fluids contained within those vessels.

107. When the villi are examined at such a period after a meal containing oleaginous matters as has sufficed for its partial digestion, their lacteals are seen to be turgid with chyle, the extremity of each being embedded in a collection of globules presenting an opalescent appearance, and giving to the end of the villus a somewhat mulberry-like form. It was supposed by Prof. Goodsir,† by whom this appearance was first observed, that these globules were cells developed

* Kölliker, 'Manual of Hum. Histology,' p. 325.

† 'Edin. New Phil. Journ.,' July, 1842, and 'Anatom. and Pathol. Observ., pp. 5—10.

Fig. 20.



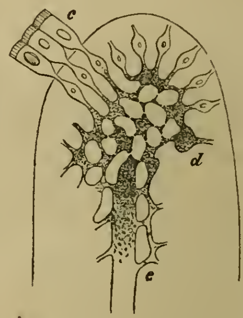
Perpendicular section through one of Peyer's patches in the lower part of the ileum of the Sheep. *a*, Lacteal vessels in the villi. *b*, The superficial layer of the lacteal vessels (rete angustum). *c*, The deep layer of the lacteals (rete amplum). *d*, Efferent vessels provided with valves. *e*, Lieberkühn's glands. *f*, Peyer's glands. *g*, Circular muscular layer of the wall of the intestine. *h*, Longitudinal muscular layer. *i*, Peritoneal layer.

Fig. 21.

A perpendicular section through the wall of the Processus Vermiformis (Man). *a*, Lieberkühn's glands. *b*, Solitary follicle. *c*, Lacteal vessels, surrounding but not penetrating the follicle. At *d* are seen the larger efferent vessels, provided with valves.

within the basement-membrane during the act of absorption, from what he considered to be granular germs visible in the same situation during the intervals of the process; but there can now be little doubt that the appearance in question is really due to the distension of the cylindrical epithelial cells *investing* the villi with the lacteal fluid; and as it is a matter of much interest to examine and explain the mode in which absorption in this, its first stage, is effected, the attention of many observers has been directed to the structure of these cylindrical investing epithelial cells; and if the observations of Heidenhain Brücke be correct, our knowledge of the mode of absorption of various substances, and especially of those of an oleaginous nature, will be materially simplified. According to these investigations,* the investing cells of the villi (*c*, Fig. 22) are of cylindrical form, with a ciliated border, and are filled with a clear sarcode containing a bright nucleus. The cilia stand erect during life, but quickly disappear after death, being replaced by a globular swelling projecting from the mouth of the cell, occasioned by the imbibition of water. The wide and free extremity of these cells is supposed by some (Brücke) to be almost or completely patent, or closed only by a plug of sarcode-like substance, whilst Funke† and others consider it to be covered by a delicate septum perforated like a colander with extremely fine canals or pores. The small and attached extremities of these cells are believed to be prolonged into the interior of the villi, becoming continuous with the caudate processes of the corpuscles of the connective tissue (*d*) which constitutes the matrix, and which again open, as shown in Fig. 22, into the lacteal vessel (*c*), thus affording a direct means of entrance for the fatty matters into the absorbent system, and explaining the occasional introduction of solid particles into the circulating current.‡

Fig. 22.



Diagrammatic representation of the Origin of the Lacteals in a Villus:—*e*, Central lacteal; *d*, Connective-tissue-corpuscles with communicating branches; *c*, Ciliated columnar epithelial cells, the attached extremities of which are directly contiguous with the connective-tissue-corpuscles.

* See Heidenhain in 'Moleschott's Untersuchungen,' band iv, 1858, p. 251; and Brücke in band viii, 1862, p. 495; and in 'Denkschrift. d. k. Akad. d. Wiss. zu Wien,' band vi, p. 105.

† 'Physiologie,' 1863, p. 365.

‡ These epithelial cells were described by MM. Gruby and Delafond ('C Rendus,' 1843, 1195), as possessing cilia on their free margin; but Kölliker and Funke considered this appearance as illusory, and produced by the thick membrane closing the free extremity of the cell being perforated by very delicate pores or canals, whilst after death it split up in such a manner as to *resemble* a bundle of cilia (Kölliker, 'Mikroskop. Anat.,' 1860, p. 329). Balogh, agreeing with Kölliker as to the lines in question being canals, differed from him in believing them to be not pre-existent, but merely the indications of the passages made by the molecules of fat in penetrating the delicate tissue occluding the mouth of the cell ('Moleschott's Unters,' band vii, 1861, p. 556). Brettauer and Steinach, on whose observations the statements of Brücke, Heidenhain, and other later authors are founded (Brettauer and Steinach, 'Sitzungsbericht d. k. Akad. d. Wissen. zu Wien,' 1857, band xxiii, p. 303), maintained that the apparent cilia were prolongations of the cell-contents, the cells themselves

108. In regard to the degree in which the function of nutritive absorption is performed by the lacteals and by the sanguiferous system respectively, considerable difference of opinion has prevailed. When the absorbent vessels were first discovered, and their functional importance was perceived, it was imagined that the introduction of alimentary fluid into the vascular system took place by them alone. Such an idea, however, would be altogether inconsistent with the facts of Comparative Anatomy;* and it is completely negatived by the results of experiment. For that absorption is effected to a very considerable amount by the agency of the blood-vessels, is shown in the first place, by the readiness with which aqueous fluids and even alcohol are taken-up from the parietes of the stomach, and are carried into the general circulation. Thus in a case of extroversion of the bladder, observed by Mr. Erichsen,† in which the urinary secretion could be collected immediately on its passing from the kidney, when a solution of ferrocyanide of potassium was taken into the stomach, this salt was detected in the urine in one instance within 1 minute, and in three other instances within 2½ minutes. In all these cases, however, the stomach may be presumed to have been empty, and the vascular system in a state of aptitude for absorption; since the experiments were made either after a long fast, or at least four hours after a light meal. When, on the other hand, the salt was introduced into the stomach soon after the ingestion of alimentary substances, a much longer period elapsed before it could be detected in the urine; thus, when a substantial meal had been taken two hours previously, the interval was 12 minutes; when tea and bread-and-butter had been taken one hour previously, the interval was 14 minutes: a similar meal having been taken twenty-four minutes previously, the interval was 16 minutes; when only two minutes had passed since the conclusion of such a meal, the interval was 27 minutes; and when a solid meal had been concluded just before the introduction of the salt, the interval was 39 minutes. These facts are of great importance, in showing the very marked influence which the state of the *stomach* exercises upon the absorption of matters introduced into it. Not less important, however, is the state of the *vascular system* in regard to turgescence or emptiness; for it was found by Magendie, that when he had injected a considerable quantity of water into the veins of a dog, poison was absorbed very slowly; whilst, if he relieved the distension by bleeding, there was speedy evidence of its entrance into the circulation. The rapidity with which not only aqueous but alcoholic liquids introduced into the stomach may pass into the general circulation, has been shown by the experiments of Dr. Percy;‡ who found that when strong alcohol was injected into the stomach of dogs, the animals would sometimes fall insensible to the ground *immediately* upon the completion of the injection, their

terminating with a smooth circular margin. They described the columnar arrangement as broadest and most distinct in fasting animals, whilst in cells filled with fat it diminishes to one half or one third of its former breadth, and the striæ disappear, so that only a bright narrow rim or border is left. Lastly, Wiegandt is stated in 'Canstatt's Jahresbericht' for 1862, p. 32, to view the cilia as merely the optical expression of striæ or wrinkles.

