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# TRANSACTIONS

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# TRANSACTIONS.

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## Descriptions *of* New *and* Rare Diatoms. Series XIV.

By R. K. Greville, LL.D., F.R.S.E., &c.

(Read Nov. 9th, 1864.)

(Plates I & II.)

### Plagiogramma.

*Plagiogramma Wallichianum*, n. sp., Grev.—Valve linear, rounded at the ends; costæ two in the middle, and one each end, with a few intermediate pervious striæ. (Figs. 7, 8.)

*Hab.* St. Helena; rare; Dr. Wallich.

A minute, but well-marked species, of which I find a characteristic sketch of the valve in Dr. Wallich's note-book. I have also obtained views of the frustule in both aspects, in the portion of the dredging he was kind enough to place in my hands. It is not very closely allied to any described species, differing materially from *P. pygmæum*, to which it approaches in size, in the pervious striæ, and strictly linear form. Length ·0017″.

### Pyxilla, n. gen., Grev.

Frustules free, oblong, transversely bivalved, box-like, minutely cellulate; each valve terminating in a short, thick apiculus.

This genus must obviously be associated with the *Pyxidiculæ;* indeed, the two species of which it is composed, might almost have been placed in *Pyxidicula* itself, so loosely is that genus at present defined. In both sections, as it stands (including both *Pyxidicula* and *Dictyopyxis* of Ehrenberg), there are, according to my view, species bearing little, if any, generic affinity; and, as the minute fossil diatoms I am about to describe, possess a striking character of their own, I prefer to keep them apart, rather than add to the existing uncertainty and confusion, which, after all, is mainly owing, as my friend Mr. Ralfs has remarked, to various so-called species being still little known.

*Pyxilla Johnsoniana,* n. sp., Grev.—Frustule cylindrical-oval, simple (no contraction at the suture). (Fig. 6.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

This rare species has only occurred to me twice, but it is highly probable that in some other samples of the deposit, both it and the following may be more frequent. The cellulation is so minute as to be correctly defined as punctate; but the cellules, when sufficiently magnified, appear to be regularly hexagonal. The suture is situated at somewhat more than one third of the total length from one extremity. Length of frustule ·0025″.

*Pyxilla Barbadensis,* n. sp., Grev.—Frustule contracted at the suture, one valve cylindrical, the other globose. (Fig. 5.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

A most beautiful diatom. The globose valve with its contracted base and terminal apiculus, resembles the bulbous dome which crowns the minaret of an eastern mosque. Although there is a great contraction between the valves, the suture itself is acute and somewhat prominent, as in some of the *Creswelliæ.* The punctation is as minute as in the preceding species, and, under a high power, comes out equally beautiful as hexagonal reticulation. Length ·0030″.

## CRESSWELLIA.

*Cresswellia Palmeriana,* n. sp., Grev.—Very large; frustules in front view short, cylindrical, with truncate ends; connecting processes numerous, truncate; cellules punctiform at the suture, becoming larger and hexagonal towards the ends. (Fig. 9.)

*Hab.* Hong Kong harbour, John Linton Palmer, Esq.; Shark's Bay, Australia, in stomachs of Ascidians; Dr. Macdonald.

The largest and finest of all the known *Cresswelliæ,* discovered by my acute and very obliging correspondent, Mr. J. Linton Palmer, Surgeon, R.N., who has kindly transmitted many new things, accompanied with notes and sketches. One large diatom of singular interest I hope shortly to publish as a new genus, under the well-merited name of *Palmeria.* The subject at present under consideration is a giant in *Cresswellia,* the frustules being no less than ·0030″ to ·0035″ long, and ·0040″ broad, somewhat contracted towards the suture. The connecting processes are twenty and upwards, and truncate, as in *C. Turris* and *turgida,* and situated just within the margin of the truncate end of the valve. A very remarkable character is conspicuous in the structure, which, near the suture, is punctate, but, by degrees, becomes more and more distinctly cellulate, the cellules towards the ends being hexagonal, and about ten in ·001″. I have as yet seen only two frustules in connection. While engaged in preparing this paper, I was agreeably surprised to discover in some Shark's Bay slides, in the cabinet of my friend, Mr. George Norman, both front and side views of this species. For the finest example in my own cabinet, I am indebted to the generosity of Lawrence Hardman, Esq., the well-known diatomist and admirable microscopical manipulator, whose friendly assistance in some very critical investigation, I shall hereafter have a more favorable opportunity of acknowledging.

*Cresswellia cylindracea,* n. sp., Grev.— Frustules cylindrical (not contracted at the suture), truncated, unequal in length; connecting processes numerous, fine, truncated; structure obscure. (Fig. 10.)

*Hab.* Hong Kong harbour; May and June; John Linton Palmer, Esq.

Another very notable species, which we owe to the exertions of Mr. Palmer. It exhibits a larger number of frustules in connection than any other hitherto observed, and, at first sight, bears no inconsiderable resemblance to a *Melosira.* The connecting processes, and even the suture, are inconspicuous in specimens preserved in balsam, but come out more distinctly when burnt on the cover and mounted dry. The structure is dense and obscure, the colour pale, with a tinge of yellow.

It is by no means rare in one of the gatherings kindly sent me by its discoverer. Length of frustules ·0015″ to ·0025″, or more; breadth about ·0018″.

*Cresswellia Barbadensis,* n. sp., Grev.—Small; frustules elliptic, conspicuously cellulate; suture sharply prominent;

connecting processes about 8; aculeate, situated near the suture. (Fig. 11.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Although I have been familiar with this little species for some years, I have refrained from its publication until I could quite satisfy myself that it was constant to its characters. An extensive series of individuals having now passed under my observation, I no longer hesitate to admit its claims. Its ellipsoidal form and acute prominent suture, with the circle of aculeate processes arising at a short distance from the suture, constitute an assemblage of characters which cannot fail to identify it. The cellules are 5—6 in ·001″. Diameter nearly always about ·0020″.

*Cresswellia sphærica.*, n. sp., Grev.—Minute; frustules spherical; cellulation very minutely punctiform; connecting processes numerous, truncate, forming a terminal coronet. (Fig. 12.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Distinguished by its small size (·0010″ in diameter), its globular form and very minute cellulation, the cellules being as many as about 12 in ·001″. Although very rare, I have seen, at least, a score of specimens, but only a single example of frustules in connection. The processes are very slender and numerous, and are arranged in a diverging circle.

*Cresswellia minuta,* n. sp., Grev.—Very minute; frustule oblong, with rounded ends; cellulation exceedingly minute. (Fig. 13.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by Mr. C. Johnson; very rare.

The length of this, the smallest species of the genus, is ·0010″, the breadth ·0005″. The connecting processes being more or less injured, I am unable to say whether they are truncate or aculeate.

### LIRADISCUS, n. gen., Grev.

Frustules simple, discoid (circular or oval) with a narrow connecting zone; valves somewhat convex, sinuato-reticulate, more or less hispid.

The objects of which I now venture to constitute a new genus, have long been a source of perplexity to me. Sometimes I have even doubted whether they were diatoms at all; but have at length come to the conclusion that they have, at least, more right to be included in the family than the

*Xanthiopyscidæ.* The valves are remarkable for the sinuous, inosculating veins and furrow-like interstices. The veins are produced here and there, into elevated points, or short spines, not always very obvious, unless in an oblique or front view. The genus is related on the one hand to *Pyxidicula* and its allies, on the other, to the *Coscinodisceæ.*

*Liradiscus Barbadensis,* n. sp., Grev.—Valve circular, with a wide sinuous reticulation passing towards the margin into radiating lines. (Fig. 14.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; rare.

Valve hyaline, the large flexuose reticulation occupying from one half to nearly the whole of the disc, and much less hispid than in the following species. I have never seen the front view. Diameter about ·0030″.

*Liradiscus ovalis,* n. sp., Grev.—Valve elliptic-oval, the sinuous reticulation reaching nearly to the margin, more or less hispid. (Figs. 15, 16.)

*Hab.* Barbadoes deposit, Cambridge estate, frequent; in slides communicated by C. Johnson, Esq.

The valve varies considerably in the size of the reticulation, and in the degree of hispidity. In some specimens it is difficult to perceive the spines in a side view, except where they rise up close to the margin. Long diameter about ·0025″. I am under an impression that a third species exists in the deposit, with a smaller reticulation, and the little spines crowded.

## AULISCUS.

*Auliscus notatus,* n. sp., Grev.—Small; valve strictly circular, with two processes; whole surface covered with nearly equally distributed minute puncta. (Fig. 2.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

This elegant minute diatom while evidently allied to *A. punctatus,* is, I believe, truly distinct. The valve is very much smaller and strictly circular; and the punctation is uniform, not exhibiting the slightest tendency to radiation. In the specimens which I have seen, the processes are situated at some distance from the margin. Diameter ·0018″.

*Auliscus Barbadensis,* n. sp., Grev.—Valve elliptic-oval, with a small umbilicus, 2 processes, 4 radiating lines arranged in a cruciform manner, and 2 less conspicuous lateral ones. (Fig. 1.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; extremely rare.

In outline, but in no other character, resembling *A. ovalis*. The radiating lines which form the cross, are simple as they leave the centre, but afterwards, by giving off two or three very short ramuli, terminate within the margin in pencils of rays. An intermediate pencil on each side is obscure, but probably might be more decided in other examples. Long diameter ·0025″.

## BIDDULPHIA.

*Biddulphia fimbriata*, n. sp., Grev.—Structure minutely dotted; valves with the angles produced into curved, obtuse horns, and furnished with a marginal row of long filaments. (Fig. 4.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; rare.

A most extraordinary species, of which I have seen at least half a dozen examples in different degrees of preservation. The horns are slightly tumid towards the base, and the terminal articulating surfaces obliquely truncate. The most remarkable feature consists in the filaments which fringe the discoid margin of the valve. None of them appear to be quite perfect at the apex, and yet in the specimen figured they are as long again as the horns. Minute raised points are sparingly scattered towards the margin of the valve. Diameter ·0035″.

*Biddulphia spinosa*, n. sp., Grev.—Structure very minutely punctate; valve elliptical, produced at the angles into 2 minute horns, and armed with 3 marginal spines on each side, besides 1 opposite each horn. (Fig. 3.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; rare.

Although this diatom is decidedly rare, I cannot have seen fewer than a dozen or more specimens of the valve, all retaining its well-marked characters; the only variation being some difference in the breadth, and in the acuteness of the ends. The horns are very small, obtuse, and without any inflation at the base. Diameter about ·0030″.

## TRICERATIUM.

*Triceratium Dobreeanum*, n. sp., Norman in lit.—Large; valve with straight sides and obtuse angles produced into prominent pseudo-nodules (elongated processes); 3 vein-like lines projecting from each side, and the whole surface, except the angles, filled up with circular, remote, subequidistant cellules; connecting zone filled with similar cellules arranged in oblique decussating lines. (Figs. 23, 24.)

*Hab.* Dredged off Sydney, New South Wales, in 15 fathoms. N. F. Dobrèe, Esq.

This splendid *Triceratium* was detected by Mr. Norman in some material dredged by his friend Mr. N. F. Dobrèe, near Sydney. It is a very beautiful object, and fortunately, Mr. Norman obtained both front and side views of the frustule. The valve is very convex, and has three vein-like lines projecting from each side, the middle one of which reaches half way to the centre. Remotely scattered over the surface are circular cellules, and at the angles are very prominent pseudo-nodules,—so called, but which in the front view turn out to be elongated processes; a circumstance which shows how difficult it is to describe these objects in the absence of perfect materials. The front view is very interesting, as showing the processes referred to, terminating in a little obliquely placed disc so exquisitely dotted as to remind the observer of the compound eyes of insects. These punctate discs are the articulating surfaces; and it is scarcely possible to resist the conclusion that some communication must exist between the processes of the frustules so united by means of this structure. Are they the base or scars of minute vessels intended to hold the chain of frustules together until the period of maturity and separation? A little above, and on the inner side of the punctat spaces are terminal spines, the bases only being left in the specimens before me. In position they resemble those which I have observed in various other *Triceratia,* in some species of *Entogonia,* and in the genus *Hemiaulus.* In the connecting zone of our present species, the round cellules are arranged symmetrically in oblique decussating lines. One specimen (fig. 24) exhibits a variation of structure intermediate between the connecting zone and the valve, consisting of a broad belt of totally different cellules, much larger, of a roundish-oval slightly quadrate shape, and closely arranged. How so remarkable an organisation should occur in one example and not in the others, is sufficiently perplexing. Distance between the angles of the valve ·0060″.

*Triceratium neglectum,* n. sp., Grev.—Valve with straight sides and subacute angles, with transverse lines cutting them off so as to leave a nearly equal hexagonal centre; structure minutely punctate, in lines radiating from a small punctate umbilicus; but, within the angle, passing in right lines from the transverse line. (Fig. 20.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.

I am not aware of any species with which the present diatom can be compared. There is no appearance of a pseudo-nodule. The transverse line which cuts off the angle is not like a rib, but appears rather like a break in the continuity of the radiating lines of puncta, or like a groove, for there is a perceptible shadow. But there is not actually a break in the continuity of the lines referred to, but a sudden termination; for the space between the transverse line and the angle is filled up with a different set of lines, arranged at a right angle to the transverse line. Distance between the angles ·0025″.

*Triceratium Kittonianum,* n. sp., Grev.—Valve triradiate, the angles prolonged into narrow linear arms terminated by prominent pseudo-nodules; structure reticulato-cellulate, three rows of cellules being contained in the arms. (Fig. 18.)

*Hab.* Deposit at Nottingham, Maryland, U.S; F. Kitton, Esq.

A very interesting species allied to *T. Solenoceros* and *ligulatum,* and, indeed, so similar in form, that any one, in the absence of minute examination, might be pardoned for pronouncing all three identical. Mr. Kitton, as I find from the drawings he has kindly permitted me to see, referred our present species to *T. Solenoceros;* but the differences are in reality very decided. The last-named species has not the very slightest trace of a pseudo-nodule. In *T. Kittonianum,* on the contrary, it is conspicuous, and in the front view (according to Mr. Kitton's drawing) projects above and below the connecting zone, like a hammer. The structure, also, is much more widely cellulate. Our new species, therefore, differs from *T. Solenoceros* both in structure and in being furnished with a pseudo-nodule; and from *T. ligulatum* in structure. The front view of the pseudo-nodule in the latter has not been seen. The cellules of *T. Kittonianum* are hexagonal, and in the arms about 8 in ·001″. Distance between the angles ·0060″.

*Triceratium nitescens,* n. sp., Grev.—Small; valve triradiate, the arms linear-oblong, rounded at the ends, with 5—6 short vein-like lines on each side, and minute puncta between the lines, the whole forming a marginal band, leaving a blank space down the middle; centre with a few scattered puncta enclosing an irregular triangular space. (Fig. 19.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

A most brilliant and beautiful diatom allied to *T. lobatum*, but apparently distinct. The arms are much longer and narrower; and the punctation is confined to the intervals between the lines on the same side, thus leaving a well-defined, broad, blank space extending down the middle of each arm to the central area. The latter is occupied by a small cluster of puncta opposite each side-angle, with a few scattered intermediate ones, so as to enclose an obtusely triangular blank space. Distance between the arms ·0028″.

*Triceratium cancellatum*, n. sp., Grev.—Valve with slightly concave sides and subacute angles; surface with 6 alternate radiating elevations and depressions, filled with radiating lines of cellules which become large and somewhat quadrate towards the margin and angles, which latter contain large pseudo-nodules. (Fig. 17.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; extremely rare.

A very curious and unquestionably distinct species. The surface is undulated in such a way that when the angles are in focus, they appear to terminate a ridge or elevation which radiates from the centre, while the middle of the margin at each side is out of focus, and in like manner terminates a radiating depression. The cellulation gradually increases in size from the centre to the margin, and to the angles, where it ends abruptly at the pseudo-nodules which, in the front view must be considerably elongated processes. There is a sort of indication of the commencement of vein-like lines, here and there at the margin, especially near the angles, which is shown by some of the cellule-walls becoming thickened for a short distance inwards. Distance between the angles ·0032″.

*Triceratium acceptum*, n. sp., Grev.—Small; valve with nearly straight sides and obtuse angles containing a conspicuous roundish pseudo-nodule; structure composed of lines of minute puncta radiating from an umbilicus of a few larger puncta, the lines diverging in a fan-like manner to the sides, and converging towards the angles. (Fig. 21.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Although the sides of the valve are nearly straight, there is a perceptible approach towards convexity. The pseudo-nodules are transversely roundish-oval, and somewhat resemble the mastoid process of an *Auliscus*. Distance between the angles ·0025″.

*Triceratium exornatum*, n. sp., Grev.—Rather large; valve with nearly straight sides and rounded angles, which contain large hemispherical pseudo-nodules, having a nucleus of very minute puncta; surface with 6 alternately raised and depressed radiating undulations; structure composed of lines of minute puncta radiating from a small blank umbilicus; margin coarsely striated. (Fig. 25.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; very rare.

This fine diatom belongs to a small group in which occur the remarkable undulations of the surface of the valve, already described in *T. cancellatum.* They exist also in *T. insigne,* a fact which I overlooked in my description of that species, but which was detected by my acute friend Mr. Ralfs. It may be a question whether the present diatom be not a variety of the one last named, but after the examination of a series of specimens, I am under a very strong impression that the two, although very nearly related, are really distinct. Our present species is larger, the sides always nearly straight, and the angles less rounded. In *T. insigne* the sides are always considerably concave, and the angles hemispherical, a very striking character. Distance between the angles ·0050″.

*Triceratium quadrangulare,* n. sp., Grev.—Large; valve with 4 rounded, somewhat produced angles, and sides with a concavity in the middle; cellulation conspicuous, irregularly hexagonal, radiating from the centre; the cellules becoming suddenly very small within the angles, which exhibit no decided pseudo-nodule. (Fig. 26.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; very rare.

A very fine species with a graceful outline, and pale, delicate reticulation. Margin thickened, or perhaps, rather involute, especially at the lateral concavities. The valve might be almost described as four-lobed, each lobe broadly elliptical-ovate, with the angle produced. Distance between the angles ·0038″.

*Triceratium Atomus,* n. sp., Grev.—Very minute; valve with slightly concave sides and rounded angles, where there is the appearance of a small pseudo-nodule across the extreme apex; margin with 4—5 minute puncta; central structure obscure. (Fig. 22.)

*Heb.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

I can make nothing more out of this very minute diatom than what is contained in the specific character.

# TRANSACTIONS.

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## Notes *on the* Vinegar Plant.
## By Henry J. Slack, F.G.S.

(Read January 11th, 1865.)

The term "Vinegar Plant" is applied to a tough, leathery formation, which, under certain circumstances, makes its appearance in saccharine solutions undergoing the acetous fermentation. It is, no doubt, essentially the same plant as that which occurs in a less compact form, in the French vinegar vats, and which encrusts the birch twigs or shavings used in the German process.

Vinegar plants are frequently employed in domestic economy for the manufacture of vinegar; and a well-grown specimen bears considerable resemblance to a piece of buck-skin leather that has been soaked in water. If a young vinegar plant is placed in a vessel containing half a gallon of brown sugar and water, to which a little treacle may be added, and is kept in a dark warm place, it grows rapidly, chiefly by accessions to its under surface, and it extends laterally till it reaches the sides of the vessel, the form of which it assumes. In a month or six weeks the saccharine solution will be converted into strong, well-flavoured vinegar. The plant is then removed, and the vinegar boiled to kill the spores it contains.

At the close of this process of vinegar making, the plant will be found to have increased greatly in thickness, and the under, or newly formed portions will be of a softer and looser texture than the upper layers. In this condition the plant is readily divided by horizontal splitting into two or more layers, one of which, if placed in a fresh solution, will soon excite the vinegar fermentation, and increase in bulk while the acetic acid is formed.

The 'Micrographic Dictionary' contains a digest of various observations made upon this plant. The general mass of the plant is described as a structureless jelly, having polymorphus structures imbedded in it, and "exhibiting transitions which," as the writer says, "render it impossible for them to be regarded as of distinct origin." Amongst the imbedded objects, the 'Micrographic Dictionary' speaks of cells like yeast, but generally elliptical, of others with short cylindrical joints, and of long tubular filiaments terminating in elliptical cells, so as to resemble *oidium*. Branched filaments are likewise mentioned, and it is stated that when a vinegar plant is left upon a solution after the saccharine matter has been separated, patches of blue, green, and yellow mould—*Penicillium glaucum*—appear. From these facts, the writer in the 'Micrographic Dictionary' considers that the vinegar plant may be regarded as the mycelium of the *Penicillium glaucum* vegetating actively, and increasing by crops of gonidia or gemmæ. It is also stated that yeast-cells are not to be distinguished from cells found in the vinegar plant.

An examination of the vinegar plant with low powers, shows no more than the 'Micrographic Dictionary' describes; but if very thin portions are carefully illuminated and viewed under a magnification if from one to three thousand linear, it will be found that the gelatinous matter, hitherto treated as structureless, contains millions of small bodies resembling the bacteria that occur in the pellicle of solutions set aside to develope infusoria These bodies vary considerably in size, some not exceeding $\frac{1}{16000}''$ in length, others twice as big, or more. If stained with iodine, they sometimes become a little plainer; but the more delicate will not appear as beaded structures to an observer coming quite fresh to their examination. I do not think all are beaded, and some seem to be in an intermediate stage. The number that can be made out as beaded will depend upon the time employed in the investigation; and in the course of a week or two an observer will be able to trace their structure to a sufficient extent to justify the belief, that all either possess, or tend towards, the bacterium form. I believe the yeast plant is commonly associated with bacterium-like bodies, and probably when their number is moderate, they do not noticeably interfere with the vinous fermentation. In the vinegar plant they are so numerous as to suggest the idea that they play an important part in the complicated series of actions which the plant, as a whole, excites. When a solution of common sugar is converted into vinegar, a series of processes occur, every one of which seems to be correlative with the growth of the plant, though under other conditions they may be produced by purely chemical means. The cane-sugar assimilates one equivalent of water and becomes fruit-sugar, the fruit-sugar is changed into alcohol and carbonic acid and the alcohol oxydized, first into aldehyd, and then into acetic acid. Professor Miller says, "the formation of aldelhyd appears always to precede the production of vinegar."

When saccharine matter is fermented into alcohol by the agency of yeast-cells, no other microscopic vegetation is present in sufficient quantity to affect the result; but when the vinegar fermentation is carried on we find cells closely resembling yeast-cells, and also a great number of other cells, and these cells, together with the gelatinous material to which they give rise, and in which they are imbedded, appear to be oxydizing agents by which the alcohol is further transformed.

Since I described the bacterium bodies which the vinegar plant contains, in the 'Intellectual Observer,' vol. iv, p. 238, I have made further experiments with vinegar plants, and now venture to claim the attention of the Society to some of the facts ascertained. I took a large vinegar plant out of a saccharine solution in which it was growing, and left it on a plate in a warm room. It soon came to the condition of a slightly moist piece of leather, and was allowed to remain in that state for some time. In dry weather it lost a little moisture, and on damp days took in a fresh supply. It was finally placed in a large porcelain dish, filled with sugar and water, and soon yielded a great crop of blue, green, and yellow mould, with beautiful strings and tufts of spores. No vinegar appeared, though the sugar disappeared, and after the process had gone on for some months, I obtained no alcohol on distilling a portion of the liquid.

A microscopic examination showed that the same structures were present in this vinegar plant as it had contained when it was engaged in acetefying the solution in which it originally grew, and there could have been no general death among them, since they produced magnificent crops of mould. In the original state of the plant, the different kinds of cells seemed to form a co-operative colony, and the growth of this colonial system was correlative with the production of the vinegar. After the plant had been removed from the solution and exposed freely for a considerable time to the air, it seemed to die as a colony, though particular cells gave birth to innumerable spots of mould. The plant did not, in this instance, decompose or go to pieces;

but when the solution was allowed to evaporate, it remained tough and strong.

Another thin young vinegar plant was dried in an oven, at a temperature too low to burn it. When this process was completed, it was like a layer of gelatin, and chinked when thrown upon glass. If exposed to the air, it absorbed enough water to make it like moist parchment.

Portions were kept perfectly dry in a bottle for several months, and then, when moistened, they appeared to contain all the various kinds of vinegar-plant cells uninjured. Several pieces were put in saccharine solutions; but in no cases of experiment—prolonged from May to November—did a vinegar fermentation ensue, although in one instance butyric acid was produced. Subsequent attempts to obtain butyric acid in the same way were unsuccessful; but in one case I detected a faint smell of some compound of that series. In December, vinegar began to appear in a Preston salts bottle, in which a piece of the dried plant had been placed in May. Sugar was occasionally added, as that first introduced disappeared, together with enough water to compensate for evaporation. Nothing like a tough vinegar plant has yet been formed in this bottle; but the various cells are found in a looser state of aggregation, and the bacterium bodies abound.*

The dried portions of the vinegar plant were not dead, because in several experiments I obtained by their immersion in a saccharine fluid, a new growth of gelatinous matter abounding in mycelium threads and other formations. After having completely stopped, what I call, the colonial life of a vinegar plant, I have not yet succeeded in its restoration, but expect to do so by allowing plenty of time.

Being desirous of knowing to what extent the bacterium-like bodies existed in that form of the vinegar plant which encrusts the birch twigs used in the German process of acetification, I applied to Messrs. Hill, Evans & Co., the proprietors of the Great Vinegar Works at Worcester, and they kindly sent me a sample of the twigs from a vat in full action. The delicate gelatinous matter on these twigs contained abundance of the bacterium cells, and after the twigs had been exposed to the air for some days, I placed them in a saccharine solution and obtained no vinegar, but plenty of the coloured mould.

Many efforts have been recently made in France to trace the influence of bacterium-like bodies in the production

* At the present time (March) this formation is growing more dense, and seems likely to become a true vinegar plant.

of disease; and some observers have argued that the species of such organism may be inferred from the conditions under which they live and the kind of work they perform. I fear that such criteria cannot be relied upon, since, in the experiments I have detailed, the same cells have been grown under different conditions; first, in a rich saccharine solution, in which the only vinegar present was the small quantity imbibed by the gelatinous structure of the plant in its previous position; secondly, as the fermentation proceeded, they grew in a strong vinegar solution, and lastly, they produced the blue, green and yellow mould, when both vinegar and sugar had disappeared.

My experiments show that a fragment of vinegar plant taken out of the solution in which it was growing and giving rise to acetic acid, continues to grow and excite a similar action in another solution if quickly transferred to it; but that if, before being put in the second solution, it is dried or exposed for some time to the air, its acetifying properties are not displayed. Thus the same species of plant, presenting the same physical appearance, may differ considerably in the chemical actions it can excite, and in its own method of growth; giving rise in one case to fresh co-operative colonies of associated cells, in another to crops of blue mould, and in a third, to mycelium threads and cells, which do not excite the vinegar fermentation. It would, I think, be dangerous to conclude that two of these humble organisms *must be* of different species, because they have been grown in different fluids, and may be killed by a transference from one to the other, and it would be interesting to ascertain under what divers circumstances spores of the same plant could be induced to vegetate, and what varieties of fermentation or other actions they could be made to produce.

# MICROSCOPICAL SOCIETY.

## ANNUAL MEETING,

FEBRUARY 6th, 1865.

### *Report of Council.*

THE Council have to make the following report on the progress of the Society during the past year:

Since the last anniversary twenty persons have been elected members of the Society. Two members, Mr. C. Loddiges and Mr. H. Morley, have died during the past year. Several members have resigned, and in revising the list for printing, several names of persons who had resigned for some time were removed. From an accurate revision of the new list the number of members appears to be as follows:

| | |
|---|---|
| Honorary Associates . . . . . . | 4 |
| Compounders . . . . . . . . . | 60 |
| Annual Subscribers . . . . . . . | 284 |
| Total . . . . . . | 348 |

This being from the printed list, it may be considered as accurate.

The Library has been increased by many contributions, and the collection of objects, as will be seen from a report shortly to be read, has received many additions, the number now amounting to 1319.

The Journal has been regularly published, and, as usual, circulated among the members.

### *Report on the Cabinet of Objects during the past year.*

At the annual meeting, 1863, the cabinet contained 1137 objects.
Do. 1864, do. 1235,
being an increase of 98 objects in the year.

The cabinet now contains 1319 objects, being an increase of 84 objects during the past year, presented as follows:

1864. April 3, 4 slides of *Trichina spinalis,* by Dr. Vogel.
May 11, 50 slides of various woods, by H. Black, Esq.
Oct. 14, 24 slides of Diatomaceæ, by Dr. Lewis, of Philadelphia.
Do., 4 slides of glass crystals, by — Hendry, Esq., of Hull.
Dec. 14, 2 slides of Homeocladia, by Dr. Eulenstein.

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ELLIS G. LOBB.

*January* 11, 1865.

# AUDITORS' REPORT.

## Receipts.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| By Balance from previous year | | | | 103 | 1 | 11 |
| Admission Fees of 19 New Members | | | | 19 | 19 | 0 |
| Compositions | | | | 31 | 10 | 0 |
| Dividends on £753 6s. Consols | | | | 22 | 0 | 8 |
| Sundries— | | | | | | |
| 1 Catalogue | 0 | 1 | 0 | | | |
| Screws | 0 | 7 | 0 | | | |
| | | | | 0 | 8 | 0 |
| Annual Subscription— | | | | | | |
| For the year 1861 | 1 | 1 | 0 | | | |
| " " 1862 | 7 | 7 | 0 | | | |
| " " 1863 | 23 | 2 | 0 | | | |
| " " 1864 | 159 | 12 | 0 | | | |
| " " 1865 | 40 | 19 | 0 | | | |
| | | | | 232 | 1 | 0 |
| | | | | £409 | 0 | 7 |

## Payments.

| | £ | s. | d. | £ | s. | d. |
|---|---|---|---|---|---|---|
| To Salary of Assistant Secretary | | | | 21 | 0 | 0 |
| " Curator | | | | 10 | 0 | 0 |
| Editors of the 'Microscopical Journal' | 155 | 16 | 2 | | | |
| Postage and Delivery of ditto | 12 | 11 | 0 | | | |
| | | | | 168 | 7 | 2 |
| Rent | | | | 25 | 0 | 0 |
| Expenses of Soirée, viz.— | | | | | | |
| Fittings and Gas | 6 | 7 | 10 | | | |
| Refreshments | 19 | 0 | 6 | | | |
| | | | | 25 | 8 | 4 |
| Messrs Powell and Lealand, for Objectives | | | | 22 | 12 | 6 |
| W. Ross, for Paraboloid | | | | 1 | 13 | 6 |
| Printing and Stationery— | | | | | | |
| Printing | 9 | 17 | 0 | | | |
| " List of Objects | 17 | 14 | 9 | | | |
| Books | 2 | 7 | 6 | | | |
| | | | | 29 | 19 | 3 |
| Assistant Secretary, Collection of Subscriptions | | | | 14 | 4 | 0 |
| Ditto for Petty Expenses | 7 | 3 | 9 | | | |
| Lamp Oil, &c. | 1 | 9 | 6 | | | |
| Copying List of Objects | 2 | 2 | 0 | | | |
| Advertisements | 1 | 9 | 0 | | | |
| | | | | 12 | 4 | 3 |
| Subscription Ray Society | | | | 1 | 1 | 0 |
| Balance in hands of the Treasurer | | | | 77 | 10 | 7 |
| | | | | £409 | 0 | 7 |

We, the undersigned, have examined the Treasurer's accounts, with the documents and vouchers, and found the same to be correct. The amount of Stock in Consolidated Three per Cents. being £753 6*s.* 0*d.*, and the balance in favour of the Society being £77 10*s.* 7*d.*

P. H. LEALAND.
RICHARD BECK.

The President then delivered the following Address:

## *The* PRESIDENT'S ADDRESS *for the year* 1865.

By C. BROOKE, Esq., M.A., F.R.S.

GENTLEMEN,—I cannot but regret to remark that during the past year the papers communicated to our Society have been less numerous than usual, though by no means wanting in either novelty or interest.

Dr. R. K. Greville, to whom the Society is so largely indebted for the laborious investigation of the Diatomaceæ, has contributed three papers (series xii, xiii, & xiv). A large number of the new species described belong to the genus Triceratium. It appears to me that it would be a point of much interest to determine whether some of the quadrangular forms, to which the term *tri*ceratium is by courtesy applied, are merely accidental varieties of form, or whether they present specific, or even generic differences; the determination of this question is impossible until we are fortunate in being able to appeal to the growth and development of living, or at all events recent, forms. Several species of a new genus, Creswellia, are described by Dr. Greville, in which the frustules are connected by long processes. Mr. H. S. Lander has given a description of Marine Diatoms found at Hong Kong: these chiefly belong to the curious tribe Chœtoceros.

Our 'Transactions' are again enriched by an important paper by Dr. Beale, "On the Structure and Formation of Striped Muscle; and on the Exact Relation of Nerves, Vessels, and Air-tubes (in the case of insects) to the Contractile Tissue of Muscle." This paper further illustrates the advantages derived from the admirable methods of preparation, which Dr. Beale has elsewhere fully detailed,* when the objects are submitted to the high magnifying powers which we can now employ in the investigation of minute structure. The facts observed, and the inferences drawn from them, differ from those propounded by Kölliker, Kühne, and other continental observers, mainly because greater optical power (by which I do not mean mere enlargement), combined with improved methods of preparation, has developed many points of structure, which have hitherto remained beyond the reach of visual power, and the existence of which was therefore unknown. It has, I believe, been suggested that

* 'How to Work with the Microscope, Third Edition, p. 205, *et seq.*

some of the appearances described by Dr. Beale may be the result of manipulation. I can only express my own conviction, that in this case "seeing is believing;" although I am fully aware that microscopic illusions are neither rare, nor difficult to produce.

