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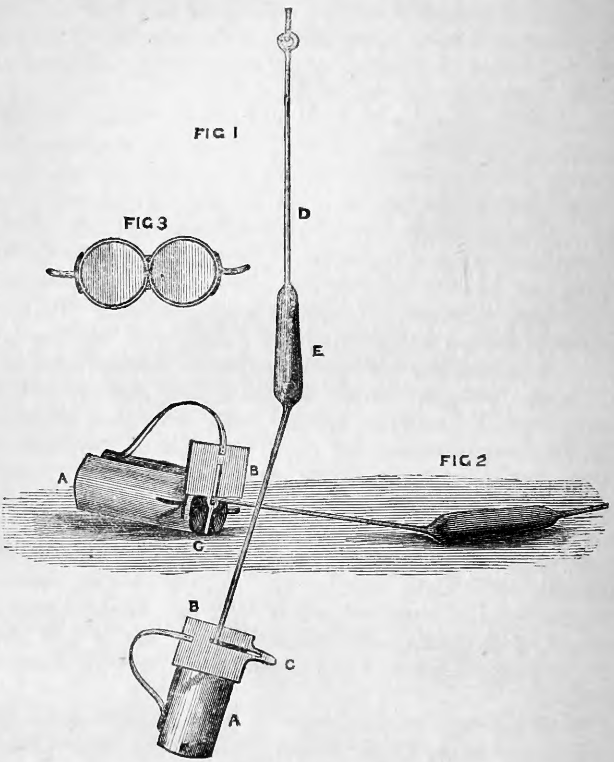
ORIGINAL COMMUNICATIONS.

On Apparatus *for* Dredging *at* moderate depths *in the* Deep Sea, *and for* Capturing Floating Objects *from* Shipboard. By G. C. Wallich, M.D.

During a recent voyage from India, the success attending the use of certain appliances contrived by me for capturing such marine objects as came in our way, induces me to offer the subjoined account of them to the public. I may mention that, although familiar with the ordinary form of towing net and sounding apparatus, it struck me that much more might be done by resorting to some simple form of casting net, than is possible where the chapter of accidents is relied on for bringing within the jaws of the towing net the objects required, and by constructing some more portable sounding apparatus, which would at the same time prove effective at moderate depths, and bring up a much larger quantity of material than is attainable under the ordinary sounding lead, or the more complicated and cumbrous contrivance of Lieutenant Maury and others. I would further premise that whoever desires to make a collection of marine floating molluscs, tunicaries, ascidians, and the like, and also the minuter organisms which exist in all latitudes in the open ocean, to a greater or lesser extent, will be grievously disappointed if he imagines that the trailing net used astern of a ship will suffice for the purpose. For, to be at all successful, constant and unremitting watchfulness is, in the first place, essential; and what is equally important, a fitting place of observation at the stern of the vessel, with ten or twelve feet of the water bend. In my own case, the quarter gallery of a 1500-ton merchantman afforded the best of all look-out ports; and from it I was enabled to use the casting net about to be described with ease and certainty. In the clear blue water of the open sea it is astonishing how rapidly the eye accustoms itself to detect creatures of the minutest size; and how readily it learns to distinguish, even in the small patches of calm water between each wave when a considerable sea is running, any object that may chance to be swimming near the surface. Nor is this confined to the portion of sea immediately below the observer, but it can be done at a distance of several yards. In order to embrace this distance the following casting net was constructed, and in the course of a short practice it became easy to pitch this net, quoit fashion, over any object within such range.

A hoop is made of half-inch rod iron, two feet eight inches



A. Copper cylinders, closed at lower end. B. Valve with curved spring. C. Stud for forcing up the valve plate on touching bottom. D. Iron rod. E. Weight.

Fig. 1.—Showing position of apparatus whilst sinking, the valve being closed.

Fig. 2.—Showing position on reaching ground, the valve being opened.

Fig. 3.—Showing tilting rods, as seen from mouths of cylinders.

in diameter. At any point in this hoop a ring or eyelet-hole is formed by a loop of the rod, for attachment of the line. Sewn round the hoop is an oblong bag, the bottom of which is not tapered off, but allowed to remain square, the material called crinoline being at once the strongest, cheapest, and, from its open web, the best adapted for the purpose. This bag is about a yard or somewhat less in depth. The line must be stout, such as is used for deep-sea fishing, for instance. A coil of this is held loosely in the left hand. The right grasps the ring, close to the eyelet-hole, in a horizontal position, and throws it with a twist, just as a quoit is thrown, with the mouth of the bag downwards, over the object to be captured; as much line as is necessary being allowed to slip without check out of the left hand.

The hoop instantly sinks, the pervious nature of the material forming the bag offering little or no resistance. The moment it has passed deep enough to embrace the object, a sudden haul on the line tilts the mouth of the hoop up vertically, the sides of the bag at once collapse on each other, and the enclosed object is secure. So readily does this simple casting net answer its purpose, that at one cast in moderately calm weather it brought up a couple of open-sea mackerel, each a foot and a half long; and molluscs, tunicaries, ascidians, and other creatures of various kinds, were, with ease, brought within reach. This casting net is, of course, equally available on the shore, off a pier, rocks, &c.

In the *drag* net used by me, I found it of great advantage to have the hoop made also of iron, but of a triangular shape, instead of the ordinary round form, each angle having an eyelet-hole or ring, whereupon to attach the three connecting intermediate lines. By lengthening one of these three lines somewhat, the hoop was always kept with the same angle downwards, and thus prevented the constant turning, and twisting, and jerking, attendant on the use of the ordinary circular hoop, whenever the ship's rate exceeded four or five knots.

For soundings, in moderate depths, up to three or four hundred fathoms, the following apparatus is most efficient:

A half-inch rod of iron, four and a half feet long, is bent at its centre to an angle of about 150°. At one end a loop is formed for attachment of the line; at the other, about six inches is reflected on itself in the same plane as the angle referred to, and within this reflected portion is jammed the connected band of two copper cylinders, soldered strongly together side by side; their closed ends being of course directed outwards, their open mouths towards the angular part of the rod. In order to prevent regurgitation and loss of contents, a valve is formed of a plate of metal sufficiently large to extend right across the mouths of both cylinders. In the centre of this is cut a slot or aperture, to admit of vertical motion to the extent required, the plate being attached by a curved, moderately strong, flat spring to the farthest end of the rod or cylinder, and at the centre of the margin of this plate, intended always to rest on the bottom, is attached a stud of several inches in length, whereby the moment contact with the surface of the ground is made the plate is made to rise and admit whatsoever presents itself. To complete the apparatus, a twelve- or fourteen-pound lead weight is *cast* round the upper portion of the knee formed at the angle of the rod; a small rod of iron, about eighteen inches in length, is riveted at the outside of the mouth of each cylinder. This rod is bent somewhat backwards, its use being, in event of the cylinders touching the bottom in a lateral direction, to *tilt* them forward again. Lastly, the line being attached, the apparatus is ready for use.

In sounding, it should be hove astern as far as possible. Now it will be observed that, owing to the angle in the iron rod, and the heavy weight appended to a particular part of it, whilst in the act of sinking such weight will remain perpendicular, whilst the cylinders will be held out from the perpendicular to the extent of the angle. They will nevertheless touch the bottom first at their outer closed ends, which will then act as a fulcrum, on which the rod will turn till it also reaches the bottom. The line being now hauled upon, each cylinder acts as a scoop, and on leaving the surface is effectually closed up by the return of the valve to its normal position.

Of course soundings with this apparatus, or indeed with any apparatus, can only be effected in perfectly calm weather or at anchor, its advantage over other forms consisting in its simplicity, its certain action, and the great quantity of material it is capable of bringing up. No doubt it admits of mechanical improvements in many ways, and these could with ease be carried out; but as the organisms found at the sea bottom are daily engrossing more attention, whilst those procurable near the surface are not only interesting in themselves, but can be made to yield up the minute structures they feed upon, and from which the microscopist eliminates many a choice repast, I trust the foregoing detail may not prove without interest.

Notes *in* Reply *to* Dr. Walker-Arnott.
By Dr. Donkin.

Professor Walker-Arnott having considered it proper to attack me in the preceding number of this Journal (p. 164), on certain facts demonstrated by me in my paper on the 'Marine Diatomaceæ of Northumberland,'* I consider it my duty to offer a reply.

I confess myself at a loss to comprehend Dr. Arnott's reason for accusing me of having acted towards him with want of courtesy. But *I presume* it is because I have pointed out, in the postscript of my paper, that my *Pl. rectum,* n. sp., is identical with that form to which he has given the cognomen of *Apr. Ralfsii.* Dr. Arnott imagines I had no right to mention his name in the matter, because he had not then published his *description* of the form in question. But he evidently forgets that at the period when the postscript of my paper was written, slides had been distributed amongst observers (mounted from Mr. Ralfs' Penzance gathering) containing this species in abundance, with his—Dr. Arnott's—generic and specific name appended.† Thus, then, it is evident that the *name* given by Dr. Arnott to a particular diatomaceous form became, actually and virtually, published. I therefore, after examining well authenticated specimens of this same form, had a perfect right to criticise, in any becoming manner, Dr. Arnott's conclusion and synonyme; and more especially so when I knew that I had previously described to the Microscopical Society‡ the very same species under a different name.

Now it appears to me that Dr. Arnott would have acted much more in that spirit which ought to guide every philosophical discussion, had he, instead of accusing me of being guilty of a grave social offence, attempted to refute the accuracy of my assertions, and to establish his own hypothesis on a firmer and more indestructible basis. But since he has declined to do so, I must, of necessity, call his attention still more closely to the error he has committed in referring the subject of dispute to the genus *Amphiprora.* On reading Dr. Arnott's description, which, he will permit me to observe, is very vague and without anything specially diagnostic, of *Apr. Ralfsii,* in the last volume of this Journal, p. 91,

* 'Trans. Micros. Soc.,' vol vi.

† One of these slides was sent to me by an esteemed correspondent, Mr. Roper, and another from Dr. Montgomery, of Penzance.

‡ On the 21st of October, 1857.

and his subsequent foot-note, p. 164, it is clearly apparent, that he supposes this form to be an Amphiprora *because the valve is carinated*—the carina being constricted in the middle —and the striæ transverse. Now, on the other hand, I have shown* that the structure of the valve (there being *two* sets of striæ, one *long.*, the other *trans.*), together with its peculiar outline and sigmoid median line, and also the *absence* of *alæ*, or lateral plates, as seen in the F.V., prove that it is a true *Pleurosigma.* I have likewise pointed out,† that a carinated and constricted F.V. is not, when taken in the abstract, a *generic character*, and ought not longer to be relied upon as such. This assertion is amply proved by *Pl. carinatum* ‡ (a genuine Pleurosigma, with oblique striæ, easily resolvable in the F.V.), which has a very strongly keeled and constricted valve. After a careful and frequently repeated examination of all our genuine British species, I am convinced that the presence of *alæ*,§ attached laterally to the valve, constitute the only true generic feature of the *Amphiproræ*, while the carinated and constricted F.V., though always, more or less, present, is merely of secondary importance, being possessed by several species of *Pleurosigmata* with *straight valves;* thus proving a close natural affinity between the two genera. Therefore, as Dr. Arnott *admits* the *absence of alæ* in *Pl. rectum* (alias *Apr. Ralfsii*), his attempt to refer it to the genus Amphiprora is contrary to analogy, and simply a violation of the law, which has been observed by all competent observers, in placing new species in this latter genus. With regard to the markings of the *Amphiproræ*, I may further add, that when striæ are present there is only a *single* set, transversely arranged. This peculiarity is of considerable importance in distinguishing them from their allies, the *Pleurosigmata.*

Dr. Arnott, however, will probably object to these conclusions, having taken upon himself to ignore the existence of any such species as *Pl. carinatum;* he denies the fact of its having oblique striæ, and observes: "I do not believe the striæ are oblique, but only appear so in consequence of the position of the light." Now, I wish to know on what grounds Dr. Arnott considers himself justified in contradicting the statements of others on any scientific subject, without having in the first instance satisfied himself, by actual obser-

* See my description of *Pl. rectum*, n. sp., 'Trans. Micros. Soc.,' vol. vi.
† In Op. cit., Postscript.
‡ See description of this species, Op. cit.
§ The universal presence of alæ in the genus Amphiprora was first pointed out by my late lamented friend, Professor W. Gregory.

vation, that such statements are erroneous. Now, as he has never examined a single specimen of *Pl. carinatum*, his objections to this form are simply imaginary, and being, therefore, of no importance, according to the principles which regulate the determination of every scientific truth, they are unworthy of refutation. It may not be amiss here to repeat, even emphatically, that my published description of this remarkable species is perfectly correct, both as regards the shape of its S.V. and F.V. and as regards the nature of the striæ, of which there are two sets obliquely arranged, and easily resolvable, with sufficient power and proper illumination, into cellules, having a quincuncial arrangement; but owing to the valve being compressed laterally towards the median line into a keel, these markings are most easily seen on the F.V.

Dr. Arnott pronounces my *Pl. arcuatum* to be *Pl. fasciola.* In reply, I must observe that whereas the former is a strictly marine form, being only found on the open shore or in deep water, the latter only occurs in brackish water, in the living state. But independent of this very important fact, the two forms present structural differences of a specific nature, which cannot be ignored. In the first place, the extremities of *Pl. arcuatum* have each a strong *double* curve, that is, each is *strongly sigmoid* between its base and its apex. Whereas each extremity of *Pl. fasciola* has only a *single* curve, or in other words, is *gently arcuate* between its base and apex. In the second place, the extremities of *Pl. arcuatum* are much longer than those of *Pl. fasciola.* In my figure of the former species the extremities are represented much too short, a fact kindly pointed out to me by Dr. Greville. Thirdly, the striæ are much finer than those of *Pl. fasciola.*

As to my *Apr. duplex* being the same form as *Apr. paludosa,* as alleged by Dr. Arnott, I must observe that the very fact of the former being a strictly marine species, while the latter, according to the late Professor Smith, is the only fresh-water form in the whole genus, renders such an allegation simply untenable. Besides, a mere examination of figures of the two forms cannot fail to convince any one of a specific difference.

Dr. Arnott says my figures and descriptions lead him to believe that my *Pl. Wausbeckii* and *minutum,* and probably also *angustum,* are the same form as *Pl. rectum,* or, in other words, his *Apr. Ralfsii.* I am, however, led to suspect that his examinations of my descriptions, at least, must have been exceedingly superficial, otherwise he could not have arrived at such a conclusion. Dr. Arnott also states his belief that all these last mentioned species occurred in Mr. Ralfs' Penzance gathering. Repeated examinations, however, have convinced me that this is an error, as *Pl. rectum* is the only form I can detect. It is necessary to state that my *Pl. Wausbeckii* is the variety of *Pl. balticum*, figured by Professor Smith in his 'Synopsis;' but I am at a loss to understand why he considered it as such. There is certainly nothing more than a generic resemblance between the two forms as regards outline, colour, and the relation of the median line to the margin, while the striæ of *Pl. Wausbeckii* are considerably finer than those of *Pl. balticum*.

I confess myself at a loss to understand Dr. Arnott's hypothesis, which enables him to look upon the two members of my new genus *Toxonidea* as accidental or twisted conditions of *Pl. strigosum, angulatum,* and *æstuarii,* produced by a peculiar process. This *assertion* I do not credit; and nothing short of *actual observation,* I feel assured, will satisfy any partial inquirer as to its validity. It would be well, therefore, were Dr. Arnott to state whether he has seen such a phenomenon take place, and if so, to describe it. For undoubtedly any physiological or *pathological* process which can effect so great a change, not only in the general outline, in the relative position of all the parts, and in the cellular structure of the siliceous valve of the Diatome, must of necessity be a most singular one, and its demonstration by Dr. Arnott cannot fail to attract that interest which falls to the lot of every important physiological discovery.

These remarks, I trust, will be amply sufficient to show that Dr. Arnott has, on very insufficient grounds and in no liberal manner, accused me of creating "*supposititious*" species out of mere varieties, and thereby encumbering science with useless and unmeaning names. As to the regret which he expresses at what he calls "*rushing into print,*" without making myself acquainted with what others are *doing,* I must observe, in reply, that while, in my paper, I have studiously avoided any attempts at plagiarism by adopting as my own the published discoveries of other observers in the same field, I was at the same time unable to command the supernatural assistance of an Asmodeus, to unveil to my observation their present doings and cogitations. It is certainly true, as stated by Dr. Arnott, that I had described certain species which had previously been found by M. De Brebisson at Dines. Of this fact, however, I was entirely ignorant until a few days prior to its publication; when M. De Brebisson himself sent me some slides, mounted from his gathering made in that locality, in order to ask me whether the new species contained on them have any resemblance to those discovered by me on the Northumbrian shore. M. De Brébisson at the same time informed me that he had not published any description of these new forms. In January last I sent him a copy of my paper, and after reading it he wrote to me to say that he had adopted all my names for those particular species, with which he was previously acquainted; thus exonerating me from all blame in the matter. On this ground, therefore, Dr. Arnott ought not to express his disapprobation.

On a Deposit *of* Diatomaceæ *and* Mollusca, *in the County of* Antrim. By G. Dickie, M.D., Professor of Natural History, Queen's College, Belfast.

In a field at Bellahill, a few miles from Belfast, and in the County of Antrim, a sepulchral tumulus has existed from time immemorial.

In the end of January last, this mound was opened, under the superintendence of the Rev. A. J. Lee. It seems to have had for its foundation the surface of the ground where it was reared; that is to say, there was but little previous excavation, the ashes of the deceased having been placed on or near the surface, and then the earth and other material heaped over them. Mr. Grattan, of Belfast, first directed attention to the nature of part of the material dug out from the foundation of the tumulus, having recognised it as one of those deposits, called fossil earths, now known to be of very general occurrence.

Two varieties of the earth were found—the deepest in thin layers among peat, pure white, and entirely siliceous; the other more superficial, in large masses, of a buff colour, and effervescing freely with an acid. The presence of calcareous matter in the latter was easily accounted for, by the existence of fragments and entire shells mixed with it. Two of these are common fresh-water mollusca, viz., *Lymneus truncatulus* and *Planorbis vortex;* the former was by far the most abundant of the two. Along with them were found four well-known land species, *Helix arbustorum, H. rotundata, Zua lubrica,* and *Clausilia nigricans;* these were very rare, compared with the fresh-water species.

After careful examination of the deposit, I found the following Diatomaceæ:

Epithemia turgida, Sm.
„ *gibba*, Kütz.
„ *zebra*, Kütz.
„ *Hyndmanni*, Sm. (very rare).
Amphora ovalis, Kütz.
Cocconeis placentula, Ehr.
Campylodiscus costatus, Sm. (very rare).
Surirella ovata, Sm. (very rare).
Navicula ovalis, Sm.
„ *firma*, Kütz.
„ *liber*, Kütz.
„ *patula*, Sm.
„ *rhomboides*, Ehr.
Pinnularia viridis, Sm.
„ *divergens*, Sm.
„ *radiosa*, Sm.
Synedra delicatissima, Sm.
Cocconema cymbiforme, Ehr.
„ *cistula*, Ehr.
Gomphonema vibrio, Ehr.
„ *olivaceum*, Ehr.
„ *capitatum*, Ehr.
„ *tenellum*, Sm.
Odontidium mutabile, Sm.
Denticula sinuata, Sm.
Orthosira orichalcea, Sm.
Mastogloia Grevillii, Sm.

Three or four of these were not at first observed by me, but recognised by Professor G. Walker-Arnott, of Glasgow, to whom specimens were sent.

Mr. Lee, in his notice of the tumulus,* states that its shape was somewhat different from that of others in Ireland, "being more flattened and less elevated;" and further adds—"This may be accounted for by the continued action of the waters of the lake, which probably surrounded it for centuries; the former existence of which is proved, not only by the geological formation of the locality, but by the remains of fresh-water shells, and lake Infusoria found in the substratum on which the tumulus stands." Respecting this inference, I would remark that it is totally at variance with the facts observed. It is obvious that a tumulus, consisting of comparatively loose material, could not have existed for any length of time exposed to the action of water, often more or less liable to agitation by winds and floods. But supposing the mound capable of resisting the action of the lake for "centuries," how could peat be produced under it, and how could the Diatomaceæ have lived and propagated beneath it, and much less the fresh-water Mollusca? It is obvious, moreover, that the shells of terrestrial species, accidentally mixed with the others, could not possibly have been drifted to such a place as the foundation of a heap of mould, seven feet in height and forty-five in diameter. I visited the locality in company with my friend, Mr. James MacAdam, and having examined the facts above mentioned, I never doubted that the tumulus had been raised long after the draining of the lake. Mr. Lee states, that "the character of the remains discovered in this tumulus incline us to fix the date of its formation anterior to the Christian era." Long previous to this epoch the lake had disappeared, and the physical conditions of the place

* 'Ulster Archæological Journal,' May, 1858.

been completely altered, for there seems no reason to conclude that since the raising of the tumulus, at a time when the surface of the field was accessible, there had been such important changes in the district as would be implied by the accumulation of a large body of water, upwards of seven feet in depth, and the subsequent drainage of the same.

NOTES *of the* MICROSCOPICAL EXAMINATION *of a* LOOSE CARTILAGE *from the* KNEE JOINT. By W. WOODHAM WEBB, M.D., Lecturer on Histology and Minute Anatomy at the Middlesex Hospital.