* See 'Princ. of Comp. Phys.,' chap. iv.

† 'Medical Gazette,' vol. xxxvi, p. 363.

‡ 'Experimental Enquiry concerning the Presence of Alcohol in the Ventricles of the Brain,' p. 61.

respiratory and cardiac movements ceasing within two minutes; and that on post-mortem examination in such cases, the stomach was nearly empty, whilst the blood was highly charged with alcohol; thus rendering it almost certain, that not merely the final destruction of nervous power, but the immediate loss of sensibility, was due to the action of alcoholized blood upon the nervous centres. Finally, numerous experiments have been made by various physiologists, which have demonstrated that absorption of alimentary and other substances may take place from the walls of the stomach; these substances having been prevented from passing into the intestine by a ligature around the pylorus. Now, as the absorbent system does not present that peculiar arrangement in the coats of the stomach, which it does in those of the intestinal tube, there can be little doubt that the introduction of such substances into the system must be effected chiefly, if not entirely, through the medium of its sanguiferous capillaries.

109. That the blood-vessels of the intestinal tube largely participate in the introduction of soluble alimentary matter into the system, has been clearly proved by various observations upon the constitution of the blood of the mesenteric veins; these having shown that, after the digestion of albuminous and farinaceous or saccharine substances, albuminose, dextrin, grape-sugar, and lactic acid, are detectible in that fluid, whose usual composition is greatly altered by the presence of these substances, as well as by the augmented proportion of water which it contains. Moreover, it is asserted by Bruch,* that so large a quantity of fat is absorbed into the blood-vessels, that the superficial capillary network sometimes presents an opalescent whiteness. We may consider the sanguiferous vessels, then, as affording the usual channel by which a large part of the nutritive materials are introduced into the system; but these are not allowed to pass into the general current of the circulation, until they have been subjected to an important *assimilating* process, which it appears to be one great office of the liver to perform, whereby they are rendered more fit for the purposes they are destined to serve in the economy. Of this we shall presently have to speak. But the absorbent power which the blood-vessels of the alimentary canal possess, is not limited to alimentary substances; for it is through them almost exclusively that soluble matters of every other description are received into the circulation. This, which may now be considered a well-established fact, was first clearly shown by the carefully conducted experiments of MM. Tiedemann and Gmelin,† who mingled with the food of animals various substances, which, by their colour, odour, or chemical properties, might be easily detected in the fluids of the body; after some time the animal was examined; and the result was, that unequivocal traces of such substances were not unfrequently detected in the venous blood and in the urine, whilst it was only in a very few instances that any indication of them could be discovered in the chyle. The colouring matters employed were various vegetable substances, such as gamboge, madder, and rhubarb; the odorous substances were camphor, musk, asafœtida, &c.; while, in other cases, various saline bodies, such as chloride of barium, acetate of lead and of mercury, and some of the prussiates, which might easily be detected by chemical tests, were mixed with the food. The colouring matters, for the most part, were carried out

* Siebold and Kölliker's 'Zeitschrift,' April, 1853.

† 'Versuche über die Wege auf welchen Substanzen aus dem Magen und Darmkanal ins Blut gelangen,' Heidelberg, 1820.

of the system, without being received either into the veins or the lacteals; the odorous substances were generally detected in the venous blood and in the urine, but not in the chyle; whilst of the saline substances, many were found in the blood and in the urine, and a very few only in the chyle.* A similar conclusion might be drawn from the numerous instances in which various substances introduced into the intestines have been detected in the blood, although the thoracic duct had been tied; but these results are less satisfactory, because, though there is probably no direct communication (as maintained by many) between the lacteals and the veins in the mesenteric glands, the partitions which separate their respective contents are evidently so thin, that transudation may readily take place through them.

In the chapter devoted to the blood, the amount of attention devoted to chemical considerations has been much reduced in this edition, and for the very good reason that little reliance can be placed on the chemical analysis of substances having the high combining proportions of the constituents of the blood. The field which still opens up the highest prospect of future discoveries in the blood is that of the morphology of its globules and crystals, which can alone be studied by the aid of the microscope. There is an interesting section in this work, not found in the previous editions, on the vital properties of the blood, which we presume is written by the present editor, and also another section on the balance in the vital economy, in which an elaborate account is given of the debtor and creditor account of the body during reception of supplies and rejection of waste. There is also a good *résumé* of all that has been done on the glycogenic function of the liver, and the section on the urine is brought up to the present state of our knowledge.

Much has been done in the structure and function of the nerves. Amidst the large amount of contradictory results and opinions, the editor has managed to give the principal facts in this difficult branch of inquiry.

The chapters on muscular tissue, and on generation and development, have been considerably extended, and new observations recorded.

The number of woodcuts have been increased from 156 to 206, and several of the old ones replaced by new. The getting up of the work is worthy the famous house of Churchill. Works on physiology are sometimes supposed to

* Colin, however, on examining the fluid of the thoracic duct, readily found iodide and ferrocyanide of potassium in dogs, sheep, and oxen, to which these salts had been administered eighteen minutes previously. ('Bulletin de l'Académie,' xxvii, p. 948.)

be only written for medical students. We shall be glad to see this immensely injurious impression removed, and recommend all who have a stomach, heart, and brain to keep in order, to study this work. We trust the time is coming when the study of this most necessary of all the sciences will be rescued from the hands of a class, and pursued by all people who wish to live in obedience to the laws of their Creator.

NOTES AND CORRESPONDENCE.

A Cheap and Portable "Turntray."—In the "social" use of the microscope, there is, as every microscopist well knows, a great amount of discomfort in having continually to be shifting one's seat, which is alike troublesome and fatiguing to one's friends as to one's self, but this is of minor importance compared with the unfitting the eye for observing, and which, with a binocular, is a far more serious drawback than with the single tube, so that some contrivance to obviate this has become almost a necessity. The *revolving table* is certainly capable of rendering this changing unnecessary, but the table is not only not without its inconveniences, but it has also the more objectionable item of cost to prevent its coming into general use. Nor does it appear that any efficient substitute for it has yet been brought into favour. What is required is *a tray* capable of holding one full-sized instrument together, its lamp and condenser so arranged that it may be passed from the observer to a friend sitting by his side, or to a party of four or five or more in succession. The indispensable essentials for it to possess are, first, efficiency; that is, sufficient solidity and steadiness to prevent vibration, and to move freely without friction or noise; next, cheapness; then comes portability; and last, but not least, it must possess a certain amount of "good looks" to ensure its admission to the drawing-room. These desiderata I have succeeded in combining in what I have styled a "turntray," and which has delighted all who have seen it.