The only contribution to instrumental appliances is by Mr. D. E. Goddard, "On an Improved Mounting Table." The improvement consists in raising the middle of the slide from contact with the surface of the hot plate by two slips of metal, on which the ends of the slide rest; the too rapid transmission of heat to the balsam, and object to be mounted, is thus conveniently and completely controlled.

It can scarcely be considered a part of my functions to review the 'Microscopical Journal,' the pages of which contain two papers by Mr. E. R. Lankester, "On the Anatomy of the Earthworm;" and one by Mr. Lockhart Clark, "On Microscopic Appearances, illustrating the Pathology of Tetanus;" but I may be permitted to express my regret that the Society should not have had the advantage of receiving communications from such able writers, and at the same time careful observers; since many points of great interest are frequently elicited in the subsequent discussion.

We have to regret the decease of two members during the past year: Mr. Conrad Loddiges, the eminent horticulturist, and Mr. Henry Morley, who formerly took some active interest in the affairs of the Society.

Mr. Conrad Loddiges was the only surviving son of Geo. Loddiges, of Hackney. He was the youngest member of the firm of C. Loddiges and Sons; and after the deaths of his father and uncle, and the expiration of the lease of a part of the horticultural premises, he relinquished business, but retained his love for botany; and a choice collection of ferns was ever a source of much interest to him. He was also interested in entomology, and possessed a fine collection of Lepidoptera. He was much attached to microscopic studies, possessing three good instruments by Tully, Powell, and Smith and Beck; he was present at the house of E. J. Queckett, Esq., on the formation of the Microscopical Society, and was one of its original members. The state of his health, however, has for a long time prevented his attending the meetings of the Society.

Our cabinet now contains 1319 objects; showing an increase of 84 during the past year. The chief of these are 50 sections of various woods from Mr. H. Black, and 24 slides of diatoms from Dr. Lewis, of Philadelphia. Our library has been augmented by the addition of many volumes.

Twenty new members have been elected during the past session; and our present numerical strength is 349, against 353 at the last anniversary. As, however, several names have been removed from our list, comprising those who have for several years ceased to manifest any interest in our proceedings, or to contribute to our funds, I am not inclined to think that our effective force is in any degree diminished or impaired.

The available powers of the microscope have recently been largely augmented by the successful construction of an objective of $\frac{1}{50}$th-inch focus, by Messrs. Powell and Lealand. These able mechanicians have long held the foremost position in the construction of very high magnifying powers, having first produced a $\frac{1}{16}$th in the year 1840, and a $\frac{1}{25}$th in 1860. It must, however, be borne in mind that the priority of construction of an effective $\frac{1}{25}$th objective is due to Mr. Wenham, to whom the microscope has been so largely indebted for its developments; this excellent glass was completed by him in the summer of 1856. It is constructed on a principle differing from that usually adopted in the construction of deep objectives, in having a single front lens. The advantages of this mode of construction appear to me to be considerable, and to merit the careful attention of opticians.

This triumph of optical skill has been constructed for Dr. Beale, and as I have not myself had the opportunity of more than a casual inspection of it, it may not be inappropriate to quote from the 'Proceedings of the Royal Society,' vol. xiv, p. 35, Dr. Beale's own account of its performance:—"The $\frac{1}{50}$th is even better than the $\frac{1}{25}$th, which is now made instead of the $\frac{1}{26}$th. Plenty of light for illuminating the objects to be examined is obtained by the use of a condenser provided with a thin cap, having an opening not more than $\frac{1}{30}$th-inch diameter. The preparation may be covered with the thinnest glass made by Messrs. Chance, or with mica; and there is plenty of room for focusing to the lower surface of thin specimens, which can alone be examined by high powers transparent objects.

"I beg to draw attention to these very high powers, at this time more particularly, because the facts recently urged in favour of the doctrine of spontaneous generation, lately revived, may be studied with great advantage. Not only are particles too small to be discovered by a $\frac{1}{16}$th well seen by a $\frac{1}{25}$th or a $\frac{1}{50}$th, but particles too transparent to be observed by the $\frac{1}{25}$th, are distinctly demonstrated by the $\frac{1}{50}$th. I feel sure that further careful study, by the aid of these high powers, of the development and increase of some of the lowest organisms, and the movements which have been seen to occur in certain forms of living matter (Amœba, white blood-corpuscles, young epithelial cells, &c.) will lead to most valuable results bearing upon the much-debated question of *vital actions.*

"The most delicate constituent nerve-fibres of the plexus in the summit of the papillæ (see 'Phil. Trans.,' for 1864), can be readily traced by the aid of this power. The finest nerve-fibres thus rendered visible are so thin that in a drawing they would be represented by fine single lines. Near the summit of the papilla there is a very intricate interlacement of nerve-fibres, which, although scarcely brought out by the $\frac{1}{25}$th, is very clearly demonstrated by this power. In this object the separation of the fibres, as they ramify in various places one behind another, is remarkable; and the flat appearance of the specimen as seen by the $\frac{1}{25}$th, gives place to that of considerable depth of tissue and perspective. The finest nerve-fibres, ramifying in the cornea, and in certain forms of connective tissue, are beautifully brought out by this power; and their relation to the delicate processes from the connective-tissue corpuscles can be more satisfactorily demonstrated than by the $\frac{1}{25}$th. The advantage of the $\frac{1}{50}$th in such investigations seems mainly due to its remarkable power of penetration."

In my last year's address I stated the results of some comparative observations on the capabilities of the $\frac{1}{12}$th and $\frac{1}{25}$th inch objectives; whether a comparison of the $\frac{1}{12}$th and $\frac{1}{50}$th may lead me to the same result I am not at present able to state. I also then stated that the best results in illuminating the $\frac{1}{25}$th had been obtained with a Kelner eyepiece used as a condenser. The results then obtained have since been unquestionably surpassed by an achromatic condenser made by Mr. Ross, the optical part of which is identical with his $\frac{4}{10}$ths inch objective. This was shown to the Society at a recent discussion on the illumination of objects under high powers, in which it may be remembered that much useful information was elicited.

The last subject to which I shall now feel it my duty to call the attention of the Society is the competition for the medals offered by the Society in the spring of last year. With a view to stimulate the inventive genius of opticians to some improvements in the economical production of good working instruments, the Society offered three Quekett medals for the best microscope in each of three classes:

1. A binocular at ten guineas.
2. A student's microscope at five guineas.

3. An educational microscope at three guineas.

The Society's proposition has not met with universal favour, for not one of the principal London firms has entered into this competition. Seventeen microscopes have, however, been submitted to us for examination; of these five are of the first class, seven of the second, and five of the third. These instruments possess very various degrees of excellence; several undoubtedly have great merit; others, on the contrary, sacrificing quality to quantity, exhibit a coarseness of workmanship hitherto, I believe, unparalleled in the construction of microscopes. In some the objectives consisted solely and entirely of combinations of French doublets; had the employment of these been contemplated, I have no hesitation in saying that they would have been formally excluded in the terms of the Society's proposal.

Two of these microscopes, in the first and second classes respectively, and by the same maker, are manifestly superior to the rest, both in workmanship and optical performance; such, in fact, is the quality both of the workmanship and of the objectives, that the Committee have entertained very grave doubts whether they can really be produced at the proposed prices; they have, therefore, hesitated in recommending the award of the medals until they shall have received the most ample assurance that the public will be supplied with instruments of a quality equal to the samples sent.

It is superfluous to say that in offering the medals the Society never contemplated being made the vehicle of a costly advertisement. Microscopes submitted to competition at a price at which they could not be produced would palpably be only a delusion and a snare—a delusion to the public in purporting to be a legitimate commercial transaction, and a snare to the maker, in the shape of a constant inducement to cover the loss, if not to make a profit, by rendering subsequently inferior workmanship. It is sincerely hoped that the circumstances here alluded to may not be found ultimately to defeat the well-meant efforts of the Society to render a public service to the advancement of microscopic research.

In conclusion, it is now my duty to resign the chair, the duties of which, I fear, I have but imperfectly fulfilled, in favour of a gentleman whose name is too well known in the world of science to require any eulogy from me. His researches more immediately connected with the objects of our Society consist principally in an elaborate investigation of the forms of snow-crystals, the beautiful symmetry and regularity of which evinces the uniformity of the molecular forces by which the solidifying atoms are aggregated.

# Descriptions *of* New *and* Rare Diatoms. Series XV.

By R. K. Greville, LL.D., F.R.S.E., &c.

(Plates III & IV.)

(Communicated by F. C. S. Roper, F.L.S., &c. Read 8th March, 1865.)

## Clavularia, n. gen., Grev.

Frustules free, linear-elongated, with numerous transverse pseudo-dissepiments interrupted by a central, smooth, external plate. Valve linear, with a central inflation, and a longitudinal row of strong puncta on one of its margins, which, in the front view, are shown to be the heads of short subcapitate processes.

It is very difficult to define this exceedingly curious diatom; indeed, it would be hopeless to attempt to do so without the aid of figures. For two years I was only acquainted with the valve; and when I subsequently met with several specimens of the entire frustule, I should scarcely have ventured to identify them as belonging to the same thing, if I had not fortunately discovered an individual in an oblique position, which left no doubt whatever of the fact. I shall leave it to other diatomists to speculate on the affinities of this strange-looking production.

*Clavularia Barbadensis*, n. sp., Grev.—(Figs. 1—3, Pl. III.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Frustule ·0060″ to ·0080″ in length, and scarcely ·0002″ in breadth, perfectly linear, except at the acute apices, having narrow margins, one of them (which I call the upper) strong and coloured. Numerous transverse dissepiments occur throughout the whole length, at irregular intervals, except for a space of about ·0014″ in the middle, which is occupied by a smooth lamina, folded up, as it were, and pressed against the surface, and so concealing the dissepiments, convex above, where it is on a level with the coloured margin, and gradually tailing off below into the uncoloured margin. Along the upper margin are situated a row of very short, stout, subcapitate processes, standing up like little nails, at irregular distances, evidently arising out of the substance of the margin itself, and of the same colour, and having no reference to the pseudo-dissepiments. The number of these processes varies; two generally, but sometimes three or four, belong to the centre, and between the centre and each apex there are from six to nine. The valve is the view which occurs most frequently, and strongly resembles a *Ceratoneis,* there being an oblong inflation or expansion in the middle, which passes suddenly into the long, exceedingly narrow, subacute arms. The processes above described appear in the view of the valve as strong, brilliant puncta, seated on one of the margins; but the puncta which occur in the centre or inflated portion (nearly ·0004″ in breadth) are situated more or less in the middle of the space, and not on the margin.

## SYNEDRA.

*Synedra clavata,* n. sp., Grev.—Valve broadly club-shaped, with an obtusely elliptical apex; striæ coarse, interrupted by three longitudinal lines. (Fig. 4.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

The striation of this fine species is extremely like that of *S. robusta.* Of the three longitudinal lines one runs up the middle, the others near the margin. The striæ are about 15 in ·001″. Length of frustule ·0080″; breadth at widest part ·0015″. It is an extremely rare diatom, not more than four or five specimens having occurred in the hundreds of slides I have examined.

## COSCINODISCUS.

*Coscinodiscus Mossianus,* n. sp., Grev.—Large; valve very convex, umbilical cellules loosely arranged, those of the central portion of the disc very large, roundish, irregularly radiant, becoming somewhat smaller, quadrangular, and symmetrically radiant towards the margin, within which they terminate in a crenate line. (Fig. 22.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.

One of the finest species of this exquisitely beautiful genus which I have ever seen; and so well marked that the characters above given will be sufficient to distinguish it in a moment. Nothing can be more beautiful than the symmetrical radiance of the parts towards the margin, or the regularity of the crenate termination of the lines of cellules. I do not perceive any trace of puncta or striæ. The diameter of disc is ·0062″; the lines of cellules at the margin, 5 in ·001″. It gives me much pleasure to dedicate one of the most attractive of Mr. Johnson's discoveries to his friend

Mr. Moss, of Lancaster, who has aided him in his investigations, and to whom I, also, am indebted for interesting contributions to my cabinet.

### AULACODISCUS.

*Aulacodiscus gigas*, n. sp., Grev.—Very large; disc with numerous (10) rays, and large, round, equal cellules, somewhat distant in the centre; umbilicus a defined, circular, blank space, minutely granulate; ray-furrows gradually widening, until they enclose the almost marginal processes; margin punctate. (Fig. 23.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.

Among the finest and rarest of Mr. Johnson's many discoveries. It is at the same time an unquestionably distinct species. The spaces unoccupied by the large rounded cellules show a very evident granulated structure, extending even to the margin, which, contrary to what is usually observed in this genus, is not striated. The umbilicus is large and well-defined by a circle of cellules, a pair of which mark the commencement of each of the ten rays. The latter are not conspicuous as they leave the umbilicus, but soon begin to widen, and then become very characteristic, passing closely round the processes, which lie within the loop like a stone in the bottom of a sling. The cellules are rather sparse for some distance from the centre, become gradually more numerous, and for more than half the radius closely fill up the compartments. Diameter ·0090″.

### HEMIAULUS.

Dr. P. A. C. Heiberg, in his beautiful 'Conspectus criticus Diatomacearum Danicarum,' has proposed to make *Hemiaulus* the type of a new family; but the diatoms I am about to describe—not the least curious of the treasures of the Barbadoes deposit—in the present and following Series will probably tend to modify his views. The following synopsis of his characters will, I trust, accurately convey his ideas; and in translating it from the Danish I have to acknowledge the kind assistance of my friend Mr. James B. Davies, Assistant-Curator of the Museum of Natural History in the University of Edinburgh. It is right to state, however, that for the sake of perspicuity, I have occasionally deviated from the literal words of the text.

HEMIAULIDÆ, fam. nov., Heiberg.

Frustules uniform (Cellens Skaller ensdannede), symmetrical in both front and side views, rectangular, or nearly so; as seen in front view provided with horn-like processes tipped with one or two straight or inclined spines, which are often decurrent; the horns on their outer side straight, and forming a right angle with the base of the valve (Grundflade). Sculpture composed of larger and smaller cellules variously arranged, in addition to which, costæ are often present; the sculpture of the connecting zone less conspicuous.

TRIBE I. *Hemiaulidæ genuinæ.*

Frustules, both in the side and front views, symmetrical in both the long and the transverse axes (or, if there be more axes of the same value, symmetrical with them all).

Gen. 1. *Hemiaulus,* Ehr.

Valve elliptical (lanceolate oval), produced at the angles (extremities of the long axis) into horn-like processes, tipped with a spine.

Gen. 2. *Trinacria,* n. gen., Heiberg.

Valve with a regular triangular outline (having three axes or diameters of equal value); frustule as seen in the front view with three corner processes, each of which terminates in two spines.

Gen. 3. *Solium,* n. gen., Heiberg.

Valve regularly quadrangular or rhomboid; frustule, as seen in front view with four corner processes, each tipped with two spines.

TRIBE II. *Hemiaulidæ cuneatæ.*

Valve ovate; connecting zone wedge-shaped; frustule only symmetrical in the long diameter.

Gen. 4. *Corinna,* n. gen., Heiberg.

Valve regularly ovate; the frustule, as seen in front view with two unequal corner processes, the larger one corresponding with the broad end of the valve, each tipped with a single spine.

Of the above genera, Dr. Heiberg describes and figures three new living species of *Hemiaulus,* two species of *Trinacria,* one of *Solium,* and one of *Corinna.* I now proceed to record the Hemiaulidæ observed in the Barbadoes deposit, not including the well-known *Hemiaulus Polycystinorum,* which is abundant.

*Hemiaulus reticulatus,* n. sp., Grev.—Rectangular; angles produced into short, sharply truncate horns tipped with a spine at the inner angle; space between the horns concave, with one or more convex projections, cellules minute, hexagonal. (Fig. 5.)

*Hab.* Barbadoes deposit, Cambridge estate, in slides communicated by C. Johnson, Esq.

This is the only species of the genus as far as I know which possesses a true hexagonal cellulation; the structure of the whole group being generally areolate or punctate. The cellules are 7 in ·001″. Breadth of frustule ·0030″. The horns appear to be short, but in *H. Polycystinorum* this is a variable character. The central projection forms a gentle arch and there is a slight one on each side, but if we are to judge from the species above named, this also is sometimes an equally variable character.

*Hemiaulus mucronatus*, n. sp., Grev.—Rectangular; angles produced into rather short horns tipped with a spine at the inner angle; space between the horns nearly straight, with a large, central, convexo-conical projection, bearing a minute mucro on its summit; structure composed of equal, roundish, quadrate cellules arranged in parallel lines. (Fig. 6.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Of this species I have seen many examples; and as it has much of the general appearance of *H. Polycystinorum*, I have no doubt that I have frequently passed it over for that diatom. The eye requires to be specially directed to the cellulation which of itself is a sufficient diagnosis. Looking at the valve in its front view, as represented in the figure, the cellules form vertical parallel lines. They are 5 in ·001″. Breadth of frustule ·0030″.

*Hemiaulus punctatus*, n. sp., Grev.—Rectangular; angles produced into short narrow horns; space between the horns convex, divided into a large central and two lateral smaller lobes; structure punctate, the puncta becoming smaller towards the angles. (Fig. 7.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Although I have this pretty species with the frustules *in situ*, I have not been able to detect the very least trace of spines at the apices of the horns. There can, however, be scarcely any doubt regarding their existence in more perfect examples. The puncta are much larger, and more sparse in the middle of the valve, which give it quite an ornate appearance.

*Hemiaulus pulvinatus*, n. sp., Grev.—Rectangular; valves closely and minutely punctate, the angles produced into short narrow horns, tipped with a spine at the inner angle; space between the horns concave, the concavity interrupted by a large cushion-like projection. (Fig. 8.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Chiefly distinguished by the close and minute punctation, and by the large single projection, the convexity of which is somewhat flattened. It occupies nearly half of the whole breadth of the valve, which is ·0025″.

*Hemiaulus lobatus*, n. sp., Grev.—Rectangular; valve with the angles produced into slender horns, each tipped with 2 minute triangular teeth; space between the horns concave, 5-lobed; structure punctate; 2 lines of very minute puncta passing along the horns. (Fig. 9.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

The two lines of very minute dots on the horns, and the different character of the teeth which terminate them, seem to indicate a different group of the *Hemiaulidæ*. The central projection is the largest, and almost hemispherical. All of them are enclosed, as it were, within a concave hyaline limbus, which, passing up the side of the horns, ends in the little tooth at the inner angle. Breadth of the frustule ·0020″.

*Hemiaulus exiguus*, n. sp., Grev.—Minute, rectangular; valve with the angles produced into elongated-conical horns tipped with a spine; space between the horns occupied with a single convex projection; structure minutely and remotely punctate. (Fig. 20.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Rather ambiguous in appearance, having, in some respects, the aspect of a *Biddulphia*; but the rectangular form, and the presence of the little spine at the apex of the horns, show a greater affinity with *Hemiaulus*. Breadth of frustule ·0011″.

The following diatoms, while they cannot be referred to the present genus, appear to belong to the family, and would probably constitute two or three genera had sufficient materials been at our command. At the same time they are so rare, and the probability of obtaining an additional supply of the particular sample of the deposit in which they occur so small, that I think it desirable not to lose the present opportunity of making them known. It will be understood, then, that the letter "H," which stands before the specific name, represents merely the family; or, if it be thought preferable, for form's sake, it may represent the genus *Hemiaulus*, with more than one mark of doubt.

*H. tenuicornis*, n. sp., Grev.—Very minutely punctate, not wholly rectangular; valve with the angles produced into very long, slender, incurved horns; space between the horns nearly straight, with a slight central projection. (Fig. 10.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

In none of the specimens which have come under my notice have I been able to see the minute teeth which we would naturally look for at the apices of the horns. The latter, also, present a strange anomaly. In other members of the same group, or, at all events, very closely allied, the horns of opposite frustules are united by their ends; but in the present case it is impossible. In some specimens the apices even cross each other; and in scarcely a single instance have I seen them otherwise than in contact. What can be the position of frustules *in situ?* The size varies. The largest example I have observed has the length ·0095″, the horns alone being ·0050″. The breadth ·0025″.

*H. lyriformis,* n. sp., Grev.—Nearly smooth, not strictly rectangular; valve with the angles produced into long, narrow horns inclined more or less inwards, and tipped with two minute triangular teeth, and towards the base having externally a deep contraction; between the horns a long, narrows central process. (Figs. 11, 21.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

A singular diatom, but evidently belonging to the group under consideration. The body of the valve is small, serving merely for the stand, as it were, of the lyre-like horns. These are always inclined inwards, sometimes so much so as nearly to touch each other at the apex. The space between the horns is concave, the concavity being interrupted in the middle by a narrow, linear, erect process connected on each side with the horns by a hyaline limbus, which passes up their inner side. At the base the horns curve suddenly inwards so as to leave a deep notch between them and the bottom of the valve, giving to the whole organism the general appearance of a lyre. Breadth of frustule from ·0014″ to ·0020″. Length ·0025″ to ·0030.″

*H. angustus,* n. sp., Grev.—Narrow, very minutely punctate, the puncta scattered; valve with the angles produced into very long, linear, straight horns tipped with two acute triangular teeth and with a row of puncta down the margins; space between the horns concave. (Fig. 12.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Although the horns of this species are straight in themselves, there is a manifest tendency to an inward inclination; so that it must range along with those in which the frustule (taken in connection with the horns) is not truly rectangular. With the following species there is considerable affinity, notwithstanding essential differences. Breadth of frustule ·0013″. Length ·0050″.

*H. longicornis,* n. sp., Grev.—Not strictly rectangular, very minutely punctate, puncta scattered; valve with the angles produced into long, linear, more or less incurved horns tipped with two sharp teeth; space between the horns with a single arch-like projection. (Fig. 13.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

The valve, in its front view (as figured), with its long and somewhat incurved horns suggests a resemblance to the shafts of a light carriage; occasionally, however, the horns, although inclined, are almost straight. They are very slender and have the appearance of being thickened upwards in consequence of a hyaline limbus or edging being more broadly developed towards the extremities where it terminates in the teeth. A beautiful row of minute dots passes down each horn. The breadth of the frustule is ·0020″. Length ·0035″.

*H. alatus,* n. sp., Grev.—Not rectangular, minutely punctate, puncta in irregular lines; valve with the angles produced into rather long linear, connivent, toothless horns, having a hyaline border; space between the horns with a small conical projection. (Fig. 14.)

*Hab.* Barbadoes, Cambridge estate, but in a different sample of the deposit; in slides communicated by C. Johnson, Esq.

This is a well-marked diatom and perfectly constant to its characters, differing only occasionally in its relative proportions. The whole surface is more obviously punctate than in any of the preceding non-rectangular species. The horns have a more carriage-shaft-like bend than even in the one last described; but they have no terminal teeth, which is remarkable, because the hyaline limbus from which the teeth are apparently derived is here very strikingly developed. There is also a peculiarity in the hyaline margin on the inner side which I have not observed in other species. It is composed of two plates, one of which arises near the central projection and reaches nearly to the inward curve of the horn; the other commences at about the same point and is continued to the apex. The average dimensions may be set down as, breadth ·0020″, length 0026″. Sometimes the breadth is greater, while the horns are at the same time shorter.

*H. hastatus,* n. sp., Grev.—Valve very minutely and closely punctate, widely conical, the angles produced into stout, rough, diverging horns, terminated by long, hyaline, very acute, spear-like apices; space between the horns excavated, and filled up with a hyaline limbus. (Fig. 15.)

*Hab.* Barbadoes deposit, Cambridge estate, along with the preceding; in slides communicated by C. Johnson, Esq.

In this curious diatom we have a form very aberrant in its conical valve and diverging horns. Nevertheless the affinity may be distinctly traced. Here the hyaline limbus, filling up the cavity at the base, reappears as in former cases, terminating the horns, not in the shape of delicate spines, or minute triangular teeth, but in that of a most lethal-looking weapon—a strong angular acute spear, as long as the horn itself. The latter is robust and rough, with coarse points, forming, as it were, a very fitting, firm handle to the blade it supports. It would be not a little interesting to discover the frustules of so extraordinary a production *in situ.* It will probably prove the type of a new genus. Breadth of frustule ·0035″, length to end of horns ·0045″.

*H. ornithocephalus*, n. sp., Grev.—Smooth, rectangular; valve with the angle produced into short, thick, straight, capitate horns, having a single triangular tooth; space between the horns straight. (Fig. 16.)

*Hab.* Barbadoes deposit, Cambridge estate, very rare; in slides communicated by C. Johnson, Esq.

This, it will be at once perceived, is an equally aberrant form; and there can be little doubt that if we knew it more perfectly, it would, like the preceding, constitute a new genus. The horns do not form a straight continuation of the margin of the valve, but rise from a swollen base a little within it. They appear to be cylindrical, and terminate in spherical knobs, which, by the addition of the little lateral tooth, are irresistibly suggestive of a bird's head. Breadth of frustule ·0019″, length ·0016″, the horns occupying about two thirds of the space. I have only seen a single specimen.

## TRICERATIUM.

*Triceratium Moronense*, n. sp., Grev.—Large; valve pulvinate, with somewhat convex sides and prominent pseudo-nodules; surface with rather widely separated and broken lines of minute, remote, radiating puncta, leaving a small, irregular, vacant space at the umbilicus. (Fig. 18.)

*Hab.* Moron fossil deposit, Province of Seville; C. Johnson, Esq.

A beautiful and distinct species, very convex at the edge of the valve. The punctation constitutes the most distinctive feature. The minute, circular, brilliant dots are arranged in radiating lines, but at considerable distances both between the lines and from each other; and occasionally the lines are interrupted, as if one or more dots had dropped out. The whole substance is somewhat hyaline. The margin is striated, or rather, the terminations of the striæ of the frustule, as seen in the front view, appear more like puncta. Distance between the angles ·0045″.

*Triceratium araneosum*, n. sp., Grev.—Minute; valve with somewhat convex sides and rounded angles; central portion filled with a fine, cobweb-like, irregular network of unequal cellules, which are connected with the margin by a few short lines. (Fig. 17.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

The only species with which the present diatom can be contrasted is *T. labyrinthæum*, which is double the size; and although it possesses a network of cellules not reaching to the margin, the cellules are much larger, of a totally different shape, and filled with puncta.

These two curious diatoms resemble each other only in outline, and in the circumstance that the cellules form an internal cluster, which is connected with the margin by a few radiating lines. Distance between the angles ·0016″.

## ENTOGONIA.

*Entogonia elegans*, n. sp., Grev.—Valve with convex sides and somewhat produced, obtuse angles; the border-compartments filled with very numerous, minute cellules; central triangle with regular radiating costæ. (Fig. 19.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.

The convex sides and produced angles give an outline to the valve distinct from that of every other species. In some respects it approaches *E. marginata*, but the lines of the inner triangle are not moniliform, and the cellules of the border-compartments are much more numerous and more closely disposed. In the latter character it differs from *E. pulcherrima*, as well as in the very conspicuous pseudo-nodular, circular, blank space. The regularly radiating costæ, independently of other characters, separates it from *E. amabile*, in which the costæ are more or less interrupted. In the specimen I have drawn, a number of spines may be seen, mostly near the margin, but they are of no diagnostic value. Spines present themselves occasionally in various diatoms, as, for example, in *Eupodiscus Jonesianus*, to which my acute correspondent, Mr. J. Linton Palmer, at Hong Kong, first drew my attention. In some specimens he kindly sent me, a dozen strong spines may be seen on a single disc, chiefly near the margin, but by no means confined to it, and so unsymmetrically arranged that it is easy to see they are of an abnormal character.

## COCCONEIS.

*Cocconeis naviculoides*, n. sp., Grev.—Valve broadly oval, punctate, with a smooth, slender margin; puncta forming a somewhat distant series of intersecting lines concentric with the extremities; median line straight, with a linear-lanceolate belt of transverse striæ on each side, interrupted at the nodule. (Fig. 24.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Very similar in the puncta, and in the beautiful curves in which they are disposed, to *C. Barbadensis*; but the species is strikingly distinguished by the lines of transverse striæ running along each side of the median line, as we see in many *Naviculæ*. Length of frustule ·0030″.

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# PHOTOMICROGRAPHY, *its* APPLICATION *and* RESULTS.

By R. L. MADDOX, M.D.

(Read March 8th, 1865.)

THE application of photomicrography possesses some points of such general interest to the microscopist that, at the request of your President, Mr. Glaisher, I have the honour to offer a few remarks on the subject, to accompany some of its results and illustrations which will be placed before you by Mr. How, of Foster Lane, through the medium of his oxy-hydrogen-gas lantern.

The various methods adopted by the working microscopist in his investigations, that are not of a direct manipulatory character, belong chiefly to chemistry or physics. Photomicrography as yet has scarcely obtained more than passing attention. The question, then, arises whether its application is likely to prove useful to him when engaged in the determination of doubtful points in structure, desirous of representing minutiæ the most delicate, the general characters of minute objects, or small parts of larger ones, for the purpose of ordinary illustration, or to supply the place of the usual drawings of the lecture hall, either as corrected diagrams or, through the additional aid of a properly constructed and well-arranged gas lantern, to display these representations to even a widely spread audience. This is no narrow question, to be hastily set aside, stripped of its legitimate bearings by a prejudiced judgment, or the limits of its applicability determined by the display of a few dozen objects; rather may they be expected to exhibit the failings, weaken the cause, concede the question, than enforce the truth. Still, wherever difficulty attends investigation, science renews her claims, petitions the neighbouring branches for support along the widening stream of knowledge, and, though she may not at once acknowledge the debt in full, she passes it to the common well, where daily contributaries tend, and leave the issue to a future day. Fully persuaded myself that it has advantages both of a scientific and art value, and in a belief that it will eventually assist the microscopist, it was necessary to test its application in the delineation of objects most diverse in structure, colour, and size, and with the ordinary full range of objectives from the 3-inch to the $\frac{1}{12}$th; this also without any reference to uniformity in the dimensions of the images, but bearing in mind the usual loss in definition by too great enlargement. The adaptation of the microscope to the camera is so generally known that it scarcely seems feasible to enter on the arrangement employed, except in a casual manner, or to allude to one or two points of practical convenience. I have always preferred a separate instrument to the usual microscope, fixed on a stout base board at one end, supported by double triangle-legs of convenient height, and of a size that it can be handily used in a room at an open window. The range of the camera, which has the sliding-front removed, is obtained by attaching a bellows portion, or a flexible open-ended bag supported at the edges of its four sides with stout elastic web, between the camera and an upright or square board attached at right angles to the base board, near one end, and this piece has a circular aperture through which the short and wide body of the microscope, when placed horizontally, slides whilst using the rack-and-pinion or the slow motion, which may work near to the neck or in the arm of the microscope. To facilitate the use of the latter, its milled brass head is deeply grooved and turned towards the base board, in which, on its central line over the part likely to be traversed by the longest focus objective, an oblong slit is cut. Underneath the base board is supported a rotating rod carrying a reel on the end beneath the slit. A cord is passed round this through the slit and over a second reel, which has a sliding motion between its points of support to accommodate itself to the play of the rack; from this pulley is passed another band which is engaged in the groove of the milled head of the fine adjustment. This is exceedingly sensitive, worked by rotating any part in the length of the rod, or by its handle at the opposite end of the base board, beneath which it is placed to be out of the way and not likely to injure the face of the objective by any accidental mismanagement. Or the same action is equally gained by attaching to the arm from the rack carrying the tube or body of the microscope a vertical slip of stout brass plate, which passes through the slit in the board, and is pierced near its end with an even aperture, in which works a double-coned pin, screwed into the centre of the end of the rod carrying the reel. An open oblique slit between the upper part of the hole and one edge of the strip of brass permits the rod being easily removed or placed in its bearing. A band passes from the reel on the rod over the groove in the milled head of the slow motion. In this method the rod beneath the board follows the play of the rack. That there should be no slip, the reel on the rod is covered with a piece of vulcanized india-rubber tubing. The convenience of being able to act on the fine motion at a distance from the stage is very great, the focus being under immediate inspection, and the eye likely to be kept a less time exposed to the action of a bright glare.

To meet a difficulty very often present, the object not lying in parallel plane with the objective, the position of the focussing screen being supposed to remain always parallel with it, I devised a small adjusting stage. It consists of two thin plates of brass of any convenient length and width, pierced in the centre with an aperture sufficient for the size of any object likely to be used; the under plate is slightly shorter than the upper by the width of a thick strip of brass at each end, and to these are screwed four flat springs, which, by embracing the under plate, keep the plates together. They are separated by four conically pointed tangent screws, working in these strips near the corners; the conical points, acting on a bevelled edge in the upper surface of the under plate, force the top one to lift at every angle from the centre, thus elevating the object on it. The whole is attached for use to the central aperture of the stage of the microscope by a ring collar, which thus affords a means of rotation of its own, if required.