THE cartilage on which these observations were made, was removed from the knee-joint of an elderly man in the Norfolk and Norwich Hospital, by my friend Mr. Cadge, surgeon to that institution. It was of somewhat larger size than is usual in such formations, and was of a flattened and elongated shape. Its general appearance was that of a nodule of fibro-cartilage, but the section towards the interior gave rise to a rough gritty sensation, and showed a darker and uneven surface. When dried, the internal parts were quite opaque, and crumbled away if scraped.

By all the older writers it seems to have been regarded as an established fact that the denser portions of these loose cartilages were of true bony character; and even in Wedl and Rokitansky, we only meet, in reference to them, with the vague terms of ossification, cretification and calcification, none of which convey any definite information as to the exact histological condition of the structures, or their mode of growth.

Before being submitted to me for examination, the specimen had been much handled and kept in dilute spirit. It was, therefore, not in the most favorable state for ascertaining the nature of its superficial investment; but I believe that epithelium had been present on those parts least exposed to pressure, though on the flatter portions there was no trace of such cells. It is only by dealing with the most delicate preparations that any accurate knowledge of these growths can be arrived at, and even with them a micro-chemical analysis is necessary.

A very thin vertical section, under a power of 220, brought into view the following appearances. On the surface was a condensed layer of fibrous tissue which had a horizontal disposition, and swelled up and became gelatinous with acetic acid. This gradually lost all indications of fibrillation, and merged into a hyaline matter, studded with innumerable flattened and elongated nuclei, very closely applied to each other, and arranged in strata towards the exterior, but becoming more and more scattered and expanded as they were traced inwards. The several stages of vacuolation and formation of cell-spaces could now be distinguished around these isolated nuclei, while the periplastic matter was clearer and without any marks of definite organization. Among the fully formed cells the usual tendency to multiplication by division showed itself, and somewhat further in this tendency assuming, as in ossifying cartilage, a linear direction, parallel and perpendicular rows of cells, with but a small amount of intervening matter, constituted the bulk of the substance.

Some of the mature cells manifested a change in the nature of their contents. These had hitherto been clear and fluid, with the exception of the nucleus, but now opaque granular material began to be seen. The end-to-end cells also coalesced with a regularity which converted them into short tubules, closely packed together in groups. These tubules, or many-celled spaces, soon became filled with an amorphous saline deposit to such an extent, that all traces of cell-wall and periplastic matter were concealed, and the mass appeared but one uniform solid block. The disintegrating and analytic influence of reagents was here required to demonstrate the actual condition of this reputed bone.

Dilute caustic soda, by expanding the intercellular matrix disclosed the whole series of tubules or spaces originating in the fused cells of which the part was made up, and so isolated the casts about which the cell-walls were accurately moulded. The addition of hydrochloric acid caused the entire solution of these concretions, with effervescence, and left exposed the empty and bare cell-walls, retaining their perfect contour, with the nuclei still adhering in their natural position and integrity. Longitudinal irregularities or puckerings, produced no doubt by chemical action, gave to these walls a sort of fibrous look. The very centre of the mass consisted of numerous stellate groups of these elongated spaces with cretaceous contents, round the aggregate of which were arranged the perpendicular rows of cells undergoing the process of fusion, and filling up of their areas.

There was no indication of nerve, vessel, bone-corpuscle, or other structure, which could warrant the classification of this abnormal articular growth as an osteophyte. Beyond a certain depth from the surface, all the changes taking place were those of retrograde metamorphosis.

The description follows the appearances, as seen in passing the eye over a thin section from the circumference to the centre.

Phenomena *of* Internal Movements *in* Diatomaceæ *of the* North Sea, *belonging to the* Genera Coscinodiscus, Denticella, *and* Rhizosolenia. With a Plate. By Professor Max Schultze.

The sea around Heligoland is rich in large Diatoms, which are frequently brought up in considerable numbers by the fine net. Several of the species very abundant there have been found by Ehrenberg at Cuxhaven, as *Coscinodiscus, Zygoceros, Eucampia, Triceratium* ('Abhandl. d. Akad. d. Wiss. z. Berlin,' 1839). Others are still not known out of that region, as *Chætoceros* (Brightwell, 'Quart. Journ. of Micr. Science,' 1856, p. 105, tab. vii), *Denticella, Rhizosolenia.*

By far the most numerous forms of the genus last named occurred towards the end of the autumn. The Rhizosolenia are readily to be distinguished with the naked eye, and were wanting on no day in the excursions undertaken in company with my father and the Messrs. G. Wagener, Lieberkühn, and Kupfer. In a glass containing them one perceives, by transmitted sunlight, a glittering, proceeding from small rods of a hair-like fineness, which refract and bend the light, like crystals of Cholesterine, but more strongly, so that they shine in all the colours of the rainbow. The rods not unfrequently attain the length of 2 to 3 lines.

Perfect examples of the genus *Rhizosolenia* Ehrbg., so far as I am aware, have only been found by Brightwell up to the present, and were first mentioned in No. XX of the 'Quart. Journ. of Micr. Science,' 1857, p. 191, and were afterwards figured in the later numbers of the same Journal. These being all procured from the stomachs of Ascidians and Salpæ, as also from *Noctiluca,* were seen filled in part with organic, but not living, contents. Still, Brightwell, in the last-mentioned place, states, from his own observation, that *Rhizosolenia setigera* shows a movement like other Diatoms, in which the tubes push themselves slowly backwards and forwards. Here also it is mentioned that Rhizosoleniæ occur freely, swimming in the seas of warmer latitudes.

Herr G. Wagener first drew my attention to the peculiar currents of granules occurring in the Rhizosoleniæ, which induced me then to make further researches among other Diatoms, where they had been observed by G. Wagener, also in *Coscinodiscus*, and finally I saw them in a large *Denticella*. Great transparency of the siliceous coats is necessary for a clear observation of the streams of granules. Those forms of *Coscinodiscus* the sculpture of whose shells is very delicate, as *C. centralis*, Ehrbg. ('Micro-geologie,' tab. xxii, fig. 1), with which a form common at Heligoland agrees, are consequently more fitted than others, such as *C. radiatus* and *C. patina*, Ehrbg., which are finely marked, and possess an opaque, sharply sculptured shell. For the same reason *Triceratium*, of which many species occur at Heligoland, is not adapted for observation. In several Diatoms placed together, whilst living, in a fluid adapted for the preservation of Medusæ,* could be observed, in addition, a radiate, threaded arrangement of the organized contents, corresponding with that in which the granular streams would have been observed in life, as, for instance, in the large transparent *Navicula angulata*.

The whole movements I have seen neither in *Rhizosolenia*, nor in *Cosinodiscus* and *Denticella*. The internal movements are of the following kind:

Coscinodiscus and *Denticella* (figs. 11—13) show, in the living state, a nucleus placed almost in the centre, but still drawing near to one of the side walls; it is a round, colourless vesicle, of the size of a human blood-corpuscle, with a large, strongly refracting nucleolus—it might be taken for a cell with a nucleus, but which last would then want the nucleolus. Around this body is found an accumulation of a finely granular colourless mass, from which radiate a multitude of finer and coarser cords, passing through the internal space of the Diatoms, which is of a water-like clearness, in all directions. They all come to an end at one of the surfaces of the siliceous covering, lying closely round an exceedingly

* This fluid, consisting of common salt ℥iv, alum ℥ij, sublimate gr. iv, dissolved in two quarts of distilled water, is well adapted for the preservation of small organisms, procured by fishing with the fine net in the sea. One rinses out the corner of the net in a glass filled with this solution instead of sea-water. In this manner, after several repetitions, one obtains a sediment which may serve as a mine for the whole year. Noctiluca, Echinoderm, and Annelid larvæ, Entomostraca, Diatoms, Polythalamiæ, and Polycystiniæ are admirably preserved, both in their soft parts as well as their hard structures. To make them transparent, glycerine should be afterwards added. In the circumnavigation of the world, glasses containing this fluid, each filled at different places and noted, would furnish richer and better material for the study of geographical distribution and variety of forms than searching the stomachs of animals or the filtering of several bottles brought back filled with sea-water.

delicate layer of the same finely granular matter. In the latter, as in the fine granular substance enveloping the nucleus, and frequently in an incompletely fixed state of the wall, entirely concealing it, are imbedded vesicles of a coloured material. These are ochre-yellow, and round or somewhat pointed; they are of the latter form in *Denticella.* They lie close to the siliceous covering, either presenting an entirely uniform distribution at equal distances from one another (as in the examples delineated), or are arranged in reticulated cords, uniting among each other, as has been more than once seen in *Coscinodiscus.* In the threads and in the finely granular external layer are found appearances of currents. Specimens brought freshly from the sea, or kept at most some hours in a glass, are alone fitted for the observation of these. From the finely granular mass surrounding the nucleus the stream goes in, and to the, as it appears, more homogeneous, if not structureless, mass, consisting of threads at the periphery; and in the same threads, or others, different granules return back to the centre. The threads are thickest near the nucleus, and attenuate themselves on their way by division, anastomosing reticulately with one another, till, in their finer distribution, they represent a delicate web lying close to the siliceous coat, in which, or in a more homogeneous layer, immediately on its exterior, the coloured vesicles are imbedded. The nucleus does not always lie close to the siliceous covering; it may also approach the middle of the internal space. *Coscinodiscus* possesses a form like a shallow round box, whose bottom and top is arched like a watch-glass. If one views such a body from the side, and the nucleus with the granular mass enveloping it is situated in the middle, between both side walls, there goes more frequently a stronger cord of granular matter from it to the centre of the latter. In this way the middle appears possessed of a darker axial cord. In such a middle situation, the nucleus seems to increase before the commencing propagation by division. After the appearance of two new watch-glass-shaped walls, with their convex surfaces turned to one another, that sprout of division possesses a nucleus closely adhering to the newly formed wall. So also in *Denticella* (as fig. 12 shows), where certainly the situation of the nucleus is disclosed only by the accumulation of the darker granular mass, as the centre of the radiating threads. The coloured vesicles are omitted in this figure; they presented the same uniform destribution as in fig. 11, so that a complete removal of the same seems not to interfere with the appearance of the division.

Somewhat differently does the granular stream flow on in *Rhizosolenia*. The long, completely transparent, very delicate siliceous tubes possess yellow contents, as Brightwell indeed saw; and certainly this yellow colour is dependent on coloured vesicles of a long oval, nearly rod-shaped figure, almost equaling in their long diameter those of *Coscinodiscus* and *Denticella*. They lie imbedded in a colourless substance, containing fine granules, which is again the seat of the appearances of currents, in which here, however, departing from the Diatoms first described, the coloured vesicles take a lively part. A denser opaque accumulation of the granular matter and coloured frustules, situated sometimes in the middle, at others nearer one end of the tube, in which a nucleus, as in *Coscinodiscus* and *Denticella,* could not be seen, presents itself as the centre of the currents. These do not radiate in all directions through the middle of the tube, but confine themselves closely from the beginning to the surface of the siliceous coat, and run off usually as fine, stretched, parallel threads, until, in the pointed end of the tube, they unite themselves again to a generally small expanding opaque mass. I once counted in the circumference of the tube sixteen such granular threads, flowing parallel and beside each other. The current is in each of the threads double. Small granules, flowing in a more homogeneous substance, sometimes more quickly, at others more slowly, collect themselves together here into a little mass; they are there seen only singly, projecting out on the margin beyond the surface of the thread, or apparently entirely imbedded in it. Frequently one or many of the coloured frustules are laid hold of by the current and carried far away to a distance; others lie quietly between the streams in a perfectly undisturbed layer. Bridge-like joinings, meltings away, and divisions also occurred. So much I remember. Alas! more accurate notes I did not make. It may be that the phenomenon, for that reason, will commend itself to others for further research.

The granular currents described, namely, those in the interior of *Coscinodiscus* and *Denticella,* entirely resemble those known to exist in *Noctiluca*. In it they proceed from a dark mass, which eccentrically took the place on which the spherical body possesses a heart-shaped recess, and radiate in all directions in the interior of the hollow space of the body, which is filled with a clear fluid, passing away into an exceedingly fine network of streams immediately under and surrounding the skin, and ultimately melting away with skin itself, which (if we would transfer an idea from the plant-cell to the *Noctiluca,* only represents the most external layer of the proto-plasm) is of the nature of clear albumen; this also appears not to be wanting in *Coscinodiscus,* though in it covered by the siliceous coat, as it is in most plant-cells by one of cellulose. The currents of granules are also perfectly similar to those found in the extended threads of Gromiæ, Polythalamiæ, and Polycystiniæ. Unger has briefly ('Anatomie und Physiologie der Pflanzen,' 1855, p. 282)—a view previously more specially propounded by Cohn ('Nachträge zur Naturgeschichte des *Protococcus pluvialis,*' Aus d. Leopoldinischen Akademie-Shriften)—classed together the currents in the fluid contents of plant-cells (2 B), the hairs on the filaments of *Tradescantia,* with the phenomena presented by the threads of *Amœba porrista,* or the Polythalamiæ, as I describe them, and the movements of the protoplasm he declares are exactly similar to those of the so-called sarcode of the Rhizopoda. I have compared the frequently described phenomena in the hairs on the filaments of *Tradescantia* with the currents in the Diatoms, as well as in the threads of the Rhizopoda, and must acknowledge their great similarity. I chose for the observation *Tradescantia procumbens,* the hairs of whose filaments present very transparent cell-walls and entirely colourless contents; the latter, in *Tr. zebrina,* for instance, being more or less real, detracts somewhat from the distinctness of the movement phenomena. In the former, also, the granules are larger, and the material of the threads apparently more homogeneous. From the layer of protoplasm enveloping the nucleus proceed several thicker or thinner threads, traversing the cell in all directions, more frequently, however, lying close to the cell-wall (as in *Rhizosolenia*). They consist clearly of a basic material, with strongly refracting granules imbedded in it. The latter flow in the interior, or, as it were, on the surface of the threads, either in one direction only, or in opposite directions at the same time in one and the same thread, as may not unfrequently be observed. In the broadest threads this double direction of the current is nearly universal, but it occurs also in the finest, which are almost imperceptible. The granules generally pass by each other undisturbed, or it may happen that one is taken back by the others—a proof that the double direction of the stream is not due to two separate threads. Individuals flowing quickly overtake others going more slowly in the same thread, and may then, as I once saw, suddenly turn back and proceed in company. The threads divide themselves frequently in a forked manner, and a granule reaching the point of division stops before committing itself to the one or the other way. The shape and direction of the thread are subject to continual change. The forked division, for instance, proceeds from the base of the threads at the cell-nucleus to the other ends, which meet together on the internal surface of the cell-wall. Or it forms out of the forked division a bridge to a thread lying close beside it, while the branch part melts away with this. The bridge then runs upwards or downwards between both threads; it shortens itself, while the latter draw near one another; finally they melt away completely with each other into one, so that now a broader stream flows where there were formerly individual fine threads. On the internal surface of the cell-wall is found a thin, coherent, protoplasmic layer. So it appears after the application of reagents, which cause it (the primordial utricle) to become shrivelled. By means of syrup I could bring out here what A. Braun arrived at in the Characeæ ('Monatsberichte der Berliner Akademie d. Wiss.,' 1852, p. 225). The cell-contents, sharply circumscribed, drew themselves back from the membrane of the cell; besides, the appearance of currents in the interior still continued for a long time. In this way one can convince himself that the granular currents and fluctuations (for such are here frequently alone present in places), occurring in the mid-layer of the protoplasm, are not related to the last layer (Hautschicht, Pringsheim) but only to the inner stratum of the parietal layer (granular layer). In this way those in *Noctiluca* are comparable with the above. In distilled water I have seen the appearance of a stream maintain itself in individual cells for twelve hours, and in thin syrup for twenty-four. It would be well worth the trouble to try the influence of a series of solutions on the movements described, perhaps like those made by Kölliker with the spermatozoa. In this way interesting disclosures might be expected.

The movements remarked in the protoplasm of plant-cells ought not, in my opinion, to remain neglected, as they may act as an explanation of the mysterious appearances of life in the sarcode threads of the Rhizopoda, and I recommend the comparative study of the former to those who consider the threads in Polythalamia as possibly or probably a compound of small cells. In *Tradescantia* the same phenomena occur in undoubted cell-contents, which must, therefore, be related to animal life.

Of Rhizosoleniæ I have observed two different species. The largest, and by far the most abundant, is undoubtedly identical with Brightwell's *R. styliformis*, described in the 'Quarterly Journal of Microscopical Science,' Jan., 1858, xxii, p. 94, and delineated in Plate V, fig. 5. The tubes are cylindrical, pretty abruptly pointed at both ends, and furnished at the extremity with a small siliceous point, apparently solid, or at least with very thick walls, sharply marked off from the cavity of the cylinder. The pointing of the species, according to various positions of the tube obtained by rolling it round, originates nearly like a cut-out quill-pen. The length and thickness of the tubes vary much. I have seen them from 0·4 to 0·7''' Par. in length, and 0·025 to 0·04''' in thickness. The most examples are found in the act of division, which is in an oblique direction, while others consist of from three to six individuals cohering together. Of such I have measured several. A. Four coherent individuals, 0·68''', 0·42''', 0·4''', 0·46''' in length. B. Three ditto, 0·7''', 0·76''', 0·68''' in length. C. Three ditto, 0·72''', 0·54''', 0·52''' in length. D. Six individuals attached to each other, 0·52''', 0·74''', 0·5''', 0·52'', 0·5'' in length; the last was broken off; the entire length of the tube was 3'''. Characteristic of *R. styliformis* are the ringed markings which the shell possesses. These appear not remarkable in water, but come out very sharply after subjection to a red heat, or desiccation after previous treatment by acids. I have taken pains in fig. 4 to give a most correct drawing of the same, as they appear in that position of the Rhizosolenia which resembles a cut quill-pen, with the cut surface turned towards the observer. The upper part of the two individuals shown in fig. 3, still hanging together after the division, turned round in its long axis towards the left about 90°, would then present the same view as fig. 4. The oblique falling-off side of the young ends is presented to the beholder. On it, in the middle, is found a design like the tip of a lance. It is, to look at, in a manner like an impression of the once closely applied end of another individual. Here a confinement of the shell to the very last may take place during the division, perhaps even an aperture in the siliceous coat remains in the dark lines, *a, a,* which I could sometimes nowhere discover. The ringed markings of the shell are made by linear incisions, therefore the shell most commonly breaks in the rings. A wider and finer marking of the siliceous coat could not be discovered, either in the red-hot condition or by the use of oblique light.

The second species, which is rarer in Heligoland, I have named *R. calcaravis* (figs. 5—8). It is smaller than the first, and occurs in solitary, not in numerous, individuals adhering together. Length 0·20'''—0·25'''; thickness, 0·025. Specimens of 0·25''' already showed the oblique division in the middle. Once only I saw three individuals hanging together, and of these one was caught again in the act of dividing. Their lengths were 0·15, 0·15, and 0·225.‴ On the siliceous coat I could not perceive a ringed marking. The pointing at the ends is waved, and the extreme point, sharply marked off, as in *R. styliformis,* is bent like a bird's claw. The level of the curves of these points in the two ends of one individual are not parallel, but cut themselves at a sharp angle. The two specimens delineated at fig. 8 present a provisional, not clearly explicable peculiarity. They were found without organized contents. They adhered firmly to one another, as they are figured, being only slightly changed that the cause of their cohesion may be shown. The length of the specimen on the left was 0·2‴, that on the right 0·25‴. In both the upper point was broken off nearly at the middle; but a kind of termination was again effected by a very delicate membrane. Both contained in the interior, moderately near one end, two spikes of new individuals made fast to each other in an inverted direction. I suppose these examples were caught in the act of dividing, for which purpose they had developed the new spikes in the middle. They may be released later from their original situation by the death and subsequent maceration of the contents. Lastly, the young points differed from one another. As is evident in figs. 9 and 10 (magnified 330 diam.) the point of the former has a double, strongly refracting contour, while that of the latter is paler and more delicate. Fig. 9 lay in the specimen figured on the right above, and in that on the left below, *a, a.* Fig. 10 was the reverse, *b, b.* After the division in the Rhizosoleniæ, as also in *Coscinodiscus* and *Denticella,* the siliceous covering of the parent individual still remains for a long time uninjured over the divided place (compare figs. 6 and 12). After this is cast off, the offspring of the division always adhere for some time to one another. So likewise in *Rhizosolenia styliformis,* as in fig. 2, where the dotted lines indicate the original union by the siliceous covering which is here at present wanting. Specimens are frequently seen to whose free ends still adhere portions of the already cast-off siliceous covering of the parent. Rhizosoleniæ broken off, close the opening with a siliceous plate arched like a watch-glass. Still they appear, in addition, immediately after the closure to develope a new and regular terminal process. I have seen specimens of the species, at least, which certainly show, if it may be so somewhat artificially explained, that the broken-off point, getting placed inside the tube, may become incarcerated by the ensuing closure.