It consists of a stout rectangular board, twenty-three inches long and thirteen and a half inches wide, working on a pivot at one end, and on two revolving runners at the other, and being thus supported on three points, it is always steady in any position. The ends are strengthened by two other inch-thick crop pieces, which are also raised for the working parts so as to bring the surface upon which the instrument stands as near to the table as possible, leaving the lower side only just free from touching it. Being under two feet long, and few tables being less than four feet wide or across, it is capable of accommodating from two to six or more persons at an ordinary dining-table, or placed on a circular centre table, as many as can sit around it. It thus becomes, for one instrument, equally useful as the whole table would be.

In common deal it may be made for a very few shillings. In solid well-seasoned inch-thick mahogany, French-polished, with bronzed iron centre support, corked for steadiness and to prevent scatching, and with highly brass runners, it ought to be obtained in London for about a guinea or less. The builder (himself a very clever hand) whose workmen made it for me, is so impressed with the belief in its usefulness and the certainty of its being approved when seen, that he has volunteered to provide a number of them during the slack time of winter, at the lowest possible cost, to be sent out as patterns, or he will supply the trade with them, if required.—W. Kencely Bridgman, 69, St. Giles', Norwich.

Zoosperms in the ovaria of Pulmogasteropoda.—In reference to the above subject I see that Dr. Lawson has proposed, in the number of your Journal for July, some objections to the common opinion that the ovary in these animals is in reality a hermaphrodite gland; they appear to me by no means insurmountable, and with your permission I will do my best to answer them. His first objection is, that the zoosperms are found fully developed in the ovary, and imperfectly formed in the spermatheca, and must therefore have undergone a species of retrograde development. This is by no means my experience; on the contrary, in the ovary of *H. aspersa,* I have found zoosperms in the immature condition, which he calls spermatophora; that is, still united by their heads into bundles, and having yet a good deal of the granular contents of the parent cell remaining attached; and in the ovary of Arion they have occurred in a still earlier stage, so that there is no necessity for the hypothesis of retrograde development.

With regard to his other objections, viz., there being only one excretory canal to the ovary, and the impossibility of the passage of the zoosperms into the spermatheca, I may state that I think I have seen in Helix a small tube situated in the connective-tissue, and which surrounds the ovarian duct, but of this I am not certain; at any rate, granting that the canal is single as far as the abdomen gland, it is just possible that the ova are not sufficiently mature to be impregnated, until they have passed that gland, and then the structure of the uterus permits the separation of the two products, for on the prostate side of the uterine tube is situated a groove or gutter extending its whole length, separated from the main cavity by a longitudinal valve-like structure, which allows the two canals thus formed to communicate with each other along its free edge; this groove runs directly into the vas deferens, and thus conveys the zoosperms into the penis, from which their transference into the spermatheca appears easy. I find that Dr. Lawson has not described this twofold structure of the cavity of the uterus, or rather, denies it; but I found it easily enough, and it is well described by H. Nickel in 'Müller's Archives' for 1844. As to the prostate being the largest gland of the whole apparatus, I should hardly think that that alone would be sufficient to substantiate its claim to the character of testis. Besides the above considerations in favour of the hermaphrodite character of the ovary, there are a few others, such as, if this gland does not secrete the zoosperms, how could they get there? Its duct is strongly ciliated, and the direction of the ciliary current is towards the outlet, and one would suppose that they would find great difficulty in making way against the stream, and in an immature condition it would be still more trying.

In opposition to the above facts, Dr. Lawson has only to put forward the size of the prostate and a few "oval and elliptical, epithelial-like cells, usually described as the parents of zoosperms."

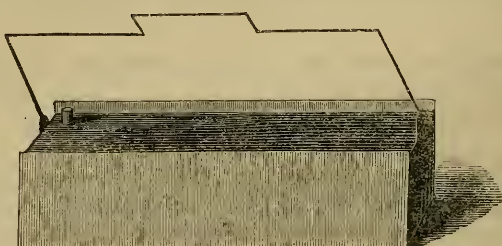
I will leave it to your readers to say which view is most likely to be correct, and which looks more like a *petitio principii*.—Alfred Sanders, F.L.S., Brixton.

The Theory of Circulation in the Vorticellidæ.—I have seen the contractile vesicle of Vorticellidæ to present the following appearance under the microscope in the majority of cases:

First. On certain movements of the reflector the vesicle entirely disappeared, but that on subsequent alterations of the position of the reflector I observed its reappearance. I am inclined to think that any subsequent contraction-like appearance of the vesicle was due to the fact of its having been removed from the line of focus by the movements of the living animal; to the same cause I also attribute an expansion-like appearance of the vesicle. Hence the characteristic term "*contractile* vesicle" is inappropriate, unreasonable, and unfounded; the plain word *vesicle* being truthful.

Secondly. I have never witnessed the processes proceeding from the vesicle, stated by Lachmann to have been observed by him; I believe that what he thought to be processes or branches of the vesicle were merely occasional interpositions of the cilia of the disc between the object and the microscope; I believe that the delusion sometimes assumes an almost convincing aspect, not of two distinct processes, as Lachmann has observed, but of branches to and from the vesicle, indefinite in their position and number. Thus, we see how easy it is to account for the fallacy into which Lachmann and most other naturalists have fallen. I acknowledge that there is a vesicle of unknown use in the Vorticellidæ; I deny the existence of a "contractile vesicle," acting as a heart. I acknowledge the presence of cilia; I deny that of vesicular branches or vessels. Hence I infer that the statement that there is a circulatory apparatus in the Vorticellidæ is without foundation, and may only be regarded as a picture painted by a vivid imagination, or as an hypothesis promulgated for a selfish purpose. I invite the investigation of naturalists who have not as yet made themselves practically acquainted with these animals; and at a future period, when, having become thorough masters of this department of zoological science, I would ask them to give *me* the credit of, and to support, the views I have in this paper expressed.—WILLIAM HANDSEL GRIFFITHS.

Mr. Goddard's Mounting Table seems liable to the objection that there is no provision for regulating the temperature so as to prevent it rising to the boiling-point of balsam. I have for a long time used a water bath of tin or zinc 14 by $3\frac{1}{2}$ by $3\frac{1}{2}$ inches with a ledge running round the top



to prevent the slides slipping. If a cover of cardboard be placed on this to keep off the dust, and the orifice through which the water is introduced left open, the apparatus with the slides on it may be left to itself for any reasonable time over any source of heat. An hour or two generally suffices to harden the balsam, and the air-bubbles (if any) disappear. —T. G. STOKES, Aughnacloy.

PROCEEDINGS OF SOCIETIES.

Bristol Naturalists Society.

The following extract from the Second Annual Report of this Society will be interesting to many of your readers:

"In respect to the transactions of the second year, a brief outline of the several excursions and meetings will offer many points worthy of notice in this report.

"The excursions, four in number, took place in the order following:—In the month of June, a trip was arranged to Clevedon by rail, thence on foot to Walton Castle, and along the hill, returning by the sea-side to Clevedon. The Rev. G. W. Braikenridge communicated to the party a botanical history of the locality, and the President, Mr. Wm. Sanders, explained the geological phenomena most worthy of notice in the course of the walk.

"The second excursion, in July, had for its object the examination of the deep cutting near Patchway, on the line of the S. W. Union Railway, on which Mr. Charles Moore, of Bath, favoured the party with his company, and collected the materials for a paper read by that gentleman at one of the meetings.