The carrier for the achromatic or other form of condenser is attached to the under surface of the stage, as I prefer in the illumination to shut out diffused light as much as possible from the under surface of the object. It seems preferable to have a full-size collecting or posterior lens in the achromatic combination, by which means a large volume of light is made to replace, as it were, the defect of the decrease in angular aperture occasioned by the withdrawal of the focus of the condenser, either to avoid the sun-spot or injuring the object and objective if of very short focus. The illumination is by direct sunlight, generally employing Abraham's achromatic prism in place of the mirror if the object be not large. In the determination of structure I anticipate better results from the use of concentrated parallel rays by achromatic lenses or a speculum reflector. On trying the prism and a plano-convex lens for a condenser, the foci meeting, the resulting image was deficient in vigour, and a certain amount of fogging very evident. Using sunlight, it is difficult, under long exposure, to hit the balance between the necessary light and the diminishing stops. Although much may be gained by the use of oblique illumination in the ordinary employment of the microscope, it opens a question in photomicrography as to the correctness of the representations, for the interference in some objects arising from the obliquity of the light may be so great as to furnish a corresponding error. This is seen more especially when the oblique pencils, playing on the edges or angles of the refracting body and being possibly repeated, even in the structure by reflection, render a single line or marking double or compound.

I do not here take into account the so-called "blurring" of photographers, said to arise from the reflection of the actinic rays after passing through the collodion film, by the back surface of the glass plate, or the indistinctness of bordering due to objects lying a little out of focus, and, as in the case of fine hairs, also depending on interference. The error alluded to is noticed more particularly when the object has a certain thickness, as in some of the Coscinodisci; then it may furnish to the hexagonal areas an appearance as if the sides of the depressions or elevations were made up of a series of short rods or superimposed planes. This is especially the case when the object is focussed into. In some of the discs, as in Actinophænia, a *slight* obliquity in the illumination tends to furnish a bolder contour to the object, of value when the pairs are united in the stereoscope. Mr. Wenham, some time since, pointed to this instrument as likely, through photomicrography, by high-power objectives, to render considerable assistance in determining such points as are with difficulty, if not uncertainty, interpreted by the usual method of observation. To obtain this second or combining image, preference is given to every slight alteration in the illumination and focus, if not also in shifting the object a very little to the right or left. In these match-photographs the images have to be kept down to the usual size of the stereo-plate, that the entire object may be combined; or they may require to be overlapped. Some of the discs or more solid-shaped Diatomaceæ, when copied as transparent positives and viewed in the stereoscope, have a charming appearance.

The Actinophænia, Coscinodiscus, and Craspedodiscus, from the wonderful sculpturing on their surface when thus seen, keenly contest for the highest feelings of admiration, whether towards themselves as objects of innate beauty or towards the Great Artificer. The Diatomaceæ and many of the objects were mounted in balsam, and others in glycerine or glycerine and gum; when the former were tried "dry," the focussing in sunlight was uncertain. A few objects, from their colour, gave me considerable difficulty, some portions being quickly impressed, the other parts being without any definition. The method by which I endeavoured to meet this was to follow up a suggestion of Mr. Shadbolt, namely, to give a somewhat similar colour to the whole object as had the densest portions; this would naturally place the least coloured on a nearer equality with the most coloured as regards the actinic rays. The question was how to effect this without procuring a too lengthened exposure, as no form of heliostat was employed. First, I tried tinted glass beneath the object, by which some advantage was obtained, yet not sufficient; secondly, varnishing the back of the object-slide with a transparent, dark, resinous varnish was adopted; this, although it answered to a very great extent, brought in a difficulty—the field of the negative had minature markings, which also pervaded the image. Therefore, setting aside both these methods, I determined on using a slow collodion and a rather acid bath. These measures enabled me to give in some cases over seventeen seconds' exposure in concentrated sunlight, of some objects, with excellent results, without a trace of fogging or solarization, and the image was brought up to a normal density without much trouble.

More than five years since, I tried bleaching certain dye-wood-cells with hydrochloric acid and chlorate of potash, after removing the colouring matter as much as possible by aid of solvents, but the cells were generally left with such an amount of roughness as to interfere with definition. After seeing that Dr. Hicks employed a similar plan to bleach insect textures, trial was made of it on them, but very many of the minute hairs were found to be removed, the surface more or less roughened, and thus injured for the purposes of photomicrography. This, however, might have been due to some error on my part. Unfortunately I am not acquainted with any method for preserving the natural appearance of the internal organs of insects, as seen in the "live-box." The granulation given by the use of chromic acid, bichloride of mercury, carbonic acid, &c., interferes too much with the definition to be of use in "differentiating" the internal organs for photomicrography.

In staining the tissues of entire insects by the carmine fluid, we introduce a most unfortunate colour for the photographer; but when the prints from the negatives, or the transparent positives for the stereoscope or lantern, are to be coloured, this defect is less apparent.

The process of tissue-staining opens a fresh field for us. From my success in obtaining fair negatives from some of Dr. Beale's excellent preparations, I feel convinced photomicrography *can* be made, if required, to furnish assistance to the *anatomist* and *physiologist* for *class instruction.* When the object and microscope are not used, coloured prints of a sufficient or convenient size might be employed to more closely explain the enlarged diagrams. In the measurements of objects the plan is open to less variation than when trusting only to the eye; should the objects differ among themselves, the difference, as seen in the print, could be readily determined; the striæ in the Diatomacea, the angles of minute crystals, the felting quality of wool, the coarseness or fineness of vegetable products (as cotton), might claim attention, even as relates to their market value. To the draughtsman it will furnish a means to correct or supply the copy for the pencil; in this manner it has been employed in the American edition of Dr. Draper's 'Physiology,' and as direct photograph prints in the title-page of Dr. Beale's recent edition of 'How to Work with the Microscope.' Should an easy and permanent method of printing from photograph negatives be discovered, we may hope for its profitable adoption in the illustration of our scientific literature, as refers, at least, to the microscope. It is now stated that a plan has been found by which a correct image can be printed from a negative or positive on to the wood-block. A very small quantity of nitrate of silver is used with other substances, and these are sufficient to receive and furnish the impression without injury to the texture of the wood, or interfering with the ordinary method of woodcutting.

Still, with these claims before us, what has been its progress for the last ten years? With us the climate may tend to hinder its advance; those who would occasionally employ it may not be able to spare their time in the sunny hours; hence we must look to artificial illumination. From experiments with the magnesium light, I am sure we have for very many objects an adequate source of illumination, though it remains to determine the best means for its ready application and the necessary correction for the actinic rays; these are mechanical points.

The value of the oxycalcium light has been already decided by the conjoint labours of Drs. Abercrombie and Wilson, of Cheltenham. By its use, and a very simple substitute for the bellows-camera, as described in the last July number of the 'British and Foreign Quarterly Review and Medico-Chirurgical Journal,' they have produced some most charming results, remarkable for the softness of the shadows, delicacy of outline, and transparency in the detail. Doubtless we shall eventually be able to obtain, if advantageous, instantaneous pictures of the circulation in some of the most transparent forms of insects, or in aquatic larvæ, especially when the blood-globules are of considerable size, and in transit appear, as it were, from their sarcode condition, often dragged into very oblong forms, which may help to determine the direction of the current, and when the insect will bear considerable compression without injury, so as to bring the irregular surfaces into closer contact with the thin cover of the slide or top of the aquatic box.

There are some of the confervoid Algæ—as *Drapernaldia Chætophora*—which have hitherto baffled many attempts. We cannot readily render the chlorophyll of the cells and at the same time preserve the fine terminating filaments; these are mostly lost in the development. If we attempt to give colour to them by staining, the appearance of the chlorophyll in the lower cells is quickly altered.

It would be incorrect to judge of its general applicability by its failures in one or two classes of objects; even if many of the Diatomaceæ have also to be excluded for more extended trials, may we not expect to obtain fresh advantages? Although it cannot disclose the latent doings of the synthetical chemistry of organic existence, or display the rules of physical destruction, it may largely assist in the elucidation of those questions which now rest on belief, and are open to the testimony of the controversialists of science. Indeed, we may expect, as the labours of individuals are collected and compared, additional superstructure will be furnished to the vast edifice the microscopist raises by his patient research. We cannot turn to the marvels of design arranged in the humblest microscopist's cabinet without desiring to have at hand some ready means of drafting from its stores a faithful recognition of its objects, which, although it may not supply a true significance of each part, may yet determine its common value; or refrain, when we examine the cabinet, richly stored with the dust of primeval age, which the Divine Hand, when "moulding confusion to such perfect forms," marked with graceful symmetry and elaborate adornment in characters of exhaustless beauty, from wishing for some easy method by which their wonderful variety might find an adequate representation.

Where can we look for this assistance if not in such plans as may diminish the labour of the draughtsman, and afford efficient means of moderately enlarging, diminishing, or multiplying the copy? Is it not to photomicrography, whether adopted on metal, stone, or glass—whether coloured or touched by the "burin" of the artist—that our effort must be directed?

*When* the *same* labour, the *same* skill, have been given to this subject as fortunately have obtained for the microscope-objective and camera-lens, *then* may the present imperfect copies be replaced by others more correct, the errors reduced to a minimum, and the reward success. When a sure and simple plan for employing such a substance as a ready sensitized collodion, which can be used wet without the constant trouble attached to the present process; or the plates kept ready prepared, and an eligible mode of supplying a strongly actinic artificial illumination; when, in fact, the camera goes hand in hand with the microscope, and photomicrography has found more favour than at present, then may we expect, from the combined application, truly useful results, and science render up more of her hidden treasures.

This imperfect response to the wish of your President would be still more so without a due acknowledgment of the valuable hints and guidance given in the writings of those, whether at home or abroad, who have contributed to the literature of the subject, where all that relates to detail is fully stated. For much that appertains to these minutiæ, also to various points connected with many of the negatives and objects, I must refer to a paper lately read before the London Photographic Society, and published in their 'Photographic Journal' for Dec. 15th ult. A candid criticism on the illustrations may render us more diligent students, and impart a new desire to thus study the minute organizations where beauty and variety solicit contemplation.

# TRANSACTIONS.

## Descriptions *of* New *and* Rare Diatoms. Series XVI. By R. K. Greville, LL.D., F.R.S.E., &c.

(Communicated by F. C. S. Roper, F.L.S., &c. Read May 10, 1865.)

(Plates V & VI.)

### Skeletonema, n. gen., Grev.

Frustules cylindrical, equal, united into a filament; each frustule or joint composed of two series of large (open?) cellules, terminating in striated borders, indicating the sutures.

*Skeletonema Barbadense*, n. sp., Grev.—(Pl. V, fig. 1.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

One of the paradoxical forms which make their appearance from time to time in this singular deposit. No specimen presenting a view of the valve has been discovered, but the structure and mode of fissiparous division is very obvious; the greater portion of each frustule is made up of a double series of very large, oblong, apparently open cellules, separated by parallel slender bars, united in the middle, end to end, the bars alternating with each other. At this point there is clearly no separation. This double series of skeleton-like cellules terminate at each extremity in a somewhat broad striated border. The whole filament is strictly cylindrical, uninterrupted by any keel, contraction or furrow, and the junction surfaces are quite plain. The diameter is ·0011″; length of frustule ·0020″; length of large cellules ·0007″.

### Strangulonema, n. gen., Grev.

Frustules united into a punctato-cellulate, cylindrical filament; each frustule contracted in the middle, and at the centre of the contracted portion expanding into a nodule.

*Strangulonema Barbadense*, n. sp., Grev.—(Fig. 2.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

We have here another filamentous diatom, which, like the preceding, cannot be referred to any existing genus. Only two specimens have been observed, neither of them possessing more of the filament than is given in the figure, which, however, may fairly be assumed to represent a perfect portion. Commencing with the frustule, where division takes place, it may be compared to two decanters soldered together at their mouths. The parts representing the bodies are ornamented with punctiform cellules, arranged in close parallel lines as far as the shoulders, where a sudden contraction in the diameter occurs, forming the neck of each decanter, and which is quite smooth, while the resemblance to the rim of the mouths is carried out by the sudden expansion of the neck into a rather broad disc, equal in its lateral diameter to that of the frustule at the opposite ends. This ring-like disc is marked on its circumference by a deeply indented, rather faint line, somewhat like that which is produced by the meeting of the teeth in cog-wheels, and which, of course, suggests the idea of separation; but I have been unable to ascertain whether this be really the case. On the other hand, the suture at the broad ends of the frustule is conspicuous. Length of frustule ·0040″; diameter ·0010″.

## COSCINODISCUS.

*Coscinodiscus splendidus*, n. sp., Grev.—Disc large, convex; cellules large, hexagonal, all equal except those of the outer row, which are generally more or less oblong; margin quite smooth. (Fig. 3.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

A most beautiful species, and not very rare in some portions of the sample of the deposit which has furnished so many good things; for it is a curious circumstance, and not uninstructive to those who may be engaged in examining this deposit, that even in the same small lump one part will often be found richer than another. Of all the slides mounted by my indefatigable friend (and their name is legion) from one and the same general sample, a proportion only contain the species now described; and, in like manner, a number of other fine forms appear to be most unequally distributed. It was my friend's custom to chip off and clean a piece of the indurated earth from time to time, and, unaccountable as it may seem, these successive experiments often brought species to light previously unobserved, and sometimes never seen afterwards, the same cautious system of investigation being pursued in all cases. It may be remarked that, as a general rule, those examples of the deposit which are of a chalky or light density are poor in diatoms, while they are sometimes rich in polycystins; but it by no means follows that the converse prevails. This Mr. Johnson, Mr. George Norman, and myself, have ascertained to our cost. To the courtesy of his Excellency James Walker, Governor of Barbadoes, I have been indebted for a box of specimens from various localities in the island, and Dr. Mouat most kindly supplied me with another large collection; and although a number of these came from the Cambridge estate, and bore a close outward resemblance to the solitary precious sample received by Mr. Johnson, not one of them repaid the trouble of cleaning. Mr. George Norman likewise examined an equally extensive series of specimens transmitted to him last year, and very promising in appearance, but with no better result. Many specimens, when prepared for examination, are found to be composed, as far as organic remains are concerned, of the mere pulverized débris of diatoms and polycystins; others may contain débris less broken up, with possibly a few entire discs of one or two species. Others, again, are more productive, and the most rich in every sense are those in which the heavier diatomic forms prevail; a fact which seems to be connected with the law of gravitation at some period in the history of the formation of the deposit. But some additional causes seem to have been at work relative to the polycystins; for while diatoms occur most abundantly in certain of the more compact and heavy parts of the deposit, polycystins are more copious and perfect in some of the lighter parts; and, although the two orders are more or less intermingled, those parts in which one order is developed most abundantly, both in number of species and perfection of structure, are deficient in the other. The deposit is said to be very extensive, and to be of great thickness. It is to be regretted that no memoranda have accompanied the specimens transmitted to this country, regarding their relative position in the deposit, &c. Nothing but a careful examination on the spot, along with a diligent use of the microscope, will suffice to clear up the difficulties we labour under on the whole subject.

*Coscinodiscus splendidus* is exceedingly similar in general appearance to *Cresswellia superba*; so similar, indeed, that if the spines of the latter happen to be out of focus, the one might be readily taken for the other. But a closer examination shows that, apart from the spines, the irregularity of the outer row of cellules is characteristic of the *Coscinodiscus*, as also the much narrower margin. The diameter is variable, but fine examples, like the one figured, are about ·0050.″ Number of cellules scarcely 4 in ·001″

*Coscinodiscus Macraeanus*, n. sp., Grev.—Disc large, slightly convex, with large, equal, hexagonal cellules, and with a broad hyaline border, having a narrow line next the cellules, giving off remote, radiating, clavate processes. (Fig. 4.)

*Hab.* Indian ocean; Dr. Macrae.

In size this fine species is equal to the last, while the cellulation is somewhat smaller. As in the preceding also, the cellules being regularly hexagonal, there is no radiant arrangement, the structure resembling a uniform piece of network. The characteristic feature of the species lies in the row of brilliant, coloured, clavate processes given off by a narrow line which constitutes the boundary of the cellulation. Diameter of disc ·0050″. Cellules 5 in ·001″.

## PORODISCUS.

*Porodiscus splendidus*, n. sp., Grev.—Disc circular (occasionally broadly oval), very convex, with a large umbilical pseudo-opening; structure a radiating reticulate cellulation. (Fig. 5.)

*Hab.* Barbadoes deposit, Springfield estate; Laurence Hardman, Esq.

One of the finest species of the genus, distinguished at once by the larger and more lax cellulation. It is remarkable that it should never have occurred in specimens of the deposit brought from the Cambridge estate, in which all the other species have occasionally been found. *P. oblongus* is common to both, though chiefly associated with our present new species. The diameter of the disc is 0030″. Radiating cellules about 8 in ·001″.

I take the present opportunity of stating that I have recently met with several discs of *Porodiscus major* ('Trans. Mic. Soc.,' Vol. XI), all more or less imperfect, but which show the size to be not less than ·0045″ in diameter. The pseudo-opening varies in size, and so does the degree of sparseness of the granules in the central portion of the disc. I beg to offer the following amended character:

*P. major*; disc circular, very large and convex; the radiating puncta very minute, brilliant, more or less remote for some distance round the pseudo-opening, afterwards close, with faint rays formed by pairs of the longest lines. Diameter ·0045″.

### LIRADISCUS.

*Liradiscus minutus*, n. sp., Grev.—Frustule minute, nearly sphærical. (Fig. 6.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

This will be recognised at once by its small size, the diameter being only from ·0007″ to ·0010″. When viewed in front it is exceedingly like a *Cresswellia*, except in the connecting zone.

### ARACHNOIDISCUS.

*Arachnoidiscus Grevilleanus*, n. sp., Hardman MS.—Disc with the concentric circles of the cellules continued uninterruptedly to the centre, the umbilical point being filled up with a rosette of a few very minute linear cellules. (Fig. 7.)

*Hab.* Barbadoes deposit, Springfield and Cambridge estates; Laurence Hardman, Esq.; C. Johnson, Esq.; R. K. G.; rare.

The few species of this exquisite genus are in such confusion that I cannot venture at the present moment to disentangle them. It is doubtful how far the characters by which they are distinguished are really of value. Possibly some mistakes may have originated in consequence of differences between the upper and under valves having been overlooked. The granules (or cellules) which surround the umbilicus are subject to great variation; and the number of radiating ribs, both long and short, appear to depend on the size of the valve. With regard to the species now under consideration, on which my friend Mr. Hardman has done me the great honour to bestow my name, it differs so essentially from every other so-called species that I cannot hesitate to admit it. It does not even correspond with the definition of the genus itself, which attributes to the disc a "central hyaline nodule or umbilicus." In our new diatom there is not the remotest trace of anything of the kind. The long radiating ribs penetrate nearly to the centre, where the cellules begin to lose their concentricity, and to become gradually smaller, the central point itself being occupied by a little star composed of about six very minute, linear, truncate cellules. It is satisfactory that specimens should have been obtained from different sources: from the deposit of the Springfield estate, by Mr. Hardman; from that of the Cambridge estate, by Mr. Johnson and myself. It appears, however, to be extremely rare. The diameter is upwards of ·0050″; but, as in the other species, the size is probably exceedingly variable. *A. ornatus* is sometimes very small; but I have a disc before me ·0200″ in diameter, belonging to Mr. Hardman's cabinet.

### CESTODISCUS, n. gen., Grev.

Frustules disciform (circular or oval); disc with radiating granules or cellules, and a submarginal circle of obtuse processes unconnected by means of special radiating lines of cellules with the centre.

The diatoms which I propose to comprehend under this name would be *Aulacodisci* if any communication existed between the processes and the centre of the disc. But no such communication does exist, and the question consequently arises whether they ought to be united with *Eupodiscus*, of which *Aulacodiscus* itself, according to Kützing, is only a section, or kept altogether apart. Taking *Eupodiscus* as it stands, it is anything but a natural genus, and the time is probably not far distant when the non-radiant species, at least, furnished with mastoid processes similar to those of *Auliscus*, will be grouped into a distinct genus. Looking, then, upon *Eupodiscus Argus* as the type of that genus, I cannot bring myself to do such violence to nature as to place the beautiful little discs now under consideration beside it. At the same time I honestly confess that the best generic character I can frame is weak, and I can do little more than rest for the present upon the natural feature unknown among the *Eupodisci* of numerous equidistant intramarginal processes.

*Cestodiscus Johnsonianus*, n. sp., Grev.—Disc small, circular, with subremote lines of radiating granules of various lengths, passing suddenly towards the margin into a band of minute puncta; processes very numerous. (Fig. 8.)

*Hab.* Moron deposit, in the Province of Seville; C. Johnson, Esq.; R. K. G.

A small, pale diatom, apparently extremely rare, as Mr. Johnson and myself have only found one specimen each. At first sight it would pass for an unquestionable *Aulacodiscus*; but, as its excellent discoverer remarked, there are positively no channels of communication, nor special parallel lines of granules, between the processes and the centre. I have given these discs the most careful examination, and can certify the correctness of my friend's statement. The processes are arranged without any reference to the longer lines of granules, or, indeed, to any lines at all. There is no umbilicus, but a few irregular granules before the radiation commences. The lines are not crowded, and the shorter ones which come in to fill up the disc leave little open spaces. Towards the margin the lines suddenly disappear in a belt of close, minute, radiating puncta, in which the processes are situated, nineteen in number, on little roundish vacant spaces, as is often seen in the *Aulacodisci.* Diameter ·0032″.

*Cestodiscus* (?) *ovalis,* n. sp., Grev.—Disc from broadly oval to narrow elliptical-oblong; radiating granules spherical, passing into a crowded band of smaller granules, which is succeeded by fine striæ and the circle of processes. (Fig. 9.)

*Hab.* Moron deposit; Rev. T. G. Stokes; R. K. G.

I have not been able to satisfy myself regarding the precise nature of the processes in this species. They are evidently not so like those of *Aulacodiscus* as in the preceding diatom, but they are not spines. The disc is not furnished with a regular umbilicus, although there is often a small, irregular, blank space. The granules radiate very irregularly, and terminate suddenly at the commencement of the band of the smaller ones. The latter form an uneven outer line, from whence the fine striæ are continued to the margin. The number of processes is about twelve or fourteen. In size and relative proportion the disc varies greatly, being sometimes quite narrow. The specimen figured is a very fine one, ·0030″ in length. In order to bring out the characters more clearly I have magnified both the species of this genus 600 diameters.

## BIDDULPHIA.

*Biddulphia sinuata,* n. sp., Grev.—Valve very minutely punctate, sinuate, with a two-lobed median elevation and a group of spines in the centre of each lobe; processes rather long, capitate. (Fig. 10.)

*Hab.* Bardadoes deposit, Cambridge estate; extremely rare.

Unfortunately the only part of the frustule which I have seen is the valve, which, however, is of the chief importance, and in the present instance affords such valid characters that no doubt can be entertained on the subject of the diagnosis. It is manifest at a glance that the species it most closely approaches is *B. pulchella;* but its affinity lies only in the contour of the valve. The differences are remarkable and instructive, showing how very nearly one species may resemble another in one aspect, while in every other it is removed to a distance. Instead of being conspicuously cellulate, as in *B. pulchella*, the structure of our new species is extremely close and very minutely granulate or punctate. The median elevation, in place of being simple, with concentric cellules and centrical spines, is 2-lobed, with a little cluster of spines in each, and the processes are more slender, prolonged, and capitate. The length of the valve before me is ·0047″; but the size probably varies, as in other species of the genus.

*Biddulphia elegantula*, n. sp., Grev.—Very minutely punctate; valve, as seen in the front view, with the angles produced into very slender, rectangular, slightly capitate horns, not swollen at the base; median elevations 1—5, central one large, with 1 or 2 spines. (Figs. 12—14.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

The nearest ally of this species is *B. Tuomeyii*, from which it differs in the almost filiform horns, not inflated at the base, and which form a right angle with the base of the valve, as in *Hemiaulus*. The puncta of the whole structure are also more minute. As in *B. pulchella*, *Tuomeyii*, &c., the number of median elevations is variable. How this is to be accounted for is a problem at present unsolved. Does the frustule represented at fig. 12 ever arrive at three median elevations, or at five, as in fig. 13? We can scarcely venture to maintain that the most perfect cell before us arrived at its present condition without passing through the stages characterised by one and three median elevations; yet, on the received theory, diatoms increase in size only in a direction parallel with the suture. It appears that we are driven to the conclusion that there must be a law of development in this order, the operation of which has never yet been traced. Length of valve, showing five elevations, ·0045″.

*Biddulphia inflata*, n. sp., Grev.—Large; valve in front view produced at the angles into very thick, short processes, rectangular on the outer, beveled off on the inner side, and broadly truncate on the top; median surface undulate, with slight elevations, divided by costæ extending very little below the surface. (Fig. 15.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

I do not think that the true philosophical naturalist will blame me for making known these reliques of an ancient life because they may not be in the perfect condition we should look for in recent species. At the same time, while we hold that some allowance ought to be made for the treatment of genuine fosssil organisms, it would be very rash, unless in extreme cases, to introduce objects whose nature and position is a question of mere speculation. Few things have interested me more, in the course of the searching investigation now carried on for several years, than the variation of form and structure exhibited by diatoms evidently belonging to the *Biddulphia* and *Hemiaulus* groups. Of most of these the valves alone have been discovered, presenting only the front view; still, the characters are so prominently brought out that the family connection is undoubted, and a variation in the organs displayed, of which we had no previous conception.

The eccentric-looking diatom now before us is totally unlike any recent species. The substance is smooth and hyaline, with thinly scattered spherical granules, which become more numerous and prominent on the processes. The latter are enormous in proportion to the rest of the valve, being each of them ·0014″ thick; the upper part is thickly studded with minute puncta. Five slight convexities are found in the median space, separated by costæ, which disappear just below the surface. Length of the valve figured ·0075″.

*Biddulphia corpulenta*, n. sp., Grev.—Large; valves in front view with the angles produced into short, thick, conical, obtuse processes, having a shoulder on their inner side; median surface convex, with slight elevations, separated by costæ reaching nearly to the suture, and bifid at their extremities. (Fig. 16.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

Another very extraordinary species, smooth and hyaline, with a few remotely scattered, faint puncta, and a close cluster of more minute puncta at the apex of the processes. The ends of the valve are not rectangularly straight, as in the preceding, but undulate. The costæ are bifid at their base near the suture; the apices divaricate and slightly incrassated, showing a curious affinity with *Porpeia*, in which the costæ are curved inwards and the ends thickened. The general appearance of the valve also approximates in some degree to some of the *Porpeiæ*.

*Biddulphia tenuicornis*, n. sp., Grev.—Valve, as seen in front view, somewhat quadrangular, the angles produced into erect, long, almost filiform, obtuse horns; median space furnished with three long spines, one centrical, and one before each of the horns; structure very minutely punctate. (Fig. 17.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

Not having seen the upper surface of the valve, I am unable to speak with certainty as to the precise situation of the spines; but as all the specimens I have seen were alike, there would appear to be only three spines, and, as far as I can judge, two of them are exactly opposite the horns. From the singular angularity of the front view, it is not improbable that the top may be flat, as in *B. Baileyi*. Length of the valve, ·0030″; length of horns, ·0018″.

*Biddulphia nitida*, n. sp., Grev.—Small, punctate; valve in front view showing the horns to be produced considerably within the angles; horns elongated, erect, swollen and punctate at the base, somewhat capitate and curved outwards at the apex; median space convex. (Fig. 11.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

A single but quite perfect frustule has only been discovered. The characters are very decided. The surface is conspicuously punctate, appearing almost rough. The connecting zone smooth, as well as the horns above the swollen base. Breadth of frustule ·0022″.

### PORPEIA.

This genus, established by Professor Bailey, appears to be well founded. The incurved costal plates are probably never more than two in number, and in the new species about to be described assume a very peculiar and marked character.

*Porpeia quadriceps*, Bail.—(Figs. 18, 19.) Ralfs, in 'Brit. Inf.,' 1861, p. 850, pl. vi, fig. 6.

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; rare.

Frustules rectangular, minutely punctate; the angles of the valve produced into rounded capitate processes, the head of which is either supported on a short thick neck, or does not entirely rise above the level of the median space, as in Professor Bailey's drawing. This space, in small specimens, forms a simple arch, giving off the curved costæ at, or close to, the angle, and in larger specimens an arch in the middle, while the space between the arch and the processes is nearly straight. In such cases the curved costæ are given off at the commencement of the arch.

Being under an impression that the diatom I have now figured may be the species proposed by my late friend Professor Bailey, I have refrained from separating it. At the same time it is necessary to remark that the figure engraved from his drawings in Pritchard's 'History of Infusoria' does not correspond with any specimens in my cabinet. One error (if it be one) lies in the curved costæ being made nearly twice as long as they ought to be. This character is very constant. Another error consists in the processes being made to rise but little above the level of the median space, whereas in all my specimens the line commences at the contracted neck, leaving the heads of the processes quite clear. I have thought it right, in the mean time, to include Bailey's diatom (or rather the figure from his drawing) in my few words of description; but it is quite possible that the two may be distinct, and indeed highly probable, if the Gulf-stream diatom should prove to be a living species.

*Porpeia quadrata,* n. sp., Grev.—Valve, as seen in front view, forming nearly a parallelogram; the angles rounded, very slightly produced; median space nearly straight, the costæ descending vertically at the inner angle of the processes, and then curving inwards and approximating, but not quite parallel with the suture. (Fig. 20.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

It is very interesting to find the leading character of the genus so conspicuously carried out in this and the following species. The substance is hyaline, and, with the exception of a row of very minute marginal puncta in the nearly straight median space and at the apex of the processes, and a very few larger ones scattered near the curved plates, the surface is smooth. Length of valve ·0035″; but this is a variable character.

*Porpeia ornata,* n. sp., Grev.—Frustule forming a parallelogram; valve in front view punctate, produced at the angles into very slightly convex processes, rounded at the corners; median space quite straight, the costæ taking an outward curve, then becoming exactly parallel with the suture, and approximated at their apices. (Fig. 21.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

A beautiful species, which, when first observed, a couple of years ago, puzzled me exceedingly. Several examples have occurred since, and there can be no doubt now regarding its true position. Length of valve in the finest specimen discovered ·0040″.

### HEMIAULUS.

*Hemiaulus symmetricus,* n. sp., Grev.—Valve in front view produced at the angles into linear horns, sharply truncate at the top, and tipped with a single spine; structure cellulate, the cellules somewhat quadrate, arranged in transverse lines, rather larger in the series forming the slightly concave median space, becoming punctiform in the horns. (Fig. 22.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

This bears some relation to the exceedingly variable *H. Polycystinorum;* but the uniformity of the cellulation, the form of the cellules themselves, and the total absence of elevations and of transverse costæ in the upper surface of the valve, have led me to separate it. Length of valve ·0040″.

*Hemiaulus ? ? robustus,* n. sp., Grev.—Valve in front view exceedingly minutely punctate, produced at the angles into broad, elongated, incurved horns, dilated and rounded and turned outwards at the apex, and having a row of puncta down the inner margin; median space concave, with a small central elevation. (Fig. 23.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

This, of course, is not a genuine *Hemiaulus;* and I only introduce it as another of the highly curious series of forms belonging to the family which the patient researches into the Barbadoes deposit have brought to light. It is evidently allied to some of those already published in the 'Transactions' of the Society. I have elsewhere remarked that these papers can only be regarded as miscellaneous contributions to our knowledge of diatoms; and, with regard to such subjects as those now before us, unless some record were made of their existence, science would be none the better for their discovery. Other naturalists will now be enabled, under more favorable circumstances, to take up the subject where I may be compelled to abandon it. It is already obvious, I think, that Heiberg's proposed new family of *Hemiaulideæ* will, if it can be established at all, require considerable revision. The length of the valve of *H. ? ? robustus* is ·0020″; the length of the horns ·0030″.

*Hemiaulus ? ? capitatus,* n. sp., Grev.—Valve in front view hyaline, smooth, the angles produced into erect, thick, inflated horns, with large spherical heads; median space with a large centrical spherical process, supported on a short neck. (Fig. 24.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

It will not do to speculate too boldly on the immediate affinities of this very distinct diatom; so far only can we speak with confidence when we refer it either to the *Biddulphieæ* or the *Hemiaulideæ.* The apex (or articulating surface) of the horns is very minutely punctate. Length of valve ·0017″; length of horns ·0013.

### TRICERATIUM.

*Triceratium Hardmanianum*, n. sp., Grev.—Large; valve with straight sides and subacute angles; central space filled up with a somewhat hexagonal figure, extending to the margin, and furnished with radiating puncta and imperfect radiating costæ; within this is a triangular figure, having a large spine in the centre surrounded by a circle of smaller ones; angles within, furnished with puncta and vein-like lines and indistinct pseudo-nodules. (Fig. 25.)

*Hab.* Barbadoes deposit, Springfield estate; extremely rare; Laurence Hardman, Esq.; Professor Hamilton L. Smith.

One of the rarest and most beautiful species of the genus, and as such, I have the more pleasure in bestowing upon it the name of its finder, Laurence Hardman, Esq., of Rock Park, Birkenhead, to whom I am indebted for one of the only two specimens he has hitherto met with. From a drawing kindly transmitted to me by my eminent correspondent, Professor Hamilton L. Smith, of Kenyon College, Gambier, Ohio, it is evident that he also must be associated in the discovery. Like another diatom of the present series, *Porodiscus splendidus*, it has only occurred in samples of Barbadoes deposit brought from Springfield estate. The sculpture of the valve is exceedingly rich and varied. In the centre we have, enclosed in a small well-defined triangle, a strong spine with a circle of small ones, and a few intermingled puncta. This triangle is surrounded by a broad, somewhat hexagonal band, filling up so much of the body of the diatom as nearly to cut off the angles. From the outer margin of this band a number of costæ of different lengths are given off to the interior, none of which reach the inner boundary. The angles are filled with roundish cellules rather unequal in size, and faint, anastomosing, vein-like lines. Distance between the angles ·0040″.