The Diatoms shown in figs. 11 and 12 must be referred to the genus *Denticella,* if we consider Ehrenberg's *D. amita* ('Microgeologie,' tab. xxx, A, figs. 2, 3, 7) as the typical form. They agree very closely with the form named by Bailey *Zygoceros* (*Denticella* ?) *mobiliensis* ("Microsc. Observ. made in South Carolina, Georgia, and Florida," 'Smithson Contrib.,' vol. ii, p. 40 of the separate copies, tab. ii, figs. 34 and 35), which cannot be, however, a *Zygoceros,* but is a true *Denticella,* as Herr J. Müller informed me in reply to an inquiry respecting his opinion. One might impute the difference from our species to the inaccuracy of Bailey's somewhat rough drawing. The size Bailey does not mention. The specimen given in fig. 11 measured 0·11‴ in length (without the prickles), and 0·065‴ in breadth. That in fig. 12 was 0·125‴ in length, and 0·098‴ in breadth. The lengths of the individual sprouts of division were 0·055 and 0·065‴; it was thus much less than their breadth, which, in connexion with the other measurements already given, presents a great variety in form. Young specimens, at first released by the division, sometimes appear broader than they are long, at others longer than they are broad. Besides, there occurred at Heligoland much smaller *Denticellæ,* which (either the young of our species or of a new one) appeared to have originated in a different manner than by division. The cross-cutting of our *Denticella* is barley-corn shaped, and ends naturally above and below in two external projections. The spines are placed internal to the projections, not in the two lines uniting the projections to one another, but the one to the right and the other to the left of them. Hence the uneven appearance the one has compared with the other in the two individuals caught in the act of dividing (fig. 12).

In water the siliceous coat appeared destitute of all finer structure. With great pains two cross lines can be perceived, running parallel to each other, which are shown in our drawings. These are always at the same distance from the upper and under ends, and approach more closely to one another the shorter the individual. After the application of a red heat, and by the use of oblique light, there is brought into view a fine hair-like marking of the surface, as seen in *Navicula angulata.* Such a fine clothing *D. mobiliensis* of Bailey, from the coast of Florida, shows. After all the information given, our Denticella will be easy again to recognise. I have named it *Denticella regia.*

On some Conditions of the Cell-wall *in the* Petals *of* Flowers, *with Remarks on some so-called* External Secondary Deposits. By Tuffen West.

In working over microscopic subjects generally, my attention was arrested by that well-known object, the petal of the geranium, and the attempt to reconcile the appearances found with the descriptions in books led to investigations, some of the results of which are embodied in the following communication. How far these agree with the opinions entertained by previous observers will best appear in the course of my remarks.

It may be desirable to state at the commencement the mode of examination followed. Considering the soft and perishable nature of the structures to be determined, it seemed essential that they should be viewed as quickly as possible after being gathered, before any changes from the natural condition of the parts in life could have taken place. Some petals, as those of Clarkia, are so exceedingly delicate, that even the water added for their examination speedily renders them a confused mass, in which little is discernible save certain large Raphidian cells. So essential has it appeared to have the flowers freshly gathered, that I have felt obliged to reject some observations made on withered petals, lest wrinkling of the cell-wall might have been thus induced, and erroneous opinions formed—the serious nature of which will be seen as we advance. Descriptions of appearances brought into view in petals dried, mounted in Canada balsam, blistered by heat (I had almost said tortured to produce false appearances), cannot therefore but be viewed with distrust. Were anything to be gained by it, it would not be difficult to explain the nature of the errors induced by such modes of examination.

Having then procured perfectly fresh flowers, a petal was detached, and bent backwards so as to expose the outline of the layer of cells forming the inner surface; another petal, bent inwards upon itself, gave the outline of the external surface; the margin was next examined, and, finally, portions torn up with needles. Glycerine was found very useful in rendering the structures distinct, and I may mention also that it preserves most petals in a highly satisfactory manner.

In the great majority of the plants examined, which amounted to some hundreds, when a profile view is thus obtained, it will be found that the cuticle is not uniformly level, but the cells composing it are mostly elevated towards the centre, more or less above the general surface. Such elevation is almost invariably greatest on the inner surface of the petals, and the descriptions here given, with only one exception, apply to such. Between the cuticles the tissue is generally stellate, in one or several layers.

These elevations may be formed, either by general convexity of the outer cell-wall (*Ranunculus aquatilis*, fig. 1—iris, fig. 2), or dome-shaped (ten-week stock, fig. 3), or a partial elevation of the centre (featherfew, *Pyrethrum parthenium*, fig. 4), mammilate (geranium, fig. 5—orchis, fig. 6), awl-shaped, acute (sweet william, fig. 7—mimulus, calceolaria, &c.) On the outer surface of the tubular corolla of Comfrey, *Symphytum officinale* (fig. 8), they are very long, and intermixed with undoubted hairs. In the Cruciatæ they appear to be the coloured petalline hairs of Balfour. The most rudimentary condition of these elevations is that of a minute papilla, rising abruptly from the centre of every cell, or nearly so; a good example of this is seen in Gladiolus (fig. 9). That they are truly hairs in a rudimentary condition, the examination of an extensive series of instances will leave no doubt. On the lip of a brilliant little blue lobelia every gradation may be met with, from the slightest convexity of the cells to true hairs $\frac{1}{100}$ in. in length, and equally so on the same part in *Antirrhinum majus*. To these mammillate protuberances has been attributed the velvety appearance of the surface of petals; they form truly the "pile," so to say, "of the velvet." It seems probable, also, that from their convex form, they may act as lenses in magnifying the brilliancy of the coloured chlorophyll. Another way in which the richness of the hues of flowers is enhanced would, perhaps, scarcely suggest itself readily to any but an artist. I allude to the separation of the colour into regularly arranged symmetrical spots by the colourless cell-walls, thus obtaining what is technically called "air;" an effect that is rudely imitated by artists, according to the substance on which they work and the facilities which their materials may afford for its production. That this idea is not fanciful, may be readily seen by comparing an imitation

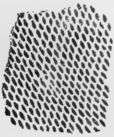


Fig. 1.

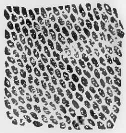


Fig. 2.

on wood of the stippling of the miniature painter (fig. 1), who requires thus to produce the utmost degree of brightness which his colours will afford with fig. 2, a diagrammatic representation of part of the petal of the scarlet geranium, under a very low power. That the radiating lines seen not unfrequently on the cell-wall in this situation can have any appreciable effect in producing the brilliancy of flowers, as maintained by Schleiden, seems, however, more than doubtful.

These papillæ, or " mammiliform protuberances," may be either marked with lines or dots, or smooth and destitute of both. Good examples of these lines are presented by the petals of geranium (fig. 5), and pelargonium (fig. 14). When the outer cell-wall is papillate, they assume a radiate arrangement, which is seldom distinctly perceptible in the cells of petals, the surface of which is plain. These lines have been considered by Schleiden and Carpenter to be probably due to secondary deposit, and such was, up to a recent period, my own belief. In examining the petal of ladies' bedstraw (*Galium verum*, fig. 10), I found an interesting condition of the parts. The cells here are not elevated above the general surface into papillæ, but are covered with large, raised, tubercle-like spots, arranged with considerable regularity, of a glassy transparency, and showing section distinctly. Some idea of their appearance may be formed by imagining a plate of glass, whilst still soft, to be pressed out in spots by a small blunt tool, and cooling rapidly, to retain the impressions thus caused, which, by turning the glass over, would become elevations on the now uppermost surface. Similar tuberculoid dots are found on the lobelia before-mentioned on *Antirrhinum majus*, &c. Schleiden long ago described " tubercles " studding hairs from the fornix of *Anchusa Italica*, and figures them as if formed by layers of successive deposit in some cases. In this he has been followed by other authors; and Quekett represents some of them detached, as if rubbed off, which, were they really tubercles, might occur. At the time when this Anchusa was in flower, I was unfortunately too much engaged to be able to hunt after it; but hairs presenting external elevations are not uncommon.

The example of Galium just mentioned showed conclusively, however, that tubercle-like elevations *might* be

Fig. 3

Fig. 4.

present on the walls of cells, or their prolongations, without the presence of external secondary deposit. The cell-wall is pretty thick, firm, of exquisite transparency, and can be clearly traced as *forming* the tuberculoid elevation. A diagram (fig. 3) may serve to render my meaning clear. If the elevations were due to secondary deposit, we should see distinctly, as in the imaginary instance (fig. 4), the cell-wall continuous, and supporting an extraneous substance.

Having satisfied myself, from this instance, that on the outer surface of vegetable cells, protuberances and hairs were not *necessarily* owing to external secondary deposit, I made very numerous examinations into analogous cases, the results of which have led me to believe that the views now held on this subject will require much modification to render them consonant with truth. I have met with no certain example of such, though one or two instances have occurred to me in which there might be a degree of doubt, from the top of the tuberculoid elevation being somewhat thicker than the sides; in *Galium mollugo* it is so. But we need not hence assume that this is from secondary deposit, for it is certain that the cuticular cell-walls are not of equal thickness in all parts, and such an appearance may be easily explained without such an hypothesis.

Hairs of much value for the purposes of our present inquiry occur in the throat of the pansy (*Viola tricolor* and varieties of *V. lutea*, fig. 11). They are large ($\frac{1}{50}$th in. long), knobbed all over; these knobs, clearly produced by outward bulging of the cell-wall, are themselves irregular with lesser warty prominences, and towards the attached end of the hairs they subside into interrupted subspiral lines, equally due to folding. A sectional view of hairs from the throat of verbena (fig. 12) and petal of the musk-plant (fig. 13) shows that the dotted markings they possess arise in the same way.

The radiating lines on the petals of geranium, &c., are likewise caused by corrugation. In petals removed from the scarlet geranium whilst the bud is still very immature, neither the papillæ, the radiating lines, nor certain so-called "hairs" arranged round the base of the papillæ, are present. But on examining petals from flowers advanced to about twenty-four hours from the period of opening, these are all found pretty well developed. Being still in a soft condition, the action of nitric acid diluted may be watched under the microscope, causing evolution of the cell-walls and disappearance of the radiating lines or folds, with consequent appreciable increase in size of the papilla out of which they were formed. The petal of the larkspur shows the same facts equally well. When the eye is thoroughly familiarised with the objects, the optical appearances alone are almost sufficient to enable a confident opinion to be formed.

Round the margin of the cuticular petalline cells of pelargonium (fig. 14), geranium, in all its species, so far as I have had the means of ascertaining (fig. 5), periwinkle, *Vinca major* (fig. 15), nemophila, and others, are little dentate processes, appearing, when viewed from above, as if pointing inwards towards the centre of the cell to which they belong. Seen in profile, it becomes evident that they do not project freely into the cavity of the cell, nor outwardly, but are indeed in close apposition with the cell-wall. These are really pats of internal secondary deposit, as is proved by watching the progress of their development and the action of nitric acid. Such little pats are common at the most projecting part of the curves of sinuous petalline cells; the curves sometimes become angular, and this appearance is much increased by the deposit. In the clove-pink (fig. 16) this secondary deposit is laid down more irregularly; in the petals of the white poppy (*Papaver somniferum*, fig. 17) and St. John's wort (Hypericum) they form an imperfect spiral. Another case of what will be probably found to be due to the same cause is met with in some petals just within the point of the papilla; this is the case in *Orchis maculata*, and in *Vinca major* (fig. 15).

It would be interesting to ascertain if, when papillæ occur, we may expect to find them in other species of the same genus, and in allied genera; also to what degree they retain similar forms and markings. My observations are not sufficiently numerous to found safe generalizations upon, but they appear to favour the idea that such may be the case.

In conclusion, it may be well briefly to recapitulate the propositions here sought to be established. They are—

1st. The prolongation of the outer cell-wall of the cuticle of petals into mammillary protuberances as a *usual* condition; such elevations being, with rare exceptions, most marked on the inner surface, and being hairs in a more or less rudimentary condition.

2d. That the markings on the parts here named (which may be divided into two kinds, lines and dots, though examples of an intermediate nature occur) are both caused by corrugation of the cell-wall, and *not* by external secondary deposit upon it.

Note.—The dots here spoken of on some petalline cells and many vegetable hairs have a special interest, from the light they throw on the true nature of the markings of the Diatomaceæ. In each we have minute spots, but in the first named they are *above*, in the latter *below* the general level of the surface. It is as unphilosophical then to apply the term "cellules" to the markings of a diatom, as it would be to give it to the tuberculoid dots in question.

On the Optical Powers *of the* Microscope.

By P. G. Rylands, Esq.

The period has not yet arrived when even all those who employ the microscope methodically, as a means of scientific investigation, possess an intelligent comprehension of the principles on which it is constructed and the nature of its powers as an optical instrument. There is a large region beyond mere manipulation, into which few apparently care to enter. The writers of our introductory treatises have been curiously imitative in dealing with this portion of their duty. They indulge us with nearly the same very elementary diagrams, refer us to Ross's capital article "Microscope," in the 'Penny Cyclopædia,' and then, with here and there only a trifling exception, leave the matter pretty much as they found it. Surely the time has arrived which calls for more than this; when an optical treatise on the microscope, worthy of the name, is not only desired by the few but required for the many. In the meantime, until this boon be granted, your pages will continue to do good service by dealing with these matters, and, as heretofore, in such a manner as to secure to your readers a large store of information.

I had hoped that some more able hand than mine would have undertaken the subject on which I now propose to occupy a portion of your space; but it has not been so, and I therefore offer the following remarks on the optical powers of these instruments to your readers, without further introduction.

The first power which I shall mention requires little remark. It is the one which has attracted the greatest share of attention, from being that which constitutes the most prominent characteristic of the microscope. I mean magnifying power. For our present purpose it is sufficient to remind the reader that magnifying power has to do with size, and *size only*. It expresses simply the *dimensions* of the enlarged image presented to the eye of observers, as compared with the size of the natural object when viewed at the adopted standard distance, ten inches, from the eye. Or, in other words, it may be said to express the magnitude of the angle subtended by the enlarged image, at the eye, as compared with that subtended by the object itself under the circumstances named.

The second, or penetrating power, is a subject which cannot be dismissed so easily. The origin of the term will be found in the 'Phil. Trans.' for 1800, in an article by Sir William Herschel, entitled, "On the Power of Penetrating into Space possessed by Telescopes." In that article we are told that when, owing to the darkness, a distant church-steeple was invisible, a certain telescope described showed the time by the clock upon it very clearly. This, adds Sir William, was not owing to magnifying power alone, for the steeple could not be discerned by the naked eye.

Following out the suggestions of this incident in a truly philosophic spirit, the author has given us, in the article referred to, all that is required to apply the term correctly to the microscope.

Unless I am mistaken, the first use of the word in connexion with the microscope occurs in the 'Microscopic Cabinet.' Judging from the manner in which it is there employed, we should perhaps define it as synonymous with angular aperture. Most persons, I fancy, were at a loss to see the connexion between the name and the thing signified, for, while some few writers were content to adopt the term with the explanation given, others, considering it an entire misnomer, began to speak of angle of aperture, and have since defined "penetrating power" to mean superior definition, thickness of field, &c. This has naturally led to confusion, and that not amongst those only who make small pretensions. Dr. Carpenter, in his 'Manual,' tells us that the penetrating power of *an object-glass* "depends upon the degree of distinctness with which parts of the object that are a little out of focus can be discerned," or, in other words, longitudinal focal range or thickness of field. The editors of the 'Micrographic Dictionary' mention "two distinct kinds of penetrating power," one the same as defining power, and the other angular aperture, combined with oblique illumination. They propose that the term should be laid aside as tending to confusion! I think it may be shown that the confusion is not altogether attributable to the term, and that the whole difficulty not only admits of an easy solution, but that the subject is sufficiently important to warrant a careful investigation.

The authors of the 'Microscopic Cabinet' had in their minds, there is no doubt, the true origin and meaning of the term. They erred in not giving a sufficient explanation. They borrowed it from the telescope, and, seeing that the telescope and the microscope are essentially the same instrument, but modified to adapt them to different purposes, the use they made of it was perfectly justifiable; at the same time it must plainly be used to mean the same thing in both cases. Sir William Herschel has shown, in the article already referred to, that the words penetrating power have a definite meaning, and that the amount of this power possessed by a telescope can be obtained by calculation. This must be true of a microscope also. This power must not be confused with angular aperture, which has reference to the objective alone; neither has it any connexion with either definition or thickness of field. In one word, as magnifying power expresses the angle subtended by an object or image at the eye of the observer, so penetrating power is the measure of the angle subtended by the eye at the object, or the equivalent of that angle in the case of telescopic or microscopic vision. The one is the measure of size, the other of brightness. This latter, however, must not be confused with "illumination." The one power is neither less important nor less essential to distinct vision than the other. There required little magnifying power, and there was no illumination, in the case of the church-steeple, still the hour could be read on the dial. It is the power by which this was accomplished that we have to consider.*

Referring those who wish to investigate this matter fully to the paper in the 'Phil. Trans.,' I shall content myself with making use of such portions of Sir W. Herschel's formula as is sufficient for our present purpose. This may be given as follows:

Putting P for the penetrating power of a refracting telescope,
x for the proportion of light which remains for purposes of vision after passing through a single lens,
n for the number of lenses in the instrument,
A for the available diameter of the object-glass,
and a for the diameter of the pupil of the eye; we have—

$$P = \sqrt{\frac{x^n A^2}{a}}.$$

By applying this to the microscope, we shall obtain that which alone can be correctly called "penetrating power." We shall see clearly in what the value of increased angular aperture really consists, and I think we shall come to the conclusion that the term under consideration represents something sufficiently important to prevent its being laid aside on account of any foregone carelessness or confusion.

The great distinction between the telescope and the micro-

* We are not told what magnifying power was employed in viewing the church-steeple, but I gathered from something in the paper that the penetrating power of the telescope was about forty times that of natural vision.

scope exists in the fact that while the former, practically speaking, is suited to receive parallel rays from a distant object, the latter has to deal with rays which are sensibly divergent from a closely approximate point. On this account the formula will require some modification.

In natural vision the rays emergent from any point of an object, which are employed for the purposes of vision, form a cone having the area of the pupil of the eye for its base. When the microscope is applied, the available aperture of its anterior lens takes the place of the pupil, and a cone of very different proportions is substituted. It is on the relative magnitude of the angles at the vertices of these cones—allowance being made in the latter case for the light lost in its passage through the instrument—that penetrating power depends. Thus the connexion with angular aperture is seen to be sufficiently close to form some excuse, perhaps, for one definition which has been given.

It is only necessary to premise further that the formula may be stated in a rather more convenient form, thus:

$$P = \frac{A}{a}\sqrt{x^n}$$

If A be now made to stand for half the angle of aperture of an objective, and *a* half the angle subtended by the pupil of the eye at ten inches, instead of the diameters of these apertures as before, the formula applicable to microscopes will be—

$$P = \frac{\tan A}{\tan a}\sqrt{x^n}$$

Further, if we are content to adopt 0·2 inch as the mean or standard diameter of the pupil, which is sufficiently exact for general purposes, the equation becomes—

$$P = 100 \tan A \sqrt{x^n} \; *$$

* From two series of measurements of the diameter of the pupil I obtained the following results:

In full daylight, near the window of a well-lighted room, 0·15 in.; at the most convenient distance for distinct vision from a Highley's argand gas lamp, 0·25 in.; the mean of the whole being 0·2 in.

As simplicity is a great matter in such calculations as the one now under notice, it may be worth while to remark, that if the value of x^n for the instruments of our best English makers should be found to be sufficiently constant, which is quite probable, the expression, so far as they are concerned, may be reduced to a single operation, and the value of P taken almost at sight from a table of tangents.

The angle of aperture of an objective should be obtained by Mr. Lister's method ('Phil. Trans.,' vol. cxxi; see also Quekett, p. 464), separately with each eye-piece and length of draw-tube.

I shall not stay here to point out the advantages of obtaining the amount of penetrating power in the manner described; this, and all that need be said further on the subject, will, I trust, be sufficiently clear from what follows.

The third power—the visual power of microscopes—is one which has been so rarely recognised as distinct, that probably even the name will be new to most of your readers.

It is well known that the extent to which vision is aided by a telescope (for we must be indebted once more to that instrument) is very rarely expressed by its magnifying power; that two instruments, equal in both magnifying and defining power, may differ widely in their visual power; and as in the telescope, so in the microscope, for they are essentially the same in principle.

Perhaps an example will most easily explain what is meant by visual power, and its connexion with the two already described.

Some years ago, when my attention was first directed to this subject, I made the following experiment with a common marine "day and night glass." Having extemporised a "pancratic tube," by which the power of the instrument was increased to 43, I directed it to a sign-board at the distance of 489 yards. This object had the double advantage of being readily approachable in a direct line, and of having upon it letters of various sizes, so that it exhibited several degrees of legibility. Its distance, too, was ascertainable with sufficient exactness. Having impressed upon my mind the appearance of the board as presented by the telescope, I approached it until it was as legible and looked the same to the naked eye. From the peculiarity of the object, this point was ascertained at once within the limit of three or four feet. According to the popular idea, I ought to have been at one forty-third the original distance, the power of the glass being 43. Instead of this, however, I had passed over only fifteen sixteenths of the space; that is, the visual power was only 16, although the magnifying power was 43. This was not quite what I expected, but the examination was not long delayed.

In order that an object shall be seen through a telescope (or a microscope) as when viewed at one forty-third the distance, it is necessary, not only that the angle subtended by it at the eye—the magnifying power—but also the angle subtended by the eye at the object—the penetrating power—shall be increased forty-three-fold. When this is the case, the visual power will be forty-three also. If we approach an object bodily, these angles naturally increase in the same proportion, but it is not so where optical instruments are used. Still, visual power must be a compound of the other two, and calling the three powers M, P, and V respectively, from their initials, we ought to have, *in all cases*—

$$V = \sqrt{MP}$$

To test the experiment just related by this, the value of P having been carefully determined at the time, we find M = 43, P = 6, and

$$V = \sqrt{43 \times 6} = 16{\cdot}06$$

The value of V, as obtained by measurement, was 16·3, which is as near as could be expected under the circumstances, although every precaution was taken to ensure correctness. Visual power is, therefore, essentially *the* power of a telescope.