"The next expedition in August, was directed to the Lias Quarries of Keynsham, and the great fault in the stratification of Bitton-hill. The objects of the party were successfully accomplished under the guidance of the President, Mr. Sanders.

"In September, a party again assembled, undeterred by the very unfavorable weather experienced on two of the three previous excursions, to explore the fossil beds of the limestone formation on the banks of the Avon from the Hotwells to Sea-Mills, and to obtain from the marshes below Shirehampton certain botanical specimens. This excursion formed an agreeable close to the series of summer meetings.

"On the 1st of October, the society resumed its evening meetings at the Institution.

"The question of election of new members was discussed at this meeting, and the future management and responsibility of the elections transferred to the Council,—the time of the meeting being thus devoted to the scientific engagements of the evening. The Council were further empowered to invite the attendance of ladies on suitable occasions.

"Mr. Charles Davis read a paper on the Natural History of Amber, and Mr. Hugh Owen communicated an interesting discovery by Mr. Jonathan Couch of an open tube leading from the ear to the air-bladder of certain fishes, analogous to the eustachian tube in the higher animals.

"In November, Mr. W. W. Stoddart read to a large audience (including ladies amongst the visitors) an account of the tea-plant, its properties and adulterations.

"At a very full meeting in December, Dr. Beddoe gave an account of the Maori race of New Zealand, and Dr. Joseph Swayne exhibited portraits drawn by himself of the chiefs of that race, lately resident in our city. Mr. Charles Ottley Groom also made observations on the cranial characteristics of the aboriginal New Zealanders. On the same evening, Mr. Frederick Martin exhibited a collection of specimens illustrating the Marine Zoology of Clevedon, and read a paper descriptive of them.

"At the January meeting, Dr. Samuel Martyn read a paper describing two species of Holothuridæ, known in the commerce of the Chinese waters under the name of Trepang, and used there as an article of food. Specimens, drawings, and chemical demonstrations accompanied the paper. Mr. Henry Swayne then read a paper on 'Anthropoid Apes,' illustrated by examples selected from the Museum.

"At the February meeting, a proposition of the Council was made to the society to purchase a specimen of a rare bird (Apteryx) for the Museum. Mr. Leipner gave a short account of this bird, and the recommendation of the Council was adopted. Mr. Moore of Bath then read a paper entitled 'Results of a geological ramble to Patchway,' illustrated with specimens. On the same evening, Mr. Collens exhibited an improved Burette for the purpose of volumetric analysis, which obtained the approval of several gentlemen experienced in that department of practical chemistry.

"On March the 3rd, a numerous attendance of members and visitors demonstrated the increasing attraction of the society's meeting. The new purchase (a fine specimen of Apteryx) was exhibited, after which Mr. Stoddart displayed a series of illuminated photographs of objects illustrating the natural history of our locality, and described the objects exhibited in his account of 'A Naturalist's walk.'

"The concluding meeting of the winter session was occupied by Mr. William Lant Carpenter's descriptive account of the material called 'waterglass,' used in modern fresco painting, with a detailed analysis of a specimen of the material used for the decoration of the new houses of parliament. Mr. Chas. O. Groom read a paper on the 'Nidification of a few birds that breed in Britain.'

"This cursory notice of the many interesting excursions and meetings of the society during the past year, may suffice to give a general and connected view of its scientific transactions. The details having been rendered familiar to all our members by the regularly printed abstracts, do not require to be further dwelt on. Your Council cannot, however, refrain from pointing with the liveliest satisfaction to these evidences of sound and steady advance to a high, scientific position, which must be a matter of earnest congratulation to all concerned.

"They feel, moreover, that the society may now take another and very important step in its onward career, and to this they would beg to direct especial attention.

"In the April meeting of this year, your Hon. Secretary expressed his views and wishes in regard to the accomplishment of a complete history of the Geology, Palæontology, Mineralogy, Botany, and Zoology of our locality, and as far as might be possible, its entire collective natural history, including the highest and lowest forms of animal and vegetable life. A work of such large dimensions, and requiring such assiduous labour, can be surmounted only by the combined and continuous efforts of many naturalists qualified by previous experience and exactitude of knowledge in various departments; a work, however, worthy of their united powers, and offering great opportunities and a high reward. It must be a source of just pride to the society, that it can feel *able*, as well as willing, to undertake so important a work, and that it can look forward with confidence to its completion in due time. The society has, however, fairly committed itself to this undertaking with full faith in the powers of many distinguished members, and with the praiseworthy determination to carry out their resolve to the best of their ability. At the last meeting, your Council was entrusted with the arrangements necessary for working out this scheme, and preparations are already being made. A careful study of details is, however, requisite, and the amount of work before the society appears to increase daily, as each detail passes under consideration."

Birmingham Natural History Association.

Microscopical Section.

Mr. Thomas Fiddian in the Chair.

July 12th.—Mr. Davies read his paper on the Entomostraca, commencing by stating that he should only describe the most common species. He passed on to give an account of that interesting creature *Cyclops quandricornis;* showed, by the aid of diagrams, the different stages through which the young pass before arriving at its mature state.

The *Canthocamptus minutus* claimed attention, but being in many respects so similar to the first described animal, was soon despatched to make way for the family Daphniadæ, the creatures which appear to be the most common of all the Entomostraca. The paper was rendered very intelligible by numerous diagrams, and by the microscopes of the society.

Aug. 9th.—Dr. Hind read his paper on *Trichina spiralis.* He commenced from the discovery of the Trichina in England, by Mr. Hilton in 1832, and closely followed its history down to the present time. The paper was illustrated by the exhibition of mounted specimens of muscle containing Trichina.

Sep. 13th. The chairman, Mr. Thomas Fiddian, read a paper on the History of the Honey Bee. He commenced with the different histories given of it by the ancient Grecian philosophers, and carefully traced its history down to the present time. The anatomy of the bee was illustrated by diagrams lithographed expressly for the purpose; one of each Mr. Fiddian presented to each gentleman present.

At the conclusion of the paper, Mr. Fiddian exhibited the entire works of Dr. Power, R. Hook, Zahn, Baker, Martin, G. Adams, G. Adams, jun., Dr. Hill, Leeuwenhock, Goring and Pritchard, many of which had formed part of the library of the late Dr. Golding Bird.

Mr. H. Webb exhibited the luminous moss *Schistostega pinnata.*

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DESCRIPTION OF PLATE I A,

Illustrating the Rev. W. Houghton's note on Canals in the Head of the Eel.

Fig.

1.—Head of *A. acutirostris*, showing the orifices of the canals.
a. Anterior orifice.
b. Posterior ditto.

2.—The same, with the soft parts removed, and with a bristle inserted into each canal.

3.—Side view of same.

4.—Vertical section of cranium of *A. acutirostris.*

5.—Membranous fold or hollow in which the canal terminates.

DESCRIPTION OF PLATE I B,

Illustrating Henry Giglioli's paper on some Parasitical Insects from China.

Fig.

1.—*Lipeurus Diomedeæ*, female, about two and a half times larger than nature; the dorsum is shown.