*Triceratium pauperculum*, n. sp., Grev.—Minute; valve with straight sides and rounded angles; surface with a few remote scattered puncta; margin with short broad striæ; angles cut off by a transverse line, forming pseudo-nodules very minutely punctate. (Fig. 26.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

A small portion only of the angle is cut off by the transverse lines, and that portion, called a pseudo-nodule in the lateral view, forms in the front view a projecting process or short horn. Distance between the angles ·0016″.

*Triceratium trilineatum*, n. sp., Grev.—Minute; valve with nearly straight sides and subobtuse angles; structure composed of very minute radiating puncta, and a dark line extending from the centre to the middle of the margin on each side; within the raised angles a minute obscure pseudonodule. (Fig. 27.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Substance rather thin and delicate; area of the valve somewhat concave, the circular outline of the concavity leaving the angles a little raised. The three dark radiating lines seem to consist of a few closely approximating, slightly elevated rows of cellules.

## DICLADIA.

*Dicladia? Barbadensis*, n. sp.—Large; valves conical, each produced into two elongated, robust, diverging horns. (Fig. 28.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

In the extremely robust habit, and in both the valves being nearly equally developed into long horns, this diatom differs from the *Dicladiæ* generally. In the present example, it is true, one valve is more developed than the other, indicating perhaps an approach to the usual condition of the genus, where the processes of one of the valves are nearly or wholly abortive. But in another specimen the horns of each valve are nearly equal. Conspicuous puncta, or rather prominent granules, are scattered in groups on the valves and lower parts of the horns; but this, I apprehend, is an inconstant character. Breadth of the frustule ·0020″; length, including both valves, ·0060″.

## GONIOTHECIUM.

*Goniothecium prolongatum*, n. sp., Grev.—Valves narrow-oblong, extending at each end into a filiform continuation twice as long as the middle portions; the latter conjoined by two minute processes. (Fig. 29.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Distinguished at a glance by the long, linear, filiform, truncate, and parallel terminations of the valves, which do not become in the least degree connivent.

## Pinnularia.

*Pinnularia Hartleyana,* n. sp., Grev.—Large; valve broadly linear, somewhat inflated in the middle and at the rounded ends; costæ radiate, leaving a wide median space, as well as a transverse fascia extending to the margin. (Fig. 30.)

*Hab.* In a sluggish stream at Cavalla, Liberia; Rev. Benjamin Hartley.

A splendid new species, belonging to a small section of the genus characterised by the transverse smooth fascia in the middle of the valve. It is longer, although less robust, than *P. cardinalis,* and is remarkable for much narrower striæ than are found in the larger *Pinnulariæ,* the number being about 20 in ·001″. The length of the frustule is ·0090″; breadth in the middle ·0013″.

For the gathering containing this fine diatom I am indebted to the kindness of my friend the Rev. Benjamin Hartley, now resident in Liberia. It is associated with *Synedra biceps, Nitzschia obtusa, Pinnularia mesolepta, Himantidium gracile, Navicula crassinervia, Eunotia diodon,* &c. I trust that the success which has attended his first collection in Liberian waters will induce him to continue his researches.

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# *On the* Structure *and* Affinities *of the* Polycystina.

By G. C. Wallich, M.D., F.L.S., &c.

(Read May 10th, 1865.)

Although our knowledge of the characters and true position in the animal kingdom of the Rhizopods has of late years been largely augmented through the combined labours of both Continental and British naturalists, it is a singular fact that the *Polycystina,* so long regarded by the microscopist as favorite objects, should have been, comparatively speaking, neglected; and that, up to the present period, no attempt should have been made to reduce the family, *as a whole,* to anything like systematic order.

It shall be my endeavour, on the present occasion, to perform this task to the best of my ability. But I would take the opportunity of stating at the outset, that it forms no part of my purpose to describe species. I shall accordingly restrict myself to indicating what appears to me to be the natural position of the *Polycystina* amongst the other

Rhizopods; to describing their plan of development and (so far as I know) their mode of reproduction; and, lastly, to pointing out how the rudimentary siliceous skeleton of this family may be rendered available for its classification on a natural system.

In order to accomplish these objects, however, it becomes imperative on me to review the various systems heretofore proposed in classifying the Rhizopods, and I shall strive to do so as briefly as is consistent with the necessity for an explanation of the grounds on which I seek to effect a modification of these systems; and, amongst other changes, to remove the Polycystina to a lower position in the series than has heretofore been assigned to them.

To the late Professor L. Müller, of Berlin, is due the credit of having established the true nature of the *Polycystina.* In his admirable memoir '*Uber die Thalassicollen Polycystinen und Acanthemetren des Mittelmeeres*' (published in 1858) they are associated, as stated in the title, with two other families, under the designation of the "Rhizopoda Radiaria seu Radiolaria." The definitions, as found in the above work (pp. 16, 17), are as follows:

*Rhizopoda Radiaria seu Radiolaria.*

A. Solitary. *Radiolaria solitaria.*
  1. Without shell; with or without siliceous spicules. *Thalassicollina,* restricted to *Thalassicolla.*
  2. Animal enclosed in a siliceous foraminated shell. *Polycystina.*
  3. Animal naked, with siliceous radiate spines. *Acanthometrina.*

B. Compound. *Radiolaria polyzoa.*
  4. Naked, or with siliceous spicules. *Sphærozoidæ, Sphærozoum.*
  5. Enclosed in a siliceous foraminated shell. *Collosphæridæ.*

As I shall have occasion to state my views regarding the expediency or otherwise of accepting variations in the characters of the pseudopodia as distinctive of the Orders into which the Rhizopods are divisible, I would merely observe, at present, that, under the system thus constructed, the *Polycystina* which have no nucleus, are associated with two families which possess this organ in a highly developed degree. And further, that, in consequence of the unguarded

*List of Errata, to be appended to Dr. Wallich's Paper on the Polycystina, which appeared in the July number.*

Page 58, line 17, for "Acanthemetrina," read "Acanthometrina."

,, 60, ,, 27, for "whether," read "both."

,, 64, over words "Protodermata" and "Proteina" respectively, insert numerals "II" and "III."

,, 64, insert terms "monomorphous" and "polymorphous" respectively under the word "pseudopodia," which occurs twice.

,, 66, line 16, for "to," read "of."

,, 69, ,, 11, for "classifications," read "classification;" line 13, for "these," read "their."

,, 71, line 24, for "Encyrtidium," read "Eucrytidium,"

,, 72, ninth line from bottom, for "conditions," read "condition."

,, 73, line 11, for "Monastb.," read "Monatsb."

,, 75, ,, 14 and 15, for "tubular; *throughout*," read "*tubular* throughout."

,, 81, ,, footnote, for "Polycystine," read "Polycystina."

,, 84, above word "Sub-families," insert the word "CYCLODINA," and under the word "asymmetrical," insert the word "MONODINA."

,, 232, fifth line from bottom, for "F.R.S.," read "F.L.S."

manner in which the term "*nucleus*" has been employed, in Müller's work, to signify a portion of the structure totally distinct from that to which it usually, or indeed legitimately, applies, not only has his classification been impaired, but, on his authority, has an error been promulgated by other writers, the importance of which can hardly be over-estimated. For, if it be admitted, as I presume is the case, that physiological advance is deducible from the gradually increasing complexity of a creature's organization, the presence or absence of such an appendage as the nucleus must necessarily be regarded as of higher significance than the degree of frequency with which the pseudopodia coalesce, or the form these processes assume when projected beyond the general mass of sarcode.

The next important addition to our knowledge of the Rhizopods is contained in the work of MM. Claparéde and Lachmann ('*Etudes sur les Infusoires et les Rhizopodes,*' published at Geneva almost immediately after the appearance of Müller's memoir. According to these writers, the Rhizopods may be arranged as follows:

| | | | | |
|---|---|---|---|---|
| Neither calcareous test nor multiple foraminated chambers. | Pseudopodia rarely inosculating with each other. | Siliceous spicules absent. No yellow cellules. | PROTEINA. | *Amœba.* *Actinophrys.* |
| | | Siliceous spicules present. Yellow cellules present. | ECHINOCYSTIDA | *Acanthometra.* *Thalassicolla.* *Polycystina.* |
| | Pseudopodia forming numerous inosculations with each other. | | Gromida | *Gromia.* |
| Test generally calcareous, and constituting several chambers; but at times single. Its walls pierced with multitudinous minute apertures. | | | Foraminifera | *Monothalamia.* *Polythalamia.* |

In this system, in which we have presented to us the first really comprehensive view of the principal Rhizopodal families, there occur some striking peculiarities. To these must be accorded more than a passing notice, inasmuch as they involve not only characters but conclusions somewhat at variance with what is known of the organisms to which they relate.

Thus, although the invariable absence of a calcareous test may undoubtedly be said to characterise the primary division, it involves the separation of the *Foraminifera* from the whole of the other Rhizopods, and hence, from the *Polycystina,* the animal of which I hope to be able to show is identical, in every essential respect, with that of the former family. Whilst the presence or absence of closely foraminated ("*multiple poreuses*") chambers, even did it afford a distinction between the two families, ought no more to be regarded as proof of their physiological distinctness from each other, than the composition of the test in *Gromia* (supposing no valid ground for such separation to exist, as in reality does exist) can be accepted as a sufficient reason for separating it from the *Foraminifera.*

Again, whilst the greater frequency with which the pseudopodia inosculate might, at first sight, be regarded as distinguishing the *Gromida* from the *Amœbina,* it likewise removes them from the *Actinophryna,* in some of the genera belonging to which this property is by no means rare. It will be seen hereafter that, although I follow MM. Claparéde and Lachmann in placing *Gromia* apart from the *Foraminifera,* I do so on totally distinct grounds from those named by them, namely, in consequence of my having detected in that genus the presence both of a nucleus and contractile vesicle.

With regard to the distinguishing character said to be furnished by the "yellow cellules," I may observe that bodies, which I believe to be identical with them in origin and office, have been met with by me in all the Rhizopods, whether marine and fresh-water. In such of the fresh-water genera as have exhibited them the yellow colour is absent. But when we take into consideration the fact that tints, varying from the most brilliant crimson to shades of olive-brown and brilliant yellow, are constantly met with in the sarcode of the oceanic forms, and that these tints apparently vary with varying conditions of the same species, if not actually of the same individual, we may rather look on the colour of the so-called cellules as being immaterial, than as affording a valid distinguishing feature in their structure. In the *Foraminifera* they have been very generally noticed. In the *Acanthometrina, Thalassicollina,* and *Polycystina,* they constantly occur, and also in two new families of which I shall have to speak hereafter. But they are present also in the *Amœbina* and *Actinophryna,* although, as already stated, destitute of colour in these genera; the reason for assuming their identity in the latter case with the "yellow cellules," being that evidence exists in both cases to show that, wherever present, these bodies constitute the rudiment of the young organism.

Of Professor Schultze's classification of the Rhizopods, as set forth in his treatise '*Uber den Organismus der Polythalamien* (Foraminiferen),' Leipzig, 1854, it is only requisite to state that I entirely concur with Dr. Carpenter in considering any Ordinal division based on the presence or absence of a "test" as altogether untenable; and that throughout the elaborate work in question the occurrence of a nucleus in the *Foraminifera* is wholly negatived. Carpenter affirms with perfect truth that no such organ is to be found in this family. I am inclined to believe, however, that, whilst the bodies called "yellow cellules" are only *derived* from the nucleus in the two higher Orders, in the lower they normally constitute its representatives. It will presently be seen that on the possession or otherwise of the organ, in a definite form, I base my Ordinal separation of the Rhizopods.

There is a very voluminous monograph on the "Radiolarian" Order of the Rhizopods,* allusion to which would gladly have been avoided by me, inasmuch as the views regarding specific limits therein contained seem calculated rather to retard than to advance our knowledge of the organisms of which it treats, by attaching weight to those minute and endless structural differences which, occurring amongst creatures so simple and therefore so pre-eminently susceptible to varying external influences, yield characters of no real significance. It is obvious, moreover, that in a work based on such an estimate of all these minute differences we must expect to find the nomenclature of the subject, already sufficiently perplexing and cumbrous, rendered doubly so by the introduction of a host of new names; whilst the task of extracting whatever novel information it contains would involve a degree of labour few persons have the inclination, and still fewer the leisure, to bestow upon it.

In saying this much, I most earnestly disclaim all intention of speaking uncourteously, for no one can be more deeply impressed with the almost unparalleled amount of industry the author has brought to bear on his undertaking—industry misdirected, it is true, but nevertheless most laudable.

The last, and, as I conceive, by far the most important classification of the Rhizopods, is that recently offered by Dr. Carpenter, an abstract of which originally appeared in the 'Natural History Review' (Oct., 1861, p. 456), but which has been more fully given in "*The Introduction to the Study of the Foraminifera,*' published by the Ray Society. Of this work, and of another on the same subject by Professor Williamson,

* 'Die Radiolarien (Rhizopoda Radiaria'). Von Dr. Ernest Haeckel. Berlin, 1862.

also published by that society, I speak with reverence, for from the enlarged views pervading the writings of these two authors has been gleaned much of the knowledge I have endeavoured to turn to account whilst completing a study of organisms to which, in a living condition, they have not had access.

"It is in the structural and physiological condition of the *animal,*" says Dr. Carpenter, "that we should look for the characters on which our primary subdivisions should be constituted;" and in pursuance of this proposition he informs us that, notwithstanding "the extreme simplicity and apparent vagueness of these conditions, a careful scrutiny will make it clear that, under their guidance, lines of demarcation may be drawn as precise as in any other natural group, between three well-known types, *Amœba, Actinophrys,* and *Gromia;* the sarcode bodies of these three types presenting three distinct stages of differentiation of the protoplasmic substance of which they are composed, and exhibiting, in virtue of that differentiation, three very distinct modes of vital activity." ("*On the Arrangement of the Rhizopoda,*" by Dr. Carpenter, 'Natural History Review,' Oct., 1861, p. 460.)

The classification based on these three primary types will readily be understood on reference to the subjoined table, quoted from 'The Introduction to the Study of the Foraminifera,' (p. 17).

RHIZOPODA.

| LOBOSA. | RADIOLARIA. | RETICULARIA. |
|---|---|---|
| *Amœbina.* | *Actinophryna.* | *Gromida.* |
| | *Acanthometrina.* | *Foraminifera.* |
| | *Polycystina.* | |
| | *Thalassicollina.* | |
| INFUSORIA. GREGARINIDA. | SPONGIADA. | PROLOPHYTA. |

Whilst the definitions of the three orders may be advantageously quoted as given in the abstract already referred to.*

* "1. RETICULARIA.—The body composed of homogeneous granular protoplasm, without any distinction into ectosarc and endosarc; neither nucleus nor contractile vesicle; pseudopodia composed of the same substance as the body, extending and multiplying themselves by minute ramifications, and inosculating completely wherever they come in contact; a continual circulation of granular particles throughout the viscid substance of the body and its extensions.

"2. RADIOLARIA.—Incipient differentiation of the protoplasmic substance into endosarc and ectosarc, the former semifluid and granular, the latter more tenacious and pellucid; a nucleus and contractile vesicle; pseudopodia rod-like, usually tapering from base to point, composed of same substance as the ectosarc, exhibiting little disposition to coalesce or ramify, having a more or less regular radiating arrangement, and not showing any constant circulation of granules in their substance, although a movement of particles adherent to their exterior is often to be distinguished.

Now, subscribing as I do, in the fullest sense, to the doctrine that we must look to the structural and physiological conditions *of the animal alone* for those characters on which we are to base our primary subdivisions, it would, indeed, be somewhat singular that I should have arrived at results differing materially from those arrived at by Dr. Carpenter, were it not the case that in nearly every instance in which our opinions come into collision, his deductions are based on data furnished by the observations of others, and not on his own personal experience. It is true, moreover, that our respective estimates of the value of certain characters also differ. But even this admits of explanation, inasmuch as the characters which I regard as surpassing in physiological as well as structural importance those selected by Carpenter, and on which I principally rely for the establishment of my system, are, in a great measure, new and original. It will be seen, however, that I have profited by his teaching in regarding the animal of the *Foraminifera* as belonging to the simplest Rhizopodal type; whilst, as established by him before the really complex nature of *Amœba* was pointed out by me,* this Rhizopod and its allies must be regarded as belonging to that type which is the most highly developed.

Having made these prefatory observations, and in order to admit of more ready comparison, I now submit, for the approval of those interested in the subject, a tabular view of the Rhizopodal families, arranged in accordance with the gradual evolutions of those organs which are held by me to constitute the only trustworthy *indices* of physiological and structural progress.

"3. LOBOSA.—More complete differentiation of the protoplasmic substance into endosarc and ectosarc, the former being a slightly viscous granular liquid, and the latter approaching the tenacity of a membrane; a nucleus and contractile vesicle; pseudopodia few and large, being in reality lobose extensions of the body, which neither ramify nor coalesce, having well-defined margins, and not exhibiting any movement of granules on the surface, the circulation in their interior being entirely dependent on the changes of form which the body undergoes as a whole."—*Loc. cit. supra*, pp. 466-7.

* 'On an undescribed Indigenous Form of AMŒBA,' by G. C. Wallich, M.D., 'Annals and Magazine of Natural History,' April, 1863. "Further Observations" on the same subject, *op. cit.* for May and June, 1863. "On the Value of Distinctive Characters in AMŒBA," *op. cit.*, August, 1863. "Further Observations on the Distinctive Characters and Reproductive Phenomena of the Amœban Rhizopods," *op. cit.*, November, 1863. "Further Observations" on the same subject, *op. cit.*, December, 1863; and, lastly, "On the Extent and some of the principal Causes of Structural Variation among the Difflugian Rhizopods," *op. cit.*, March, 1864.

RHIZOPODA.

| No definite nucleus. *No* contractile vesicle. | | Definite nucleus. *No* contractile vesicle. | | Definite nucleus. Contractile vesicle. | |
|---|---|---|---|---|---|
| 1. HERPNEMATA.* | | PROTODERMATA.† | | PROTEINA.‡ | |
| Shell never siliceous. | Skeleton invariably siliceous. | Skeleton solid. | Skeleton tubular. | Pseudopodia. | Pseudopodia. |
| FORAMINIFERA.<br>*Lieberkühnia ?* (Clap.)<br>*Pamphagus ?* (Bail.) | POLYCYSTINA. | PLAGIACANTHIDÆ.<br>ACANTHOMETRINA.<br>THALASSICOLLINA. | DICTYOCHIDÆ. | ACTINOPHRYNA.<br>*Actinophrys.*<br>*Gromia.*<br>*Lagynis.*<br>*Euglypha.*<br>*Cadium ?* (Bail.)<br>*Protocystis* (Wal.)<br>*Plagiophrys ?* (Clap.) | AMŒBINA.<br>*Amœba.*<br>*Difflugia.*<br>*Arcella.*<br>*Pseudochlamys.* |
| | | SPONGIDÆ. | | INFUSORIA. | |

* From ἑρπω, to creep, and νημα, a thread.

† From πρωτος, first or earliest, and δερμα, skin.

‡ This name is adopted from the classification of MM. Claparéde and Lachmann, inasmuch as the Order so designated comprises the two families whose affinities they recognised, although on grounds which appear to me of very minor importance as compared with those now adduced.

It will be seen that, in these definitions, all reference to characters derived from the degree of apparent differentiation presented by the sarcode mass and pseudopodia is rigidly excluded. This circumstance demands explanation.

Those acquainted with the physiological phenomena ascribed to the Rhizopods are well aware that processes similar in result, if not identical in their mode of operation, with those on which the life of the higher orders of animals depends, are stated to be observable. Carpenter's graphic description of these phenomena must, indeed, be familiar to every one. Nevertheless, it appears to me that we have been going a little too far in taking for granted all that has been asserted on the subject, and have allowed theory so far to take precedence of actual demonstration that lines of demarcation between the varying degrees of consolidation of the ectosarc, as compared with the endosarc, have been drawn, which further acquaintance with the Rhizopod proves to be untenable. In a paper such as this it is desirable to avoid all mere speculation. But the fact I am about to adduce seems of such importance as to warrant the conclusion that, although the Amœban and Actinophryan families do unquestionably incept solid food-particles, digesting and assimilating whatever portions are nutritious, and extruding the remainder, it by no means follows that all the lower families derive their sustenance after the same fashion. For, during many years' study of the *Foraminifera, Polycystina, Acanthometrina, Thalassicollina,* and *Dictyochidæ* (all pelagic Rhizopods), in their living condition, notwithstanding a keen look-out for an example, I have invariably failed to discover a single instance in which there was satisfactory evidence that solid matter had been taken into the substance of the body *as food.* This fact derives additional weight from the circumstance that some of these Rhizopods occur at times in immense numbers. It is difficult, therefore, to conceive how all should present themselves devoid of everything like solid incepted matter, were such matter essential to their sustenance. For it must be manifest that, as generally attributed to the Rhizopod, the processes referred to partake of the miraculous; and, what is particulary notable, that it is not amongst the highest members of the class that these processes seem to be carried on in the absence of organs wherewith to effect them, but in those lower types in which we have hitherto failed to detect a trace of such organs.

I am compelled, therefore, although by no means on this solitary ground, to dissent from Dr. Carpenter's views regarding the value to be assigned to the differentiation of the sarcode, and, in preference, to avail myself of the more readily demonstrable and constant criterion of physiological as well as structural advance, afforded by the presence or absence of one or both of the organs on which my primary divisions of the Rhizopods are based.

But although unprepared to regard the degrees of differentiation as applicable to the demarcation of *Orders*, or, indeed, as affording perfectly constant characters under any circumstances, there cannot be a doubt as to their affording, in the great majority of cases, a valuable means of completing our generic diagnosis. Beyond this their value does not appear to me to extend. And in support of this opinion I invite a comparison of the pseudopodial processes of the *Foraminifera, Polycystina, Amœbina,* and *Actinophryna,* as figured in the works of Schultze and Johannes Müller already referred to—more particularly to the appearances presented by the *Rotalian, Milioline,* and *Textularian Foraminifera* figured by the former observer—with some of the *Polycystina* figured by the latter, in order to show that between the pseudopodia of these two families which have been ranked in distinct Orders, principally on account of supposed differences in the disposition of the pseudopodia and the tendency of these processes to coalesce, if such differences were at all recognised, they have certainly not been sufficiently depicted in the figures referred to. A comparison may also advantageously be instituted between the characters of the pseudopodia of *Gromia* and *Lagynis,* as exhibited in Schultze's beautifully executed illustrations;* inasmuch as it will there be seen that whilst those characters are, in the case of *Gromia Dujardinii,* more Amœban† than Actinophryan in type, those of *G. oviformis* are quite as Radiolarian in type as those of *Lagynis,* which, already very doubtfully placed by Carpenter amongst the Gromida,‡ is proved to belong to the *Actinophryan* and not to the *Reticularian* type, by the presence of a nucleus and a contractile vesicle, which the latter never exhibit.

It will also be observed in Schultze's work (pl. i, fig. 7) that the Actinophryan type of *Lagynis* is still more completely demonstrated by its being figured as presenting a nucleus.

* 'Uber den Organismus der Polythalamien,' pl. i and vii.

† See figure of *Amœba porrecta,* as given in pl. vii, fig. 18, and *Amœba villosa* (Wall.), 'Annals and Magazine of Natural History,' 1864.

‡ Dr. Carpenter says, "It may be doubted whether this genus" (Lagynis), "first discovered by Professor Schultze, . . . . should be ranked as an aberrant type of the family *Gromida,* or should be removed to the *Actinophryan* group, the intermediate character of its pseudopodian extensions, and the strong resemblance of its test to that of *Euglypha,* being such as to justify either position."—'Introd. to Study of Foraminifera,' p. 65.

But this is not all; for I believe that between the degree of differentiation of the sarcode body observable in the *Foraminifera* and *Polycystina* no difference of importance really exists. In both families (as may readily be seen on inspection of the plates above referred to) the pseudopodia are given off principally with reference to the number and position of the apertures occurring in the shell. In both, coalescence of the most complete kind takes place immediately on the escape of the sarcode stolons through the main or secondary apertures, to such an extent as occasionally to constitute a delicate externally investing layer, between the inner surface of which and the outer aspect of the shell the process of mineral deposit goes on. And, lastly, we find in both families the same intermittent and incomplete granular circulation. Now, these families have been ranked under different Orders.

In Carpenter's system the *Foraminifera* are associated with the *Gromida* in the first or Reticularian order; whilst the *Polycystina* are grouped with the *Actinophryna*, *Acanthometrina*, and *Thalassicollina*, as already shown, in his second or Reticularian order. On the other hand, in the system of MM. Claparéde and Lachmann the *Foraminifera* are isolated from all the other families; and, singularly enough, whilst no allusion is made to any predominant tendency in this family of the pseudopodia to coalesce, such tendency is introduced as a distinguishing character of the *Gromida*. Here, moreover, it will be seen that the *Actinophryna*, regarded by Carpenter as affording the type of the pseudopodian character in the Order which includes *Thalassicolla* and *Acanthometra*, are separated from both of these last-mentioned families, and elevated to the most highly differentiated Order in which they occur with *Amœba*.

One illustration more, also taken from Schultze's work, and I have done for the present with the discussion of pseudopodia. The figure given by Schultze of his *Amœba porrecta* (pl. vii, fig. 18), in like manner with the figures already referred to, has been copied into all our leading text-books on the Protozoa. It is, moreover, reproduced in the 'Introduction to the Study of the Foraminifera" (pl. i, fig. 18), with a mark of interrogation after the generic name, and coupled with the observation (*op. cit.*, p. 24) that "the differentiation of the Rhizopod is far less complete, and the pseudopodia seem to be as much formed by the endosarc as the ectosarc, in this and other particulars presenting the link of transition to the shell-less *Reticularia*"! In other words, between the two *extremes* of the Rhizopod series, and not between either of the two Orders most closely related to each other.

Now, this is a most important acknowledgment, if, as can be shown to be the case, the Rhizopod depicted be indeed of the *Amœban* type. And I venture to hope that it will be recognised as confirming the views above expressed, inasmuch as I am in a position to prove that, amongst the fresh-water Amœbans, examples occur in which, whilst the presence of a nucleus and contractile vesicle (even according to Dr. Carpenter's own definition of his lowest type) exclude them from association with the *Reticularia,* and render it incumbent on us to place them with *Amœba,* the pseudopodia assume the mixed characters of the *Actinophryna* and *Foraminifera* precisely in the manner depicted in Schultze's figure.*

Holding, as I do, these opinions concerning the value of the distinctive characters afforded by the substance of the sarcode, it naturally follows that I am disinclined to allow that the streaming of granules, both within the body of the Rhizopod and either along or within its pseudopodial extensions, is referable to a vital power resident in sarcode or the molecules suspended in it. I reject it, however, not because I desire to support a theory, but to establish the fact that, in every instance without exception, from the lowest to the highest type, the vital function *par excellence* consists in the inherent *contractility of protoplasm,* whilst the progression of the molecules simply becomes the exponent of that function. The contractility would seem to attain its maximum in *Acanthometra* and *Euglypha;* but, as is well known, it is also signally observable in some of the *Textularian Foraminifera* of our own shores. In all of these forms the instantaneous shooting-forth of the pseudopian projections constitutes one of the most remarkable spectacles seen under the microscope; its singular nature being, in a great measure, heightened from the circumstance that the action takes place even when the organism is confined between the glass slide and its cover.

But in order to show that no trustworthy Ordinal character is deducible from this property—or, at any rate, none that has hitherto been made strictly available—it is only requisite to bear in mind that, by a sort of general consent, the *Amœban* type of protoplasm is considered as being that in which differentiation has proceeded to the furthest limits. Yet in *Amœba* the purely secondary and incidental character of the

* See my "Observations on the Amœban Rhizopods," already referred to, as published in 'The Annals and Magazine of Natural History' for June, 1863, vol. xi, pl. x, figs. 4, 10; and for December of the same year, vol. xii, pl. viii, figs. 9-11, 12.

circulatory movement is most plainly demonstrable and universally admitted, inasmuch as it may always be seen to follow the direction in which the contractile action would urge it, and to cease altogether when that action ceases. So that we are reduced to the dilemma of assuming—which would be absurd—that one kind of contractility is vested in *Amœba* and another kind in the less differentiated genera; or of allowing that the kind manifest in *Amœba* must, *à priori,* be identical (though not necessarily in degree) with that possessed by the other Rhizopods.

Accordingly, if we revert to the classifications now proposed, we shall find that, assuming the characters of *Lieberkuhnia** and *Pamphagus*† to have been fully recorded by these discoverers, these organisms may be held to agree, in every essential respect, with the rest of the *Herpnemata.* In other words, supposing the existence of such a form as a naked *Foraminifer* or *Polycystin,* such form would, in all probability, be undistinguishable from *Lieberkuhnia.* For although true that, in the normal condition of this Rhizopod, the pseudopodia are more "*indefinite*;" that there is a more visible passage of granules within and along the substance of these processes; and, lastly, that the apparent tendency to anastomose and form membrane-like expansions, is at a maximum; there is every reason to believe that the differences observable between *Lieberkuhnia* and the testaceous families with which it is associated through the negative character (common to all) of possessing no nucleus or contractile vesicle, are due to the sarcode body being free in one case, whilst in the others the number, the direction, and the diameter of the pseudopodia, mainly depend on the position, the size, and the number of the apertures through which they have to pass. And I conceive this view is borne out by Carpenter's observation, that *Arcella* and *Difflugia* "are nothing else than testaceous Amœbans;" and further by the opinion he expresses (although under the erroneous impression that no nucleus is present) that *Gromia* is "of essentially the same character as *Lieberkuhnia.*"‡

I adduce these facts to show that, whilst confirming and following the classification of Dr. Carpenter in placing *Lieberkuhnia* and *Pamphagus* with the *Foraminifera,* I only extend the principle laid down by the same eminent authority when I associate the *Polycystina* with the *Fora-*

* Discovered by MM. Claparéde and Lachmann, and described in their 'Etudes sur les Infusoires et les Rhizopods,' Geneva, 1858, pp. 464, 466.

† Discovered by the late Professor Bailey, of New York, and described by him in the 'American Journal of Science and Arts,' vol. xv, reprinted in 'Quarterly Journal of Microscopical Science,' vol. i, p. 295.

‡ 'Introduction to the Study of Foraminifera,' pp. 27 and 29.

*minifera* on the one side, and promote *Gromia* to the highest Order on the other.

### Order I.—HERPNEMATA.

The primary and secondary characters of this Order are as follow:—No definite nucleus. No contractile vesicle. Sarcode, without any appreciable differentiation into endosarc and ectosarc, consisting of homogeneous viscid protoplasm, in the substance of which vacuolar cavities occasionally occur. Pseudopodia forming frequent anastomoses and exhibiting, both along the surface and within their substance, the phenomenon of *pseudo-cyclosis.*

In *Lieberkuhnia* and *Pamphagus* (organisms which I have not myself met with) no bodies corresponding to the sarcoblasts of the Rhizopods are spoken of by their discoverers. But, inasmuch as they have been detected by me in every other family, it is possible that they really exist and have yet been overlooked, owing to their being colourless amongst the crowd of granular and foreign bodies said to have been present. The difficulty of detecting the sarcoblasts in the fresh-water Amœbans, in which the absence of colouration renders them much less easily discernible than in the *Protodermata* (all of which, as yet known, are oceanic), lends force to such a supposition. The circumstance, however, to which I beg to direct attention specially is this—that *Lieberkühnia* and *Pamphagus are the only Rhizopods belonging either to the Herpnemata* or *Protodermata* of my system in which distinct evidence has been adduced of the power to incept solid particles *as food,* whilst amongst the large series of forms grouped by me in the *Proteina* there does not occur a single example in which it is not easy to trace the faculty. So that, even allowing, for the sake of argument, that the generalization may turn out to be only partially correct, owing to unrecognised difficulties in the methods of observation, we have nevertheless presented to us, in the occurrence of these very difficulties, a useful subsidiary character.

Of the animal of the *Foraminifera* it is unnecessary for me, in the present communication, to say more than I have already done, beyond pointing out that the "yellow bodies" (well known as occasionally occurring, and to which I have given the name of *sarcoblasts,** with a view to distinguish them from other corpuscules of nearly similar size and appearance, but of different origin) are the true rudiments of the young

* From σαρξ, flesh, and βλαστη, an offshoot. The nature of these bodies will be more particularly detailed in connection with the Polycystina.