I need not extend this already lengthy article to show how entirely all this is applicable to the microscope also. I do not say that the variation will be as great in that instrument as in the telescope, for the construction is not only more uniform,* but the peculiarities of microscopic vision confine the matter in one direction, at least within narrower limits; but I do say that the time is long gone by for the distinctions I have pointed out to be neglected, or for us to have important and valuable terms drifting to and fro in our literature without any fixed meaning, threatened with expulsion by those in high quarters, and defined by each succeeding writer according as it seems good in his own eyes. Neither should we suffer ourselves to be deceived by large numbers, expressing amplification, it may be, but failing to afford us their promised aid in our search after natural truth. Fortunately the discoveries of the past quarter of a century have led us in the right direction; what we seem now to require is simply a correct determination of the value of x^n in the foregoing formulæ; we shall then be able, with very little trouble, to estimate the visual powers of our instruments, and shall have our efforts systematically directed to the increase and perfection of that upon which their value mainly depends.

* This is more especially true of the instruments by our best English makers. The relative value of others will probably appear in a strong light when they are submitted to the test of visual power. The following approximate estimates, obtained from a French instrument, will not be without interest:

1st combination,	M = 400,	V (highest estimate)	145.
2d ,,	M = 540,	V, cannot exceed	205.
3d ,,	M = 870,	V, does not reach	320.

Observations *on the* **Development** *of some parts of the* **Skeleton** *of* **Fishes.** By Thomas H. Huxley, F.R.S., Professor of Natural History, Government School of Mines.

The following observations were made principally upon the Stickleback (*Gasterosteus leiurus*) in the summer of the present year. Some of them were briefly alluded to in my Croonian lecture "On the Theory of the Vertebrate Skull," delivered before the Royal Society on the 17th of June last, and will be more fully treated of hereafter; the rest have not yet been published.

1. *On the development of the tail in Teleostean fishes.*

The fact that at a certain period in the embryonic life of Teleostean fishes, the extremity of the chorda dorsalis or notochord is bent upwards, was discovered and its importance indicated by K. E. Von Bär, in his 'Untersuchungen über die Entwickelungs-geschichte der Fische' (1835), where he remarks, respecting the embryos of *Cyprinus blicca*—

"I was greatly surprised to observe, that from the fifth day onwards, the posterior extremity of the vertebral column bends upwards, so that the caudal fin which now begins to be developed is not disposed symmetrically, but lies more below the extremity of the vertebral column; a relation which is permanent in the cartilaginous fishes." (p. 6.)

The conception of a relation between the embryonic condition of the tail in Teleostean fish and the adult state of the same organ in *Ganoidei* and *Elasmobranchii*, thus put forth, received a further development from Professor Vogt, the able author of the 'Embryologie des Salmones' (1842), which forms a part of M. Agassiz's 'Poissons d'Eau douce.' At p. 256 of this excellent monograph, Vogt says—

"The curvature of the extremity of the chorda dorsalis, which begins to be apparent in the *Coregonus* a short time before it is hatched, and attains its greatest amount about six weeks later, is another peculiarity of the embryos which deserves to be taken into consideration, because it subsequently disappears, and exists in adult fishes only in some genera of existing Ganoids and Placoids. These relations have not escaped the notice of observers, and M. Von Bär particularly expresses himself as follows."

Vogt here gives the preceding citation from Von Bär, and then continues:

"This peculiarity, together with many other features characteristic of embryos, has naturally led me to examine into the relations which exist between these modifications and the characters which distinguish the fossil fishes of different geological epochs. . . . . . . It is a fact well known to all anatomists, that the vertebral column of cartilaginous fishes does not terminate in the same way as that of osseous fishes; in the former the bodies of the vertebræ become successively smaller from before backwards, and incline upwards more or less towards the end of the tail, so that the part of the vertebral column which carries the rays of the caudal fin forms a very open angle with the longitudinal axis of the trunk. A very peculiar form of the caudal fin results from this disposition: instead of being symmetrically bifurcated, it is simply bilobed, in such a manner that the superior lobe, situated, like the inferior, under the prolongation of the vertebral column, extends further back than the latter, which is produced only by an elongation of the anterior rays of this same inferior side of the vertebræ. It results from this, that the caudal fin of the Plagiostomes has, properly speaking, no rays* inserted in the upper face of its vertebræ.

"In osseous fishes, on the other hand, the vertebral column terminates behind in a great expansion, whose superior and inferior apophyses are strongly dilated, so as to form a large vertical plate, whose posterior edge is symmetrically truncated, so as to present an equal surface of attachment for the caudal fin-rays above and below the prolongation of the vertebral column. This caudal piece may be regarded as resulting from many vertebræ soldered together, or else as a simple dilated vertebra carrying many vertical apophyses. The chorda dorsalis is continued in its interior, and is also a little bent upwards, so that, neglecting the osseous vertebral rings which surround the chord, it terminates as in the Plagiostomes. But the apophyses of this caudal piece are always disposed in such a way that those of the superior face carry the upper half of the rays of the caudal fin, and the inferior apophyses the inferior rays; and the result is a very regular disposition of the caudal fin, which is divided into two equal lobes, whose rays are inserted like a fan upon the spinous processes of the last vertebra, and arranged in such a manner that the rays of the upper lobe correspond to the upper apophyses, and those of the lower lobe to the lower apophyses. The slight differences of form and size which

* This statement, however, is incorrect, as Müller had long before shown. (T. H. H.)

are sometimes remarked between the two lobes never affect the disposition of the rays; for even when the caudal fin is cut square or rounded, it is not less invariably divided into two nearly equal parts, the superior of which is inserted on to the superior apophysis of the last vertebra. We may, then, regard this disposition as constant among osseous fishes, despite the slight inequality which is sometimes observed between the superior and inferior apophyses, and notwithstanding the curvature of the chorda at its posterior extremity."

M. Vogt then goes on to point out that since, according to M. Agassiz's researches, all fossil fishes before the Jurassic epoch had inequilobed or heterocercal tails, while those with equilobed or homocercal tails only appeared subsequently, there is a parallelism in this respect between the several stages of the embryo of such a (Cycloid) fish as a *Coregonus*, and the groups of fishes which have at successive epochs peopled the waters of the globe. In his 'Recherches sur les Poissons fossiles,' vol. ii, p. 102, the same doctrine is thus concisely expressed by M. Agassiz:

"On the other hand, there is neither in the actual creation nor in anterior epochs, any adult fish belonging to these two last orders (Ctenoids and Cycloids) which has the vertebral column bent up, and the caudal fin inserted below it; whilst this arrangement is characteristic of embryos in a certain period of their existence. There is then, as we have said above, a certain analogy, or rather a parallelism, to be established between the embryological development of the Cycloids and Ctenoids, and the genetic or palæontological development of the whole class."

Professor Owen ('Lectures on Fishes,' 1846) describes the caudal fin of the ordinary osseous fishes thus:

"The framework of the caudal fin is composed of the same intercalary and dermal spines superadded to the proper neural and hæmal spines of those caudal vertebræ which have coalesced and been shortened by absorption, in the progress of embryonic development, to form the base of the terminal fin." (p. 67.)

It would be very desirable to know in what fish Professor Owen observed this singular process of coalescence and absorption. So definite a statement must rest on something more than mere supposition, and yet it is entirely unsupported by any hitherto published observations with which I am acquainted, and is, as will be seen below, directly opposed by my own.

In the excellent 'Lehrbuch der Vergeichenden Anatomie,' by Von Siebold and Stannius (1846), the latter ('Wirbelthiere,' p. 10) considers the vertical caudal plate to be produced by the coalescence of the superior and inferior arches, interhæmal and interneural bones "of the posterior caudal vertebra or of many of the caudal vertebræ;" and in a note it is added, that the commencement of the process may be clearly traced in the pike.

A valuable paper published by the late eminent ichthyologist, Heckel, in the 'Sitzungs-berichte der Kaiserlichen Akademie der Wissenschaften' for 1850 (p. 143 et seq.), contained the first accurate and comprehensive account of the structure of the piscine tail, and threw quite a new light on the general doctrine of the relation between ancient and modern fishes.

"The few now-living successors of the bony Ganoids with complete vertebræ, which first appeared in the Jurassic period—our *Lepidosteus, Polypterus,* and probably also *Amria* (the latter of which I have had no opportunity of examining) —still have quite imperfect terminal vertebræ, behind which a part of the chorda persists in a perfectly unossified state. At the same time these terminal vertebræ appear to be developed in quite a different way from those of ordinary Teleosteans, for the arrested commencements of the posterior caudal vertebræ, or their first centres of ossification, appear, not as in the latter, above and below at the base of already formed spinous processes, but at the sides of the chorda, before either spinous processes or vertebral arches are developed. They become thickened anteriorly, and penetrate like wedges towards the axis of the chorda. Indeed, it would seem, from the fact that different individuals of these fishes, without distinction of size, present a considerable variation in the number of their terminal vertebræ (which may be even perfectly developed) as if they constantly added new vertebræ, whereby the end of the vertebral column—that is to say, the still naked chorda—must gradually, if not perfectly, be converted into ossified bodies of vertebræ. . . . . ."

"Another group of fishes, or rather of the now-living *Teleostei* (whose origin is wrongly placed in the Cretaceous period, since it certainly took place much earlier, in the Jurassic epoch), also possess an imperfect vertebral column. No inconsiderable portion of the end of the chorda remains without developing vertebræ throughout the whole life of the fish, and becomes hidden under a roof-like arrangement of peculiar bones, which, supported upon the penultimate vertebral bones and projecting backwards beyond them, and seeming to be mere upper spinous processes, or ray bearers, unite with the broad inferior spinous processes which have coalesced so as to form a vertical fan-like plate. In these, as well as in the bony Ganoids mentioned above, the canal for the spinal cord, so soon as the vertebræ cease, passes back above the undivided chorda, and both are invested by a common case of solid cartilage, which takes the form of a long cone. It is a further peculiarity of the *Teleostei* in question, whose caudal rays, with the exception of the upper short ones ('stützen strahlen'), are altogether beneath the vertebral column, that their terminal vertebra is biconcave. The vertebral arches unite in pairs, and form by their proper elongation a double spinous process. In one part of these fishes (whose ancestors made their appearance in the Jurassic epoch) the arches are wedged into pits in the bodies of the vertebræ (as in *Thryssops, Tharsis, Leptolepis, Chirocentrites, Elops, Butirinus, Salmo, Coregonus, Saurus, Sudis, Esox, Umbra*). In the others, which only appear subsequently in the Chalk, the vertebral arches, and even the roof-like bones, are inseparably united with the bodies of the vertebræ (*Clupeidæ, Cyprinidæ, Cobitis*).

"In the great multitude of the remaining *Teleostei*, the end of the vertebral column is far more developed. The chorda is ossified to its extreme end, or crystallized into vertebræ, the last of which, therefore, possesses only a single funnel-shaped cavity, containing the end of the chorda, and turned forwards. But in the greater number of these Teleostei, whose ancestors made their appearance contemporaneously with the second division of the first-mentioned roof-tailed fish in the Chalk, the spinal canal alone is prolonged behind the last vertebral arches, as a bivalve or tubular bony sheath, between the fin-rays. These are the *Percidæ, Scorpænidæ, Sciænidæ, Chromidæ, Sparidæ, Squamipennes, Teuthidæ, Labyrinthiformes, Scombrædæ, Pæciliæ, Characinæ, Mormyridæ, Siluroidei*, and others. The smaller number began to exist an epoch later, with the tertiary formations, and in these only does the spinal marrow end at the same time with the chorda in the last vertebral body, or at least in an inseparable process of it (*Labridæ, Gadidæ, Blenniidæ, Gobiidæ, Pediculoti, Pleuronectidæ, Lophobranchii, Plectognathi*, and others)."

I have omitted Heckel's account of the vertebral column of the Pycnodonts which precedes the long and important extract here given, as less immediately germane to the present subject. Suffice it to say, that he admits altogether three modes of termination of the chorda dorsalis: 1. The end is naked or unprotected by any ossification, as in Palæozoic Fishes and existing *Ganoidei*. 2. Its unossified end is protected to a greater or less extent by lateral roof-like plates, as in the *Salmonidæ;* these Heckel calls *Steguri.* 3. The end of the chorda is enclosed within the anterior cavity of the body of the terminal vertebra, as in the *Percidæ,* &c.

I shall bring forward grounds for believing that Heckel is mistaken as to this third mode of termination, and that in these fishes the end of the chorda really extends far beyond the anterior cavity of the last vertebra.

In 1854, Stannius published (as a part of the new edition of the 'Handbuch') his 'Zootomie der Fische,' beyond all comparison the best and most exhaustive work on the subject which has yet appeared. The structure of the fish's tail is discussed at p. 29, but very unaccountably all mention of Heckel's researches is omitted. In the *Blennidæ, Ophiodini, Tænioidæ, Murœnoidæ, Fistulariæ,* the last caudal vertebra is said to end in a slight point. In *Cyclopterus, Callionymus,* the *Pleuronectidæ,* and *Plectognathi,* "the end of the last vertebra becomes flattened and slender, and is prolonged into a vertical broad plate, consisting of two quite symmetrical halves, an upper and an under."

A more detailed (but otherwise essentially similar) account to that of Heckel, of the tail of the *Salmonidæ,* is next given, and the like structure is said to obtain throughout life in the *Ganoidei,* in *Esox, Hyodon,* &c., while it is transitory in *Cyprinidæ, Characinæ,* and others.

In conclusion, Stannius points out that "many fish which pass for homocercal, show unmistakeable traces of original heterocercality."

Having verified Stannius's account of the structure of the caudal extremity in the salmon, but seeing no reason to doubt—what was generally admitted—that other Teleostean fish were truly homocercal, I pointed out, in 1855,* that the foundation of the doctrine of Vogt and Agassiz was thereby destroyed. For Vogt's observations were made on a salmonoid fish, and a right comprehension of the structure of the tail in such fishes showed, that so far from the heterocercal tail of the embryo becoming homocercal in the adult, the tail of the latter was extremely heterocercal, far more so than that of many cartilaginous fishes. In fact, all that Vogt had really shown was, that the primitively homocercal tail of the embryo becomes gradually more and more heterocercal; and he and others had been misled by the apparent homocercality of the adult fish into supposing that the heterocercality became lost again, whereas, in point of fact, it was only disguised.

* Friday evening meetings of the Royal Institution.

Consequently, Vogt's observations did not prove in the least that a truly homocercal fish ever passed through a heterocercal state; and as no observations respecting the development of the tail in what were supposed to be truly homocercal fish were extant, the doctrine that heterocercality precedes homocercality in embryonic life, was clearly not proven. On the other hand, until the development of some admitted homocercal fish had been examined, it was not disproved.

Having procured a number of very young sticklebacks and eels, which would assuredly be admitted to be true homocercal *Teleostei*, if such things exist at all, I gladly availed myself of the opportunity of examining into this point. I was not a little surprised to discover, not only that these fishes are heterocercal in the embryonic state, but that they are perfectly heterocercal in the adult condition, their apparent homocercality being, as in the case of the salmon and its allies, a mere disguised heterocercality.

In a Stickleback $\frac{5}{16}$ths of an inch long (fig. 1), I found the gradually tapering extremity of the notochord (*c*) bent upwards at a considerable angle with the axis of the body, and terminating close to the superior rounded corner of the caudal fin. In the greater part of its extent it was enclosed neither in cartilage nor in bone—though bony rings, the rudiments of the centra of the vertebræ, were developed in the wall of the notochord throughout the rest of the body.

The last of these rings (*b*) lay just where the notochord began to bend up. It was slightly longer than the bony ring which preceded it (*a*), and instead of having its posterior margin parallel with the anterior, it sloped from above, downwards and backwards. Two short osseous plates (*e*), attached to the anterior part of the inferior surface of the penultimate ring, or rudimentary vertebral centrum, passed downwards and a little backwards, and abutted against a slender elongated mass of cartilage (*g*). Similar cartilaginous bodies occupy the same relation to corresponding plates of bone in the anterior vertebræ in the region of the anal fin; and it is here seen, that while the bony plates coalesce and form the inferior arches of the caudal vertebræ, the cartilaginous elements at their extremities become the interhæmal bones. The cartilage connected with the inferior arch of the penultimate centrum is therefore an "interhæmal" cartilage. The anterior part of the inferior surface of the terminal ossification likewise has its osseous inferior arch (*f*), but the direction of this is nearly vertical, and though it is connected below with an element (*h*) which corresponds in position with the interhæmal cartilage, this cartilage is five or six times as large, and constitutes a broad vertical plate, longer than it is deep, and having its longest axis inclined downwards and backwards. Its superior and inferior margins are slightly excavated, the posterior is convex, the anterior deeply notched, so as to be divided into two processes, the anterior of which abuts against the inferior arch of the vertebra, while the posterior is applied against the posterior moiety of its under surface. On each side of the posterior convex edge of the cartilage (which they a little overlap), I found five slender osseous styles (*k*), the rudiments of the inferior caudal fin-rays.

Immediately behind and above this anterior hypural apophysis (as it may be termed) is another (*i*) very much smaller, vertical cartilaginous plate, which may be called the posterior hypural apophysis, having nearly the form of a right-angled triangle, and closely applied by its hypothenuse to the under surface of about the anterior two fifths of the free portion of the chorda. On each side of the posterior edge of this cartilage are three fin-rays (*k*), similar to those already described, so that in the caudal fin in this stage there are altogether eight double rays, and all these are inserted, not only below the notochord, but far in front of its termination.

No neural arch is as yet developed from the terminal osseous ring.

A great change had taken place in the tail of an embryo *Gasterosteus*, $\frac{7}{16}$ths of an inch long (fig. 2). All the preceding parts, however, were readily recognisable, notwithstanding their modifications.

The penultimate centrum had become much longer in proproportion to its thickness, its superior and inferior arches were much more developed, and the latter sent down a spine independently of the interhæmal cartilage, around which a sheath of bone, which had coalesced above with the posterior part of the inferior arch, was now visible. The anterior hypural apophysis had become longer in proportion to its breadth, and was coated with a thin layer of bone. The posterior hypural apophysis had greatly enlarged both absolutely and in relation to the anterior, and traces of a bony deposit on its surface were discernible. The number of fin-rays had increased to fourteen; of which two, very short, lay between the end of the interhæmal cartilage of the penultimate vertebra and the lower angle of the anterior hypural apophysis; six, gradually increasing in length, and becoming jointed superiorly, embraced the posterior edge of the inferior hypural apophysis; and six, of which the inferior were long and jointed at their ends, while the superior were simple styles, were connected with the posterior edge of the posterior or superior hypural apophysis. The terminal osseous ring (*b*) had in the meanwhile extended backwards, and now, as a slender tube, tapering posteriorly and obliquely truncated behind, embraced more than half the length of the previously free part of the notochord. As a consequence, the hypothenuse of the still triangular posterior hypural apophysis is now fixed to bone throughout its whole length, for the end of the bony sheath in question extends slightly beyond it. The remainder of the notochord (*c*) has its wall still membranous and unossified, and ends close to the superior and posterior angle of the caudal fin as before. There are no fin-rays above the notochord, nor is any neural arch developed from the terminal centrum, but the rudimentary interneural cartilage of the penultimate centrum had greatly elongated, and had taken the same position relatively to its superior arch as that occupied by the interhæmal cartilage relatively to the inferior arch, and had become surrounded by a sheath of bone. Behind this two other cartilages (*m*, *n*) lie parallel with one another above the ossified sheath of the chorda, but at present they are connected with no fin-rays. I will term these the "epiural" apophyses.

In a half-grown Stickleback (fig. 3) the anterior end of the terminal centrum was dilated and cup-like, just as if it were the anterior half of one of the ordinary hour-glass-like vertebræ, but instead of dilating again posteriorly, it is continued into a stout style, more than twice as long as the body of the penultimate centrum, and curved up so as to make an angle of 45° with the rest of the vertebral column. This stout style, with its central cavity, looks not very like the previous delicate sheath of the chorda; but such thickened sheath it really is, and with care the remainder of the notochord may be traced beyond it between two of the fin-rays into the tail-fin itself. The rays between which it lies are the uppermost of the superior set in the last-described embryo, and a new set, six in number, which have been formed above the notochord. I shall henceforward term this ossified chordal style the "urostyle."

The free part of the notochord no longer reaches, by a long way, to the posterior superior angle of the caudal fin, for the fin-rays attached to the hypural apophyses, the uppermost of which supports the posterior superior angle of the caudal fin, are now more than twice as long as the free part of the notochord, and consequently the end of the latter is by its whole length distant from the present superior and posterior angle of the fin. The whole length of the free notochord, together with the elongated terminal centrum, is about 1-16th of an inch. The hypural apophyses are attached along the under surface of the ossified walls of the notochord. They are nearly equal in size, and each supports, as before, six rays, but the number in front of the anterior hypural apophysis has increased to six or seven.

A short and rudimentary neural arch rises from the anterior end of the urostyle, and there is an indication of a second opposite the interval between the anterior and posterior hypural apophyses, where I have seen traces of what seemed to be a sutural division of the urostyle into two portions.