2.—*L. Diomedeæ*, male; the ventral side is exposed.

3.—*Docophoroides brevis*, female, magnified about three times; ventral aspect.

4.—*D. brevis*, male, magnified about three and a half times; dorsal aspect.

5.—Copulating organ of *D. brevis*, greatly magnified.

6.—Tibia and tarsus of a leg of *D. brevis*, magnified.

7.—*Nirmus mandarinus*, magnified seven times; ventral aspect.

8.— ,, ,, dorsal aspect.

9.—*Docophorus mandarinus*, magnified about seven times; dorsal aspect.

10.—*Ornithomyia Chinensis*, magnified about two and a half times; ventral aspect.

11.—Tarsus and claw of *O. Chinensis*, magnified.

12.—*Strebla molossa*, magnified about six times; ventral aspect.

13.—*Polyctenes molossus*, magnified about six times; dorsal aspect.

14.—Head of *P. molossus*, magnified.

15.—Spines from head of *P. molossus*, magnified.

DESCRIPTION OF PLATES

Illustrating Mr. J. Alder's paper on New British Polyzoa.

PLATE II.

Fig.
1.—A small portion of Cellepora ramulosa, highly magnified.
2, 3.—Varieties of C. dichotoma, natural size.
4.—A portion of the same, highly magnified.
5.—C. lævigata, natural size.
6.—A portion of the branches of the same, magnified.
7.—Lower part of the stem, more highly magnified.
8.—Ovicells of the same, much enlarged.
9.—Quadricellaria gracilis, Sars, natural size.
10.—A portion of the same, highly magnified.
11.—An ovicell of the same, much enlarged.
12.—An avicularium of the same, enlarged.

PLATE III.

1.—Palmicellaria elegans, natural size.
2.—The same, magnified.
3.—A portion of the same, highly magnified.
4.—A cell of the same, more highly magnified.
5.—E. lorea, natural size.
6.—A small portion of the same, highly magnified.
7.—An avicularium on the lower lip of the same, as seen from above.
8.—E. lævis, natural size.
9.—A portion of the same, highly magnified.
10.—An ovicell of the same, more highly magnified.
11.—Outline of a small variety of E. lævis, natural size.

PLATE IV.

1.—E. Landsborovii, natural size, from Mr. Embleton's specimen, now in the Newcastle Museum.
2.—A portion of the same, highly magnified.
3.—A cell of the same, with ovicell and avicularium, more highly magnified.
4.—Scrupocellaria Delilii, natural size.
5.—A portion of the same, magnified, front view.
6.—Back view of the same.
7.—A cell of the same, with ovicell, magnified.
8.—A central avicularium, ditto.

PLATE V.

1.—Hornera borealis, natural size.
2.—A portion of the same, magnified, front view.
3.—A small portion, more highly magnified.
4.—Back view of a portion of H. borealis, magnified.
5.—A small portion, more highly magnified.
6.—An ovicell of the same, highly magnified.
7.—An ovicell of H. frondiculata, highly magnified.

DESCRIPTION OF PLATE VII,

Illustrating Mr. Lankester's paper on the Earthworm.

Fig.

1.—Pharynx, with radiating muscular fibres, opened so as to show the loose interior fold or pouch.

2.—Structure of œsophageal glands.

3.—Muscular fibre from pharynx.

4.—The three pairs of œsophageal glands.

5.—Earthworm opened by a dorsal incision, the transverse muscles partially removed.

a. Cephalic ganglia.
b. Muscular pharynx, with attaching fibres.
c. Ciliated tubules (segment-organs).
d. Enlarged lateral blood-vessels.
e. Œsophagus.
f, g, i. Male organs of reproduction.
h. Œsophageal glands.
k. Crop.
l. Fibrous stomach or gizzard.
m. Intestine.

6.—Alimentary canal, removed from the other viscera.

7.—Setæ, natural size $\frac{1}{20}$th of an inch.

8.—Seven segments from the lower part of the body, showing the setæ natural size $\frac{1}{3}$rd of an inch.

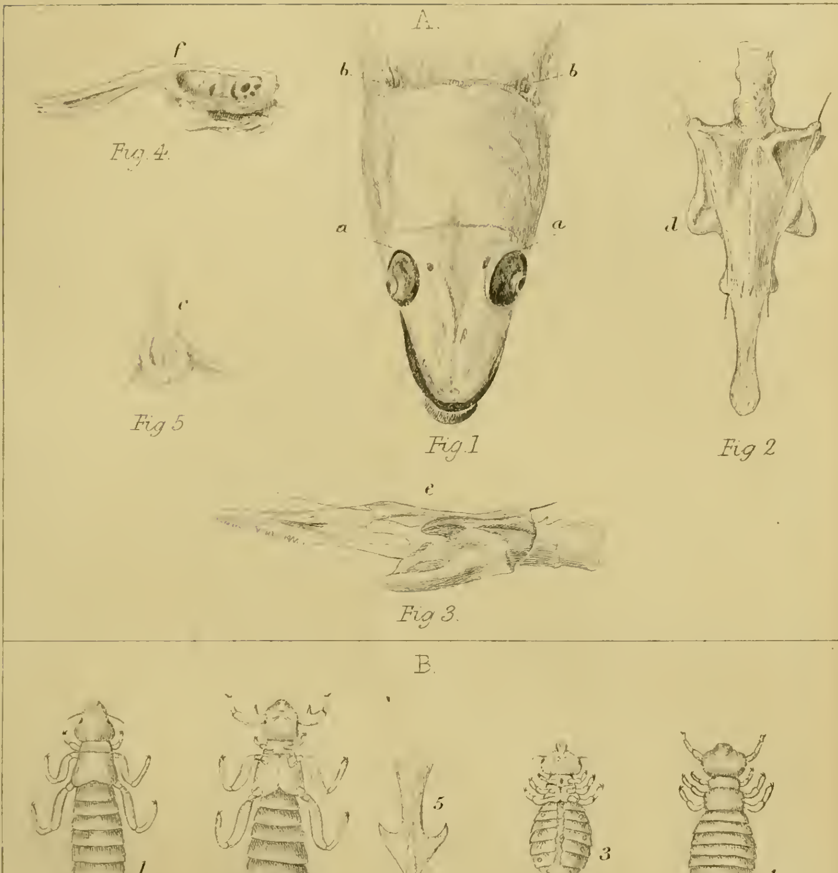
9.—First, second, third, and fourth segments.

10.—Crystalline body from the anterior pair of œsophageal pouches.

11.—Integument of earthworm, all viscera being removed. *a a.* Dorsal muscle. *c c.* Lateral muscles. *e e.* Ventral muscle. *f.* Neural canal. *b b.* Lateral setigerous glands. *d d.* Ventral setigerous glands.