*Foraminifera,* and probably of all the *Rhizopods.* And whereas in the case of the marine and fresh-water genera I have been enabled to collect sufficient data to prove that these bodies, although developed within the parent protoplasm, become ultimately extruded therefrom; and, in the testaceous forms, that the deposition of the shell-material dates, as a general rule, from this period; the development of the "test," whilst still within the parent sarcode (as originally stated by Ehrenberg and afterwards by Schultze), occurs in some examples amongst the *Foraminifera,* and brings the phenomenon within the category of viviparous reproduction; hence confirming my own discovery of this being a phase of the reproductive system of the *Amœbans.**

Passing on to the character of the sarcŏde substance of the *Polycystina,* I may remark that the appearances presented are, in every essential particular, identical with those observable in the *Foraminifera;* the minor differences observable in the variation in number, size, and distribution of the pseudopodia being, as already stated, manifestly the consequence —or I should rather say the accompaniment—of equivalent differences in the foramination of the siliceous skeleton. In support of this view, it is but requisite to compare the pseudopodia of such Polycystina as *Podocyrtis* (Ehr.) or *Encyrtidium* (Ehr.) (in which they are comparatively few, much attenuated and scattered), with those of the spongy, and more particularly the discoidal, *Haliommata* (in which their number is as incalculable as the meshes of the minute siliceous network from whence they issue, and they constitute a dense, velvety covering which completely obscures the skeleton), to perceive at a glance that a much wider gap exists between the pseudopodia of these genera than is traceable between those of the two first-named *Polycystine* genera and those of a Rotalian *Foraminifer.*

But it remains still to note another point of resemblance between the characters of the *Foraminifera* and *Polycystina* afforded by their sarcode; namely, that in all the latter the entire surface of the siliceous skeleton is enveloped in a more or less delicate film of protoplasm, formed by the coalescence of the extruded bases of the pseudopodia—or, in other words, of the pseudopodian stolons; whilst in some of the *Foraminifera,* as averred by Williamson originally, and afterwards by Carter, Schultze, and Carpenter, and confirmed by my own observation, such an investing film of sarcode is also to be detected. This layer may, indeed, be

* On "*Amœba villosa,*" by G. Wallich, M.D., 'Annals and Magazine of Natural History' for June, 1863, p. 441.

regarded as an example of universal coalescence; and, as I have elsewhere shown, it appears to serve an essential office in the deposition of the mineral substances of which the shells of the testaceous Rhizopods are composed. For the distinction of this very important layer I propose the name *chitonosarc.**

In this family the sarcoblasts are sometimes very conspicuous, and more likely to be seen than in the *Foraminifera*, in consequence of the invariably crystalline texture of the skeleton. They are correctly described by Müller as occupying a position, for the most part, immediately within the siliceous framework. There are exceptions to the rule, however, arising from peculiarities in the configuration of some of the genera.

## Order II.—PROTODERMATA.

*Characters.*—Definite nucleus present, but no contractile vesicle. Sarcode so far advanced in differentiation that the ectosarc constitutes a nearly hyaline stratum of much more tenacity than the endosarc, which still retains much of the general consistence of that of the HERPNEMATA. The transition, however, from ectosarc to endosarc is gradual. Here, as in the last-named family, true vacuolar cavities occur. The pseudopodia, *when present,* are scattered and attenuated, rarely coalescing; for the most part rigid, but still highly contractile; and exhibiting, in their interior and on the surface, only such minute granules as find their way into the ectosarc. Pseudo-cyclosis manifest. Sarcoblasts conspicuous.

In this Order, as its name implies, we discover for the first time the evolution of an approach to membranous structure. But this does not occur in the more highly differentiated conditions of the ectosarc, which has already been alluded to, but in the capsule which invests the nucleus. This capsule was pointed out by Professor Huxley as being present in *Thalassicolla*, at the same time that he laid down the Rhizopodous nature of that organism.† I may mention that in the same year that his researches were published, and again in 1857, I became acquainted with the appearance and intimate structure of *Thalassicolla, Collosphæra,* and *Sphærozoum.* But I entirely failed in tracing their affinities. From speci-

* "On the Process of Mineral Deposit in the Rhizopods and Sponges," by G. C. Wallich, M.D., 'Annals and Magazine of Natural History, January, 1864," p. 72 *et seq.* From χιτων, a tunic, and σαρξ, flesh.

† "On the Genus *Thalassicolla*," by T. H. Huxley, F.R.S., Surgeon Royal Navy, 'Annals and Magazine of Natural History,' 1851, 2nd ser., vol. viii, p. 434 *et seq.*

mens in my possession, as well as from drawings and notes taken at the time, I have, however, been enabled carefully to re-examine them and confirm Professor Huxley's statement. But I am still unable to satisfy myself as regards *Sphærozoum* (Mey.) (the *Thalassicolla nucleata* of Huxley), and would rather provisionally refer it to *Noctiluca*, with which organism it was shown by Huxley to assimilate in many of its characters.*

In the *Plagiacanthidæ*, or first family of the Protodermata—the name of whose typical genus I take from the *Plagiacantha arachnoides* of M. Claparéde ('Monastb.,' 1856, p. 500), which is generally identical with *Acanthadesmia* (Müll.)—we have a connecting link between the *Polycystina* and this Order. For, whilst their siliceous skelcton is formed on the type of the single-chambered *Polycystina*, the sarcode body presents, in a marked degree, those characters which distinguish the Protodermata. That is to say, in addition to the greater degree of differentiation attained by the sarcode, we observe a nucleus of large size, protected by a membranous and hyaline capsule; surrounding this the granular, sometimes very brilliantly coloured, endosarc, towards the outer portion of which the sarcoblasts are imbedded; and, finally, the nearly colourless ectosarc, in which the sarcoblasts seem to occur only during their transit towards the outer world. To this family will be found to belong those strikingly curious forms in which the tendency to asymmetrical growth attains the greatest limit, and which are known under the names of *Dictyospiris*, *Stephanolithis*, *Spongolithis* (Ehr.), and *Cladococcus*, *Stylocyclia*, and *Acanthodesmia* (Müll.).

In the *Acanthometrina* we observe a much more complex disposition of the siliceous parts than has heretofore presented itself. These consist of a series of symmetrical spicules, distinct from each other, but invariably uniting at their bases to constitute the common axis of the organism, which is generally, although not invariably, solid at the point of union. The spicules, which in most cases take the form of ensiform, hastate, or remiform spines, of wonderful symmetry and beauty, and occasionally of great length, are, however, solid *throughout* and *never*, as supposed by Müller, tubular; the semblance of tubularity being produced by the

* Without speaking positively on the point, I may state my belief that no true Rhizopod is phosphorescent; and, so far as my observations on this head go, it seems probable that phosphorescence does not take place in any organisms holding a lower rank in the scale of being than *Noctiluca* and the *Entomostraca*. Should my surmise prove correct, the luminosity or otherwise of Sphærozoum might assist us in arriving at its true relations.

surfaces of the spines being strengthened by longitudinal ribs, which are again sometimes flanged at their free margins. Some idea of their form may be gained on looking at the section of an ordinary railway plate.

A peculiarity observable in the nucleus of this family consists in its being moulded, as it were, to and around the siliceous axis of the spines, whilst the nuclear capsule sends off processes which closely invest the spines to their extremities.* This character, seemingly so abnormal, results from the rudiments of the spines being developed within the sarcoblast after the nucleus has become invested with its capsule, and each spine, as it extends outwards, thus pushing the capsule before it. I may observe that I possess the clearest evidence of this from the progressive stages in which the sarcoblasts of the *Acanthometrina* are constantly met with in tropical seas.

The spines of the family furnish the type of a portion of the siliceous structure both of the *Polycystina* and the Rhozopods of the second order, which demands that they should receive a name indicative of their origin and distinct character. I accordingly propose the term *acanthostype*.† Their value in furnishing some of the most useful characters for classifying will be explained hereafter. But there is reason to believe that the acanthostype of the *Acanthometrina* generally is not so purely siliceous as that of the other families into the composition of whose skeletons siliceous material enters, inasmuch as its index of refraction is not the same; and, besides occasionally assuming a delicate roseate tint, it may be made to yield to solvents much more readily than any siliceous spicules with which we are acquainted. This, perhaps, affords an explanation of the very curious fact that in all deep-sea deposits and fossil earths I have never discovered a trace of an *Acanthometra;* nor am I aware of the skeleton of one having been met with by others in these deposits, or in the flints. The *Acanthometrina* are essentially free-floating, and, without exception, marine organisms.

Of the *Thalassicollidæ* it is not requisite that I should speak more in detail at present, except in so far as these characters demand comparison with those of the Rhizopods

* I have been unable to satisfy myself as to whether, in the living and normal state, the capsule is ultimately ruptured at the apices of the spines. In some examples they certainly have been so; but the extraordinary sensitiveness of *Acanthometrina* to the change of circumstances resulting from temporary imprisonment in the towing-net, and examination subsequently, renders it, in my opinion, probable that the rupture is an abnormal condition.

† Ακανθ, and στυπος, a stem or stock.

belonging to the other Orders; more particularly as the descriptions of their nature published by Huxley and Müller leaves little to be done in the way of structural investigation. Leaving, therefore, a few incidental facts to be mentioned hereafter, I shall proceed to give a brief account of a new family I have set apart for the reception of a small and, to some extent, aberrant series of forms, namely, the *Dictyochidæ.*

This family takes its name from the well-known objects to which Ehrenberg gave the generic designation of *Dictyocha.* If we picture an *Acanthodesmia* in which the siliceous skeleton, instead of consisting of a single *solid* basket-shaped piece, is made up of two such portions, distinct from each other, like the valves of a diatom; and which is, in addition, tubular *throughout,* we shall have a good idea of the nature of the siliceous framework of the *Dictyochidæ.* Their binary nature seems to become a link between them and the spiculiferous varieties of the *Thalassicollina,* whilst their tubularity determines their alliance, in preference to any other family of Rhizopods, to the true SPONGIDÆ. Of the tubular nature of these forms every microscopist may readily satisfy himself, under a careful analysis of balsam-mounted specimens.*

## Order III.—PROTEINA.

*Characters.*—A definite nucleus, and with it a contractile vesicle; sarcode very highly differentiated into endosarc and ectosarc; the former granular, more or less nearly colourless, very viscid, and exhibiting but little contractility; the latter nearly hyaline, very highly contractile, but never assuming a membranous consistency, except during the period of encystation.† Vacuolar cavities numerous and constant, seen principally to occur in the endosarc. Sarcoblasts abundant and frequent, but, owing to their pale colour, less easily detected than those of the oceanic Rhizopods.

As already stated in an early portion of these observations, I regard the constant presence of such organs as a nucleus

* According to the 'Micrographic Dictionary,' Kützing enumerates no less than twenty-nine *species*, the sole distinction between these being derived from the varying number of these spines!

† In my observations "On Amœba," already referred to as having appeared in the 'Annals of Natural History' for 1864, I have fully stated my views regarding the *reciprocal convertibility* of the endosarc and ectosarc of the Rhizopods. I now refer only to the apparent condition for the time being, and without prejudice to my theory, which will, I believe, be found correct.

and contractlle vesicle as of primary importance in the determination of the Ordinal unity of the families grouped together in the PROTEINA. I have already cited my reasons for regarding variations in the apparent degree of differentiation of the protoplasmic mass, and in the shape, size, number, and tendency to coalesce of the pseudopodia, as of but secondary, or, in other words, merely generic, value. But, after a laborious study of the principal fresh-water PROTEINA, extending over nearly two years without any important intermission, I am satisfied that, even regarded as generic characters, these are subject to a much wider range of variation than is usually imagined, not only in the same genus, but in the same *individual* at different periods of its existence.

It appears to me that, with all this tendency to variability (even assuming a higher significance to attach to differences in the degree of differentiation attained by the sarcode than I am at all prepared to allow) the association *in the same Order,* of families in which these differences show themselves to the utmost, is far less open to question than the grouping, in the same order, families exhibiting pseudopodia framed on the *Actinophryan* type with such a family as *Thalassicolla, in which there is not a trace of a true pseudopodial appendage;* and even the guardedly defined "active motion of granules" amongst the fibrils, "*as if* circulating," was only observed once, and then not in the typical *T. punctata* (Hux.), but in the form which he preferred to associate with *Noctiluca!*

Bearing this in view, it may be stated that the various genera of the order PROTEINA may be divided into two sections—the first, in which the pseudopodia assume the Actinophryan character, and rarely deviate from it; the second, in which these organs, though normally "lobose," frequently merge into the Actinophryan type. Hence the division into "*Monomorphous*" and "*Polymorphous*" families.

Commencing, then, with the assumption (reasons for which have been already given) that our knowledge of the animal of the Polycystina, as well as of the other lower Rhizopods, is not yet sufficiently matured to enable us to determine *specific* differences in this portion of their structure, we must obviously search for some basis on which to classify them in the mineral skeleton which accompanies the soft parts. This basis, I conceive, is furnished by the plan of growth of the embryonic skeleton, and by its subsequent stages of development. In this very important respect, therefore, does the system now offered for the systematic classification of the *Polycystina* differ from that founded on mere variations in form and *repetition* of parts, by Ehrenberg and Miller as regards the *Polycystina,* and by D'Orbigny and Schultze as regards the *Foraminifera.*

The evidence appears to me very inconclusive upon which it has been asserted that "fission" and "gemmation" constitute the principal mode in which the lower testaceous Rhizopods multiply. And it still remains to be determined whether *any* of the testaceous forms, whose chambers are connected with each other so as to admit of a complete union of the masses of protoplasm which they contain, ought to be regarded as multiple individuals, or only *as a single individual composed of more than a single sarcodic segment.* In the *Polycystina* the individual is, I imagine, undoubtedly single. So it is in the case of the *Protodermata,* with exception of of the *Thalassicollina.* The acute perception of Huxley at once satisfied him of the true state of the case in *T. punctata.* He termed it "a mass of cells united by jelly, like an animal Palmella,"* but he clearly demonstrated that *each* cell of the series is a perfect *Thalassicolla.* My own observation enables me to show that, in this family, the increase of the number of individuals is not effected (at least certainly not as a rule) by gemmation or fission, but by the evolution of the sarcoblast, and its subsequent extrusion from the parent structure. Even in the Monothalamous Foraminifera I think all the data we possess tend to the conclusion that the new brood is not the result of the detachment of a molecule of sarcode indiscriminately from any portion of the mass of the parent body, but of the development of a true reproductive corpuscle, namely, the sarcoblast, whether it eventually turns out that this corpuscule is derived from fission of the nucleus or is an independent formation. It would be impossible within my present limits to show how far the evolution of the sarcoblast, in the HERPNEMATA (*Foraminifera* and *Polycystina*) corresponds, or fails to correspond, with its evolution in the higher forms—as, for example, in *Amœba.* But I believe, and possess sufficient evidence to prove, that from the sarcoblast, in both orders, the young animal usually originates. This is a very important fact, and one deserving of a much more detailed notice than can be accorded it on the present occasion. I allude to it in this cursory way simply to enable other observers to verify it as opportunity offers. Now, each segment of sarcode in a Foraminifer can no more be said to constitute a separate being than each segment of an Annelid. The individuals forming the mass of a compound *Ascidian* (as, for

* "On Thalassicolla," 'Annals and Magazine of Natural History,' 2nd ser., vol. viii, p. 434.

example, *Pyrosoma*) are quite distinct, having each a separate and complete set of organs, notwithstanding that all are sustained within, and help to support, a common matrix. In the catenate *Salpæ* also each member of the chain is a perfect *Salpa*, the aggregation being that merely of a colony, within whose limits reproduction is going on. In *Thalassicolla* we have precisely an analogous kind of colony; inasmuch as, in this family, but in this only among the Rhizopods, is each of the members, resident in the gelatinous investiture, complete in all its parts, and, as in the case of the *Pyrosoma* just referred to, a mere member of a community.*

Those persons who have studied Dr. Carpenter's masterly classification of the *Foraminifera* are aware that those organisms are divided primarily into two sub-orders, namely, the "*Perforata*" and the "*Imperforata*," whilst the first of these *sub-orders* is again divided into three sections, comprising such shells as are respectively "membranous," "porcellanous," or "arenaceous" in their structure; whilst the second series includes only the calcareous-shelled forms. And, so far as physiological advance admits of demonstration from the characters of the shell, this basis of classification is eminently natural and scientific. But, with all due deference, I venture to express my opinion that increasing complexity in the shell can no more be regarded as proof of co-ordinate increase of differentiation in the animal portion than the fact, mentioned by Carpenter, that the "*Foraminifera* secrete shells unsurpassed in symmetry and *complexity by those of any other testaceous animals*," can be accepted as a reason for regarding the Mollusca as inferior to the Rhizopoda. I do not deny that differences in degree of differentiation do exist. All analogy tells us they do. I merely maintain that where they occur they are of too subtle a nature to serve the purpose of classification, and that it has yet to be shown that they advance *pari passu* with increased complexity of the shelly covering. On this subject I cannot refrain from quoting the opinion of that most able and scientific observer, Professor Williamson:

* In *Dactylopora* (Lamarck) there certainly appears, at first sight, good reason to doubt this view, and the example might be regarded as exceptional, were it not that this is one of the *Foraminifera* in which, according to Carpenter ('Study of the Foraminifera,' pp. 128-9), the layer of continuous sarcode externally is most manifest. Williamson was the first to direct attention to the occurrence and use of this layer. Even in the *Eozoon Canadense* there is nothing, as yet, to *prove* that the cavities of the mineral structure were not simply occupied by lobes of one and the same individual.

"The more extensive our experience," he observes, "the weaker become our convictions respecting the limits of variation in any species of *Foraminifera*. . . . That species do exist among the *Foraminifera* as elsewhere, analogy would lead us to infer; but I believe there are several actual indications of the fact more substantial than what can be supplied by mere analogy. But we have hitherto failed to detect their real specific peculiarities, or even to ascertain in what part of the living organism they are likely to be found. As yet they are but unseen potentialities, of which the eye has hitherto been unable to detect any concrete or objective manifestations; and *I strongly suspect that the remark is equally applicable to the entire group of the Rhizopoda*."*

It is in view of this opinion, to which I cordially subscribe, that I now offer the following systematic classification of the *Polycystina*.

It will be seen that one universal character distinguishes the skeleton of the *Polycystina* from that of the *Foraminifera*. It is always purely siliceous, of crystalline transparence, solid, invariably composed of one continuous unbroken piece, perfectly rigid, and unaffected by any chemical agents except those which are the known solvents of silex. Hence in this family we are deprived of those distinctive features in the composition and construction of the skeleton which, in Carpenter's system, are applied to the *Foraminifera* and afford so admirable a means of determining the sub-families. In the *Polycystina*, moreover, we have no distinction afforded by Perforate and Imperforate forms, since, virtually, *all* are perforate. That is to say, there is no exception to the rule that the siliceous skeleton is so pierced by apertures, in every portion (excepting the spinous projections, which are so but rarely), that the most complete communication may be said to exist between the contents of every chamber and the investing film of sarcode on the exterior. Even in the oldest individuals, in which siliceous deposit has gone on till the walls are so unusually thick as materially to increase the space between the sarcode within and the sarcode without, some of the apertures are rarely, but all are never, obliterated.

The growth of the mineral portion in this, as in all the other siliceous-shelled Rhizopods, except the *Dictyochidæ*, is essentially the same. That is to say, the material is deposited

* Williamson's 'Recent British Foraminifera,' published by the Ray Society, 1857. Introduction, p. 10.

† See "Remarks on the Process of Mineral Deposit in the Rhizopods and Sponges," by G. C. Wallich, M.D., 'Annals and Magazine of Natural History,' January, 1864, p. 72.

at right angles to the axis of the part, and never, as in the *Spongidæ*, in two opposite directions around a central stolon.†

In the embryonic portion of the skeleton of the Polycystina two distinct and very definite forms occur, which apparently never vary so far as to render their determination uncertain, either in the earliest or any subsequent stage of growth of the organism. To this *embryonic* skeleton I have given the name of the *omphalostype*,* and to the earliest-formed chamber, which is invariably formed around or upon the *omphalostype*, the name of the *omphalic* chamber.

The two primary types of *omphalostype* may be conveviently distinguished as the *symmetrical* and the *asymmetrical*—the one consisting of a hollow spherule of silex, which is minutely perforated just as the adult portions of the skeleton; the other, of a series of continuous siliceous filaments, which I can only liken to the framework of a coronet. In other words, it may be said to consist of a basal ring, from one aspect of which loops are projected, which unite at a common centre considerably beyond the plane of the ring, and usually terminate at this apical point in a stout spine, whilst secondary loops and spines are projected from indefinite points, and these again give off filaments. As already stated, however, the primary rudiment of the skeleton, either when in the shape of the minute perforated spherule or the coronet-like framework, *remains constant and determinable, no matter how exuberant or monstrous the growth may ultimately become.*

The importance of being readily able to discriminate between these two types depends on the fact of their corresponding to two well-defined and constant types of growth in the remainder of the siliceous skeleton, no matter what the genus or species may be: the symmetrical omphalostype invariably appertaining to those genera in which the growth of the parts takes place by the creation of fresh chambers arranged concentrically, or some portions of which are arranged concentrically, around the first or *omphalic chamber*: the asymmetrical, on the other hand, as invariably belonging to those genera in which growth takes place by the formation of new chambers from that aspect *only* which is opposite to the apex of the omphalostype.

The characters of the embryonic skeleton of the *Polycystina* to which I refer are taken at the period when siliceous deposit first shows itself in the sarcoblast. This portion of the structure consists of a minute spherical or nearly spherical mass of granular sarcode, yellowish in colour, and varying in diameter, as soon as free, from $\frac{1}{5000}$th to $\frac{1}{1300}$th of an

* From ομφαλος, a navel, and στυπος, a stock or stem.

inch; destitute of anything like a cell-wall; but shortly after projection from the parent body, exhibiting what might easily, under casual inspection, be mistaken for a nucleus. This is, in reality, the siliceous rudiment of the skeleton of the new individual. As correctly shown by Müller (who, by the way, failed to detect the derivation or future progress of the "yellow bodies"), the sarcoblasts are to be seen resting, in more or less of a layer, immediately within the siliceous framework. Subsequently, however, they are projected through the foramina, and gradually thrown off altogether.

Occasionally, during calms within the tropics, the sarcoblasts of the *Polycystina* and other oceanic Rhizopods may be taken in immense numbers, although, owing to their extreme minuteness, they are easily overlooked. The profusion, however, in which they occur, in every stage of growth, affords us the means of tracing their history in all its consecutive phases; and it is highly desirable that they should be carefully collected and studied by all who enjoy opportunities of obtaining them in their normal condition. I may add that the fossil Barbadoes earth generally contains numbers of the denuded omphalostypes, even in the earliest stages of their history.*

Without entering at present into the questions whether the sarcoblast ought or not to be regarded as a true ovum; or the siliceous deposit on the skeleton of the Polycystina should be regarded as a true secretion or merely as an exudation, or, lastly, as the combined production of vital and chemical forces, it is certain that the development of the sarcoblast invariably precedes the first appearance of the embryonic skeleton; and we are hence warranted in taking for granted that its deposition is not independent of the sarcodic body, as might be inferred were the opinion, entertained by some writers, as to the growth of the spinous processes of the *Polycystina* taking place altogether externally to the soft parts of the animal, a tenable one.

Now, in the concentrically formed subdivision of the Polycystina (namely, that which, in the classification about to be offered, I term the *Cyclodinal*) we find certain plans of growth which, at first sight, might be regarded as exceptional. I allude to those cases in which the skeleton is not spherical

* The Barbadoes earth also contains the "Coccoliths" detected by Huxley in the material of the Soundings, and by him regarded as inorganic in their nature. They were subsequently found by me to be but portions of other structures, namely, of certain spherical cells, to which I gave the name of *Coccospheres*, and which appear to be connected, in some way, with the reproduction both of the *Foraminifera* and *Polycystine.* I have also met with them as free-floating organisms in tropical seas.

externally, but compressed so as to become more or less perfectly discoidal, or, instead of being either truly spherical or discoidal shape, the form assumed is distinctly stellate. But even in the most aberrant of these sections the omphalostype remains unchanged in outline, and the transition is effected by gradations which only become obscure in those last-formed portions of the structure which are furthest removed, radially, from its central axis.

In the *Monodinal* subdivision, on the other hand, there is never such an apparent variation; for although monstrosities are to be met with now and then, in which development of siliceous material has taken place laterally, it is impossible to mistake these as having been formed in the normal course of growth of the organism. Moreover, they never assume the characters of regular chambers.

All subsequent deposits of silex, whether in the shape of foraminated chambers or spines, or portions of structure not referable to one or other of these kinds, take place on the same plan, namely, by deposit of silex at right angles to the axis of growth of the part immediately in question. In the formation of the chambers the deposit usually goes on from a number of points simultaneously around the free margin, the points becoming filaments, and the adjacent filaments ultimately anastomosing, or rather coalescing, as soon as they come in contact. As already stated, the spines are never tubular, the appearance of tubularity in the spines of some genera (as, for example, certain adult specimens of *Podocyrtis*) being due to the existence of short longitudinal furrows and buttresses on their inner aspect, where generally may be seen an aperture around a portion of the margin of which the base of the spine has taken its rise. When loops or festoons occur the process is still the same, as these may be seen in every stage of growth from the first projection of a minute filament to the stage at which the coalescence would have become complete had the protecting and formative living sarcode been left to fulfil its office. In short, the process may be familiarly likened to that by which the glass-worker extends his plastic and half molten material from point to point when manufacturing a miniature basket-work. Of course the thickening of each portion is by subsequent deposit around the original thread.

There occurs, in some of the oceanic deposits containing effete skeletons of the *Polycystina*, an abnormal growth in the discoidal group, which is certainly unique and has heretofore been overlooked. I allude to the presence of a short canal, which is found projecting from one portion of the circumference. The canal thus formed, however, is not deposited as a tube, but originally as a series of short spines arranged in circular order at right angles to the axis of the disc; the canal being subsequently completed by the projection of a film of silex from each pair of spines, which renders the canal in reality polygonal. But this only occurs in those specimens in which the spongy structure of the outer layers is so dense as probably to have impeded the animal during its efforts to extend its velvety layer of minute pseudopodia. The little canal may therefore be said to represent the analogue of the aperture of a Monothalamous Foraminifera. This statement, however, is only offered as a surmise.

Lastly, I have to speak of those singular examples in the *Monodinal* subdivision in which a repetition of parts, sometimes similar in external contour to the type of the *Cyclodina* occurs along the course of a monstrously developed spine, and might thus countenance the idea that the boundary line above laid down is untenable. It will be found, however, on breaking up such growths, that we have before us merely a more or less dense network of siliceous filaments interwoven around the spine, and that nothing at all similar to the *Omphalostype,* or a true chamber, exists within. It is important to bear this in recollection, for, perhaps, in no series of organisms does monstrosity seem to attain such a limit. We are thus enabled to account for the difficulty which has been supposed to hedge in these beautiful structures and has become a barrier to their systematic distribution heretofore.

It only remains to be stated that, perhaps, in no other family of the animal kingdom is the tendency to assume varietal form more signally manifest, at the same time that the line of demarcation remains clear between such characters as are constant and such as are accidental in their nature. Hence, notwithstanding the wide range of configuration which the *Polycystina* present, the number of species is extremely limited; and these furnish the strongest evidence that the only permanent types are those which are recognisable in the earliest condition of the structure.

The following is a tabular view of the classification of the *Polycystina* now proposed:

Family

## POLYCYSTINA.

Animal presenting the distinctive characters of the HERPNEMATA generally. Skeleton invariably siliceous, of crystalline transparence, colourless, never tubular, continuous, foraminated, forming one or more compartments.

| 1. Omphalostype symmetrical. Omphalic chamber spherical. | | | 2. Omphalostype asymmetrical. Omphalic chamber more or less pyramidal and asymmetrical. |
|---|---|---|---|
| SUB-FAMILIES. | | | |
| 1. *Sphærodina.* | 2. *Dichodina.* | 3. *Actinodina.* | *Monodina.* |
| Successive chambers arranged concentrically around the omphalic chamber, and developed upon and around the Acanthostypes which originate in the Omphalostype. Typical genus *Haliomma* (Ehr.). | Successive chambers more or less compressed or discoidal, but interrupted at opposite poles. Typical genus *Amphidiscus* (Wal.)=“*Haliomma amphidiscus*” (Müller). | Successive chambers compressed or discoidal and interrupted, forming two or more radiating lobes. Typical genus *Astromma* (Ehr.). | Successive chambers arranged one in front of the other in linear series. Typical genus *Podocyrtis* (Ehr.). |

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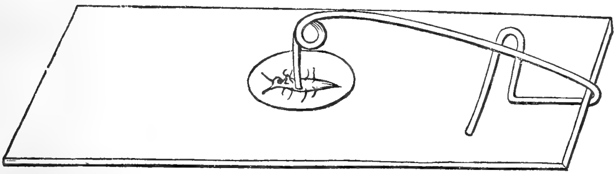
## *On a* WIRE SPRING CLIP.
By R. J. MADDOX, M.D.

(Read May 10th, 1865.)

FOR several years I have employed the accompanying form of wire clip in mounting objects. It has the following advantages:—Is easily twisted, of little cost, and quickly attached to the ordinary slide. I make the clips of wire of different thickness, on tender objects using the thinner; if necessary, by passing to the stronger we can obtain a graduated and steady pressure before closing up the object.

To make the clip, take a straight piece of brass wire four and three quarter inches in length, turn one end at six eighths of an inch with a pair of *wire* pliers at right angles; this second portion, at half an inch, again bend at right



angles in the same plane; now, at three quarters of an inch, turn the wire over on itself, leaving at the bend space sufficient to admit a thick slide. At one inch and five eighths twist the wire completely on itself, and bring the now short ends at right angles to the longest part; *file this end quite flat.* Give the first portion of the wire a slight curvature, so that the point and bend may act as a stiff spring against the under surface of the slide when applied. The figure will show how it is to be used. If required, a clip can be attached at each end of the slide. Wires of the diameters of one thirtieth, one twenty-fourth, and one twentieth of an inch are useful sizes.

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## NOTE *on the* PRISMATIC EXAMINATION *of* MICROSCOPIC OBJECTS.

By WILLIAM HUGGINS, F.R.S.

(Read May 10th, 1865.)

IT has long been in my mind that microscopical science might possibly receive some assistance from prismatic analysis. Other investigations on which I am engaged have prevented me from making experiments in this field of inquiry. Since, however, the plan which I had proposed to myself, and which I have adopted with success in a few preliminary trials, differs essentially from the arrangement of prismatic apparatus recently introduced by Mr. Sorby, a short account of my method of observing may not be without interest to the Microscopical Society.

Microscopical science can scarcely hope for the same help from prismatic analysis which astronomy and chemistry have recently received, because the objects of investigation by the microscope are not self-luminous, as are the stars and terrestrial flames. The microscopist can hope to profit by the use of the prism in the case alone of those substances which modify by a special absorption the light by which they are rendered visible, either during transmission or reflection. The discoveries, however, of Professor Stokes in connection with the peculiar optical characters of blood and chlorophyll show that even this restricted field of investigation is one of considerable promise.

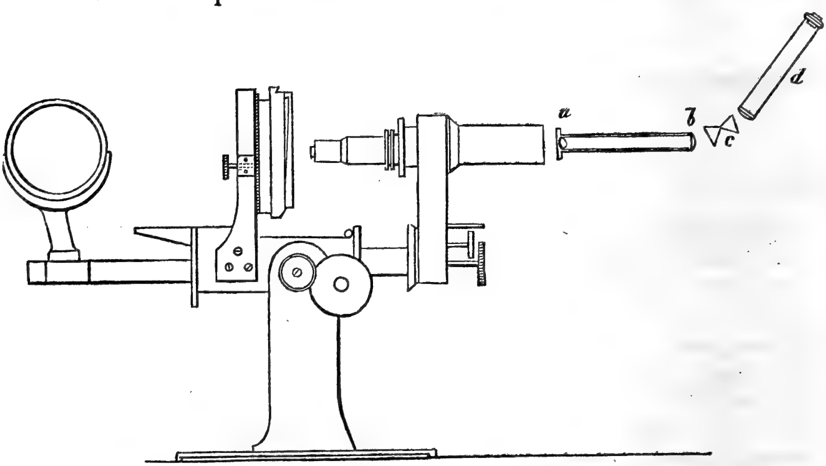
By means of the apparatus described below, the spectrum of any part of a microscopic object can be examined apart, and also can be compared with the spectra of the adjoining portions of the object.

In this manner the spectrum of a single blood-disc, or the spectrum of the contents of a single cell, can be observed, and any changes in living tissues which cause a modification of the spectrum can be watched and investigated.

Possibly microscopical physiology may receive some aid from this way of using the prism, since the deepest object-glasses, even the $\frac{1}{25}$ and $\frac{1}{50}$, may be employed.

This method of prismatic observation is equally suited to an examination of the light reflected from different parts of an opaque object.

Essentially the plan consists in arranging the slit of an ordinary spectrum apparatus in the place of the eye-piece of the microscope.




The spectrum apparatus may be of any form, may be supported on a separate stand, or be made to form part of the microscope.

Behind the object-glass, at a distance of three or four inches, an adjustable slit (*a*) is placed; the object-glass is focussed upon the object on the stage so that its magnified image falls precisely upon the slit. The opening of the slit, which may be from $\frac{1}{200}$th to $\frac{1}{400}$th of an inch, allows the light of a small part only of this image to pass on to the prisms. If desired, this part of the object may be further reduced by shortening the length of the slit. It is obvious that, by the usual stage adjustments, any portion of the object can be made to fall within the jaws of the slit and to form a separate spectrum. (See diagram.)

Behind the slit, at its own focal distance, is placed an achromatic lens (*b*). The pencils emerge parallel, and then pass through one or more prisms (*c*). The pencils are then received by a small achromatic telescope (*d*), with which the spectrum is viewed.

The eye-piece of this telescope is adjusted so that the lines of Fraunhofer in solar light, or the sodium line in an artificial light from a source containing sodium, are well defined. The object-glass of the microscope is then to be moved towards or from the object on the stage until the longitudinal lines and bars of different intensity, due to the darker and lighter parts of the object, are sharply defined in the little telescope at the same time as the lines of Fraunhofer or the double line of sodium.

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## Paraffin Oils: *their* relative Value *to the* Microscopist.

By W. H. Hall.