The anterior epiural apophysis appears greatly enlarged and bifurcated at the extremity. I am inclined to think that its anterior part represents the neural spine of the anterior neural arch of the urostyle, but it is separated from it by a wide interval. The posterior epiural apophysis is also enlarged and altered in form.

In the adult fish (fig. 4) the urostyle is at once recognisable as a slender, tapering, bony process, in which an internal cavity can be observed, and which forms as great an angle with the axis of the vertebral column as before. The length of this process, together with that of the terminal centrum, of which it is a prolongation, is about 1-14th of an inch, and no trace of the notochord is visible beyond it, so that I doubt not it is the result of the complete ossification of the walls of the chorda. The posterior hypural apophysis is as nearly as may be of the same size as the anterior, and, like the latter, carries six large fin-rays. These almost entirely support the tail, the fin-rays above the notochord not attaining more than one fourth their length, and constituting only a very insignificant portion of the root of the tail. The epiural apophyses are greatly altered, but I need not enter into a particular description of them.

Thus it appears that *Gasterosteus* is in reality an excessively heterocercal fish, the whole of its principal fin-rays being developed below the vertebral column. It is as heterocercal as an *Accipenser*, and far more so than a *Scyllium* or a *Squatina*. Furthermore it appears that the tail of this Acanthopteran fish has essentially the same structure as that of the Malacopteran salmon, except that the wall of the notochord is ossified through its whole extent, whereas in the salmon it persists in the condition which it has in the young *Gasterosteus*. I have not been able as yet to obtain so complete a series of forms of the caudal extremity in the Eel, but with some extremely interesting minor variations, which I propose to describe at length on a future occasion, the structure is similar in principle. The tail is truly heterocercal. What answers to the urostyle is divided into two portions—the anterior of which supports the anterior hypural apophysis, the posterior the posterior; and the last is not only superior to the anterior hypural apophysis, as is the case in the *Gasterosteus*, but projects beyond it posteriorly. Seeing the close resemblance in the structure of the tail which exists among all *Acanthopteri*—inasmuch as the hypural apophyses resemble more or less closely those of the stickleback, and always bear the principal caudal fin-rays, I make no doubt that what is true for *Gasterosteus* is true for all, and by a parity of reasoning, that what is true for *Anguilla* and *Salmo* is good for all *Malacopteri*; and I therefore do not hesitate to draw the conclusion that the *Ctenoidei* and *Cycloidei* of M. Agassiz, so far from being homocercal, are in truth excessively heterocercal; that is to say, more completely heterocercal than the great majority of *Elasmobranchii.*

In the heterocercal tails of the *Teleostei* there are, however, at least two well-marked varieties or grades of structure—the one, which might be called gymnochord tails, having the end of the notochord unprotected by ossification in its wall, as in the *Steguri* of Heckel; the other, which might be termed steganochord, having the end of the notochord enveloped in a styliform osseous coat, which there seems reason to believe represents the centra of two vertebræ. As a common, if not universal, character of the Teleostean heterocercal tail, by which it is distinguished from that of *Elasmobranchii*, we have the peculiar development of the epiural and hypural apophyses.

But if it be true that all Ctenoids and Cycloids are heterocercal, it is clear that the ground of the argument of MM. Agassiz and Vogt is completely cut away, so far as mere heterocercality goes. The ancient and the modern fishes are precisely on the same footing, and if the palæozoic *Ganoidei* and *Elasmobranchii* really represented embryonic conditions of existing *Teleostei*, they ought to be all strictly homocercal, for it is only in the embryonic state that a Teleostean is really homocercal.

On the other hand, however, if homocercality and heterocercality are left out of the question, there can be no doubt that such facts as those brought forward by Heckel respecting the Pycnodonts show that in certain families of fish, at any rate, there has been a gradual change from a quasi-embryonic condition of the vertebral column to one more resembling that of an adult Teleostean. So perhaps it may be admitted that the structure of the tail in some modern Ganoids is more like that of the adult *Teleostei,* while that which obtains in the ancient members of the same group is more like that of embryonic *Teleostei.* But it has never yet been shown, either that the approximation of a Ganoid to a Teleostean, or the more complete ossification of the vertebral column in these or other fishes, is a mark of an advance in general organization. I take this occasion of repeating an opinion I have often expressed, that no known fact justifies us in concluding that the members of any given order of animals present, at the present day, an organization in essential respects more perfect (in whatever sense that word may be used) than that which they had in the earliest period of which we have any record of their existence.

It may be asked, in conclusion, whether the peculiar structure of the tail of the Teleostean tribes is a modification of the vertebral column altogether peculiar to them, or whether some trace of it is not to be found in other *Vertebrata.* I believe the latter question may be answered affirmatively, and that just where so many remnants of piscine characters are found, viz., in the *Amphibia,* there is a most interesting representation of this structure. I refer to the coccygeal style of the Frog and its allies, which, as Dugès originally indicated (and I have had reason lately to satisfy myself of the fact), is formed by the coalescence of a styliform ossification of the end of the sheath of the chorda with two neural arches. Naturally, as there are no fin-rays, there are no epiural or hypural apophyses, but otherwise the resemblance of the two structures is complete.

2. *On the development of the palato-pterygoid arc and hyomandibular suspensorium in Fishes.*

On examining the region in which the complex mass of bones comprehended under the above name eventually lies in an embryo *Gasterosteus,* about $\frac{1}{3}$d of an inch long, I found in their place a delicate inverted cartilaginous arch attached anteriorly by a very slender pedicle to the angle of the "facial cartilage" formed by the union of the two trabeculæ cranii, and posteriorly connected by a much thicker crus with the anterior portion of that part of the cranial wall which incloses the auditory organ. The crown of this inverted arch exhibits an articular condyle for the cartilaginous rudiment of the mandible. Its posterior crus is not, as it appears at first sight to be, a single continuous mass, but is composed of two perfectly distinct pieces of cartilage applied together by their respective anterior and posterior edges. The anterior is continuous below with the condyle, but ends above in a free point. The posterior is continuous with the cranial wall above, but ends below in a free point immediately behind the condyle. The posterior edge of this last portion (which I shall term the hyo-mandibular cartilage, as it is the means of suspension of both hyoid and mandibular arcs to the skull) has, above, a rounded condyle for the operculum, while below this, it gives attachment to that cartilage which eventually becomes the styloid element of the hyoidean arc. That part of the cartilage which lies above the attachment of this element becomes, by its ossification, the "temporal" of Cuvier; that which lies below it gives rise to Cuvier's "symplectique."

The anterior division of the posterior crus, the condyle, and the anterior crus of the inverted arch I have mentioned, constitute a inverted V-shaped "palato-quadrate" cartilage. The anterior part of the anterior crus ossifies, and becomes Cuvier's "palatine;" the posterior part gives rise to his "transverse" and "pterygoid;" the condyloid portion, when ossified, becomes his "jugal;" and the extremity of the ascending process from this or the anterior division of the posterior crus becomes his "tympanique."

The operculum, suboperculum, interoperculum, and preoperculum, are developed in the branchiostegal membrane apart from the other bones.

These embryological facts are of great importance, as they enable us to understand, on the one hand, the different modifications of the palato-suspensorial apparatus in fishes, and on the other hand, the relations of the components of this apparatus to the corresponding parts in other *Vertebrata*.

They explain, in the first place, the fact to which Kostlin first drew attention, that in the Teleostean and Ganoid fishes there is every gradation, between the most intimate connexion of the "temporal" and "symplectic" with the other bones, and their wide separation. They enable us to understand why, in *Lepidosteus*, for example, the "jugal" remains firmly united with the representatives of the "pterygoid" and "tympanic," while it is connected with the "temporal" and "symplectic" only by the preoperculum; and they prove that the suspensorial apparatus of the sturgeon answers to the temporal and symplectic of other fishes, while the cartilaginous arch to which its mandible is articulated corresponds with the palato-quadrate arcade of the embryo. Again, to my mind, they prove that Cuvier was right in denying the homology of the so-called upper jaw of the *Elasmobranchii* with the maxilla and premaxilla of a Teleostean; for it corresponds precisely with the palato-quadrate arcade of the embryo, giving articulation to the lower jaw, which therefore is, as in the embryo, only indirectly connected with the so-called tympanic cartilage, which again is the homologue of the temporal and symplectic. In this respect, as in so many others where the skeleton is concerned, the Teleostean embryo is typified by the adult Elasmobranch and by some Ganoids.

With respect to the homologies of the bones of the fish's face in other vertebrata, the evidence of development appears to me to be no less decisive. No one who compares the development of the two will, I think, doubt that in the fish Cuvier's palatine is the homologue of the palatine of the abranchiate *Vertebrata,* that his pterygoid is the homologue of their pterygoid (wholly or in part), and that his jugal is their quadratum or incus. The comparison with the development of the frog, furthermore, leaves no doubt on my mind that the "tympanic" of the fish is a dismemberment of the pterygoid, and has not the remotest relation with the true tympanic. I can, however, find no homologue of the temporal and symplectic of the fish in the abranchiate *Vertebrata.* They appear to me to be specially piscine elements, which are only traceable as far as the *Amphibia,* where they are represented by that part of the suspensorial cartilage (quadrate or tympanic cartilage of authors) to which the hyoid arch is attached, and by the "temporal" of Cuvier. In the abranchiate *Vertebrata,* if the hyoid is connected with the skull at all, its insertion is quite distinct from that of the mandibular arch. I believe, therefore, that the branchiate *Vertebrata,* the oviparous abranchiate *Vertebrata,* and the *Mammalia,* present a series of well-marked gradations in the mode in which the ramus of the mandible is attached to the skull. In the fish it is separated by the os articulare, the quadratum, and the temporo symplectic. In the *Amphibia* the latter becomes less distinct. In the abranchiate *Ovipara* it disappears, but the ramus of the mandible is still separated from the skull by the articulare and quadratum. In the *Mammalia,* finally, these are converted into the malleus and incus respectively, and the ramus comes into direct contact with the squamosal element of the skull.

TRANSLATIONS.

On the Development *of* Sagitta. By Dr. C. Gegenbaur.

('Abhandl. d. Naturf. Gesellsch. in Halle,' 1857.)

Having in a former volume of this journal given an account of what is known respecting the structure and relations of *Sagitta bipunctata,* we have thought that an abstract of Dr. Gegenbaur's observations on the subject of reproduction in that genus would not be unacceptable; and the more so, as this part of the history of Sagitta has hitherto been involved in much obscurity.

In the sea at Messina three distinct species of Sagitta came under the author's observation. *S. bipunctata,* which he appears not unfrequently to have met with of the large size of 2″ 2‴ in length, and two other forms which he was unable to refer to any known species. One of these, 9‴ long, was of slender shape, attenuated for some distance beyond the head, and again, beyond the middle of the body, tapering off suddenly to the caudal extremity, had two pairs of lateral and one caudal fin; the former rounded and projecting but little, whilst the caudal fin was very broad. The surface of the body, moreover, was studded with warty tubercles, occasionally disposed with perfect symmetry and supporting bundles of fine setæ. The head triangular, somewhat acuminate in front. The other species was less common, the largest individuals not more than 6‴ in length, the body almost cylindrical, very slightly constricted behind the rather broad head, and truncated at the caudal extremity; the whole surface of the body was covered with very numerous bundles of setæ (0·08‴ in length), which gave it an almost villous aspect. The anterior lateral fins, very long and narrow, commenced at the end of the first quarter of the length, terminating in a projecting point about the middle of the body. The posterior pair, wider in proportion, had a strongly curved border. The caudal fin was abruptly rounded off. Both species were transparent, and had, like all their congeners, two brown pigment-spots behind the opening of the vasa deferentia. No important distinction could be drawn from the oral hooklets. From two of these three distinct species Gegenbaur obtained mature ova, derived from pregnant individuals kept for the purpose in glass vessels.

The spawn was deposited in good-sized masses of a substance not unlike swollen sago-grains. The period at which they were most abundantly met with extended from the end of January to the beginning of March.

The deposited spawn always lay unattached on the bottom of the glass vessel, and consequently when in the sea is probably pelagic, that is to say, the sport of the waves. In confirmation of which similar masses of ova were occasionally taken with a fine towing-net. They bore no resemblance to the ova described by Darwin as belonging to *Sagitta.*

The ova were enveloped in a gelatinous substance, which, however, did not appear to surround each ovum separately, but to appertain to the whole mass of eggs in common. In this respect some resemblance may be observed with the condition presented in *Terebella, Protula,* and *Arenicola,* as well also as in the *Hirudineæ* and those *Lumbricina* in which several ova are associated in one capsule (*e. g., Sænuris*).

The spawn of *Sagitta,* therefore, is closely allied to that of Annelids, and differs essentially from that of the Mollusca, and especially of the Gasteropoda, whose ova, besides the general gelatinous envelope, present also an albuminous covering surrounding each separate vitellus or several together, when the outer layer is hardened into a membranous case.

The size of the ova varies according to the species. Those of the small species measure $\frac{1}{10}'''$, and of the larger $\frac{1}{3}'''$. In other respects they are alike, perfectly spherical, and almost perfectly pellucid, with a slightly yellowish tinge, and furnished with an extremely delicate vitelline membrane.

In the centre of the yelk lies the resistant, yellowish germinal vesicle (nucleus), having a diameter about $\frac{1}{20}$th of that of the vitellus. No germinal spots (nucleoli) were noticed. Before segmentation has taken place, the vitellus appears to be composed of a perfectly homogeneous substance containing minute molecules, which are more closely crowded towards the centre than in the peripheral portion. The segmentation of the yelk, as well as the entire process of development, is quickly ended, occupying the space of seven to nine days. The process of development was the same in the ova of both the species observed.

Segmentation commences with the appearance of a groove following the equatorial line of the *vitellus,* but *beneath the vitel-*

line membrane, which divides the yelk into two equal hemispheres. This groove or depression, over which the vitelline membrane is stretched like a bridge, penetrates more and more deeply into the vitelline substance, until a complete separation is effected, between the two portions which simply remain in contact. The next division separates each hemisphere into two segments, the yelk now appearing to be composed of four segments of a sphere.

Where the four segments meet in the centre of the vitellus, a minute hollow space may be observed, formed by the rounding off of the contiguous angles of the four segments. This central space is of no small importance in the further stages of the process.

Whilst these changes are going on, the molecules above described as surrounding the germinal vesicle, and which are subsequently aggregated around the nucleus of each segment derived from the division of the original vesicle, assume a peculiar disposition. They become more densely packed around the nucleus, from which they extend in radiating lines towards the periphery.

Each of the four vitelline segments is now again subdivided into two equal portions in a direction perpendicular to the middle of its longitudinal axis, so that the whole yelk is constituted of eight equal segments. By a continuance of a similar divisional process the number of pyramidal segments goes on increasing, each pyramid having the apex directed towards the centre of the vitellus. An arrangement owing to which the segmentation of the ovum of *Sagitta* appears under a very remarkable type. Even in these latter periods of the process of segmentation, the segments never assume a spherical form as in the Mollusca and Annelids, as well as in the Vertebrata, nor constitute the aggregate masses so well known in their mulberry-like form. On the contrary, in the present case, owing to the circumstance that certain conditions, in other instances occurring only in the earliest stages of segmentation appear to remain persistent, it happens that a single segmentation-cell extends from the centre of the vitellus to the surface, and at the same time, whilst multiplying, the contiguous segments are closely in contact by their corresponding surfaces, in consequence of which they become mutually flattened. Pyramidal segments of this kind do not, so far as Gegenbaur is aware, occur in any other case. The summit of each of these four- five- or six-sided pyramids is truncated, and contributes to the formation of the boundaries of the vacant central space in the vitellus above described. The basis of the pyramid does not correspond in its curvature with a superficial area of the same size on the surface of the yelk, but forms the segment of a far smaller sphere, so that on a superficial view of the ovum, the mulberry-like stage of segmentation appears to be simulated.

On the second day the whole vitellus is subdivided into numerous pyramids which are in close contact, and form the boundary of a central cavity which has now attained a considerable size.

Before describing the subsequent formation of the embryo, Gegenbaur refers to some particulars, only briefly noticed before, respecting the formation of the products of the segmentation and their true nature, as well as to the relations of the primordial germinal vesicle to the nuclei of the latter.

The fact of the segmentation taking place *beneath* the vitelline membrane, which does not become involved in the process of development, may at first sight, he says, perhaps, excite astonishment—a proceeding of this kind appearing to be opposed to our theory of the process of segmentation as well as to our notions respecting the multiplication of eels in general. It might therefore be supposed that I have regarded some accessory structure as the vitelline membrane, whilst the true vitelline membrane either participates in the segmentary process, or, as many observers have stated, disappears at the commencement of the process. In the present case, however, Gegenbaur says, it is self-evident that he does not, under the term vitelline membrane, intend any egg-case (Eihülle), but only that membrane which is formed originally with the yelk, and surrounds it while still in the ovary; and which, in that situation, already exists at a time when the interspace between it and the germinal vesicle scarcely exceeds the diameter of the latter. This condition of the vitelline membrane recalls the observations of De Quatrefages in *Hermella,* and of O. Schmidt in *Amphicora,* in which cases segmentation also takes place beneath the vitelline membrane.

The question whether the products of segmentation in the ovum of *Sagitta,* after the primitive vitelline membrane has become detached from them, be still provided with a membrane, and consequently represent true cells or not, cannot be answered until what is a "cell-membrane" has been defined; and, in Gegenbaur's opinion, this can be comprehensively done by our regarding as a membrane the outermost thickened layer of a cell, whatever thickness it may possess, or in whatever physico-chemical relation it may stand towards the cell-contents.

Regarded in this light a membrane may be found to exist around the products of segmentation in the ovum of *Sagitta*, which membrane in the earliest stages of the development, it must be confessed, differs but little from the interior vitelline substance, and which (physically, at any rate) bears the same relation to the vitelline membrane that the primordial utricle in a plant-cell does to the cellulose membrane.

Each segmentation-cell presents an oval nucleus, which at first is situated in the thicker or outer portion of the cell, and consequently near the surface of the ovum. What becomes of it in the process of division has, in the most important particular, escaped Gegenbaur's notice; though it is to be remarked that a stage was often noticed at which many of the nuclei, much elongated, exhibited constrictions; so that, although a division of the nucleus was not seen, still such a division might be concluded to take place; to which may be added the circumstance that in no case is the cell without a nucleus. Consequently there is nothing to support the notion of a disappearánce of the nucleus before segmentation, and a new formation of nuclei after that process has been gone through. That this stage of nuclear division has escaped observation, may perhaps be explained by the rapidity with which it takes place. The same observation holds good of the germinal vesicle, the nucleus of the ovum, regarded as a cell from which all the nuclei of all the tubsequent cells arise in the same way that the latter have shemselves arisen from the ovum-cell. In the earliest stages of segmentation the nature of the nucleus was shown in a more precise manner, inasmuch as at that time, and before complete division of the yelk, two nuclei were seen to exist.

A peculiarity of the vitellus in the ovum of *Sagitta* was noticed at a later stage of segmentation. When more highly magnified, the contents of each cell were seen to be composed of spherical bodies somewhat flattened by mutual pressure, and which, at the situation of the nucleus retreating from it, left a cavity. From the nuclear cavity thus formed, radiating prolongations stretched out among the neighbouring vitelline granules.

The first indication of the development of the embryo is shown in a division of the pyramidal vitelline cells, each of which is subdivided in the middle of its longitudinal diameter, so that the central cavity of the vitellus becomes enclosed by an internal layer composed of smaller cells, which again is surrounded by a layer of larger cells, of which the surface of the vitellus is also constituted. The longitudinal axis of each of the outer cells coincides with that of a cell of the inner layers, and those cells whose axes thus coincide, had constituted, in the immediately precedent stage, a single cell. The two layers are of pretty nearly the same thickness, and in each may be seen a long, oval, central nucleus.

But whilst this division is going on, the central cavity of the *vitellus* enlarges, the cells by which it is bounded gradually becoming more and more remote from the central point; but at the same time its figure is so irregular, that it would hardly be supposed that it could be the rudiments of an important part. But its true nature is soon made manifest from an opening which, gradually becoming more and more evident, places the hitherto closed cavity in communication with the exterior. In this way arises a short canal perforating the two layers of cells, so that the original central cavity might now be regarded as the cæcal termination of an invagination or depression commencing from the exterior, unless one had not been satisfied, from previous observation, that its existence dated from a far earlier period, as early even as the first stage of segmentation.

The essential nature of the process by which the canal is formed is, for the most part, unknown; it is an act closely connected with the innermost vital phenomena, not only of the cells in the immediate region concerned, but which must also result from certain changes equally affecting *all* the cells of which the embryo is composed.

Observation has shown Gegenbaur that no mere absorption of the cells, or, at any rate, that no complete disappearance of existing morphological elements takes place, but that the opening of the central cavity is the immediate result of a separation from one another of certain parts of cells (Zellparthien).

Were it true that a solution of the cells took place, the products of such a process would be visible, and were the proceeding one of simple absorption, in some way set up by the contiguous cells, the boundary or outline of the canal thus produced would have an appearrnce different from that which it actually presents. The cells forming the boundary of the canal are disposed somewhat differently to the rest; simultaneously with the formation of the canal, they have the direction of their longitudinal axis changed in such a way that this axis in the centre of the embryo no longer coincides with that of the other cells which remain unchanged, but appears rather to be directed towards the canal itself. At the same time these cells, both of the internal and of the external layer, have become somewhat shortened.