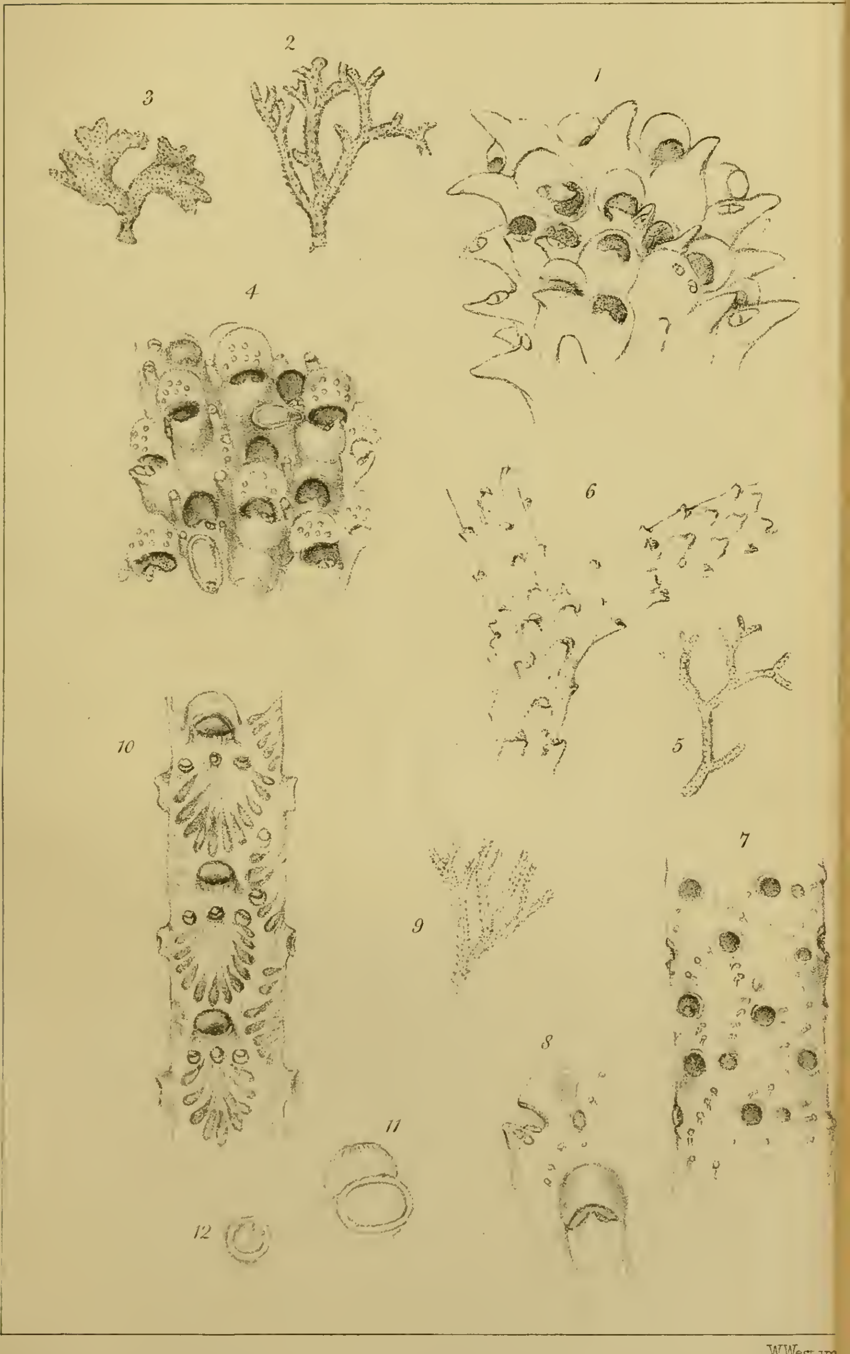
12.—Transverse section of integument. *a.* Internal epithelial layer. *b.* Parasitic nematoid. *c.* Muscular layer. *d.* Pigmentary vascular layer. *e.* Epidermis.

13.—Cells from the hepatic membrane of the intestines.



H. Giglioli, del. ad nat.

W. West, Lith.



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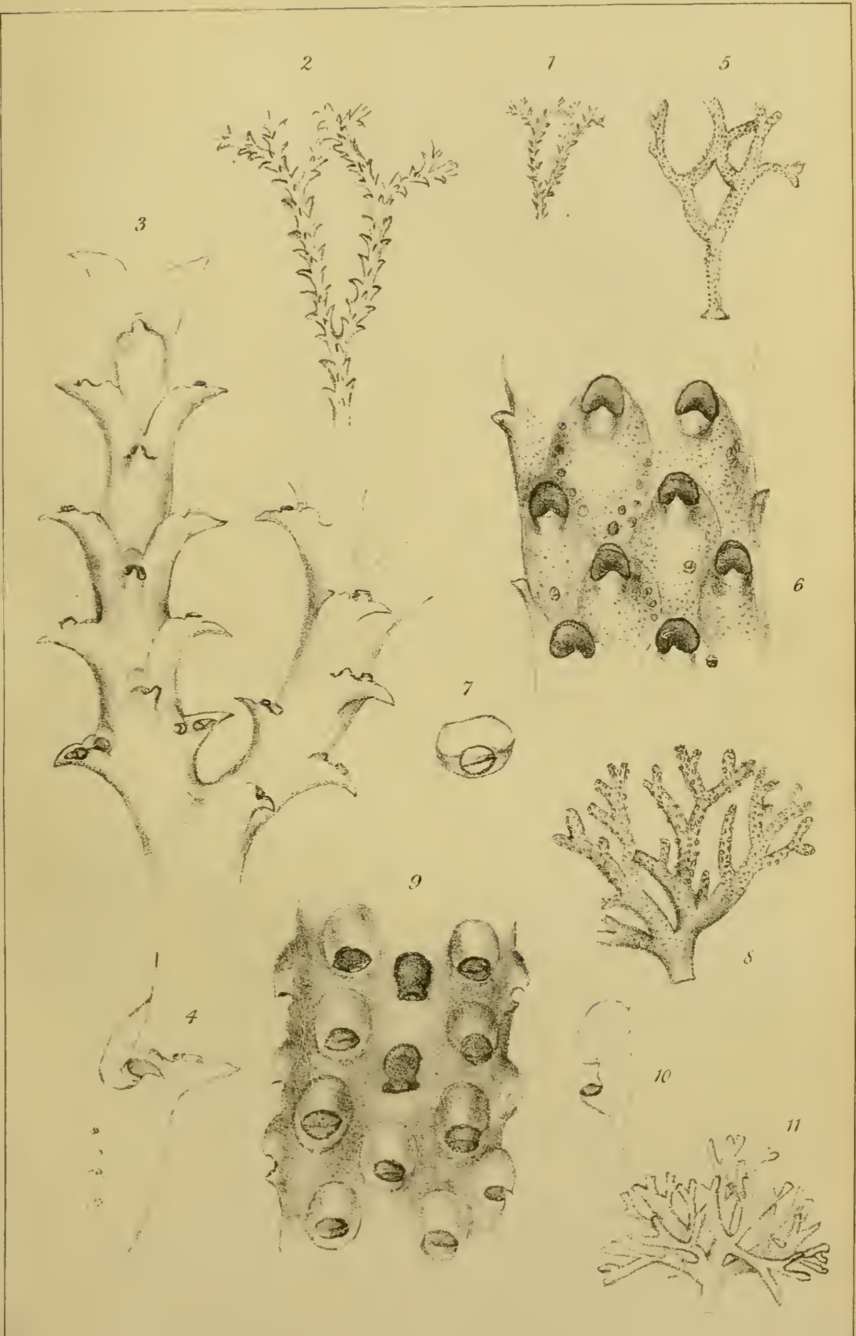