(Read May 10th, 1865.)

(*Abstract.*)

The author commenced by stating, that in order to test the relative value of certain condensers, he was desirous of trying their powers by a good and similar light, and was thus induced to compare the purity and relative value to the microscopical observer of the three paraffin oils, known as "Young's Paraffin," "Price's Belmontine," and a "Diamond Crystal Oil from America," as being always easily obtainable from any respectable dealer in these oils. The table annexed gives the result of two series of experiments, made with three lamps of similar construction, with flat wicks cut from the same piece of cotton, and with an equal quantity of oil in each lamp. The first experiment was made by placing the lamp before a concave reflector, and the light being then passed through a narrow slit in a sheet of cardboard, in front of which was a prism, the prismatic ray was received on a sheet of white paper, and the purity and breadth of colour between the red and blue rays noted as shown in the table. The second was by removing the lamp from the microscope after a bee's tongue and a micrometer were brought into focus with a one-fourth objective and a B eye-piece, and measuring the distance when it became impossible to count the rings of the first, or the lines of the second. The remaining lines of the table give the length of carbonized wick after each period of burning, the quantity of oil consumed in each trial, the temperature of the room, the specific gravity of each sample of oil, and the temperature at which it permanently ignited on water, the total result showing that "Young's Paraffin" is the best material for a microscopical lamp of the three oils examined.

| | Young's Paraffin. | | Price's Belmontine. | | Diamond Crystal Oil. | |
|---|---|---|---|---|---|---|
| | 1st Trial. | 2nd Trial. | 1st Trial. | 2nd Trial. | 1st Trial. | 2nd Trial. |
| Character of light with prism, and width of band between the red and blue .............. | Clear and bright | $\frac{8}{10}$ inch | Very dirty and dull | $\frac{2}{10}$ inch | Not so dull as the last. | $\frac{4}{10}$ inch |
| Distance at which a microscopical object became indistinct by direct light ........... | After 6 *hours* | After $1\frac{1}{2}$ *hour* | After 6 *hours* | After $1\frac{1}{2}$ *hour* | After 6 *hours* | After $1\frac{1}{2}$ *hour* |
| Bee's tongue ............ | 20 feet | 22 feet | 8 feet | 8ft.6in. | 10 feet | 11 feet |
| Micrometer 1000 inch... | — | 8ft.3in. | — | 3ft.6in. | — | 5 feet |
| Carbonized (black) length of wick................ | 6 *hours* $\frac{4}{20}$ inch | $2\frac{1}{2}$ *hours* $\frac{4}{20}$ inch | 6 *hours* $\frac{7}{20}$ inch | $2\frac{1}{2}$ *hours* $\frac{7}{20}$ inch | 6 *hours* $\frac{6}{20}$ inch | 2 *hours* $\frac{6}{20}$ inch |
| Quantity consumed...... | $3\frac{5}{8}$ oz. | $1\frac{3}{8}$ oz. | $3\frac{4}{8}$ oz. | $1\frac{3}{8}$ oz. | $4\frac{4}{8}$ oz. | $1\frac{7}{8}$ oz. |
| Temperature of room ... | 55° | 58° | 55° | 58° | 55° | 58° |
| Specific gravity (hydrometer graduated for 60°) ..................... | 826 | 823 | 816 | 815 | 810 | 810 |
| Temperature of permanent ignition on water | — | 165° | — | 160° | — | 124° |

# TRANSACTIONS.

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*On the* Anatomy *of the* Generative Organs *in certain* Pulmogasteropoda. By Alfred Sanders, M.R.C.S., F.L.S., &c.

(Read June 14, 1865.)

The phenomenon of dichogamism displayed by the Pulmogasteropoda and their allies has engaged the attention of anatomists since their science has been cultivated. The subject is old, but I think its interest is even now by no means exhausted. The physiological import of the different glands which make up the complicated dichogamic apparatus of these animals has received various and contradictory interpretations. It was the gland situated in relation to the last lobe of the liver which was the subject of greatest dispute among the earlier writers; one party, observing only the ova, and neglecting or misinterpreting the zoosperms, maintained its ovarian character; others, denying the existence of the former and paying attention only to the latter, were equally strenuous in maintaining its testicular character. These authors, thus committed to a one-sided view of the functions of this gland, were thrown on their resources to find another which would answer the purpose of a testis or ovary, as the case might be.

Although Swammerdam,* in describing the anatomy of one species of snail, calls the gland in question the ovary, in another species he assigns that character to the albumeniparous gland, while in both he sought the testis in the multifid vesicles. Cuvier † also described this gland as the ovary, and referred to the albumeniparous gland and prostate as together forming the testis. G. R. Treviranus,‡ on the contrary, held just the opposite opinion, considering the former to be the testis, and the albumeniparous gland to

* 'Buch der Natur,' trans. by Thomas Flloyd, 1758.
† 'Annales du Muséum,' vol. vii, 1806.
‡ 'Tiedemann und Treviranus' Zeit. für Physiologie,' i, 1824.

be the ovary; this opinion was followed by Brandt and Ratzeburg,* who could find no trace of ova even under the microscope; also by Prévost,† Verloren,‡ and Paasch.§ Of those who adopted the opinion of Cuvier more or less completely, C. G. Carus || was the most conspicuous; he considered the zoosperms which he saw in the follicles of the dichogamic gland to be the muscular fibres of their walls, and those which he found in the duct to be strongly developed cilia. Van Beneden¶ followed Cuvier and Carus; Pappenheim and Berthélin** attempted to prove the same thing. Rud. Wagner at first believed the gland in question to be the testis,†† but was converted to the opposite view by a letter from Carus,‡‡ but then he was considerably puzzled as to whence could have come the zoosperms which he saw abounding in it, and which had before induced him to consider it as a testis. The first writer who maintained the double character of the gland was C. Vogt, in a paper on the anatomy of *Ancylus fluviatilis*;§§ Stein|||| confirmed his statement by investigations into the structure of the apparatus in Limnaus and Planorbis. Heinrich Meckel,¶¶ in an elaborate paper, describes each follicle of the gland as possessing two membranes, one invaginated in the other, the inner producing zoosperms, and the ova being produced between the two; the same arrangement occurs, according to him, in the ducts also. V. Siebold*** entirely adopted this description; Semper,††† Gegenbaur,‡‡‡ and Moquin-Tandon,§§§ while conceding a double function to the gland, denied the existence of the second membrane. The latest writer on the subject that I know of, Dr. Lawson,|||||| has attempted partially to return to the interpretation of Cuvier, inasmuch as he considers the prostate to be the testis.

The fact of so many eminent writers taking such opposite and contradictory views of the same apparatus shows the obscurity of the subject. The object of this paper is to endeavour to clear up the matter, as far as possible, by demonstrat-

* 'Medizinische Zoologie,' 1827.
† 'Mem. Soc. Phys. de Genève,' v, 1832.
‡ 'Responsio ad Questionem,' 1837.
§ 'Wiegmann's Archiv,' 1843-45.
|| 'Müller's Archiv,' 1835.
¶ 'Ann. Sci. Nat.,' v, 1836.
** C. R., 1848.
†† 'Lehrbuch,' 1834, 1835.
‡‡ 'Wiegmann's Archiv,' 1835.
§§ 'Müller's Archiv,' 1841.
|||| Ibid., 1842.
¶¶ Ibid., 1844.
*** 'V. Siebold und Stannius' Lehrbuch,' 1845-48.
††† 'Siebold und Kölliker's Zeitschrift,' 1857.
‡‡‡ 'Vergleich. Anat.,' 1859.
§§§ 'Mollusques de France.'
|||||| 'Quart. Journ. Mic. Sc.,' 1861 and 1863.

ing the actual development and course of exit of the zoosperms in the order Pulmogasteropoda; for this purpose it is necessary to give a short sketch of the anatomy of two or three species taken from two different families in the order; I have selected *P. corneus, L. stagnalis,* and *H. aspersa,* as being distinctive species and also very common.

Fig. 1, Pl. VII.—The dichogamic gland in *P. corneus* occupies the first whorl of the shell; it is not imbedded in the liver, as is the case in *H. aspersa* and *L. stagnalis,* but simply overlaps it by its anterior extremity; it is covered by an extension of the mantle, which forms a muscular envelope, separating it from the internal surface of the shell. The gland is formed by an immense number of elongated blind sacs, which are closely packed together; the walls of the sacs are composed of a fine membrane, lined by a ciliated epithelium; they all open into a longitudinal duct, which runs along the concave surface of the gland from one end to the other. The cæcal extremities are filled with ova; the riper ones are of a yellowish colour; this, with the orange-coloured débris which also abounds in this part of the sac, gives a yellowish spotted appearance to the outside of the gland. In the development of the ovum the germinal vesicle and spot are first found free, the yolk being developed afterwards; the smallest ovum which was found that had acquired a yolk measured ·0011″, the germinal vesicle of the same measured ·0005″, and the spot ·0002″. The fact of the germinal vesicle being first formed, and afterwards developing a yolk around itself, agrees with what is found by other observers in other classes of animals. The remaining portion of the sac towards its mouth is occupied by sperm-cells and zoosperms in various stages of growth. The sperm-cells, on being examined under the microscope with the simple addition of the fluids of the animal, appear as clusters of cells, with finely granular contents, the individual cells varying in size from ·0003″ to ·0008″. I was totally unable to find any cell-wall enveloping these clusters, such as would be found if they were developed from a parent cell, as is described by some writers. On the addition of dilute acetic acid a nucleus is to be observed occupying nearly the whole of the cell in the smaller ones, but in the larger ones being more restricted in its position; this nucleus is composed of coarse granules, but does not appear to be separated from the rest of the cell contents by any distinct partition, but, on the contrary, the coarser granules of the nucleus gradually merge into the finer granules of the remainder of the cell. The course of the development of the zoosperms from these cells appears to be as follows:—The smaller ones gradually increase in size; as they grow larger they begin to elongate, the granules of the nucleus becoming more and more concentrated and compressed together, until they show only as a dark spot; as the cell elongates the nucleus also elongates and ultimately forms the caput of the zoosperm; the remaining portion becomes thinner and longer until at last the two opposite walls coalesce and form the fine thread-like tail; thus each single zoosperm is formed by the direct transformation of each single cell. As the cells occur in clusters, so the young zoosperms at first occur in bundles, but they soon break away from each other, and are then ready for the performance of their proper function.

The duct immediately after quitting the gland becomes greatly enlarged and studded over thickly with little cæca, which give it a villous appearance; it is situated in a depression in the liver, and, gradually becoming attenuated, it enters the enlarged extremity of the oviduct; the cæca and the duct are strongly ciliated, the direction of the current being towards the gland; during life the duct underwent peristaltic motions like the small intestines.

The albumeniparous gland is situated to the left of the gizzard; it is of a bluntly conical form and of a pink colour; it pours its secretion into a duct which runs through its centre, and terminates in the enlarged extremity of the oviduct, close by the entrance of the duct of the dichogamic gland.

The oviduct commences by an enlarged extremity; for $\frac{3}{10}''$ of its length it is so intimately united to the vas deferens as to require rather delicate dissection to separate them, and, were it not for the difference in colour, they would give the observer, at first sight, the idea that they were one and the same duct; the walls then acquire greater thickness, and become semi-transparent, containing large gelatinous cells; this part appears to secrete the cement by which the eggs are attached to stones after they are hatched; soon after this thickened portion the oviduct contracts in diameter and terminates externally in front of the opening of the lung on the left side of the body; immediately before its external opening it receives the duct of the spermatheca.

The vas deferens commences as a separate duct at the enlarged head of the oviduct; the prostate gland pours its secretion into it at $\frac{4}{10}''$ from its commencement. The prostate is a compact gland, made up of follicles closely pressed together; these follicles are all ciliated, and pour their secretion into a widened part of the vas deferens, which then acquires muscular parietes, and, after passing for a short distance through the parietes of the body, terminates in the penis. The penis consists of an external bag, which forms a sort of prepuce, which contains a solid rod-like prolongation of the vas deferens; this body, which recalls by its situation the glans penis, is grooved on one side and attached to the prepuce by the other, and terminates by two projecting lips; at the base of the groove is the opening of the vas deferens, surrounded by a projecting margin; the prepuce is attached to the walls of the body by two retractor muscles, and opens externally just behind the left tentacle.

Fig. 2.—In *Limnæus stagnalis* the dichogamic gland, contrary to what takes place in *P. corneus,* is imbedded in that lobe of the liver which occupies the first whorl of the shell; the cæca are globular, and are arranged on the excretory duct like a bunch of grapes. The ova and sperm-cells occupy the same position towards each other as in *P. corneus;* the ova are of the same yellowish colour, and it would be impossible to distinguish the sperm-cells of *L. stagnalis* from those of *P. corneus*; the course of development is the same in both species; the duct has the same kind of enlargement in its course as that of *P. corneus,* but it is not so large nor are the cæca upon it so long, it also tapers more gradually to its termination in the oviduct. The albumeniparous gland lies close to the gizzard, and is directed transversely across the body. The oviduct is more easily separated from the vas deferens in this species than in *P. corneus;* attached to it are two separate gland-like bodies, whose structure very much resembles that of the thickened part of the oviduct of *P. corneus,* and whose functions appear to be the same. Just before the oviduct terminates in front of the opening to the lung it receives the duct of the spermatheca, which in this species is a globular sac.

The vas deferens, on quitting the oviduct, has partly muscular and partly glandular walls, the muscular fibres forming a reticulum, between the meshes of which are situated minute gland-cells; the duct speedily becomes enlarged into a pyriform sac, after which it loses its glandular character, and becomes wholly muscular. I presume that the glandular walls and pyriform sac secrete a fluid analogous to that secreted by the prostate in the *P. corneus,* as the Limnæus possesses no distinct organ that answers to that gland; the vas deferens, after becoming muscular, passes through the parietes of the body for a short distance, and terminates in the penis; this is shaped like the italic letter *s*. The vas deferens opens into its posterior extremity on a small papilla, from which two triangular projections run down to the orifice, which is situated on the right side of the animal, and opens just behind the right tentacle.

Fig. 3.—In *Helix aspersa* the dichogamic gland consists of elongated cæca, like *P. corneus*, and is imbedded in the liver, like *L. stagnalis*. The cæca are arranged, two or three together, on the termination of a branchlet of the duct. The contents are arranged precisely as in the former species, the ova occupying the cæcal extremities, and the sperm-cells and immature zoosperms occupying the remainder of each cæcum. The course of development of the zoosperms is precisely similar in this as in the other two species, and could be described in the very same words.

The branchlets from the different groups of cæca having united together and formed a common duct, the latter leaves the gland, and becomes convoluted in regular folds. After a short course it reaches the albumeniparous gland, where it undergoes a reflexion of its course backwards in the substance of that gland; then it turns forwards again, and opens by a small orifice into the commencement of the oviduct. H. Meckel* describes a second duct, which he supposes is the oviduct, but which Semper† suggests is a nerve. The latter is correct, for not only is the quasi duct like the large nerves in structure, but it can be traced to a branch of the subœsophageal ganglion, which accompanies the oviduct on its inner side as far as its junction with the albumeniparous gland, and there divides into two branches—one, crossing beneath the oviduct and spermatheca, goes to supply the liver and gland of viscosity; the other accompanies the duct of the dichogamic gland, on which it is distributed.

The albumeniparous gland is a large sickle-shaped gland, having externally an obscurely lobulated appearance; it is situated on the right side, with its concavity embracing the enlargement of the gullet, and being overlapped slightly on its left side by the liver. It consists of large gelatinous cells, which pour their contents into a central canal, which again empties into the oviduct; this is a large canal, very much puckered, and apparently shortened by the prostate, which occupies its inner side; the vas deferens is a groove situated on its floor, being partially separated from it by a longitudinal flap, which divides the whole into two half canals.

The prostate is composed of numerous follicles, arranged along the whole length of the oviduct, each follicle opening into the vas deferens; it appears to be homologous with the

* Op. cit. † Op. cit.

prostate in *P. corneus*, the follicles, instead of being massed into a compact gland, as in the latter, being spread out and separated over a large surface; a branch artery runs up through the midst of these follicles, which, on a transverse section, might be taken for a duct. The follicles contain large cells, which are full of bright granules, and having at one end a circular nucleus; they measure about ·0030″ long. The two ducts at the anterior termination of the oviduct separate from each other, the section into which the prostate pours its secretion leading directly into the free part of the vas deferens, which goes to join the penis, its point of entrance into that organ forming a line of partition between it and the flagellum. The oviduct soon opens into the side of the duct of the spermatheca by a nipple-like projection; which from this point to its entrance into the vestibule may be called the vagina; it receives the ducts of the two multifid vesicles just before its termination.

The spermatheca is a globular sac, situated close to the anterior extremity of the albumeniparous gland, beneath the pericardium; it has a tolerably long duct, which, just before it becomes the vagina, has attached to it a diverticulum, much longer and larger than itself; which is attached by connective tissue to the oviduct, and terminates close to its commencement, and was described by Swammerdam as opening into it. During copulation the penis projects into the duct of the spermatheca, nearly as far as the entrance of the diverticulum; immediately after copulation the spermatheca-duct and its diverticulum are found to be full of mature zoosperms; generally there is a sort of spermatophore, first described, I believe, by Carus; it is a long horny ribbon, longitudinally rolled together, tapering at each end, swollen in the middle, and there containing a mass of zoosperms; this appears to get into the spermatheca, and then to be broken up.

The dart-sac has thick muscular walls, which consist of transverse and longitudinal fibres, the former being principally internal, the latter external; the dart is four-cornered, and appears to be secreted from a papilla at the bottom of the sac. These darts are occasionally to be found buried among the viscera; for instance, I have found two darts close to the albumeniparous gland in one case; in another, one dart was found in the interior of the duct of the spermatheca. The dart-sac opens into the vestibule to the right of the entrance of the vagina, the opening being guarded by a raised margin. The walls of the vestibule are studded with spicules of carbonate of lime; it opens externally, close to the right tentacle. During copulation it is everted, so as to bring the opening of the vagina close to the orifice.

The penis is composed of two parts, the flagellum and the penis proper. One is at a loss to discover of what particular use the flagellum is, as it is not everted during coition, and does not appear to be glandular; but it must be supposed to have some use in the economy of these animals, as they are at present victors in the "struggle for life," and are therefore not very likely to be found weighted by any superfluous organs.

From the entrance of the vas deferens into the penis there run four folds of mucous membrane, which terminate in a sort of glans, which is contained in a loose muscular bag—the prepuce; this opens into the vestibule, close to its external orifice, having passed beneath the retractor muscle of the right tentacle. This arrangement appears to bear some distant relation to what occurs in *P. corneus,* for a very little more would separate the male opening from that of the female; and the penis passing beneath the retractor muscle represents faintly the vas deferens of the Planorbis passing through the walls of the body.

The facts which I have thus endeavoured to describe not only confirm the opinion of those writers who, notwithstanding the improbability of the idea, yet persisted in maintaining that one and the same gland, at the same period of time, secreted both zoosperms and ova, but also show that the former—in these Invertebrata, at least—are developed in a contrary manner to that which takes place in Mammalia, in the latter being formed in the interior of cells, the "vesicles of evolution;" in the former being those vesicles of evolution themselves, simply altered in shape and attenuated. I may add that I cannot confirm the statement of H. Meckel, that each follicle is double, and that there is a double duct. The structure which he supposed to be a duct turns out to be a nerve, and the follicles of the dichogamic gland have always appeared to me to be single, the various contents not being separated from each other by any membrane, however thin.

In conclusion, I wish to explain that I have adopted the term "dichogamic" in this paper in consequence of a suggestion I found in G. H. Lewes's 'Life of Aristotle,' in which he points out the absurdity of denominating by the same word the abnormal hermaphroditism of arrested development and the normal occurrence of bisexualism as in the present instance. He coined the above word, which I have accordingly adopted.

# Descriptions *of* New *and* Rare Diatoms. Series XVII.

By R. K. Greville, LL.D., F.R.S.E., &c.

(Communicated F. C. S. Roper, F.L.S., &c.)
(Read June 14, 1865.)

Plates VIII & IX.

## Cladogramma.

Frustules simple, disciform; lateral valves convex, marked with radiating, irregularly forked lines; connecting zone ring-like.

I am not aware that Ehrenberg has anywhere defined this genus, which is only known by the figure he has given of his *Cladogramma Californicum* ('Microgeologie,' pl. 33, 13, f. 1**). Ralfs, in introducing it into his arrangement, in Pritchard's 'History of Infusoria' (1861), gives a copy of the figure above referred to, but also adds, "The characters of this genus are unknown to us." Under these circumstances, I have, in adopting Ehrenberg's name, ventured to supply a generic character.

*Cladogramma conicum*, n. sp., Grev.—Lateral valves conical, with numerous, nearly straight, forked, or simple lines. Diameter ·0017″. (Figs. 1 and 2.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq ; rare.

It is quite possible that the present diatom may differ from Ehrenberg's undefined genus, of which only the hemispherical valve has been discovered. Mr. Kitton obtained a single specimen, which was unfortunately lost in its transit through the post-office, and with it the opportunity of determining the question. His sketch, now before me, is precisely similar to Ehrenberg's figure, showing about four lines radiating from the centre, which divide and subdivide into diverging branches, about half way between the centre and margin. In the present species the valve is distinctly conical, and the lines radiate rather closely from the very centre, dividing in a straight manner somewhat irregularly, with occasional independent lines, to fill up the spaces, so that at the margin all the lines are nearly equidistant. The connecting zone appears to be slightly vertically rugose.

## Thaumatonema.

*Thaumatonema?* *costatum*, n. sp., Grev.—Minute; disc with minute radiating puncta, and 8 rib-like lines; centre a smooth nodule, giving off 2 simple, diverging, cylindrical, flatly capitate processes. Diameter ·0020″. (Fig. 3.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

I venture to place this little diatom in the genus *Thaumatonema* because the only material difference seems to lie in the absence of the little stalk which supports the diverging processes. They seem, in the present instance, to spring at once from a smooth, prominent, central nodule, but the flat dilated apices are so similar to those in the genus above mentioned that they may be regarded with some confidence as articulating surfaces. Specifically, the radiating ribs constitute an excellent character.

## DICLADIA.

*Dicladia? robusta,* n. sp., Grev.—Large; valves ovate-conical, beset with scattered minute spines, both terminating in a single strong horn. Diameter ·0020″. Length, including the horns, ·0055″. (Fig. 11.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; extremely rare.

Both valves are furnished with strong horns, as in the diatom I have called *Dicladia Barbadensis;* but in the present instance they are undivided. One of the valves is somewhat larger than the other, and both are sparingly and irregularly covered with minute spines, a few of which are found even on the horns.

## STICTODISCUS.

*Stictodiscus Hardmanianus,* n. sp., Grev.—Large; radiating compartments very numerous, reaching nearly to the centre, with 5—6 transverse rows of minute puncta at the base, followed by a single row of pseudo-pores; centre occupied by two circles of granules, and a minute cluster at the umbilicus. Diameter ·0050″. (Fig. 4.)

*Hab.* Monterey deposit; L. Hardman, Esq.

An exquisite species, well distinguished by the centrical circles of granules and the marginal rows of exceedingly minute puncta. The very numerous septa are transversely divided, so as to appear clathrate or ladder-like, while by slightly altering the focus a single pseudo-pore is observed in the middle of each division.

### LIRADISCUS.

*Liradiscus ellipticus,* n. sp., Grev.—Disc elliptical, oval, or oblong, with the ends subacute; sinuate reticulation very small. Length of disc about ·0030″. (Fig. 6.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

Very similar to *L. ovalis,* only with the ends always more or less acute, and the reticulation comparatively minute.

### ASTEROLAMPRA.

*Asterolampra eximia,* n. sp., Grev.—Large; segments numerous, more than one third of the radius in length, quadrately cellulate, their inner margin very convex, and composed of elongated cellules; umbilicus irregularly cellulate. Diameter ·0060″. (Fig. 10.)

*Hab.* Barbadoes deposit, Cambridge estate; L. Hardman, Esq.

A most beautiful species, quite distinct from those previously described. The umbilicus is loosely and irregularly cellulate, and gives off, in the specimen before me, 22 umbilical lines. The segments are remarkable for the arched outline of their inner margin, which is composed of 6 linear elongated cellules, the 4 middle ones being more prominent than the 2 lateral ones.

### BIDDULPHIA.

*Biddulphia? decorata,* n. sp., Grev.—Valve in front view rectangular, produced at the angles into short, thick, rounded processes, wholly filled with rounded cellules; median surface convex, with a single stratum of cellules, which in the front view appear to be vertically oblong; the rest of the valve smooth, with one or two transverse rows of round cellules. Length ·0026″. (Fig. 7.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

I have only seen two specimens of this diatom, the genus of which must be considered doubtful. The median surface is curious; the upper half of the oblong cellules projecting above the line, which would render the surface papillose.

## PORPEIA.

*Porpeia quadriceps?* Bail.—(Fig. 13.)

Having obtained, since the publication of my previous series, a most remarkable frustule of what I take to be a variety of this diatom, I offer a figure of it in addition to my former illustrations. It will be perceived that Bailey's drawing, as copied into Pritchard's 'History of Infusoria' (if, indeed, it represents the same thing), indicates, when compared with our present diatom, a wide range of form.

## HEIBERGIA, n. gen., Grev.

Frustules compressed, quadrilateral, cellulate, with a punctate surface at the angles, where they probably cohere; valves with one longitudinal and several transverse costæ, the longitudinal one terminating towards each extremity in a blank space.

This interesting genus, which I propose in honour of Dr. P. A. C. Heiberg, author of the valuable 'Conspectus Criticus Diatomacearum Danicarum,' is nearly allied to *Biddulphia,* but differs in having a median costa terminating at each end in a definite blank space, and in the lateral valves not being constricted at their base. There appears also to be some affinity between this genus and *Entogonia,* the broad borders of which, with their transverse costæ, strongly resemble the two sides of the valve of *Heibergia,* and the curious blank spaces near the ends of the valve in both genera seem quite analagous.

*Heibergia Barbadensis,* n. sp., Grev.—(Figs. 8 and 9.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

Frustules cellulate; cellules hexagonal, conspicuous in the valves, minute in the connecting zone; the angles broadly and slightly mammillose, finely punctate. Valves linear-oblong, longitudinally and transversely costate. The longitudinal or median costa terminating at each end in a subtriangular blank space, which is separated from the punctate angles by a belt of cellules. Transverse costæ 5—8, extending from the median costa to the base of the valve, which is not constricted. All the costæ are very slender and slightly flexuose. Length of valve ·0055″.

## HEMIAULUS.

*Hemiaulus crenatus*, n. sp., Grev.—Valve in front view with the angles produced into minute subconical horns; median space elongated, slightly convex, with numerous crenations; structure very minutely punctate. Breadth of frustule ·0037″. (Fig. 12.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; very rare.

Quite unlike any of the other species obtained from the same deposit. In the perfect frustule now before me the two valves united only measure ·0007″ in the centre, and from the suture to the apex of the horns is under ·0004″. Number of crenations 17, but this character doubtless varies according to the age (?) of the frustule.

*Hemiaulus minutus*, n. sp., Grev.—Minute; valve in front view with the angles produced into very minute short horns, tipped with a short spine; median space divided into three equal parts, the central one convex, with 2 transverse costæ reaching to the suture; structure minutely punctate. Breadth of frustule ·0014″. (Fig. 5.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

The minute horns are rather slender and the spines extremely small. The punctation of the valve is not crowded.

## TRICERATIUM.

*Triceratium figuratum*, n. sp., Grev.—Minute; valve with concave sides, and broadly ovate rounded angles; margin broad, continuous, with a few remote strong striæ; central area defined by lines cutting off so much of the angles as to leave only a minutely punctate triangular space; angles within filled with minute puncta. Distance between the angles ·0012″. (Fig. 15.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

A beautiful little species, about the size of *T. brachiatum*, and totally unlike any species I am acquainted with.

*Triceratium brevinervum*, n. sp., Grev.—Minute; valve with strictly straight sides and subacute angles, each of which is bounded interiorly by two short, marginal, vein-like lines; central area with small, scattered, remote puncta; angles filled with more minute and more crowded puncta. Distance between the angles ·0022″. (Fig. 26.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.

A very neat-looking diatom, closely allied to *T. venulosum*, of which it may possibly prove to be a variety. But in all the specimens I have seen there is only a single pair of short lines to each angle (a line on each side).

*Triceratium implicitum*, n. sp., Grev.—Minute; valve with convex sides and very rounded angles; surface nearly filled with a closely sinuate network of minutely branching lines, not reaching to the margin. Distance between the angles ·0022″. (Fig. 25.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq.; exceedingly rare.

This very peculiar little species may be regarded as remotely allied to *T. labyrinthæum*, being similar in outline and size, and having the centre filled with a sinuous network. In the last-named diatom the cells are very much larger, and are, moreover, distinctly punctate. In our new species the network is minute and delicate, without puncta, and having a sort of prickly appearance, in consequence of very short lines being given off from the walls of the cellules.

*Triceratium zonatulatum*, n. sp., Grev.—Minute; valve cruciform, the four angles with nearly parallel sides and broadly rounded ends; surface with a faint, circular nucleus, surrounded by faint, scattered puncta; angles nearly filled up with minute crowded puncta, leaving a blank, transverse space between them and the central puncta. Distance between the angles ·0012″. (Fig. 17.)

*Hab.* Singapore; obtained from shell-cleanings, by Laurence Hardman, Esq.

This, and a number of other interesting species, are preserved in the cabinet of Mr. Laurence Hardman, who has kindly placed in my hands a large number of exquisitely mounted slides for examination. It is difficult to say whether the four-angled form of many of these *Triceratia* be the normal one. In some cases I believe that it is, and that in others five or six angles may also be a constant character. On the other hand, we know that additional angles are sometimes mere variations, as in *T. Favus, T. scitulum*, &c., which are occasionally four-angled, and in *T. striolatum*, as figured by Brightwell ('Mic. Journ.,' Vol. I, Pl. IV), where the angles vary from three to five. In the little species now before us the prominent characters are the large portion of the angles filled with crowded puncta, and the transverse blank spaces which separate the mass of puncta referred to from the apparently somewhat depressed centre.

*Triceratium latum*, n. sp., Grev.—Valve 4-angled and cruciform; angles very broad, with nearly parallel sides and semicircular ends; surface with very remote, scattered puncta, the extreme ends of the angles crowded with minute puncta. Distance between the angles ·0030″. (Fig. 20.)

*Hab.* Singapore; obtained from shell-cleanings, by L. Hardman, Esq.

A striking and distinct species. The puncta are so remotely scattered that but few are situated within the portions of the valve which constitute the arms of the cross.

*Triceratium quadricorne*, n. sp., Grev.—Small, cruciform; lobes somewhat narrowed towards the rounded ends; surface covered with a faint cellulation, and a punctum in each cellule; a small cluster of minute puncta at the extreme end of the angles. Distance between the angles ·0016″ (Fig. 16.)

*Hab.* Woodlark Island, South Pacific; in a dredging communicated by Dr. Roberts, of Sydney.

The cellulation of the valve is very delicate, (not hexagonal), and the punctum within each cellule minute. There is, in addition to the characters already given, a row of small marginal puncta, which are most conspicuous in the concavities.

*Triceratium inglorium*, n. sp., Grev.—Minute, 4-angled, with the angles rounded, the sides slightly concave and faintly striated at the margin; centre with a rather large circle of subclavate puncta; extreme ends of the angles with a cluster of minute puncta. Distance between the angles ·0008″. (Fig. 18.)

*Hab.* Manilla; obtained from shell-cleanings, by L. Hardman, Esq.

I have not been able to perceive any structure in the space between the circle of puncta and the margin.

*Triceratium sexangulatum*, n. sp., Grev.—Valve with six rounded angles, and concave sides; margin rather broad, continuous, with a row of puncta in the concave portions; surface filled with somewhat crowded circular cellules, which become gradually smaller towards the margin, and leave the angles smooth. Distance between the angles ·0013″. (Fig. 24.)

*Hab.* Woodlark Island, South Pacific; in a dredging communicated by Dr. Roberts, of Sydney.

A fine diatom, beautifully marked with circular cellules, which pass into small puncta next the margin, and especially at the angles, where, however, they stop, leaving a roundish blank space, crossed by a shadowy line just within the apex.

The margin is strong, narrow, and destitute of puncta as it passes round the angles.

*Triceratium reticulatum*, n. sp., Grev.—Valve 6-lobed, with a narrow, striated margin; lobes or angles broadly rounded; surface filled with a large reticulate cellulation, radiating in fasciculi towards the spaces between the angles, and becoming smaller towards the circumference. Distance between the angles ·0019″. (Fig. 21.)

*Hab.* Barbadoes deposit, Cambridge estate; in slides communicated by C. Johnson, Esq. Extremely rare.

An exquisitely beautiful species. Cellules subquadrate, radiating from a single cellule in the centre.

*Triceratium quadratum*, n. sp., Grev.—Large; valve with 4 subobtuse angles and straight sides, from each of which project inwardly 4—5 short vein-like lines; surface filled with roundish subequal cellules, scattered in the centre, but soon radiating; angles with roundish pseudo-nodules. Distance between the angles ·0050″. (Fig. 19.)

*Hab.* Barbadoes deposit, Cambridge estate; C. Johnson, Esq.

All the specimens I have seen of this fine diatom are 4-angled. In the centre there is often a sort of umbilicus, or, at least, a somewhat irregular circle of smaller cellules, around which the ordinary cellules are often more or less scattered before they pass into radiating lines, in which they are 4—5 in ·001″. Generally, if not always, a few short central spines are present.