Viewed from the surface, the external opening of the canal —the future mouth, since the whole cavity becomes the intestinal canal—appears in the ova of *Sagitta bipunctata,* as a round, funnel-shaped depression, whilst in the ova of the smaller species it appears to be more elongated transversely.

The whole history of comparative development offers nothing analogous to this surprising mode of formation of the rudimentary intestine out of a central cavity which makes its appearance in the earliest stages of segmentation of the vitellus; and in this respect, again, *Sagitta* appears to constitute a paradoxical form.

When this canal and the central cavity into which it leads, and which increases in size and becomes irregular in form, have been fully developed, the embryo still completely fills the vitelline membrane, by which it is closely invested on all sides, excepting at the spot where the mouth is situated, and where the surface of the body presents a shallow depression.

The two layers of cells, of which alone the body of the embryo is, up to this time, constituted, are now broken up by a further transverse division of the individual cells, so that more rounded embryo cells soon become visible.

In consequence of an increase in the length of the hitherto spherical embryo, the body now necessarily becomes curved; a change which indicates a new and not less characteristic stage. There now takes place a farther differentiation of the layers of cells which were apparent at a former period. Of the cells produced from the single internal layer a stratum is formed whose clear and minute elements immediately surround the intestinal canal, and are clearly distinguishable on the outer aspect from the peripheral layer of cells formed from the simple outer layer. These layers, therefore, composed of numerous superimposed cells, correspond each with one of the primitive strata, which, we have seen, were derived from a transverse division of the simple pyramidal cells.

The central stratum Gegenbaur regards as the rudiment of the intestinal wall, and in the peripheral he recognises the integument of the body.

The anterior and posterior ends of the body approach each other, so that the mouth comes to lie within the point of incurvation. The convex surface of the embryo, therefore, corresponds to the dorsal aspect. Of the further changes in the embryo, nothing precise seems to have been observed. On the ninth or tenth day the animal is completely formed, and begins to manifest its maturity by struggling movements, in consequence of which the enveloping membrane is ruptured.

The development of the greater part of the internal organs, except the intestine, appears to take place after the escape of the embryo from the egg. No trace of the nervous system is at that time apparent, and but one pair of lateral fins exists.

The following summary contains the main points of Gegenbaur's observations.

1. The products of segmentation of the vitellus are elongated pyramidal cell-forms, which retain this character even after the appearance of the rudiment of the embryo.

2. The formation of the rudiment of the intestinal canal accompanies the segmentation of the vitellus.

3. The intestinal canal appears at first as a central vitelline cavity, its opening externally being a secondary process.

4. The development takes place *without any metamorphosis*, and even without the appearance of cilia on the surface of the embryo.

After a short discussion of the views of various authors respecting the systematic position of *Sagitta*, and a review of the principal points, chiefly embryological, connected with this still doubtful question, Gegenbaur concludes with observing that the "genus *Sagitta* must be regarded as the representative of a special subdivision between the Nematoda and Annelida, and which might be designated the "Pfeilwürmer" or "Arrow-worms."

The paper is accompanied with figures illustrating the process of development.

On the Development *of the* Transversely Striated Muscular Fibre, *in* Man, *from* Simple Cells. By Professor A. Kölliker.

(Siebold and Kölliker's 'Zeitsch. f. w. Zool.,' vol. ix, p. 129.)

The extensive prevalence of unicellular muscular fibres or of contractile fibre cells in the Invertebrata having been demonstratively shown, I was induced to inquire whether the mode of formation first noticed by Lebert, and afterwards by Remak, in the transversely striated muscular fibre of the frog, that, viz., acccording to which each muscular fibre is produced from a single cell, which becomes exceedingly elongated, did not apply to the case of *all* transversely striated fibres ('Würz. Verh.' viii. p. 113). I am now, in fact, enabled to show that the same mode of formation also obtains in the human subject. In a two-months embryo I found the muscles of the rudimentary foot in so undeveloped a condition, that it was by no means difficult to exhibit their very early conditions. The earliest forms seen by me were simple fusiform cells, 0·06—0·08‴ long containing in the middle portion, which was 0·001—0·015‴ in breadth, one or two elongated nuclei, and produced at either extremity into an extremely delicate filament at most 0·0004‴ in diameter, presenting at the same time no trace of transverse striation. Now from the muscular substance of the thigh and leg a complete series of forms, from these simple fibre-cells, which could be nothing else than elongated primordial embryo-cells, could be traced up to fibres 0·2—0·3‴ long and 0·002‴ wide, which were also attenuated at each end, and containing 4—9 elongated nuclei placed at considerable distances apart, and also presenting the first faint indications of a transverse striation, so that it could not be doubted that the future muscular fibres are derived simply from a growth in length and breadth of the original uninucleated fibre-cells, accompanied with an energetic multiplication of the nuclei; to which growth is subsequently superadded a peculiar transformation of the cell-contents. And this conclusion was the more readily arrived at from the circumstance that the nuclei of these elements presented almost all the indications of an active multiplication, which I have already described.

I am convinced that in more advanced embryos the pointed extremities of the muscular fibres will also be found; and it would also, as it seems to me, appear that these observations explain the recent discovery by A. Rollett of the occurrence of numerous free, pointed extremities of the muscular fibres in the adult.

If in the frog and in man the muscular fibres represent simple vastly enlarged cells—which, it may be remarked, is a strong proof of the active formative capacity of the animal cells—it can no longer be doubted that the same holds good of all transversely striated muscular fibres, nor in future can any distinction be drawn between contractile fibre-cells and muscular fibres as representing numerous cells. Certain distinctions will in all cases remain, with respect to which I would at present remark that the circumstance whether the elongated muscle-cell contains only one or several nuclei, affords a useful basis of arrangement. The degree of differentiation also, as heretofore, may also be regarded, though this is a point, which, as I have shown on a previous occasion, is of less weight.

REVIEWS.

Humble Creatures.—The Earthworm and the Common House Fly. By JAMES SAMUELSON, assisted by J. B. HICKS, M.D., F.L.S. London: Van Voorst. 1858.

THE appearance of works like this little book affords strong evidence of the fact that the study of natural science is gradually becoming a general object of pursuit. The popular mind is obviously beginning properly to appreciate the interest and value attached to the observation and investigation of natural phenomena, and even to perceive that the modes of thought and methods of inquiry demanded and promoted by such studies, constitute their real value, irrespective in great measure of the special subject of the inquiry.

When we find that men like the authors of this book, engaged in the active pursuit of a mercantile or of a professional life, yet find time and inclination to employ their rare leisure in the observation of the common objects around them, it cannot be denied that the minds of practical men, as they are termed, are, at any rate, alive to the advantages and delights of scientific pursuits.

The object of studies like those undertaken by Mr. Samuelson may be regarded as twofold. In the first place, as conducive to the formation of habits of close observation and comparison, they must ever be regarded as an important element in the education of the judgment and of the mental powers in general; whilst, as he observes, "the pleasurable sensations arising from the investigation of those objects, of which the book treats, render those studies a delightful recreation, and the most effective mode of relaxation for those whose days are passed, and whose minds are occupied, in the oppressive cares of business."

To one who rightly feels the true import of such studies, and is capable of properly appreciating the enjoyment to be derived from them, the particular subject of investigation will be a matter of less importance than the spirit and mode in which the inquiry is approached and carried on.

This appears to have been the author's idea when he selected as the subject of his labours such common objects as the earthworm and the house-fly, whose extreme vulgarity would lead many to deem that they were beneath the notice of the scientific student. It is, however, a very important principle to bear in mind, that in most cases the rarity of any object, or the difficulty of obtaining it, in no way adds to its value as a subject for the exercise of observation and research. In a scientific point of view, it is quite true that the commonest objects are, in most respects, as interesting as the rarest. The laws of biology, or the physiological and structural relations of living beings, may be as well studied and as profitably investigated in the commonest as in the rarest creatures. As Mr. Samuelson's book will serve to show, no one need go far from his threshold, nor spend much time and money in the search after objects upon which to spend his leisure hours of observation. It may be remarked also, as in the case more particularly of the earthworm, that it not unfrequently happens that the commonest and apparently meanest objects are those about which least is really known. The structure of the common worm, it is needless to say, is as perfect and beautiful as that of the highest animal; but common as it is, and numerous as have been the observations made with respect to it, many points in its structure, physiology, and habits, of the utmost importance, yet remain to be made out, a knowledge of which would nevertheless tend to throw very considerable light upon similar points in a great number of the annulose class, which are far less easily procured. Nothing, for instance, is yet really known with respect to the mode or the situation in which, or the period when, the ova of the earthworm are impregnated; nor, which is perhaps still more strange, do we know with certainty how the ova are expelled from the parent. The most recent researches on these points by D'Udekem and Hering have, it is true, indicated the true situation and some of the relations of the ovaries, and the complicated structure of the male reproductive organs; but further than this inquiry has not yet gone. We cite this particular instance merely to confirm the proposition that, even in the commonest objects, much may yet be left for even the best informed inquirer to complete, and that they will at any rate always afford to the beginner abundant materials for his research.

With respect to the mode in which Mr. Samuelson has executed his task, we need only remark that, although he has very properly expressed himself in an easy and popular manner, his treatment of the subject is by no means superficial or inexact. He has obviously and successfully endeavoured to make himself acquainted, both by direct observation and by reference to the best and most recent authorities, with the subjects upon which he treats. As might be expected, the account of the fly, which occupies about two thirds of the volume, is more lively and interesting to the general reader than that of the worm, and in this part of his work he has received considerable assistance from the pen and pencil of Dr. Hicks, whose name is well known as a most careful and skilful microscopic observer of many points in the structure of some parts in various insects, by papers published in the 'Proceedings and Transactions of the Linnean Society.'

We can strongly recommend Mr. Samuelson's work to all young naturalists, and more especially will those who employ the microscope in the investigation of the structure of insects, find in it many novel and interesting observations.

NOTES AND CORRESPONDENCE.

New Forms of Diatomaceæ.—The following remarks are from a paper published by Professor Gregory in the 'Transactions of the Royal Society of Edinburgh,' on "New Forms of Diatomaceæ found in the Firth of Clyde and in Loch Fine." For a description of the new species we must refer to the paper.

"In two papers read before this Society, I have very fully described the Diatomaceæ of the Glenshira Sand, which is very remarkable both for the large number of species found in it, which is certainly more than 320, and for the circumstances in which it must have been deposited. There can be no doubt, from the nature of the locality, which I have lately visited, that this bed was formed in the bottom of the Dhu Loch, a shallow fresh-water lake, at that time extending about two miles farther up the valley than it now does, and being at a higher level. In consequence of a rise in the level of the land, or a fall in that of the sea (from which—that is, from Loch Fine—the lower end of the lake is separated by a narrow and low barrier, through which the waters of the lake pass to Loch Fine), the lake has long ago been drained, till its upper end is nearly two miles from the point it must have reached when the bed of sand was formed. The present level of the lake is considerably lower than it was then; the precise difference I had no means of ascertaining, but I believe it is about 30 feet. Now, the most interesting fact about this lake is, that its actual level is that of half-tide, so that at low water the lake is discharged into the sea, while at high water the tide flows upward into the lake. Hence marine plants and animals are found in the Dhu Loch; herring, for example, are often caught in it, and were taken while I was in the neighbourhood. Hence also the present deposit in the lake exhibits a mixture of fresh-water and marine Diatomaceous forms. Now, the older sand, the subject of my paper, deposited at a considerably higher level, also contains both marine and fresh-water Diatoms; and while the individuals of the two classes are both abundant, the marine species are at least twice, perhaps thrice, as numerous as those of fresh water.

"The natural, and, I have no doubt, the true explanation of the occurrence of so many marine forms in an inland deposit, formed in a fresh-water lake, is this: that at the period when the sand was formed the relative levels of the Dhu Loch and of Loch Fine were the same as now, when similar results ensue.

"But as the lake was then at a higher level than now, so also must the sea have been at a level as much above its present one. This conclusion is in accordance with those derived from the observations made on raised beaches on the banks of the Firth of Clyde, the level of which must always have regulated that of Loch Fine since the present form of the coast has existed.

"There was, however, a circumstance which at first tended to throw some doubt on this conclusion, according to which the marine forms of the Glenshira sand must have come from Loch Fine. For although the known and described marine Diatoms found in the sand occur on our coasts, yet I was struck with the fact that out of upwards of fifty new or undescribed forms, there seemed to be no trace in deposits from the Firth of Clyde, examined by more than one naturalist during the progress of my investigation. The fact of these forms being undescribed was *prima facie* evidence that they had not occurred on the British coasts.

"Yet it was evident that the formation of the Glenshira sand, was, geologically speaking, very recent; so recent, indeed, that we could not suppose any number of species to have since become extinct. I came, accordingly, to the conclusion, that these undescribed forms must still exist in the waters of Loch Fine, or, what is the same thing, of the Firth of Clyde. I was therefore desirous to examine with care deposits from these waters, and this, during the past six months, I have been enabled fully to do.

"The materials which I have examined are the following:

"1. A small quantity of dirt or sand washed from some nests of *Lima hians*, dredged in Lamlash Bay on the 19th of July last, in four fathoms, by Professor Allman. This material, though, when cleaned, very scanty, proved the richest of all.

2. Four dredgings, made by myself, with the kind assistance of the Duke of Argyll, in Loch Fine, at different points within two or three miles of Inverary. These were all different, and three of them were interesting. They were taken at dephts of from fourteen to eighteen fathoms, early in October.

"3. Three dredgings made at the same time by the Rev. Dr. Barclay, in Loch Fine, off Strachur, at depths of fifteen, twenty, and sixty fathoms, also in October last.

"4. Three materials forwarded to me in October by the Rev. Mr. Miles, of Glasgow, who was for some time on the Holy Island, in Lamlash Bay.

"One of these was washed from the nests of the *Lima hians,* as I had reported the richness of the former. These last were from seven fathoms in Lamlash Bay. This material, dredged, I think, in June, was not so rich in Diatoms as Professor Allman's, but yet contained many interesting forms.

"The second was a coarse red sand, dredged off Invercloy, Arran, which was rather poor.

"The third was a mass of *Corallina officinalis,* taken with the hand, in rocky pools, at Corregills, Arran, when the tide was low. The Corallina, proved to have been a good Diatom trap, and yielded a material, not remarkable for the number of species, but rich in individuals, and these nearly all of interesting, rare, or new species.

"I had thus eleven different materials, no two of which were exactly alike, although in all certain prevalent forms occurred. In each, on the other hand, some forms, few or many were peculiar, and their presence gave a distinct character. A careful study of the whole has yielded interesting results; and these it is the object of the present paper to state as briefly as may be consistent with accuracy.

"The first observation is, that these waters contain a very large proportion of all the known and described marine forms belonging to Britain, including a good many which have hitherto been very rare; so scarce, indeed, in some instances, that few observers have seen them. I may specify the following as being by no means rare, several, indeed, being abundant in these materials:

Coscinodiscus concinuus.
Eupodiscus crassus.
" Ralfsii.
" sculptus.
Campylodiscus Ralfsii.
" Horologium.
Navicula Hennedyi.
" Granulata, Bréb.
" Lyra, Ehr.
Pleurosigma rigidum.
" obscurum.
Pleurosigma delicatulum.
" transversale.
Surirella lata.
Himantidium (?) Williamsoni.
Amphiprora elegans.
Podosira Montagnei.
Orthosira marina.
Grammatophora macilenta.
Biddulphia Baileyi.
" turgida.

"The second observation which I made was, that, as I had anticipated, nearly the whole of the new forms figured by me from the Glenshira sand are found living, and generally abundant, in these waters. The following list contains the names of such of the marine species, figured in my former papers, as I have found in the new materials:

" Cocconeis distans.	Navicula didyma δ.
,, costata.	,, crassa.
Eupodiscus Ralfsii; also var. β, sparsus.	Pinnularia Pandura.
Campylodiscus simulans.	,, longa.
Surirella fastuosa, very large.	,, inflexa.
Amphiprora recta.	Amphora Arcus.
,, lepidoptera.	,, crassa.
Navicula rhombica.	,, elegans.
,, maxima.	,, plicata.
,, angulosa, and var. β.	,, obtusa.
,, humerosa.	,, Grevilliana.
,, latissima.	,, rectangularis.
,, clavata.	,, lineata.
,, splendida.	Synedra undulata.
,, incurvata.	Tryblionella constricta.
,, didyma, var. γ, costate.	,, apiculata.

" I think we can hardly doubt that all the new Glenshira marine forms will ultimately be found in the neighbouring waters.

" Before going farther, I have to remark, that two of the forms in the first list above given, namely, *Campylodiscus Horologium* and *Himantidium Williamsoni,* which had only been found by Professor Williamson, who detected them both in a dredging made by Mr. Barlee on the coast of Skye, in which they were very scarce indeed, have occurred abundantly, the former in one of the Loch Fine dredgings, and sparingly in some of the others, the latter in another of them, and, though less abundantly, yet frequent in nearly all the Clyde materials. We shall see *Himantidium Williamsoni,* which Professor Smith had referred doubtfully to that genus, not having been able to see more than the front view of it, is really no Himantidium; the side view, which is very abundant in one of my dredgings, having characters quite incompatible with the genus Himantidium. On this account, I shall refer to it among the new forms which I have to mention. I have found it a matter of very great difficulty, if not impossible, to refer it to any of the genera in Smith's 'Synopsis.' I may here add, that *Synedra undulata,* which I had recognised in the Glenshira sand, but which had never occurred entire in that deposit, is frequent in the first material from Lamlash Bay (Professor Allman's), where it occurs quite entire in more than half of those I have seen, and, as I had concluded, from the imperfect specimens I had seen, attains a length of from 0·015 to about 0·02, which, for a Diatom, is gigantic. I had previously noticed a fragment of it in a recent gathering made by Professor Smith, and he had himself subsequently found it frequent in Cork harbour. The first observer, however, was Professor Bailey, of West Point, New York, who had found it still larger on the American coast, which I was not aware of till long after my observations on the Glenshira sand were made.

"The third observation I shall here record is, that in these dredgings I found, in sufficient abundance, several very curious forms which had occurred in the Glenshira sand; but the description and figuring of which I had postponed, because either they were so scarce that I could not obtain good specimens, or, being only found in a fragmentary, detached, or imperfect state, I was quite at a loss to determine their true nature and position. I think I may say that in every such case I have been enabled, by the study of the new materials, to understand the nature and structure of these obscure or doubtful forms, and to establish them as new and distinct species. I have also been enabled to understand better several of the forms which were figured in my former papers, and to correct some errors which had crept into these.

"I need not here give a list of the forms just alluded to, as the will be included in that of the new forms to be described. In that list I shall mark them with a G, to indicate that they were first noticed in the Glenshira sand.

"Lastly, in the new materials I have found a large number of entirely new and undescribed species. I may here mention, that although a good many fresh-water forms do occur in these dredgings, as must, indeed, be the case, since the Clyde and all its tributaries bring down such forms, yet the new forms in question appear to be all of marine origin. They are, in general, much too abundant to have been derived from any other quarter, whereas the fresh-water forms among them are much scattered. It is proper also to state, that although all these forms are, to the best of my belief, new to Britain, yet a few of them have been described by Ehrenberg in some of his numerous works, and also by De Brébisson. The great majority, however, have not anywhere been figured; not, at least, in any works accessible to me."

ZOOPHYTOLOGY.

On some Madeiran Polyzoa.
Collected by J. Yates Johnson, Esq.

(*Continued from* No. XXIV, p. 263.)

We continue the account of zoophytes, brought by Mr. J. Y. Johnson from Madeira, and to which he has made some interesting additions in the present year, and kindly placed at our disposal for description. In the next number of the Journal we hope to be able to include figures of all the remaining new or imperfectly described forms brought by Mr. Johnson, and shall then give a general list of the known species derived from that most interesting locality.

1. Polyzoa cheilostomata.

1. Gen. *Cellaria*, Lamx.

1. *Cellaria Johnsoni*, B. Pl. XXII, figs. 4, 5.

Front cell elliptical, surface and ridges smooth; a ridge passing from each side of the front of the cell.

Hab. Madeira, Johnson.

Nellia Johnsoni, B. 'Micr. Journ.,' No. xxii, p. 125, Pl. XIX, fig. 2.

A figure taken from an imperfect and worn fragment was given in the last part of the Zoophytology, and the species is there referred to the genus *Nellia*. The examination, however, of the beautiful and perfect specimens collected in the present year by Mr. Johnson, necessitates its removal from that genus, and its reference to *Cellaria*, Lam., used as synonymous with *Salicornaria*, Cuvier and 'B. M. Cat.' Our reasons for preferring the term Cellaria to Salicornaria will be given at another opportunity. The present is an elegant and very distinct form.

2. Gen. *Scrupocellaria*, V. Bened.

1. *Scrupocellaria Delilii*, Aud. (sp.) Pl. XXII, figs. 1, 2.

Operculum entire, suboval; a marginal spine on either side above. A small sessile avicularium on the front of each cell immediately below the aperture. Peristome smooth.

Hab. Madeira, Johnson; Mediterranean (?), Savigny.

Crisia Delilii, Savigny, 'Egypt,' pl. xii, fig. 3; Audouin, 'Expl.,' I, p. 242.