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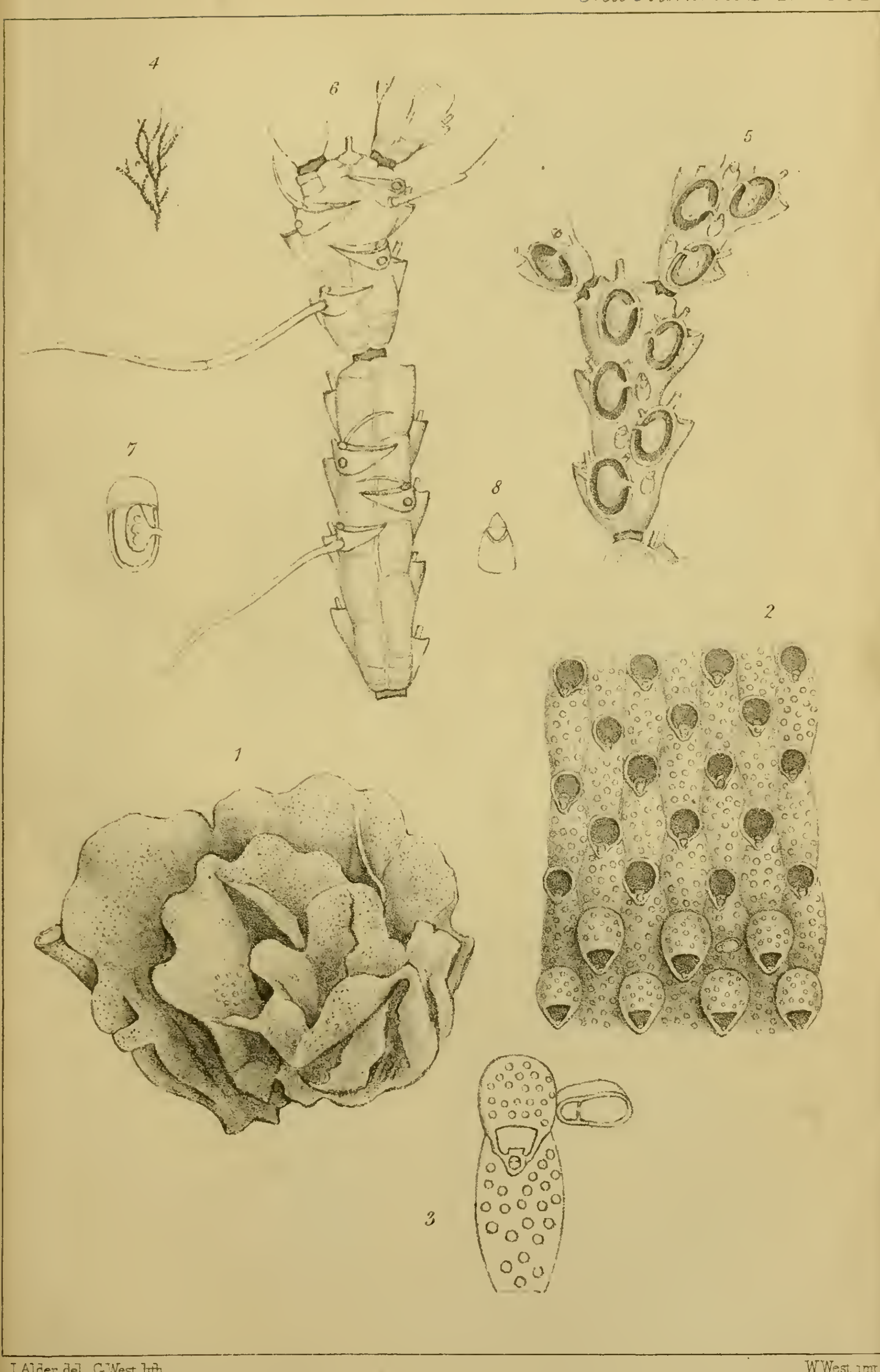
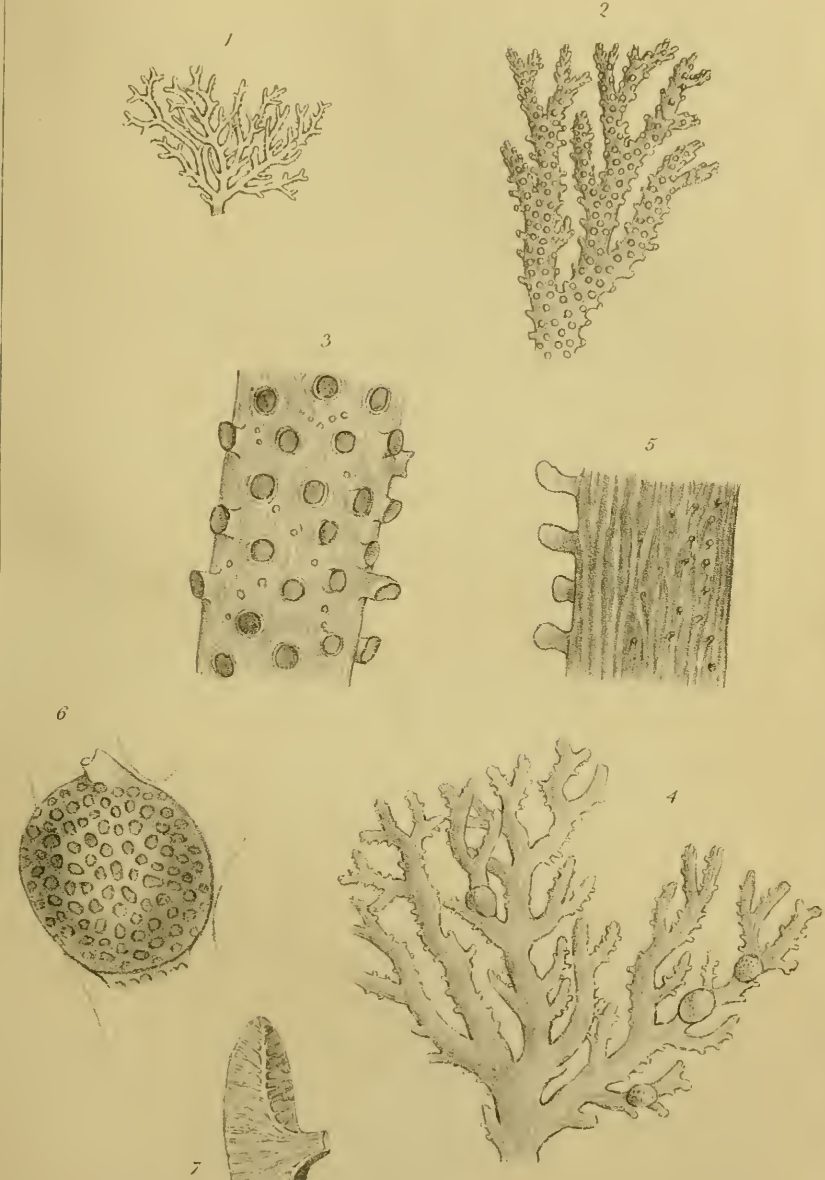


J Alder del G West lith

W West imp



J Alder del G West lith

W West imp

JOURNAL OF MICROSCOPICAL SCIENCE.