*Triceratium parallelum* (Ehr.), Grev.—Small; valve 4—6-angled; angles slightly rounded, the sides straight; centre widely and faintly reticulate, while a broad band of parallel, subremote lines of granules fills up the space between the reticulation and the narrow margin. Distance between the angles ·0018.″ (Figs. 22 and 23.)

*Amphitetras parallela*, Ehr., 'Leb. Kreideth.,' p. 63, fid. Kütz.; Kütz., 'Bacill.,' p. 135; 'Sp. Alg.,' p. 134; Ralfs, in Pritch. 'Inf.' (1861), p. 858; Rabenh., 'Fl. Eur. Alg.,' p. 318.

*Hab.* Greece (fossil); Moron deposit (fossil); Red Sea dredgings, L. Hardman, Esq.

The present diatom satisfactorily illustrates the transition from a four- to a six-angled valve. Both forms occur in slides prepared by Mr. Hardman from Red Sea dredgings, and it is impossible to deny their specific identity. The triangular valve, however, has not been observed. The quadrangular form being alone known to Ehrenberg, led him probably to refer it to the genus *Amphitetras;* but after our more recent knowledge regarding the frequency of 4—6 angles in aberrant forms of genuine *Triceratia,* and in the absence of any structural peculiarity, I have no hesitation in placing these diatoms in the genus *Triceratium.*

*Triceratium polygonium,* n. sp., Grev.—Large; valve with 6 somewhat rounded angles and straight sides; surface filled with remote radiating lines of granules, except in the centre, which is faintly reticulate; margin strong, striated. Distance between the angles ·0022″. (Fig. 14.)

*Hab.* Among ballast, at Stoneferry, near Hull; George Norman, Esq.; cabinet of F. Kitton, Esq.

An interesting form, evidently allied to the preceding, but differing in its larger size, smaller and more distant granules, and especially in the strong, rather broad, striated border.

### AMPHITETRAS.

*Amphitetras nobilis,* n. sp., Grev.—Valve very large, with broad, somewhat ovate lobes or angles, and concave sides; centre depressed; surface filled with large, roundish or roundish-quadrate, radiato-concentric granules; angles terminating in short tubular processes. Distance between the angles ·0052″. (Fig. 27.)

*Hab.* In dredgings from the Red Sea; L. Hardman, Esq.

A magnificent species, and one of many undescribed novelties contained in my friend Mr. Hardman's cabinet. The form of the lobes or angles, and short tubular apices, appear to be amply sufficient to separate it from *A. antidiluviana,* to which it is most nearly allied.

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## NOTES *on the* FRACTURE *of* POLISHED GLASS SURFACES.

By F. H. WENHAM.

(Read June 14, 1865.)

THE short communication which I submit to your notice scarcely merits consideration as a discovery; but as the microscope has in this case immediately detected the cause of a well-known phenomenon, I bring it forward as an example of the use of the instrument in practical investigations.

It is a fact known to the philosophical instrument makers, that if a metal wire be drawn through a glass tube, a few hours afterwards the tube will burst into fragments. The annealed glass tubes used for the water-gauges of steam-boilers are sometimes destroyed in this way, after the act of forcing a piece of cotton waste through them with a wire for the purpose of cleaning the bore. This will not happen if a piece of soft wood is employed.

The late Andrew Ross informed me that on one occasion, late in the evening, he lightly pushed a piece of cotton wool through a number of barometer-tubes with a piece of cane, for the purpose of clearing out any particles of dust. The next morning he found most of the tubes broken up into small fragments, the hard siliceous coating of the cane proving as destructive as he had previously known a wire to be.

After having drawn the point of a steel burnisher over the surface of a slip of polished glass, the following appearances will be observed under the microscope, using the polarizing apparatus and selenite plate, with a two-thirds object-glass. A coloured stripe is visible in the passage of the burnisher, showing that the surface of the glass has been placed in a state of tension in the direction of the line. The glass, too, seems not altogether devoid of plasticity, for the waves of colour show that it has been carried forward in ripples, resembling the mark left on a leather-bound book after the passage of a blunt point. It may be inferred from this that the mere burnishing of the surface of the glass with a substance inferior in hardness will, without any scratching, cause an irregular strain in the bore of tubes sufficient to split them, and the concussion attendant upon the fracture often reduces the tube to small fragments.

If the burnished lines upon the glass slip be examined a few days afterwards the colours will have become much less visible, showing that the strained portion of the glass partly recovers its equilibrium.

On attempting to polish out a minute scratch on the surface of a piece of glass it sometimes appears to widen during the process, and at length resolves itself into two irregular parallel rows. Also, a clean cut made with a diamond on a piece of plate-glass, if left for a time, the surface in the vicinity of the cut will break up, forming a coarse irregular line. If the diamond be raised and struck lightly on the surface of the glass, the form of the edges of the short stroke thus made may be plainly seen, using the binocular polariscope. A conical ridge of glass appears to be left with its apex under the line of the cut, and the glass is frequently wedged up on both sides of the ridge, explaining the cause of the double line of fracture which sometimes makes its appearance in polishing out a scratch. This effect may also be exemplified by observing the marks left on a polished glass surface from the light blows of a steel centre-punch. The point of the punch drives in an atom of the glass, and the fracture extends some distance into the interior, expanding downwards in the form of a truncated cone. The polariscope shows that the conical centre is in a state of compression, and that the surrounding exterior portion of the glass is also under strain.

The smooth, round edge of a glazier's diamond, when drawn over a polished glass surface, burnishes down and compresses the glass beneath the cut, and in the case of thin sheets the wedge-like force of the compressed line splits the glass nearly through; but when the glass is thick and rigid, as plate-glass, unless the sheet is bent back and broken through immediately after the cut, greater difficulty will be experienced if allowed to remain for a time, for the compressed line of glass will speedily tear up the portion on both sides, leaving a wide ragged groove in place of the original clean and scarcely visible line.

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## *On the* APPLICATION *of the* SPECTROSCOPE *to the* MICROSCOPE.

By JOHN BROWNING, F.R.A.S.

(Read June 14, 1865.)

IN the last number of the 'Quarterly Journal of Science' appeared a valuable article on "The Application of the Spectroscope to the Microscope," by H. C. Sorby, Esq., F.R.S., which attracted considerable attention in the scientific world. After making some experiments in the same direction, I promised to communicate a paper on the subject to this Society, but, owing to pressure of business, the President desired me to defer it to the present meeting.

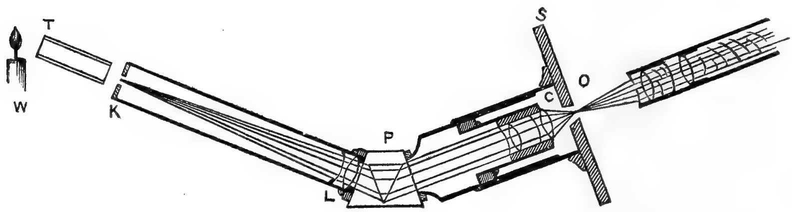
Fig. 1 represents the kind of apparatus, together with the optical arrangement, which I had found give the best results. It seems to me to possess some advantages over Mr. Sorby's original contrivance.

1st. In giving a black field round the spectrum, by excluding all extraneous light, an advantage which will be at once appreciated by microscopists. This enables faint absorption-bands to be seen which might otherwise escape notice.

2nd. By giving a spectrum of an uniform length any description of micrometer may be used for taking the measurements of the position of the bands.

As the microscope armed with this auxiliary apparatus will probably before long be used for obtaining the spectra of the absorption-bands of blood in criminal cases, the importance of being able to reduce observations to actual measurement can scarcely be over-estimated.

Fig. 1.




In Fig. 1 a prism is placed at P, which is enclosed in a box, so as to give a black field by excluding extraneous light. The ray of light, after passing between the knife-edges at K, are rendered parallel by means of the lens at L. Then passing through the prism and condenser (C), they reach the objective of the microscope. The light is placed at W. If it is proposed to examine a liquid it can be placed in a small tube (T), closed at one end. A transparent preparation may be placed on the stage S at O.

By the addition of a small telescope instead of a condenser, this contrivance can be applied to a microscope in place of the eye-piece. It can then be used for the examination of opaque objects.

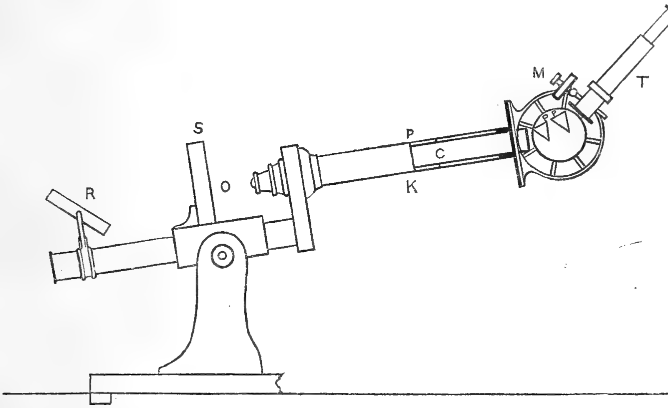
For simplicity and economy this arrangement will probably be preferred to any of the other contrivances which have been proposed, and to which I shall presently refer.

At the last monthly meeting Mr. Wenham communicated a very valuable and suggestive paper by W. Huggins, Esq., F.R.S., on "Spectrum Analysis applied to the Microscope."

Mr. Huggins had in view principally the best means of obtaining the spectra of the contents of various kinds of cells, believing that experiments in this direction would be of great value to physiologists.

The apparatus Mr. Huggins has used for the purpose consists of a star spectroscope, which I made for him; of which the collimating tube was inserted in the body of the microscope instead of an eye-piece. With this contrivance he has succeeded in obtaining a spectrum showing the absorption-bands from a mere fragment of a single blood-disc, when mounted transparent.

Fig. 2.




In Fig. 2, K represents the knife-edges, C the tube containing the collimating lens, P P the prisms, T the telescope, and M the micrometer; the object is placed on the stage S at O, and can be illuminated from below by the mirror R, if transparent, or, if opaque, from above, by any kind of condenser.

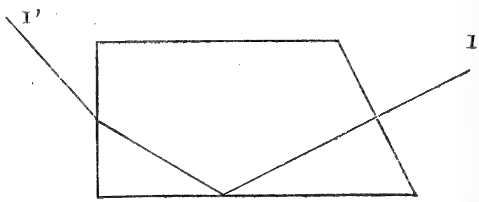
Mr. Huggins also suggested that the apparatus could be used to examine opaque objects, but the great drawback to its extended use is that it is rather inconvenient and expensive. Other investigations have, unfortunately, prevented Mr. Huggins from pursuing this subject further himself at present, but it is greatly to be hoped that he will shortly find time to devote some attention to it, as the immense experience that he has had in all kinds of spectrum observations, and the important discoveries which he has made in respect to the spectra of the stars and nebulæ would lead us to hope that he would have a better prospect of success in pursuing these investigations than an observer with less experience.

I shall now describe the most recent contrivances Mr. Sorby has devised and adopted, and which I have had the honour of working out with him. First, then, with regard to the plan of mounting the spectroscopic apparatus below the stage of the microscope, Mr. Sorby suggested that a prism might probably be made of dense flint glass, of such a form that it could be used in two different positions, and that in one of these positions it should give twice the dispersion that it would when placed in the other position; but that in whichever position it might be employed, the angle made by the incident and emergent rays should be the same.

I succeeded in making such a prism. Figs. 3 and 4 represents this prism used in two different positions and fulfilling the required conditions, *i* and *i′* being the same angle as I and I′.

For most absorption-bands, particularly if faint, the prism will be used in the first position, in which it gives the least dispersion (Fig. 3); while whenever greater dispersion is re-

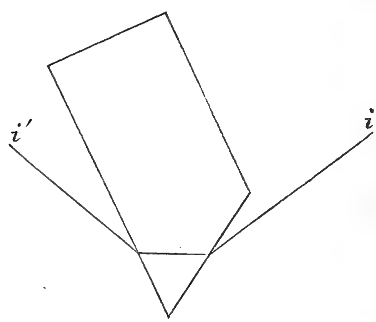
Fig. 3.




quired, so as to separate some particular lines more widely, to show the spectra of the metals or Fraünhofer's lines in the solar spectrum, then the prism must be placed in the position shown in Fig. 4.

Mr. Sorby has informed me that for liquids or transparent

Fig. 4.




objects nothing could work better than this contrivance, but it is, of course, not applicable to opaque objects.

Conversing with our President and Mr. Slack, after the last meeting, I mentioned that I believed that some form of direct-vision prisms, applied in the body of the microscope, would prove the best arrangement to answer both purposes, and Mr. Slack expressed the same opinion.

Fig. 5 represents such an arrangement made with a combination of the direct-vision prisms invented by A. Herschel, Esq., B.A. The line R R′ shows the path of a ray of light

Fig. 5.

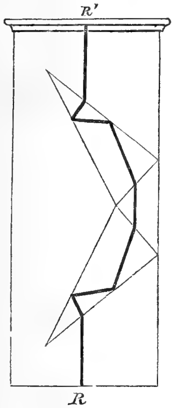
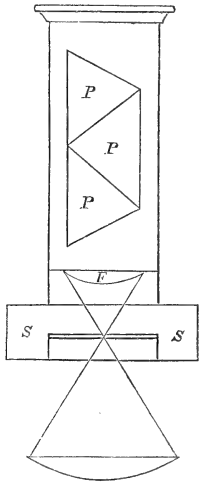



Fig. 6.




through the prisms, and it would be seen that the emergent ray R′ is parallel and coincident with the incident ray R.

About a month since, I adapted a Hoffman's spectroscope to Dr. Miller's microscope, making it occupy the place of the eye-piece. The performance was not at all satisfactory, and Dr. Miller finds the arrangement which I first described, when applied to the eye-piece in this way, gave much the best results.

I had recently made a spectroscope for the examination of the spectra of the stratifications in electrical discharges for J. P. Gassiot, Esq., F.R.S. This instrument contained a compound direct-vision prism, of the form represented by P P P, Fig. 6. Having submitted this prism to Mr. Sorby, he at once gave it the preference, on the score of compactness.

Any number of these prisms may be used, according to the amount of dispersion required. They are mounted in a similar way to a Nicol's drism, and are applied directly over the eye-piece of the microscope.

The slit S S, which is used to show the lines in the spectrum, is placed in the focus of the first glass (F) if a negative, or below the second glass if a positive, eye-piece be employed. One edge of this slit is movable. In using it the slit is first opened wide, so that a clear view of the object is obtained. The particular portion of the object of which it is desired to examine—the spectrum—is then brought to coincide with the fixed edge of the slit, and the movable edge is screwed up, until a brilliant-coloured spectrum is produced. The absorption-bands, if the specimen gives any, will then be readily found by slightly altering the focus of the microscope.

This contrivance answers perfectly for opaque objects, without any preparation; it is not expensive, and it does not add appreciably to the bulk of the microscope. When desirable, the same prism (Fig. 6) can be placed below the stage, and a micrometer used in the eye-piece of the microscope, thus avoiding multiplication of apparatus or increasing the expense. By Mr. Sorby's kindness I exhibit an almost microscopic spot of blood on a card, the absorption-bands in which can be readily seen with this arrangement. On the table I have also the pleasure of exhibiting some very beautiful crystals and solutions of Mr. Sorby's preparation.

It has been urged that there is a great similarity between the absorption-bands given by various substances. To this I answer that I have never seen two spectra alike; and I beg to direct your attention to the various diagrams which I exhibit, the best of which are Mr. Sorby's, in proof of the correctness of my assertion.

In the 'Chemical News' of June 2nd, Mons. Marc Delafontaine has proposed to make use of the absorption-bands to distinguish between the salts of erbium, terbium, and didymium.

Mr. Sorby says of the correct performance of a spectrum adaptation, "the best tests are—first, that the absorption-bands in blood can be seen when they are very faint; second, to well divide the bands in permanganate of potash; and, third, to see distinctly the very fine line given in the red by a solution of chloride of cobalt. In a concentrated solution of chloride of calcium there is a line so fine that it looks like a Fraünhofer's line. An instrument that shows all these well is all that can be desired." I am glad to say that Mr. Sorby, to whom we are so much indebted for the original idea, is actively pursuing his investigations in a new direction in this very interesting branch of science.

It is very desirable that others should also give their attention to this matter, each choosing different subjects for investigation. The recent important discoveries of Dr. Bence Jones, F.R.S., and Dr. Dupré, on the detection of lithium in the eyeball a few hours after its administration, could be advantageously carried further in this manner; and the success which has attended the researches of Professor Stokes and Mr. Sorby would lead us to believe that any time bestowed on the subject, either by the chemist, physiologist, or mineralogist, would meet with an ample reward.

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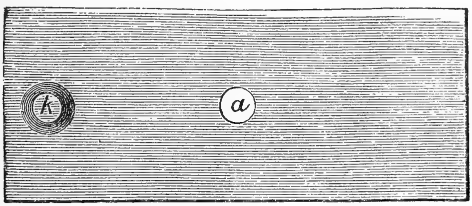
## DESCRIPTION *of a* NEW FORM *of* LIVE-TRAP, *and* PARABOLIC REFLECTOR. By RICHARD BECK.

(Read June 14, 1865.)

IN endeavouring to examine under the microscope many small living objects I had often felt a great want of some piece of apparatus by which the specimen could be confined in a small space without injury, and yet in a manner that permitted the use of the necessary object-glasses and apparatus. After trying various schemes I venture to bring before your notice the following live-trap, which supplies most of those requirements which I had been unable previously to obtain.

Fig. I.




The contrivance is simply a plate of glass (Fig. I), with a small drilled hole (*a*), covered above and below with pieces of thin glass similar to those in Fig. II; but some arrangement

Fig. II.

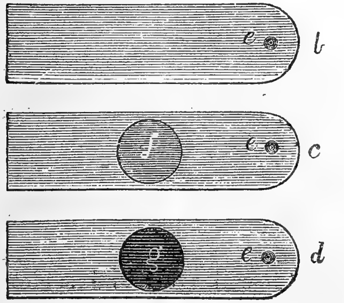



Fig III

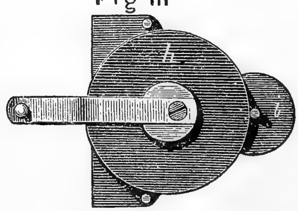
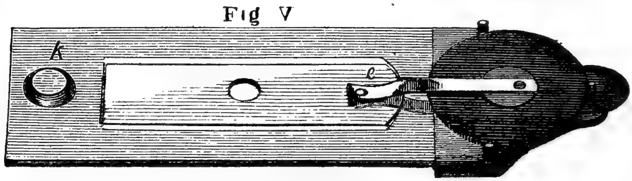



Fig IV

is required to keep these thin glass covers sufficiently in contact with, and yet free to move upon, the perforated plate; this is effected by two light springs attached to a piece of brass (Figs. III and IV), which can be clamped at the end of the glass plate; and these parts collectively, as in Fig. V, con-

Fig V




stitute the whole of the apparatus, but one or two points of detail require a little explanation.

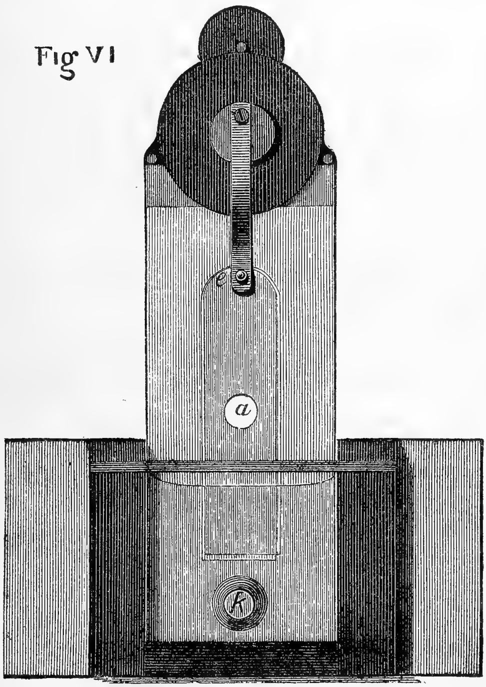
The piece of brass with the springs (Figs. III and IV) is clamped to the glass plate by first screwing down the larger milled head (*h*) until it just comes in contact with the glass, and then by screwing up the smaller milled head (*i*) against the under side of the larger one, which is thus pressed sufficiently upon the glass plate without any fear of breaking it, for it will plainly be seen that, as the resistance to the screwing down of the larger milled head alone is on one side only, the milled head, after once coming down upon the glass, would tilt with any extra screwing, and thus not only fail to hold, but also almost certainly break the plate. It is therefore necessary to understand the principle on which the two milled heads are used, or insecurity in clamping, and breakage, may prove sources of considerable inconvenience.

Each perforated glass plate is provided at the opposite end to that where the springs are clamped, with a small boss (*k*) on either side, so that the slide may lie parallel with the stage of the microscope when placed upon it; but as the plates are not all the same thickness, an "upper side" is marked upon each, and this distinction must be observed when clamping on the springs.

The thin covers (Fig. II) are each provided with a small brass boss (*e*), and when this is pushed under a corresponding hollow (*l*) on the under side of either spring they form a centre from which the cover may be turned either over the perforation in the glass plate or on one side of it. Any description as to the way in which a living object may be captured or afterwards fed and kept alive is so dependent upon the class of object under examination that my experience is very limited; I may, however, mention that a fine camel-hair pencil, slightly moistened, will hold, and seldom injure, even a very delicate specimen, and in some cases, when the object is exceedingly active, a partial stupefaction with chloroform is very useful.

For a large number of small objects in water I believe this live-trap is peculiarly well adapted, but its use for this purpose requires a few words of explanation. I presume that the rapidity with which small quantities of water dry up when under the microscope has been the annoying experience of all observers, and yet without limiting the amount of fluid there is always more or less difficulty in confining objects in a small space; if, however, after placing such specimens in this trap the free end of the glass plate be inserted in a small trough of water, as shown in Fig. VI, the fluid will rise by

Fig VI




capillary attraction between the thin covers and the plate and supply every deficiency caused by evaporation. The water contained by the trough will last for many hours, but if desirable to keep the object for a longer period the slide may be placed up to its middle or more in a jar or bottle of suitable water. With all fluid objects I have found it necessary to use silver instead of steel springs, as the latter rust almost immediately.

The facility with which all the parts of this apparatus can be taken to pieces and perfectly cleaned is also a feature of some importance.

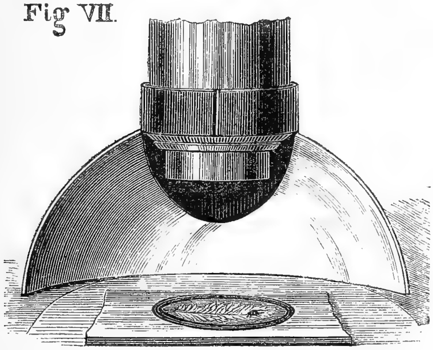
For general purposes I should propose the following assortment of the different parts of this piece of apparatus:—Two spring clamping pieces, one with steel and the other with silver springs; three glass plates, about 2, 4, and 6-100ths of an inch thick, each provided with holes of the respective diameters of 8, 12, and 16-100ths of an inch; three black brass plates exactly similar to the glass ones; a few thin covers, about 16 by 4-10ths of an inch; (two extra ones (Fig. II, *c, d*) provided with black and ground-glass discs, may sometimes prove useful, but the size of these, together with that of the holes, may be, of course, varied to suit any requirement;) and the small glass trough, which, together with the foregoing, can be completely packed in a small box.

It will be seen at once that any kind of illumination can be employed with the live-trap, and also that the object may be examined equally well from either side of the plate, but the brass plates, which I have only casually mentioned, preclude, of course, any Lieberkuhn illumination; and although they are not so easily broken and have some other qualities superior to those of glass, I should not have recommended them at all but for their answering perfectly well under a new kind of illumination, to which I venture to draw your attention.

In the last number of the 'Quarterly Journal of Microscopical Science' there is a short notice, by Mr. Bridgman, of Norwich, showing the advantage that can be gained in the illumination of many opaque objects by covering over a portion of the reflecting surface of the Lieberkuhn. This plan I have adopted for some considerable time; but I was led to do so for an additional reason to that given by Mr. Bridgman, and not only, as he says, to obtain any proportion of oblique light in one particular direction, but to make sure that I was reversing the direction of the illumination. The eye habitually connects the appearance of an object, and especially that of the light and shade, with the direction of the source of light; and as the microscope reverses the picture, the eye may be totally deceived in a matter of slight elevations or depressions, as is well known to many, and as I have lately shown to most of you in a simple way, by mounting a photograph of a glass tumbler in reversed positions.

With the binocular body one can almost instantly detect any erroneous appearance due to the illumination, but even with the use of both eyes it is a most essential thing to reverse the direction of the light when carefully examining an opaque object. My attention was more particularly drawn to the subject by Mr. Sorby, who required some arrangement of reflector in the examination of his specimens of iron and steel, and I applied half of a silvered paraboloid at the back of the object-glass, but attached to its front tube, as shown in Fig. VII; this arrangement is very satisfactory, and all the

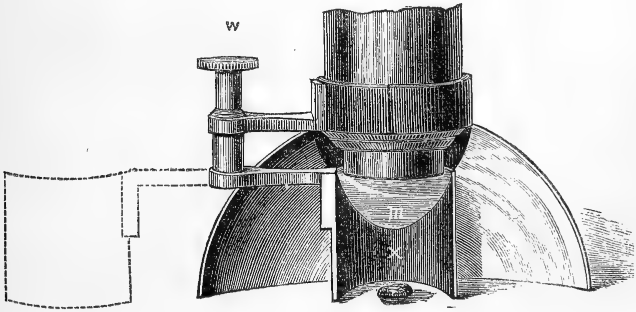
Fig VII.



adjustments are easily made with the $\frac{2}{3}$rd and lower powers; its focus is about $\frac{1}{10}$th of an inch from its lower edge, and it must, of course, receive parallel rays, so that by lamplight a condenser must be placed at the distance of its focus before the light.

To this reflector Mr. Sorby has made an addition, which shows how necessary it is to study the character of an object when determining the structure under any kind of illumination, for he found, on examining his specimens of iron and steel, that, owing to the obliquity of the illumination, the brilliantly polished parts reflected the light beyond the aperture of the object-glass, and could not be distinguished from other parts which merely absorbed the light.

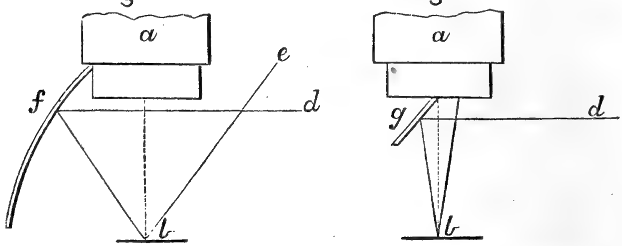
Fig. VIII.



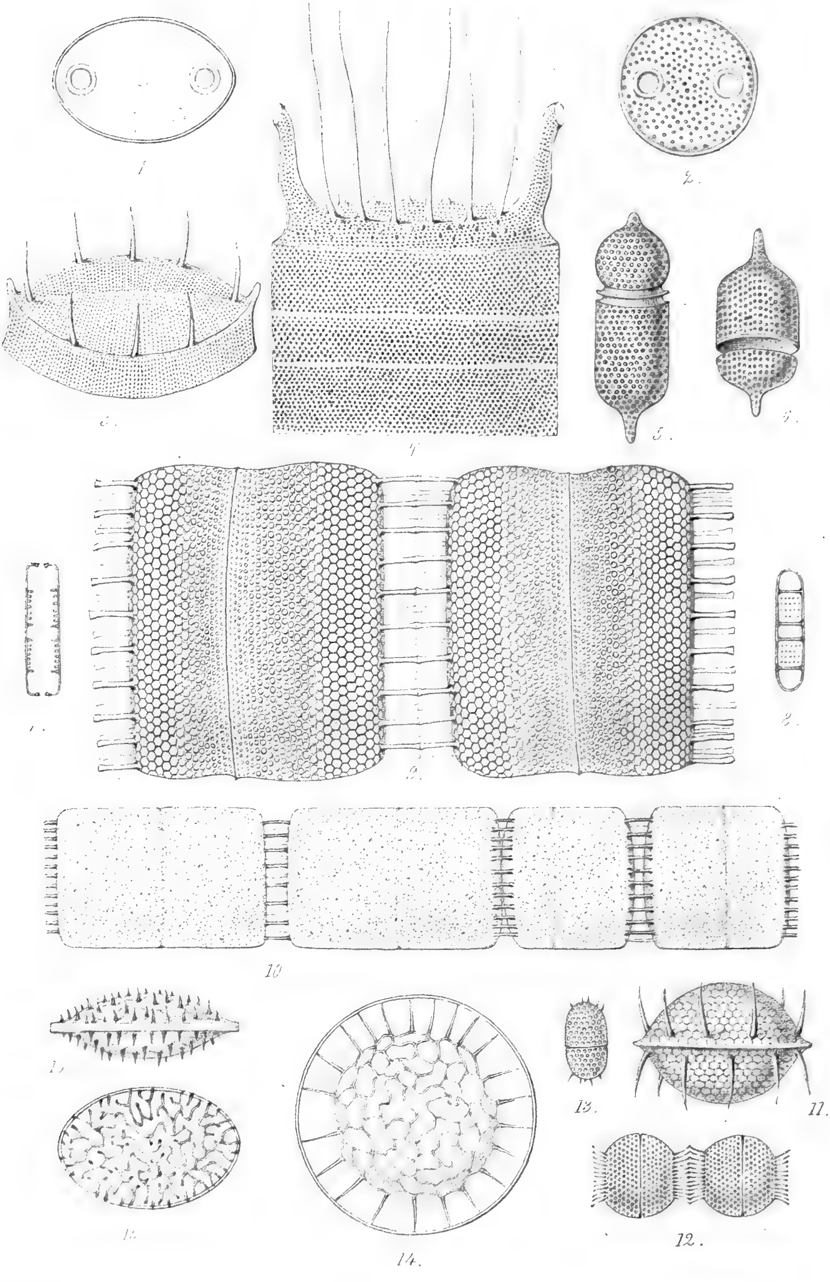
To throw the illumination, therefore, more perpendicularly, he attached a small flat mirror (Fig. VIII, *m*) immediately in front of the object-glass, and covering half of its aperture, at the same time stopping off, by a semicylindrical tube (*x*), all illumination from the parabolic reflector; by this arrangement (for the flat mirror is mounted so as to be easily turned aside by the small milled head *w*) Mr. Sorby obtains in an instant two different illuminations, and he finds the reverse appearances they give are valuable aids in analysing the true condition of the object.

The difference between the illuminations may be clearly seen by reference to the following diagrams (Figs. IX and X).

Fig IX Fig X

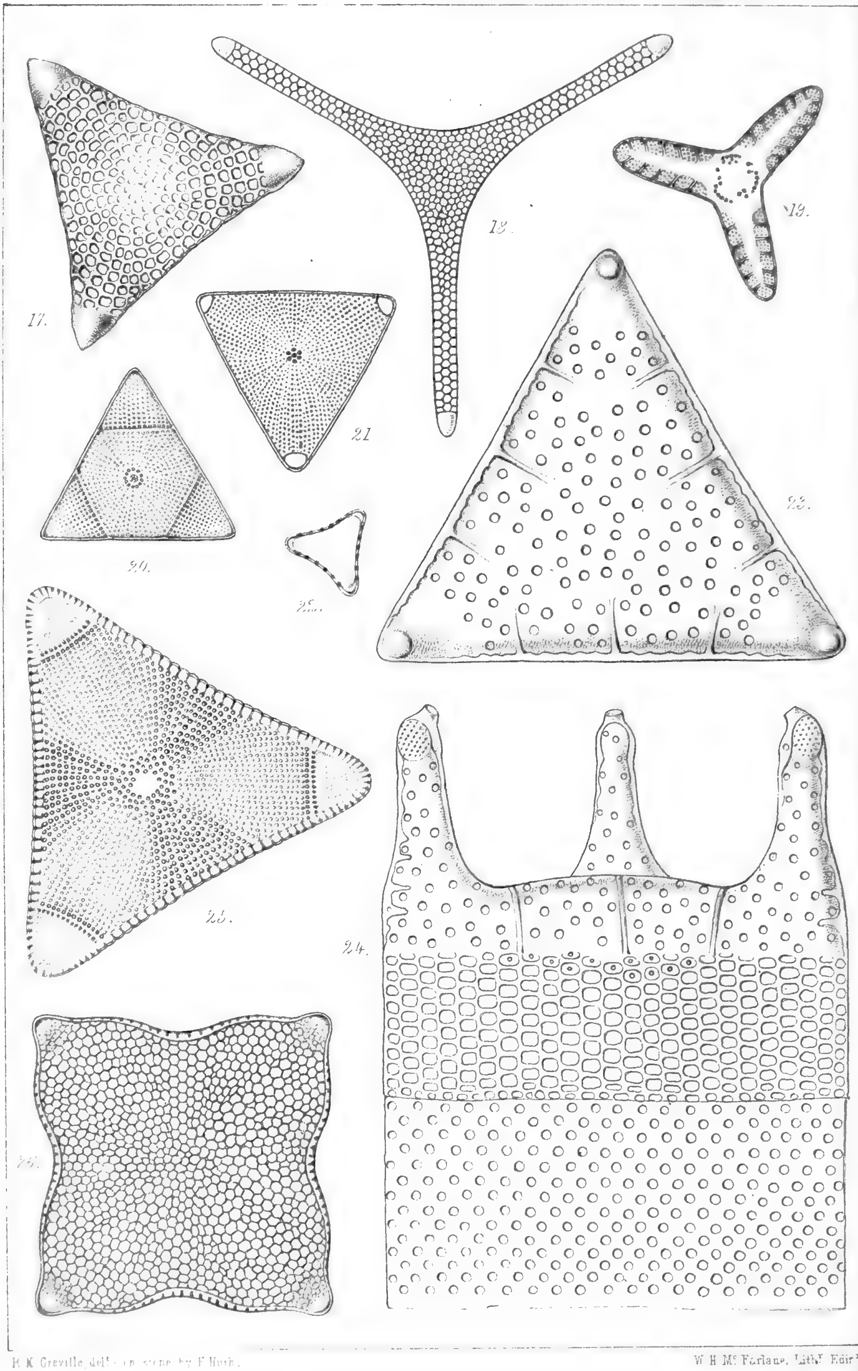



Supposing *a* to be the object-glass, and *b* an object with a perfectly reflecting surface at right angles to the axis of the microscope, it is evident that a ray of light (*d*) will be reflected by the parabolic reflector (Fig. IX, *f*), and then by the object, to a point (*e*) entirely beyond the object-glass; whereas in Fig. X the light is thrown by the flat mirror (*g*) almost perpendicularly upon the object, which consequently returns it to a point within the aperture of the object-glass.