A very distinct species, characterised at once by the minute sessile avicularium, with an acute triangular avicularium immediately below the aperture. The presence of this organ and the smooth peristome distinguish it sufficiently from *S. Macandrei*, B., the only other species with which it could possibly be confounded. Savigny's figure is very correct to nature, so that no doubt whatever can be entertained of the identity between the Madeiran and Levantine (?) forms.

3. Gen. *Lepralia*, Johnst.

1. *L. Pouilletii*, Aud. Pl. XXII, fig. 6.

Cells oval, front marked with radiating lines of minute puncta. Mouth raised, and advanced in front, with five or six marginal spines above.

Hab. Madeira, Johnson; Mediterranean (?), Savigny.

Esch. Pouilletii, Savigny, 'Egypt,' pl. xii, figs. 1—5; Audouin, 'Expl.,' p. 240.

This is another of Savigny's species, with respect to whose identification little or no doubt can be entertained. It is readily distinguished from *L. radiata*, Moll., by the absence of the large avicularia and the uniformity of the front of the cell.

2. *L. discoidea*, n. sp. Pl. XXII, figs. 7, 8.

Cells disposed in regular lines radiating from a centre, closely adnate, immersed. Mouth with a raised margin, keyhole shaped. Surface pitted.

Hab. Madeira, Johnson.

4. Gen. *Eschara*, Linn.

1. *E. distoma.* Pl. XXII, figs. 10—12.

Polyzoary ligulate, subterete, branches narrow. Upper part of cell much advanced; mouth arcuate, expanded below. Beneath the mouth, in the centre, an acute elongated avicularium, and below that, in the front of the cell, a depressed space, perforated at the bottom with two rows of minute pores. Surface minutely granular or wavy.

Hab. Madeira, Johnson.

This is the species described in last part of Zoophytology, from an imperfect fragment, as *L. distoma*, B. It is, however, as there suggested, clearly an *Eschara*.

5. Gen. *Cupularia*, Lamx.

1. *C. Lowei*, Gray (sp.)

2. *C. Canariensis*, n. sp. Pl. XXIII, figs. 6—9.

Polyzoary depressed, circular, about 0·5″ in diameter. Front of cell subrhomboidal, expanded below the middle, aperture oval. Lamina granular, with an entire margin. Back divided into quadrangular portions, in each of which are from two to four perforations.

Hab. Madeira, Johnson; Canaries, McAndrew.

A distinct and well-marked form. Numerous specimens were bought from the Canaries by Mr. M'Andrew two or three years ago.

3. *C. Johnsoni*, n. sp.? Pl. XXIII, figs. 1—5.

Polyzoary conical, about 0·25″ in diameter. Area of cell subelliptical, widest about the middle. Raised margin surrounding the upper part or oval portion of the cell produced downwards within the area, so as to present a horseshoe form. Edge of lamina denticulate or jagged, surface granular. Back of polyzoary with raised radiating ridges, each of which is more or less distinctly carinate, with a row of minute elevations on either side of the keel.

Hab. Madeira, Johnson.

It is not improbable that this form will turn out to be identical with the *C. denticulata* of Conradi, and perhaps, therefore, with the *O. Owenii*, Searles Wood, of the Crag. It is clearly distinct from the true African *C. Owenii*—1, in the conical form of the polyzoary; 2, in the horseshoe shape margin to the upper part of cell; and 3, perhaps in the row of elevations on each side of the ridges on the back of the disc. The cells also in the centre of the disc are always completely filled up, as shown in the figure—a circumstance which I have not observed in any specimen of *C. Owenii.*

4. *C. Owenii*, Gray (sp.)

Hab. Madeira, Johns.; Coast of Africa, Gray; Fossil, Crag (?), S. Wood.

2. P. CYCLOSTOMATA.

1. Gen. *Tubulipora.*

1. *T. druidica*, n. sp. Pl. XXII, fig. 9.

Crust dense, strong, thick; tubes short, upright, placed in more or less distinct circles.

Hab. Madeira, Johnson.

This appears to be an undescribed form of *Tubulipora* or *Diatopora*, and is named from the peculiar arrangement of the column-like tubes. The determination of the genus must, however, be regarded only as provisional.

ZOOPHYTOLOGY.

DESCRIPTION OF PLATES.

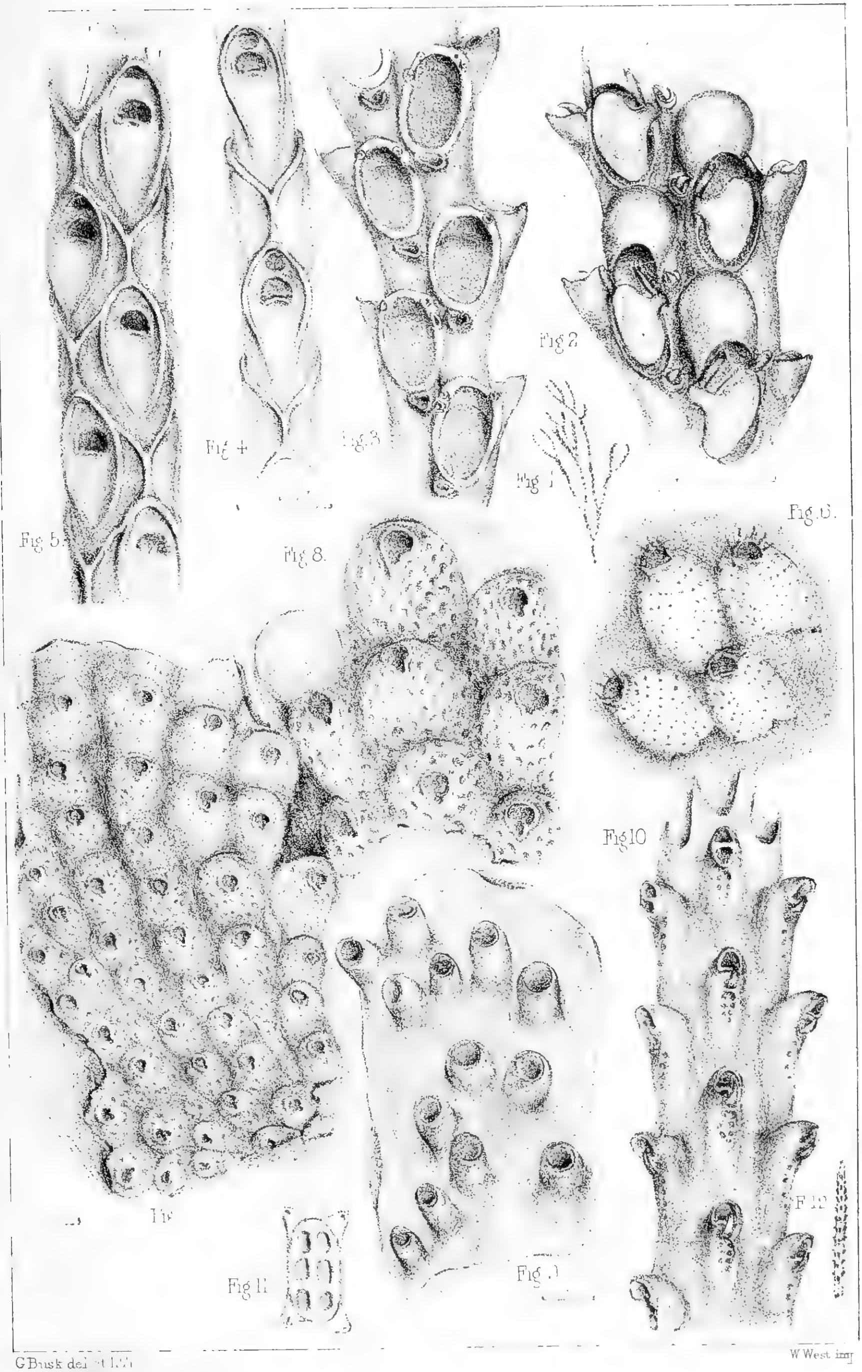
PLATE XXII.

Fig.
1.—*Scrupocellaria Delilii*, nat. size.
2.— „ „ with ovicells and opercula.
3.— „ „ in older or worn condition.
4.—*Cellaria Johnsoni*, younger state.
5.— „ „ older.
6.—*Lepralia Pouilletii.*
7.— „ *discoidea*, × 25 diam.
8.— „ „ × 50 d.
9.—*Tubulipora druidica.*
10.—*Eschara distoma*, × 50 d.
11.—Transverse section (diagram).
12.—Nat. size.

PLATE XXIII.

1.—*Cupularia Johnsoni*, nat. size.
2.—Cells near margin of disc.
3.—Cells from centre of disc.
4.—Back of disc.
5.—Single cell with cuticle and vibraculum.
6.—*Cupularia Canariensis*, nat. size.
7.— „ „ × 50 d.
8.—Back.
9.—Single cell with cuticle and vibraculum.

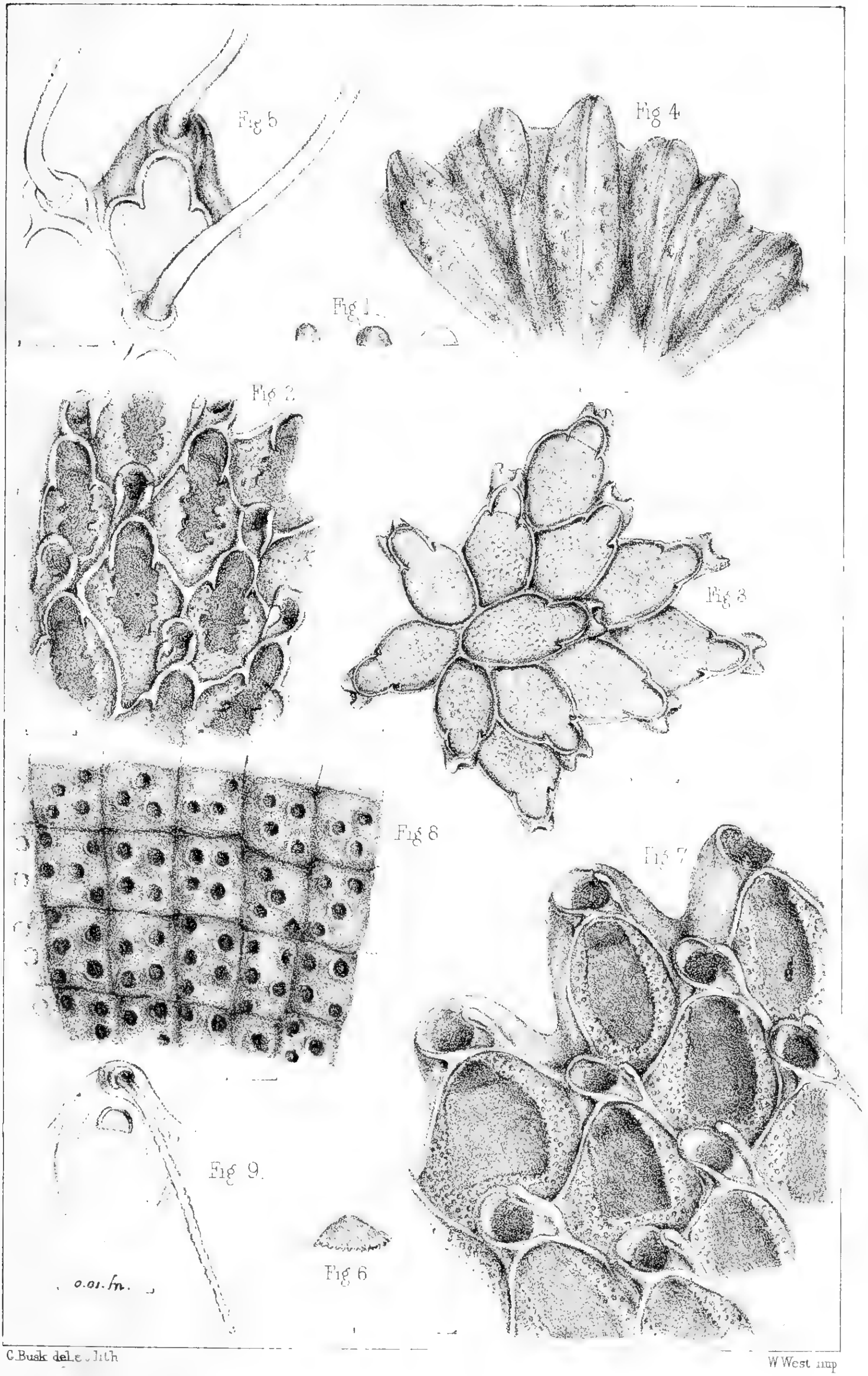
ZOOPHYTOLOGY
Plate XXII



G Busk del et lith

W West imp

Plate XXIII.



G.Busk del.et lith

W West imp

ORIGINAL COMMUNICATIONS.

The Rotation *of* Coloured Discs *applied to facilitate the Study of the* Laws *of* Harmonious Colouring, *and to the* Multiplication *of* Images *of* Objects *into* Kaleidoscopic Combinations. By John Gorham, M.R.C.S., &c.

In this paper I purpose to show how the rotation of coloured discs may be adapted—first, to assist in the investigation of the laws of harmonious colouring, and secondly, to the construction of combinations of perfect symmetry of form and colour, which result from the multiplication of images of simple patterns used as objects. Such combinations are so beautiful that they may be said to vie with, even if not to surpass, those of the kaleidoscope; and although the principle of multiplication is different in the two instruments, yet the resemblance between the figures is sufficiently strong to induce me to designate the apparatus which produces such forms by rotation as the Kaleidoscopic Colour-top.

The possibility of forming an apparent mixture of two or more colours distributed on contiguous surfaces, by rotating them rapidly on a wheel, is founded on the well-known experiment of whirling a stick, ignited at one end, rapidly round in the hand, when a continuous circle of light is at once perceived, marking out the paths described by its burning end. As the burning extremity can only be in one point of the path at the same instant, it is manifest that the impression of its light continues some time on the eye, and an uninterrupted circle of light is seen from the duration of successive impressions on the retina. Coloured surfaces, when revolved, form circular areas of colours in the same way, and if two or more differently coloured contiguous surfaces are used, as many circular areas of different colours are formed, which being superposed produce the impression of mixture. It is obvious, therefore, that if a number of images of different colours occupy the field of vision simultaneously, they will be perceived as one compound colour, just as when plates of differently coloured glass placed in apposition are viewed by transmitted light. The rotation of colours may be considered, therefore, for practical purposes, as only another mode of mixing them.

The facilities of mixture afforded by this process, as contrasted with that of ordinary mixture, by the amalgamation of the pigments with water or oil, are as follows: The colours used are chosen once for all from amongst the purest of the pigments; they are laid on circular discs of cardboard in intense washes, and thus they may be used again and again as occasion requires. They are few in number, because few only are required; they are mixed in all proportions evenly and smoothly with perfect ease by mere rotation; they are cancelled at pleasure, even during rotation, by scales constructed for the purpose, and they are liberated by the same process, just as the sounds from the pipes of an organ are stopped or unstopped by touching the keys. The relative quantities of colour entering into given compounds, moreover, can be expressed numerically by reference to a scale of degrees affixed to the wheel, thus enabling us to name a colour in reference to its constituents with some degree of philosophical accuracy. It is important to notice, however, that while the results of mixture by the ordinary process and by rotation bear on the whole a striking resemblance, a remarkable exception obtains with respect to the formation of *green*. This hue is produced in the ordinary way, as is well known, by the union of yellow and blue in almost any proportions; not so by rotation, for by a curious anomaly, there is not a yellow and blue in existence, combined in any proportions, that will form even a tolerable green.

With a graduated scale enabling us to express areas of coloured space numerically, with intense washes of pure colours, and with a given velocity, the important problem of a nomenclature of colours would appear to be solved; but the known impurity of every pigment, and our inability to produce a green hue by rotation, conspire to form an insuperable obstacle, and the construction of a nomenclature by this process, although possible, must be relinquished as useless.

The combinations by rotation serve to illustrate many of the most interesting phenomena of colour; they furnish a clue, for instance, to the theoretical composition of the pigments, elucidate the principles of contrast, evoke the complementaries, and enable us to blend colours in softer gradations than we can by the pencil. These results are obtained indeed with so much ease and certainty, that this mode of studying colour might, it is presumed, be adapted with success to educational purposes.

I propose to divide this part of the subject under the following heads: 1. Apparent mixture of two or more different colours, arranged contiguously, forming *hues, tints, shades, neutrals,* &c.; 2. Contrast of tone; 3. The complementary colours; 4. Contrast of colour; and 5. Mixture by "softening off," or insensible gradation.

The requisites for these illustrations are simple and few in number. They are a rotating apparatus or colour-top; six circular discs of white, black, green, yellow, red, and blue; six *heart-shaped scales* of the same colours; five *graduated scales* of white, green, yellow, red, and blue; and a black double semizone.*

Here I would notice, *in limine,* that the colour-top should be spun upon a table placed near the window, and when in the act of pulling the string it should be pressed firmly down, and not allowed to drop from a height, as is commonly done. The darker the rest of the room the better. The table is provided with a cloth, light or dark in colour, according to the experiments. These should be performed by daylight; the light from a white cloud is best, then the light from the sun as seen through a white window-blind; that from a blue sky is the worst kind of light that can be chosen, hence a bright cloudless day should not be taken.

A white table-cloth is used in the following experiments.

1. *On the Formation of the Hues, Tints, Shades, Neutrals, and Grays.*

The discs here employed are circles of cardboard, either white, black, or coloured (figs. 1 to 6), and which, having a slit cut completely through from the centre to the circumference, can be made mutually to overlap one another in sectors of any magnitude.

When sectors of two or more discs of different colours are screwed on the colour-top and rotated, the optical composition of each colour immediately vanishes, and is replaced by an apparent wash of one single colour only, evenly distributed on the entire surface of the disc, and which is in reality a combination, taking place in the eye itself, of the rays reflected from all the coloured surfaces employed in the experiments, thus—

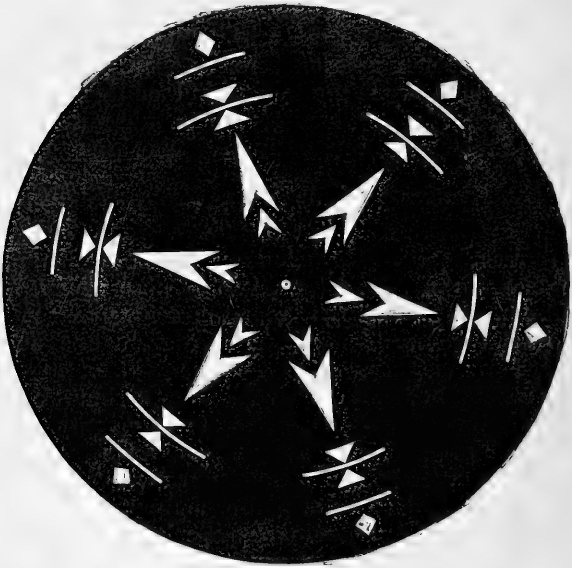
(Red + blue) = violet or a violet *hue*.
(Red + white) = light red or a *tint* of red.
(Red + black) = dark red or a *shade* of red.

* The whole of the apparatus necessary to these experiments, together with the discs for producing the kaleidoscopic effects, may be procured of the publishers, Messrs. Smith, Beck, and Beck, Opticians, 6, Coleman Street, London, under the title of the Kaleidoscopic Colour-top.

(Yellow + red) = orange or an orange *hue*.
(Red 30° + blue 165° + yellow 165°) = neutral.
(Yellow 15° + blue 15° + red 15° + black 315°) = brown (see fig. 8).
(White + black) = gray, &c., &c.

2. *On Contrast of Tone.*

Black and white are the elements of tone; a colour becomes shaded or of a dark tone by mixture with black, and tinted or of a light tone by mixture with white. The mixture of white and black is gray. Grays themselves are of different tones, varying with the relative proportions of their elements; hence there are dark grays and light grays. A dark gray *appears* still darker when viewed in juxtaposition with a light gray, and a light gray *appears* still lighter when



viewed in contiguity with a dark gray; the altered appearance of both is obviously the effect of contrast. This may be elegantly illustrated on the colour-top by appending to a circular disc of black a graduated scale of white (fig. 7), and rotating, when a series of gray bands, arranged in concentric circles, is immediately formed. The graduated scale is composed of segments of circles, which continually enlarge from the circumference to the centre by the addition of a given number of degrees (50°) in arithmetical progression. On careful examination of the gray zones formed by rotating this scale on a black ground, it will be found that each gray zone appears gradually shaded from one of its edges, being somewhat lighter at its inner edge from apposition with a darker gray, and darker at its outer edge from contiguity with a lighter gray. These remarkable modifications have been clearly demonstrated by M. Chevreul.*

3. *Of the Complementary Colours.*

The three primary colours are yellow, red, and blue. What is wanting in a given colour to complete this triad is called its complementary. The complementary of red, for example, is yellow and blue (or green); the complementary of blue is yellow and red (or orange); the complementary of yellow is red and blue (or violet), &c. If we gaze steadily on a colour for a minute or so, and then direct the eye to a contiguous gray surface, the complementary becomes visible. These conditions are fulfilled in the following well-known and elegant experiment. Place a black wafer on the centre of a sheet of emerald-green paper, and over both spread a piece of white tissue paper; the wafer no longer appears black, but red, tinged, that is, with the complementary of the green by which it is surrounded. "In this way colours are actually produced by contrast. Thus, a very small dull-gray strip of paper, lying upon an extensive surface of any bright colour, does not appear gray, but has a faint tint of the colour which is the contrast of that of the surrounding surface. A strip of gray paper upon a green field, for example, often appears to have a tint of red, and when lying upon a red surface a greenish tint; it has an orange-coloured tint upon a bright blue surface, and a bluish tint upon an orange-coloured surface; a yellowish colour upon a bright violet, and a violet tint upon a bright yellow surface. The colour excited thus, as a contrast to the exciting colour, being wholly independent of any rays of the corresponding colour acting from without upon the retina, must arise as an opposite or antagonistic condition of that membrane; and the opposite conditions, of which the retina thus becomes the

* 'The Principles of Harmony and Contrast of Colours,' by M. E. Chevreul; translated from the French by Charles Martel. Second edition, pp. 7—9.

subject, would seem to balance each other by their reciprocal action. A necessary condition for the production of the contrasted colours is, that the part of the retina in which the new colour is to be excited shall be in a state of comparative repose; hence the small object itself must be gray. A second condition is, that the colour of the surrounding surface shall be very bright, that is, it shall contain much white light."*

The required conditions are fulfilled very exactly by rotation in the following experiment. Take a disc composed of equal parts (half-discs) of white and red, and rotate; during rotation drop down upon the spindle the black double semi-zone (fig. 9), which will quickly revolve with the same velocity as that of the colour-top itself; now gently breathe upon this black zone, and when one of its rings appears of a deep red colour the other ring will present a greenish tint; the greenish hue which is thus evoked, and which is the complementary of the red, is rendered visible by being thus thrown directly upon a contiguous gray surface. Analogous results take place with every colour by arranging them in the above order; the illustrations are generally chosen, however, from green and red, as the contrasts are more palpable to the eye, and assist in educating the uninitiated in the perception of such delicate phenomena.