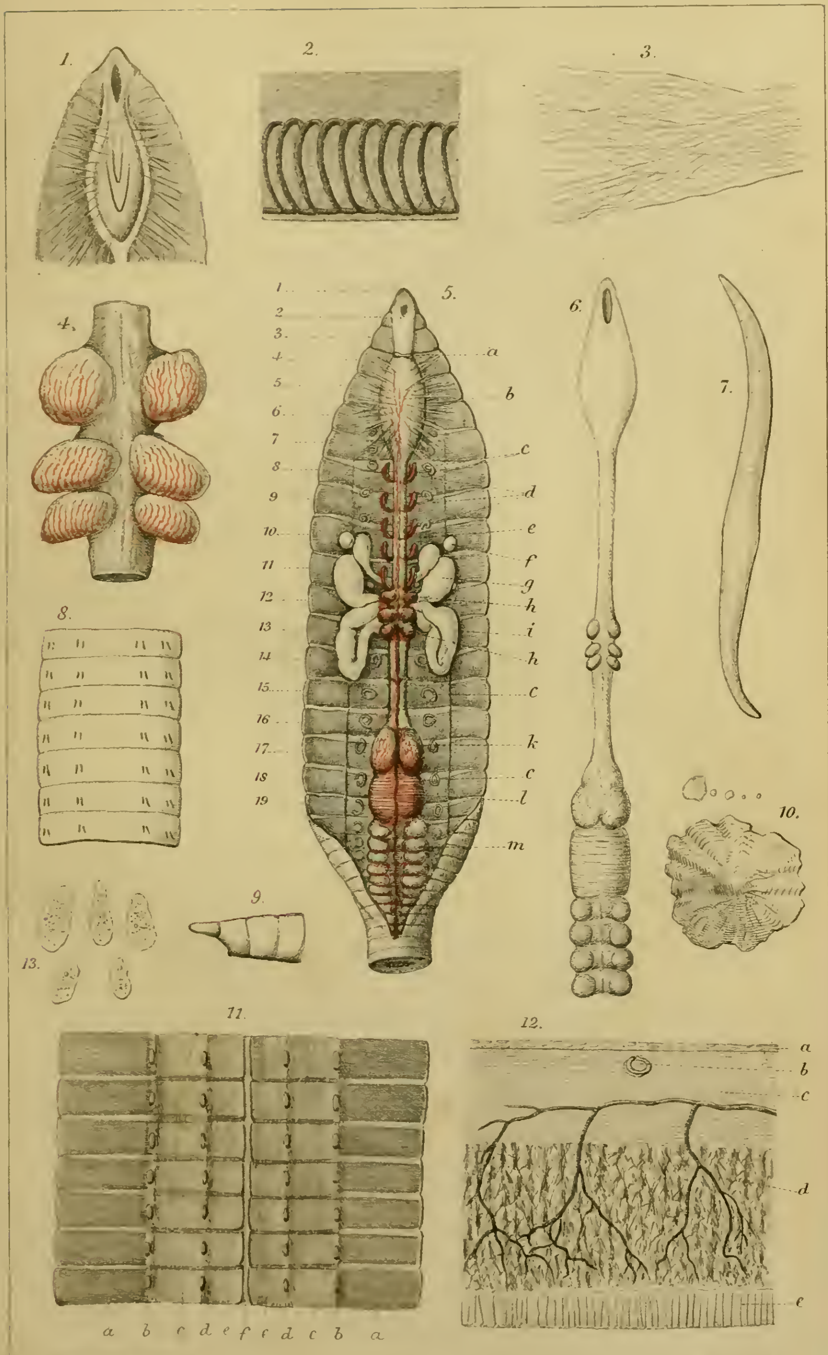
DESCRIPTION OF PLATE VI,

Illustrating Mr. Archer's paper on an Endeavour to identify *Palmoglœa macrococca* (Kütz.) with Description of the Plant believed to be meant, and of a new Species, both, however, referable rather to the Genus Mesotænium (Näg.).

1.—*Mesotænium chlamydosporum*, cell in which the "chlorophyll-plate" is not visible, by reason either of the remaining too dense contents concealing it, or of the edge view of the plate not being towards the observer.
2.—Cell, showing edge view of chlorophyll-plate.
3 and 4.—Accidental forms and positions of the chlorophyll-plate, edge view.
5.—Cell about to divide; the chlorophyll-plate, seen in edge view, divided; its inner end bluntly rounded.
6.—Cell divided.
7.—Two cells about to conjugate.
8.—Two such cells in contact, the parent coats slipping off.
9—13.—Various degrees of advancement in conjugation.
14.—Zygospore formed, with definite mucous investment.
15—19.—Various mature zygospores.
20.—*Mesotænium mirificum*, cell showing edge view of chlorophyll-plate.
21—23.—Cell-contents emerging.
24 and 25.—Cell-contents emerged and balled together into a spore-like body of a reddish colour.
26—31.—Various empty and discarded parent cell-membranes, showing the valve or lid-like portion, often detached.
32.—*Cosmarium exiguum* (Arch.), front view of frond.
33.— " " side view "
34.—*Penium Mooreanum* (Arch.), frond, with endochrome.
35.— " " dividing frond.
36—38.— " " commencing conjugation.
39.— " " front view of zygospore.
40.— " " side view of same.
42—44.— " " variously twisted zygospores.
45 and 46.—*Cosmarium pygmæum* (Arch.), front view of frond.
47.— " " side view of same.
48.— " " end view of same.
49.— " " zygospore.
50.—*Arthrodesmus tenuissimus* (Arch.), front view of frond.
51.— " " side view "
52.— " " end view "
53 and 54.— " " dividing fronds, front view.
55.— " " abnormal frond.

W. Archer del. chrono-lith.

All the figs. are × 400.



E Ray Lankester del ad nat

Tuffen West sc W West imp

Scale $\frac{1}{1000}$ of an English Inch × 700

Large caudate nerve cell with smaller cells and nerve fibres from a thin transverse section of the lower part of the grey matter of the medulla oblongata of a young dog. The specimen had been soaked for some weeks in acetic acid and glycerine. The lines of dark granules resulting from the action of the acid are seen passing through the very substance of the cell in very definite directions. Thus the cell is the point where lines from several distant parts intersect (Diagram Fig. 2). It is probable that each of these lines is but a portion of a complete circuit (see Diagram in Fig 3). A, A, A, large fibres which leave the cell. B, a fibre from another cell, dividing into finer fibres exhibiting several lines of granules. C, C, C, fibres from a younger caudate nerve vesicle. D, fine and flattened dark-bordered fibres. E, three fine nerve fibres running together in a matrix of connective tissue. F, F, F, capillary vessels.

I. S. B. del. 18[illegible]

[Harrison & Sons, Imp.