R.K. Greville del. et [illegible]

W.H.M.c Farlane, Lith.r Edin.r




R. K. Greville, delt. on stone by F. Huth.

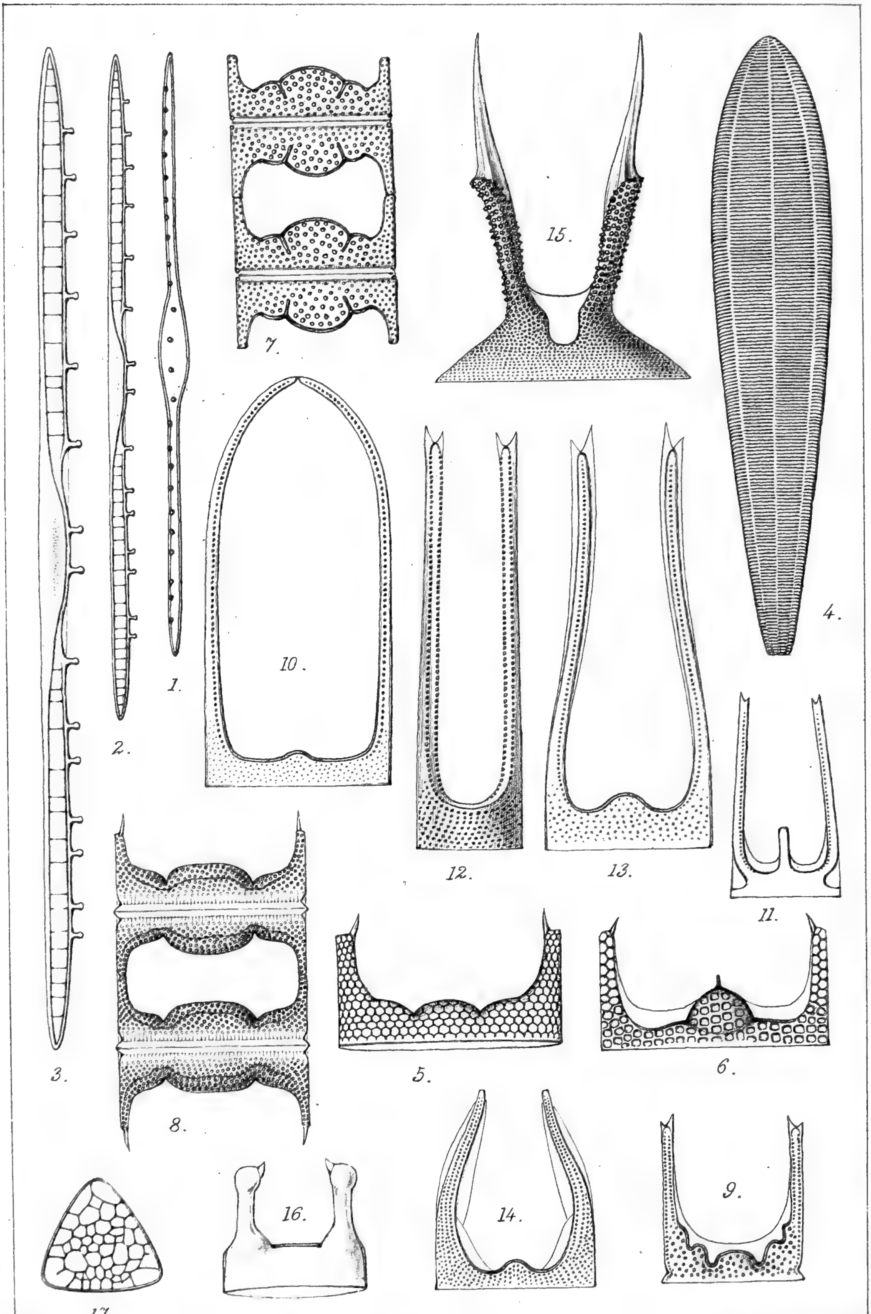
W. H. McFarlane, Lithr. Edinr.

## DESCRIPTION OF PLATES I & II,

### Illustrating Dr. Greville's paper on New Diatoms. Series XIV.

Fig.
1.—*Auliscus Barbadensis.*
2.— „ *notatus.*
3.—*Biddulphia spinosa.*
4.— „ *fimbriata.*
5.—*Pyxilla Barbadensis.*
6.— „ *Johnsoniana.*
7.—*Plagiogramma Wallichianum,* front view.
8.— „ „ side view.
9.—*Cresswellia Palmeriana.*
10.— „ *cylindracea.*
11.— „ *Barbadensis.*
12.— „ *sphærica.*
13.— „ *minuta.*
14.—*Liradiscus Barbadensis.*
15.— „ *ovalis,* side view.
16.— „ „ front view.
17.—*Triceratium cancellatum.*
18.— „ *Kittonianum.*
19.— „ *nitescens.*
20.— „ *neglectum.*
21.— „ *acceptum.*
22.— „ *Atomus.*
23.— „ *Dobrèeanum,* side view.
24.— „ „ front view.
25.— „ *exornatum.*
26.— „ *quadrangulare.*

All the figures are × 400 diameters.

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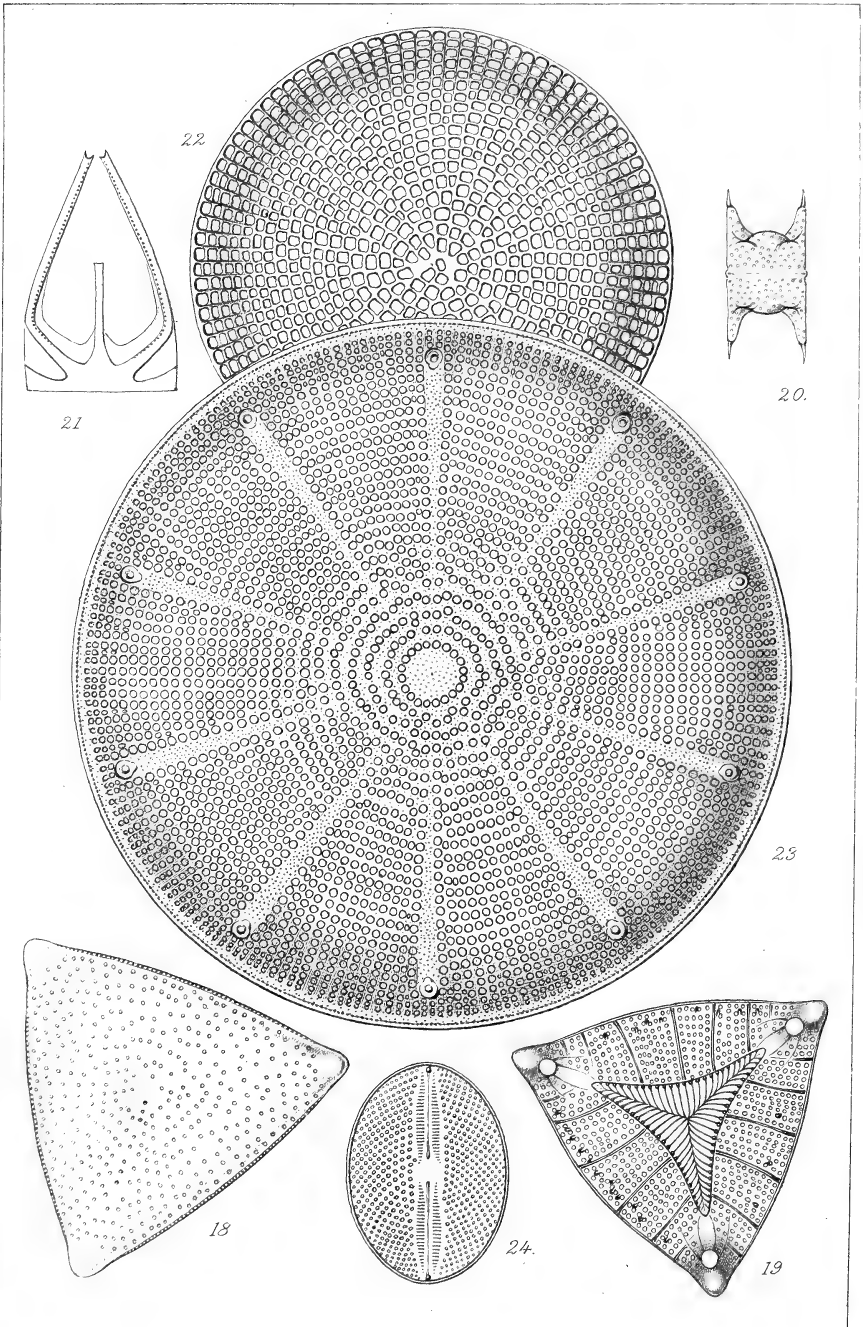


R. K. Greville, delt. on stone by F. Huth

W. H. McFarlane, Lithr. Edinr.

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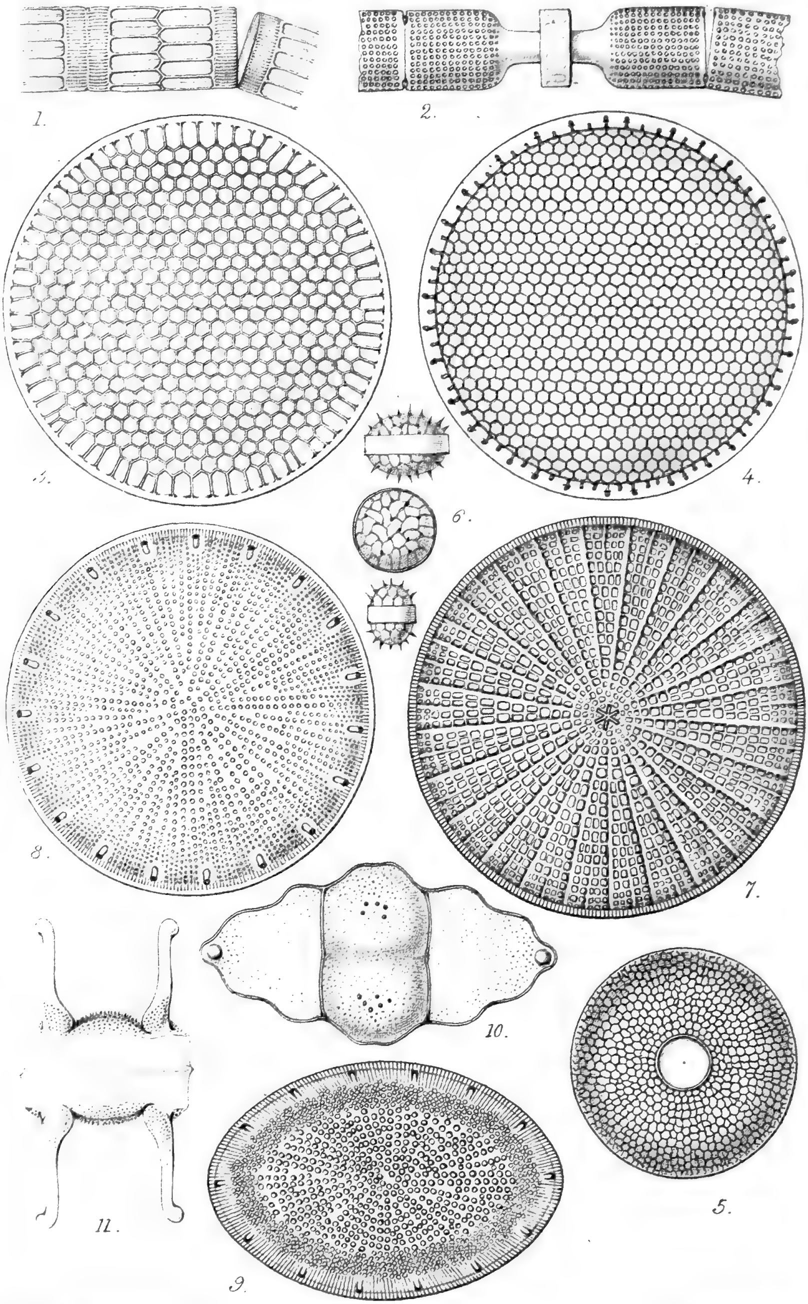
## DESCRIPTION OF PLATES III & IV,

### Illustrating Dr. Greville's paper on New Diatoms. Series XV.

Fig.
1.—*Clavularia Barbadensis*, side view.
2.— „ „ front view.
3.— „ „ front view, × 600.
4.—*Synedra clavata*, side view.
5.—*Hemiaulus reticulatus*.
6.— „ *mucronatus*.
7.— „ *punctatus*.
8.— „ *pulvinatus*.
9.— „ *lobatus*.
10.—*Hemiaulus ?? tenuicornis*.
11.— „ *lyriformis*.
12.— „ *angustus*.
13.— „ *longicornis*.
14.— „ *alatus*.
15.— „ *hastatus*.
16.— „ *ornithocephalus*.
17.—*Triceratium araneosum*.
18.— „ *Moronense*.
19.—*Entogonia elegans*.
20.—*Hemiaulus exiguus*.
21.—*Hemiaulus ?? lyriformis*, var.
22.—*Coscinodiscus Mossianus*.
23.—*Aulacodiscus gigas*.
24.—*Cocconeis naviculoides*.

All the figures, except fig. 3, × 400 diameters.

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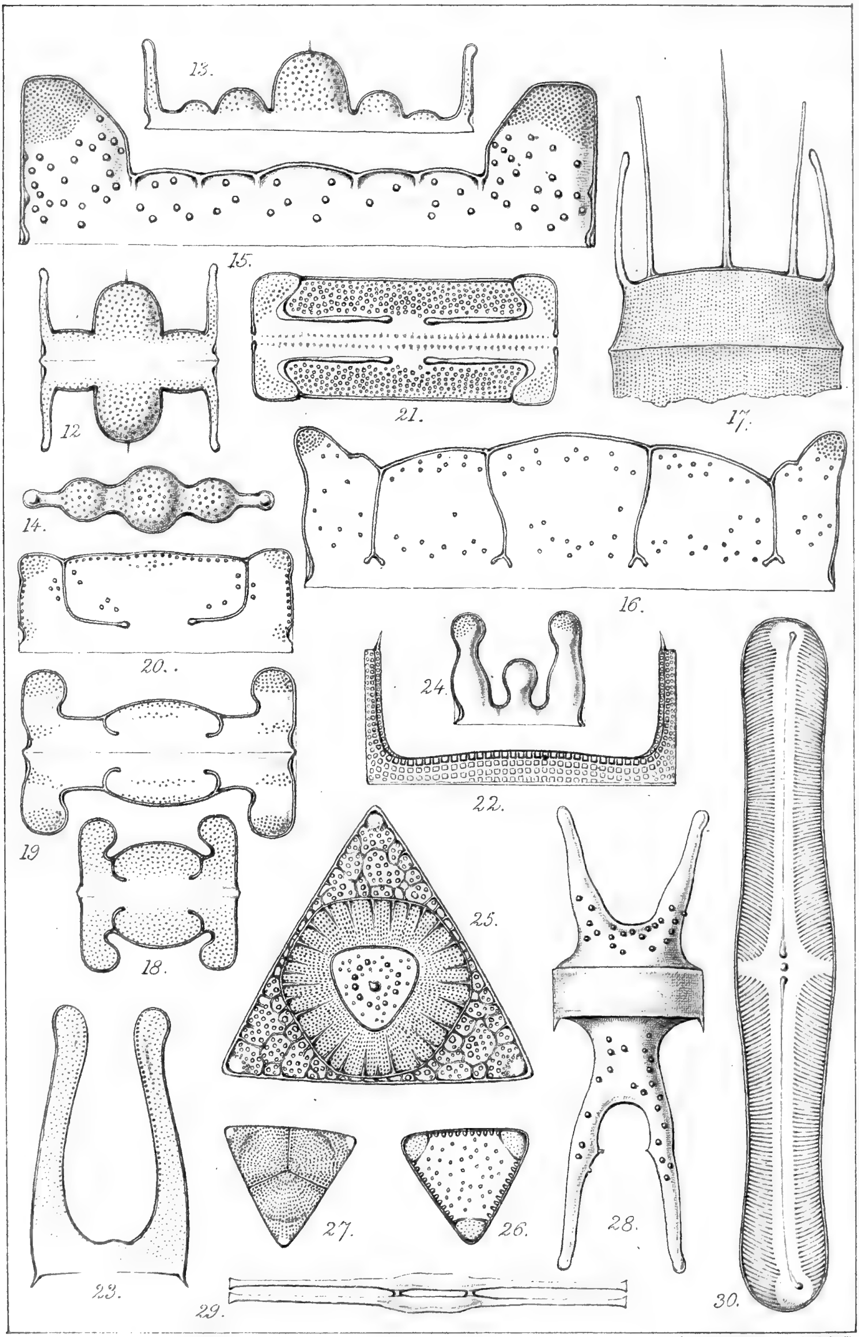


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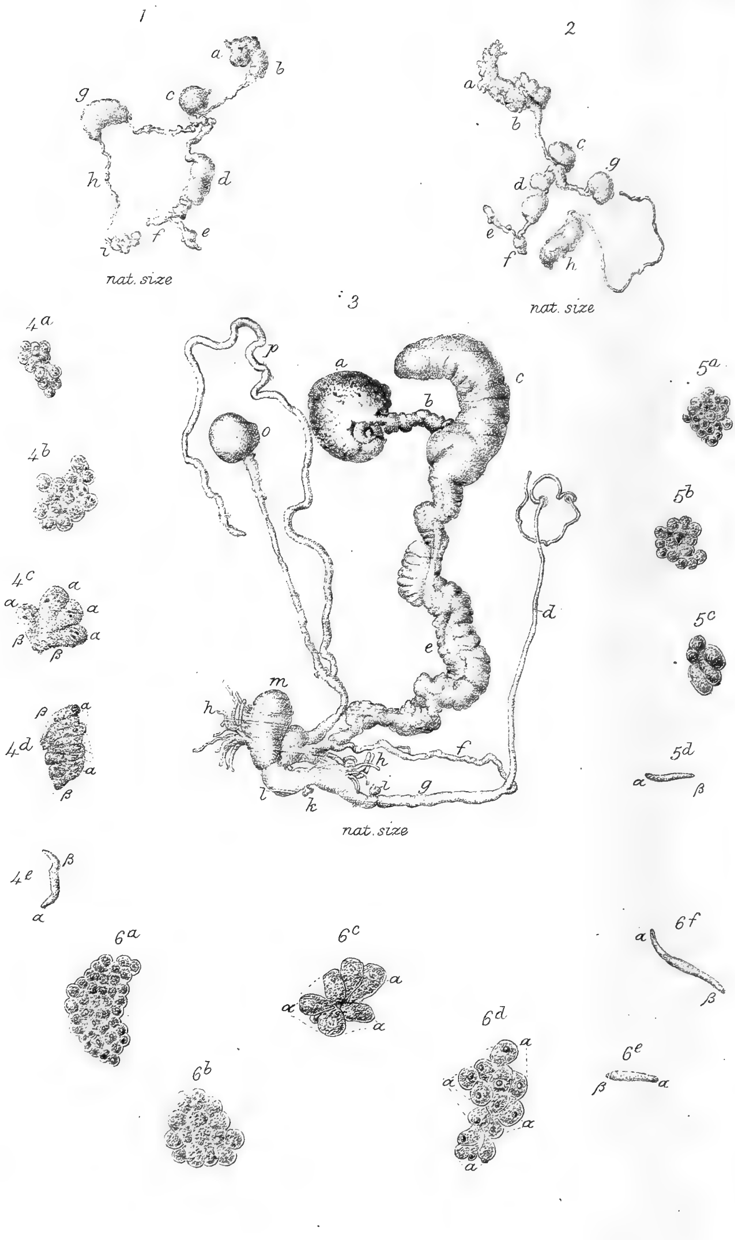
## DESCRIPTION OF PLATES V & VI,

### Illustrating Dr. Greville's paper on New Diatoms. Series XVI.

Fig.
1.—*Skeletonema Barbadense.*
2.—*Strangulonema Barbadense.*
3.—*Coscinodiscus splendidus.*
4.— „ *Macraeanus.*
5.—*Porodiscus splendidus.*
6.—*Liradiscus minutus.*
7.—*Arachnoidiscus Grevilleanus.*
8.—*Cestodiscus Johnsonianus,* × 600.
9.— „ *ovalis,* × 600.
10.—*Biddulphia sinuata.*
11.— „ *nitida.*
12—14.— „ *elegantula.*
15.— „ *inflata.*
16.— „ *corpulenta.*
17.— „ *tenuicornis.*
18, 19.—*Porpeia quadriceps.*
20.— „ *quadrata.*
21.— „ *ornata.*
22.—*Hemiaulus symmetricus.*
23.— „ *?? robustus.*
24.— „ *?? capitatus.*
25.—*Triceratium Hardmanianum.*
26.— „ *pauperculum.*
27.— „ *trilineatum.*
28.—*Dicladia Barbadensis.*
29.—*Goniothecium prolongatum.*
30.—*Pinnularia Hartleyana.*

All the figures, except 8 and 9, × 400 diameters.




Figs. 4. 5, 6, enlarged 140 diam^rs

T. West sc

W. West imp

## DESCRIPTION OF PLATE VII,

### Illustrating Mr. Sanders' paper on the Anatomy of the Generative Organs in certain Pulmogasteropoda.

Fig.

1.—Generative organs of *Planorbis corneus*, natural size.

- *a.* Dichogamic gland.
- *b.* Its enlarged duct.
- *c.* Albumeniparous gland.
- *d.* Oviduct, its enlarged portion.
- *e.* Spermatheca.
- *f.* Vagina.
- *g.* Prostate gland.
- *h, h.* Vas deferens.
- *i.* Penis.

2.—Generative organs of *Limnæus stagnalis*, natural size.

- *a.* Dichogamic gland.
- *b.* Its duct.
- *c.* Albumeniparous gland.
- *d.* Oviduct.
- *e.* Spermatheca.
- *f.* Vagina.
- *g.* Vas deferens; letter placed at its enlargement.
- *h.* Penis and its retractor muscle; letter placed on the muscle.

3.—Generative organs of *Helix aspersa*, natural size.

- *a.* Dichogamic gland imbedded in lobe of liver.
- *b.* Its duct.
- *c.* Albumeniparous gland.
- *d.* Flagellum.
- *e.* Oviduct and prostate; letter placed close to prostate.
- *f.* Vas deferens.
- *g.* Penis.
- *h, h.* Multifid vesicles.
- *i.* Retractor muscle of penis.
- *k.* Piece of integument marking external opening of vestibule.
- *l.* Vestibule.
- *m.* Dart-sac.
- *n.* Vagina.
- *o.* Spermatheca.
- *p.* Its diverticulum.

*Planorbus corneus.*

4*a*.—A group of youngest sperm-cells from the dichogamic gland of *P. corneus*, each cell measuring about ·0003″.

4*b*.—Sperm-cells from same, older, the nucleus having become more distinct.

4*c*.—Sperm-cells from same, still larger, having become more elongated, nucleus not having yet begun to be concentrated. *α*, Nucleus; *β*, cell-contents.

4*d*.—Sperm-cells from same, still more elongated and compressed; nucleus contracted to a spot. *α*, Nucleus, which ultimately becomes caput of zoosperm; *β*, part of cell, which becomes the tail of zoosperm.

4*e*.—A single sperm-cell, which has nearly attained the condition of a young zoosperm. *α*, Nucleus, elongating into caput; *β*, tail.

*Limnæus stagnalis.*

5*a*.—A group of the youngest cells from dichogamic gland of *L. stagnalis*, each cell measuring ·0003″.

5*b*.—A group of older cells from same, each cell measuring ·0005″.

5*c*.—Sperm-cells from same, which have grown larger, and have just begun to elongate, measuring ·0011″ in length and ·0005″ in breadth.

5*d*.—Sperm-cell from same, which has just begun to present the appearance of a young zoosperm. *α*, Caput; *β*, tail.

*Helix aspersa.*

6*a*.—A group of the youngest sperm-cells from dichogamic gland of *H. aspersa*, each individual cell measuring ·0004″.

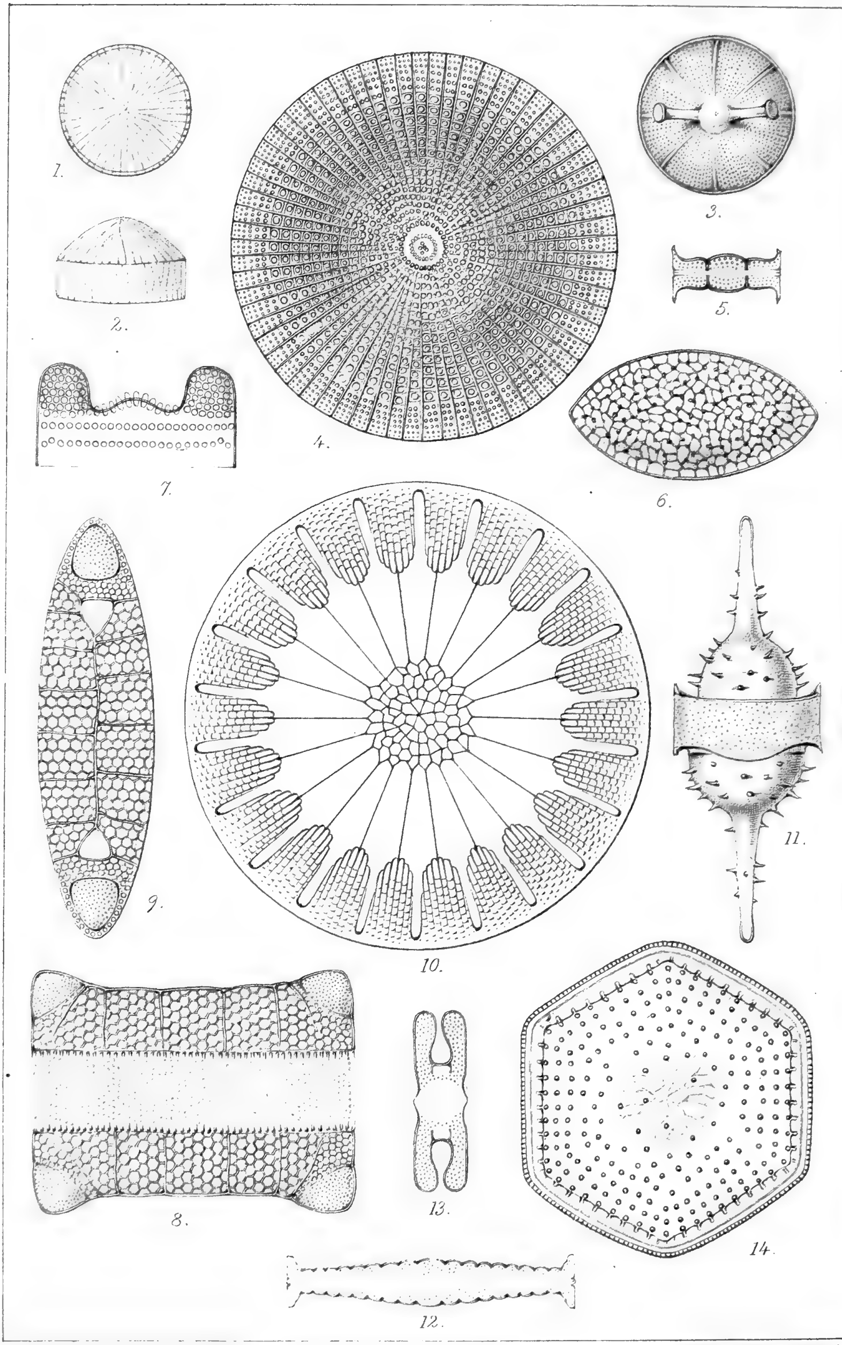
6*b*.—A group of older cells from same, measuring about ·0007″.

6*c*.—Cells from same, already beginning to elongate, the nucleus not having, as yet, begun to change. *α*, The nucleus.

6*d*.—A group of sperm-cells from same, showing the progressive concentration of the nucleus. *α*, Nucleus.

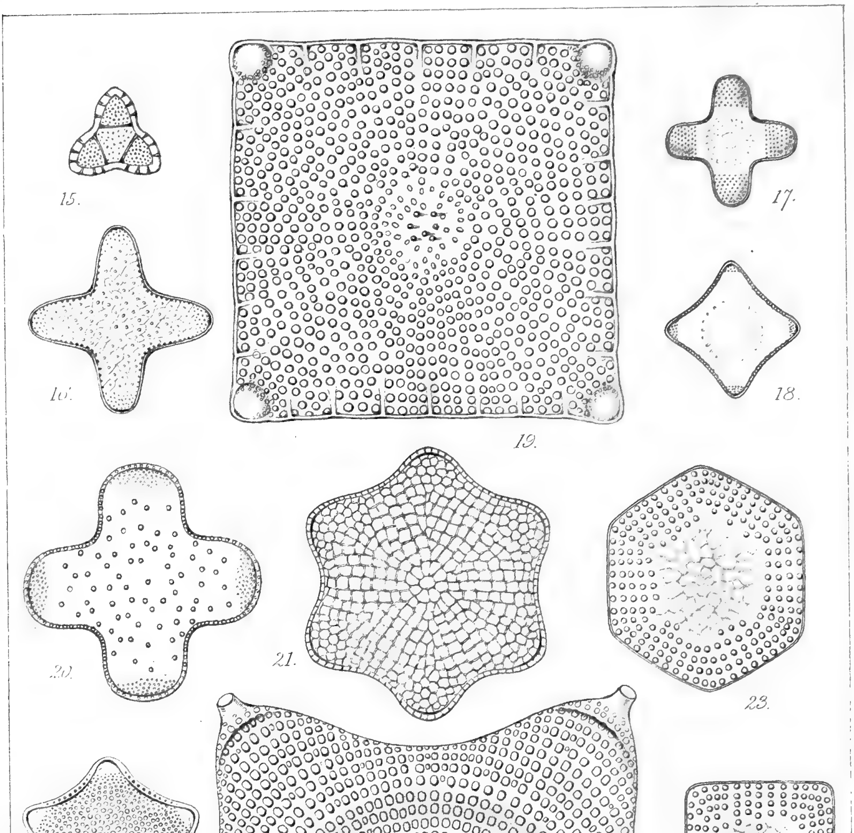
6*e*.—A sperm-cell from same, elongating, the nucleus still showing as a dot, *α*, Caput; *β*, tail.

6*f*.—A sperm-cell, still more elongated, the nucleus also now beginning to elongate. *α*, Caput; *β*, tail.




R.K. Greville, del^t

W.H. McFarlane, Lith^r Edin^r




R. K. Greville del.t on stone by F. Huth.

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## DESCRIPTION OF PLATES VIII & IX,

### Illustrating Dr. Greville's paper on New Diatoms. Series XVII.

Fig.

1.—*Cladogramma conicum.*
2.— ,, ,, front view.
3.—*Thaumatonema costatum.*
4.—*Stictodiscus Hardmanianus.*
5.—*Hemiaulus minutus.*
6.—*Liradiscus ellipticus.*
7.—*Biddulphia decorata.*
8.—*Heibergia Barbadensis*, frustule.
9.— ,, ,, lateral valve.
10.—*Asterolampra eximia.*
11.—*Dicladia robusta.*
12.—*Hemiaulus crenatus.*
13.—*Porpeia quadriceps?*
14.—*Triceratium polygonium.*
15.— ,, *figuratum.*
16.— ,, *quadricorne.*
17.— ,, *zonatulatum.*
18.— ,, *inglorium.*
19.— ,, *quadratum.*
20.— ,, *latum.*
21.— ,, *reticulatum.*
22.— ,, *parallelum*, 4-angled valve.
23.— ,, ,, 6-angled valve.
24.— ,, *sexangulatum.*
25.— ,, *implicitum.*
26.— ,, *brevinervum.*
27.—*Amphitetras nobilis.*

All the figures are × 400 diameters.

# INDEX TO TRANSACTIONS.

## VOLUME XIII.

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