4. *Contrast of Colour.*

If the eye sees at the same time two contiguous colours, they will both appear modified from their contiguity. "When it is asserted of the phenomena of simultaneous contrast," says Chevreul, "that one colour placed beside another receives a modification from it, it must not be forgotten that this manner of speaking does not mean that the two colours, or rather the two material objects that present them to us, have a mutual action, either physical or chemical; it is really only applied to the *modification that takes place before us*, when we perceive the simultaneous impression of these two colours, and which reciprocally excite each other *in the retina* of the eye."

The modifications of contiguous colours result from the addition to each of them of the complementaries of the other. If, for example, two narrow strips of red and orange paper are placed side by side, in contact at their edges, and gazed

* 'Hand-book of Physiology,' by Kirkes and Paget. Second edition, pp. 552, 553.

on for a few seconds, the red will soon incline to violet and the orange to yellow, for—

(Red + comp. of orange) = (red + blue) = violet;

(Orange + comp. of red) = (orange + green) = yellow-orange.

These effects are most apparent at those parts of the coloured bands nearest their line of contact, and become gradually weaker at those parts most remote from it.

The means employed to illustrate these phenomena in the colour-top are so simple that it is almost needless to indicate them. They consist of a series of rings of colours, affixed on differently coloured grounds, and then rotated; an orange-coloured ring is composed of red and yellow in equal portions (see fig. 10); a violet-coloured ring consists of red and blue in the same proportions. A green ring should result in like manner from equal quantities of yellow and blue; but as this hue cannot be formed by the rotation of its elements, an entire ring of emerald-green is used instead. A yellowish-green is formed of yellow and emerald-green in equal parts, and a bluish-green of blue and emerald-green. For the grounds it is sufficient to use semi-discs of those colours which compose them; thus, two semi-discs of red and blue form violet (see fig. 10); the shades and tints are constructed by adding black or white, as occasion requires. When a ring of colour is thus placed on a given ground and rotated, the modifications from contrast may be studied with advantage, for each colour is formed so expeditiously, that a considerable number of illustrations may be examined without trouble or fatigue.

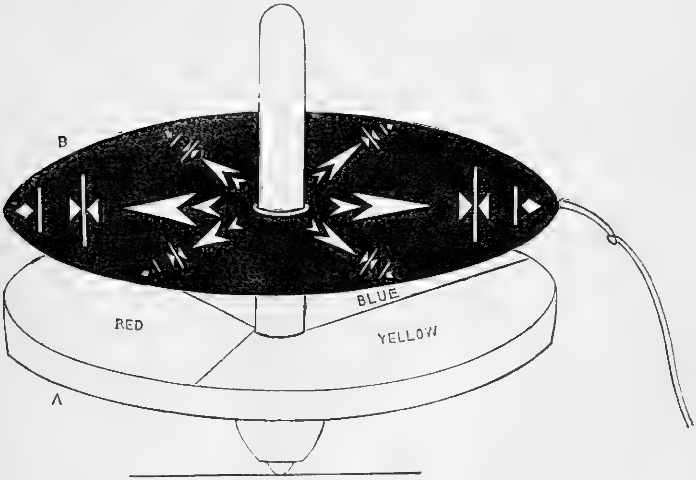
5. *The Blending of Colours by soft or Insensible Gradation.*

When a plane, bounded by two similar spiral curves (fig. 12), having its surface covered with white, black, or any colour, is affixed to a disc of a different colour, and rotated, the two colours appear to blend in the most delicate manner possible, imitating to perfection that kind of mixture known by artists as "softening off," and exemplified in the blush of the cheek, the imperceptible transition from white to red seen in the petal of the rose, the bloom on many fruits, the golden western sky at sunset losing itself in an atmosphere of blue through a rich neutral, &c. Such combinations are exquisitely beautiful. The spiral curve is thus generated:—describe a large circle, equal in size to the circumference of any of the discs (1 to 6), and a smaller circle near the centre (see fig. 11). Between these two circles draw eleven segments of circles, at equal intervals, of which the first segment, or that nearest to the circumference, is equal to 30, the second segment to 60°, the third to 90°, and so on to the eleventh, adding 30° to each segment. Now join the ends of these segments by a curved line on either side, and the curvilinear or heart-shaped appendage is completed. When such an appendage of pure white is affixed to a disc of black (fig. 12) and rapidly rotated, the mixture presents a soft transition from white to black, through an atmosphere of gray, which is most refreshing to the eye. Many agreeable transitions may be produced by using the white scale on grounds of blue, green, and red, in succession. A red scale on a ground of blue presents a most gorgeous picture—a pure red gliding imperceptibly into blue, through every conceivable hue of violet.

MULTIPLIED FIGURES BY ROTATION.

The Kaleidoscopic Colour-top.

When two rotating discs are used in a particular manner, and placed in a particular position relative to each other and the eye, they constitute the Kaleidoscopic Colour-top, or an instrument for exhibiting beautiful forms which are similar to those of the kaleidoscope, although essentially distinct as to the principle on which they are constructed. Let A, for example, be a disc having the three primary colours, yellow, red, and blue, evenly distributed in sectors of 120° on its surface, and let this disc be fixed to the colour-top and rotated. Let B be a second disc, blackened on its upper surface, and having a central aperture somewhat larger than the spindle of the top, as well as a pattern of six or eight rays cut completely through and out of its substance, so that when held vertically over the disc A it will admit of the colours being seen through such pattern when viewed from above. If now the wheel is set in motion, and the disc B be allowed to drop down upon the spindle of the colour-top, it will be held in contact with the spindle by centrifugal force, and will revolve in a plane parallel with the wheel, in the same direction and with the same velocity. In this case the colours on A appear mixed, while the pattern on B is effaced. But if the motion of B is retarded, and at the same time broken up into a series of rapid and regular jerks, or more properly *isochronous* vibrations, while the eye is held vertically over the spindle, each pattern is retained for an instant before the eye, yet sufficiently long to form a distinct image; and owing to the rapidity of the vibrations, a whole circle of images is thus portrayed on the retina of the eye before the image from the first vibration is effaced. In like manner, the colours of the disc A, which are perceived only as they are transmitted through the open designs in the disc B, appear in their primitive purity or unmixed state, the colour in one sector being reflected through a given ray of the pattern before the arrival of the colour from that sector by which it is immediately succeeded. Hence, both pattern and colours appear multiplied, thus producing the combinations.



From the construction of the instrument, about five revolutions of the disc A occur to one single revolution of the disc B. When these relative velocities are maintained, five groups of all the colours distributed on the colour-disc are seen occurring in the order of their arrangement on the disc, and repeated in perfect symmetry in the various openings of the patterns (see fig. 14, which represents a non-rotating disc, and fig. 15, the same during rotation). In this way the most beautiful variations may be effected by using different colours in various proportions on the disc A; for however numerous the colours, each colour is reflected through its proper opening in the disc B, at a given interval of space and time, without the slightest irregularity or confusion.

In order to retard the motion of the disc B, and, at the same time, to produce the vibrations, the central aperture is made sufficiently large to admit of free motion on the spindle; and there is appended, at or near its circumference, a light weight, such as a piece of string or silk, which, by its impulses on the atmosphere during rotation, both retards the motion and produces the vibrations. The proportion of the diameter of the central aperture of the disc B to that of the spindle of the colour-top is about as four to three—an aperture of four tenths of an inch, for example, to a spindle three tenths of an inch, is very effective.

As in the kaleidoscope, so in this instrument, there is only one position for the situation of the eye with respect to the discs where the symmetry of the combinations is perfect, namely, vertically over the spindle of the top, so that the whole of the circular field can be distinctly seen.

For the purpose of giving variety to the figures formed by the instrument, an assortment of fantastic patterns on separate discs may be constructed to take the place of the disc B; the disc A is also furnished with different colours. A disc of pure white forms exquisite gray combinations, with every conceivable variety of light and shade; a disc of white and green, in equal portions, is resolved into these elements, and their multiplication into a composite form is very agreeable to the eye. An elegant arrangement, whereby patterns may be coloured in the most attractive manner, is composed of half a disc of blue, and the rest of white, green, and red, in equal proportions.*

The pictures thus presented to the eye are very beautiful. Their charm would appear to depend partly upon their being reflected to the eye through a perfectly black medium, which imparts brilliancy and illumination to the colours, and partly upon their being exhibited in a state of motion, the *apparent* and *real* direction of which bear no relation to one another. While the disc is actually performing one hundred revolutions per minute, and vibrating about thirty times during each revolution, the combinations themselves often *appear* hanging in space, trembling without progressing, or perfectly motionless, or gliding round in a direction contrary to that of their real motion. These frequently recurring and illusory changes excite the curiosity, give animation to the pictures, and confer an ethereal brightness, vivacity, and splendour upon them, which is altogether and peculiarly their own.

* These coloured discs, as well as the designs already prepared on a black ground, may be procured of the publishers, Messrs. Smith, Beck, and Beck.

Descriptions of New Species *of* British Diatomaceæ, *chiefly observed by the late* Professor Gregory. By Robert Kaye Greville, LL.D., F.R.S.E., &c.

Towards the close of the year 1857, my lamented friend, the late Professor Gregory, was engaged in the examination of some Diatomaceous gatherings, the results of various dredgings made by Professor Balfour in Lamlash Bay. He had detected a considerable number of forms which he believed to be undescribed; and with reference to their publication I had completed drawings of a portion of the series, when he was attacked by his last illness. It does not appear that he had reduced any of his observations on these new species to writing; at least, I have not been able to find a single memorandum on the subject. So that, however desirous I may be to secure to the name of my late friend the credit due to his discoveries, I fear that, even with the aid of his collection, which has been most kindly presented to me by his widow, I shall perform this duty very imperfectly. It unfortunately happens that, in some cases, the slides which contained the objects to be drawn were returned to him for description, and I have neither been able to find the original slides (in the absence of any distinctive mark or label), nor additional examples of the forms in question. The present communication consequently does not contain a notice even of all the species of which I had made drawings. The wonderful memory possessed by Professor Gregory rendered *him* independent of temporary notes. The careful study he bestowed upon the forms which came under his eye, fixed every character, however minute, in his mind, and it was not until he had completed his investigations that he sat down to record them. By his death Science has lost a most successful explorer, as well as one of the most patient and indefatigable of microscopic observers.

1. *Cocconeis pinnata*, Greg. MSS.

Valve oval; striæ concentric with the extremities, robust, moniliform, distant, not reaching the median line, but leaving a narrow-elliptical blank space; length ·0014″; striæ 11 in ·001″. (Pl. VI, fig. 1.)

Marine. Lamlash Bay, in the Island of Arran. Dredged by Professor Balfour in 1857.

Among the new forms detected by Professor Gregory in the Lamlash Bay gatherings, were two or three species of *Cocconeis;* and I find that, in his correspondence with our mutual friend, Mr. Norman, of Hull, he referred to two of them under the provisional names of *pinnata* and *crassa.* Of the latter I have as yet discovered no trace; but, with regard to the former, although I have no certain clue to guide me, I think I may safely venture to assume that the form now described is the one so named by him. It is a beautiful little species, well distinguished by the short, strong, moniliform, distant striæ, and by the narrow-elliptical blank space which longitudinally occupies the middle of the valve. I have the drawing of another apparently new and fine species, but the slide containing it was returned, and I have been unable to find it.

2. *Cocconeis arraniensis,* Grev.

Valve oval; striæ concentric with the extremities, slender, faint, moniliform, contiguous, reaching to the median line; length ·0016″; striæ 30 in ·001″. (Fig. 2.)

Marine. Dredged in Lamlash Bay, by Professor Balfour, 1857.

In working through some of Professor Gregory's slides, this minute and inconspicuous form attracted my attention. It appears to be undescribed, and I do not know any species with which it is at all likely to be confounded. Under a moderate power of the microscope it is difficult to distinguish its structure satisfactorily. Compared with other species of the genus, the moniliform striæ are slender and faint; and, in consequence of their being placed close together, the eye is caught as much by the sharp lines caused by the juxtaposition of the striæ, as by the striæ themselves; and it is not until a higher power is used that the structure is cleared up.

3. *Coscinodiscus Normanni,* Greg. MSS.

Areolation forming numerous fasciculi of radiating lines or rows of areolæ, each fasciculus composed of about six rows; areolæ equal, except at the margin, where they become suddenly smaller and faint; margin smooth; diameter of disc ·0016″ to ·0036″; areolæ about 24 in ·001″. (Fig. 3.)

Marine. In the stomach of Ascidians, Hull. George Norman, Esq.

Professor Gregory's attention was first directed to this Diatom by Mr. Norman, who obtained it, as well as many other interesting species, from the stomachs of Ascidians. Believing it to be new, he bestowed upon it the name of its discoverer,—a well-merited compliment. Mr. Norman had also, in 1856, obtained abundant specimens of a Coscinodiscus-like Diatom, by washing the mud which adhered to the roots and stems of *Dutch rushes* imported into Hull from Holland. This last form was doubtfully regarded by competent observers as *Coscinodiscus subtilis* of Ehrenberg; and as the question arose, whether the two forms above referred to were not identical, I have been necessarily led into an examination of the history and characters of *C. subtilis.* The species was first described by Ehrenberg, in his 'Essay on the Microscopical Organisms of South and North America;' and the localities he assigns to it are Peru and Vera Cruz. But of the two figures which he gives (tab. I, iii, fig. 18, and tab. III, vii, fig. 4), the second, that of the Vera Cruz form, is accompanied with a mark of doubt; and it must be confessed that the figures are most unlike each other. Kützing, in his 'Bacillarien,' merely repeats Ehrenberg's stations, and adds another representation, which, again, is too indefinite to be depended on; nor does he afford any additional information in his 'Species Algarum.' The late Professor Bailey, of New York, however, who was in direct communication with Ehrenberg, found in 1850, in various districts in the United States, a *Coscinodiscus,* which he named, without hesitation, *subtilis* of that author. In the earth of the rice fields of Georgia, particularly, he discovered it in vast abundance, and expressed his surprise, that it, and a large proportion of the forms which accompanied it, were such as only inhabit salt or brackish water; indicating the presence of salt water much further up the rivers than it now extends. ('Microscopical Observations made in South Carolina, Georgia, and Florida.')

Lastly, Ehrenberg, in his 'Mikrogeologie' (1854), extends the geographical distribution of the species very considerably, giving the following list of localities, with a figure to illustrate each: Canton, China, tab. XXXIV, vii, fig. 6. Sicily, tab. XXII, fig. 4. Richmond, Virginia, tab. XVIII, fig. 35; and tab. XXXIII, xvi, fig. 7. Assistance Bay, North Pole, tab. XXXV, xxiii, fig. 5. South Pole, tab. XXXV, xxii, fig. 5. California, tab. XXXIII, xiii, fig. 4. It is much to be regretted that none of the above-mentioned illustrations are characteristic; and they appear, besides, to differ very considerably from each other. Nevertheless, we may, I think, assume with some confidence, that the American form is the true *C. subtilis.* If we now compare this with the *Coscinodiscus* discovered by Mr. Norman, in the stomach of Ascidians, we must admit that, at first sight, the two species greatly resemble each other. On closer observation, however, certain differences do constantly present themselves. In both, the most striking character is the beautiful radiation, which Professor Gregory aptly compared to that exhibited in the stars of some orders of knighthood. The lines thus formed by the areolation are grouped into what, in the absence of a better term, may be called *fasciculi,* and they appear to constitute a good discriminative character. In the Hull disc, these fasciculi, as they become well defined in their approach towards the margin, are composed of about six rows of areolæ; in the American disc, on the contrary, the fasciculi contain double the number of rows, and are themselves, consequently, proportionably less numerous. The line of separation between the fasciculi is also more evident, causing the appearance, under a low power, of a slight undulation of the surface, which effect is heightened by the straight oblique rows of the more regular areolæ. If the margin be brought into focus, the superior regularity of the areolation becomes still more apparent in the series of little intersecting arches which spring, as it were, from the inner edge of the border. These differences, not very great perhaps in themselves, yet arising, as they must do, from the structure of the valve, incline me to regard the two forms as distinct.

With regard to the disc found on the "Dutch rushes," I cannot speak with certainty. No doubt the general character of the areolation (including the radiating fasciculi) is very similar to that of *C. Normanni.* But Mr. Norman has pointed out to me the fact (which I have also since observed myself) that frustules in a state of union present, on the front view, a decided undulation, indicating, in this respect, some affinity with *Cyclotella punctata.* Sm. Syn. V, 2, p. 87, a fresh-water species.

In the centre of the disc of *C. Normanni* may be generally perceived a small irregular, interrupted, opaque circle; as if there were either minute prominences of some extraneous matter, or as if some of the areolæ were filled with it. But this appearance is not invariably present. It is most conspicuous under a low magnifying power.

Having found it difficult to convey a correct idea of the structure by means of a figure on the usual scale, I have enlarged the one given in the plate × 800 diameters.

4. *Nitzschia arcuata,* Greg. MSS.

Front view of frustule linear, arcuate, rounded at the ends; side view lanceolate, obtuse; length ·0038″; puncta, about 20 in ·001. (Figs. 4—7.)

Marine. Dredged in Loch Fine, by Professor Gregory, 1856. Lamlash Bay, Professor Balfour, 1857. In a dredging made the same year, off Invercloy, in Brodick Bay, by the Rev. Dr. Miles; Professor Walker-Arnott.

A very characteristic species, not to be confounded with any of the genus already known. It appears to be both local and rare, as it occurs in only two of the numerous Arran gatherings.

5. *Nitzschia macilenta,* Greg. MSS.

Frustule linear, slightly sigmoid, truncated; side view linear, slender, gradually tapering towards the acute extremities, keel with a single row of sub-remote puncta; striæ very obscure; length ·0150″ to ·0190″; breadth ·0004″ to ·0007″; puncta about 8 in ·001″. (Figs. 8, 9.)

Marine. Lamlash Bay, dredged by Professor Balfour, 1857.

A fine species, evidently allied to *N. sigmoidea,* but decidedly less sigmoid. The side view is very narrow. The puncta are separated from each other by irregular intervals, and are fewer than in *N. sigmoidea.* The striæ I have not succeeded in resolving, nor was Professor Gregory more successful. It is undoubtedly a marine species, and tolerably frequent in one of the Lamlash gatherings.

6. *Navicula forcipata,* Grev.

Valve oval or oblong, marked by two continuous longitudinal linear blank spaces, which contract opposite the nodule, and then expand and converge concentrically towards the extremities, where they almost meet; length ·0013″ to ·0030″; striæ 35 in ·001″. (Figs. 10, 11.)

Marine. Glenshira sand, Professor Gregory. Lamlash Bay, dredged by Professor Balfour. Cresswell, Northumberland, Dr. Donkin. Californian guano.

After a very careful examination of this little Diatom, I entirely agree with Professor Gregory in regarding it as undescribed. The examples which fell under his observation were very inferior to those which I have recently obtained, which accounts for his being led to compare the form with *Navicula pygmæa.* The finer specimens show that it is more nearly related to *N. Lyra* and *N. spectabilis,* as will be seen at once by consulting the figures. It must indeed be confessed that large individuals at first sight seem to approach very near to some small varieties of *N. Lyra.* I am, however, satisfied that the two species are really distinct. Perhaps the characters most to be depended on in our new form are —1. The greater number of striæ, about 35 in ·001″; while in *N. Lyra* they are, according to Professor Smith, only 20 in ·001″ (rather under the mark according to my estimate). 2. The invariably converging points of the blank spaces. I may add, in addition, that there is a striking *flatness* in the value of *N. forcipata;* and that the blank spaces are defined by hard, sharp lines of contour, caused apparently by an abrupt depression in the surface of the valve. This is so conspicuous, that, under a moderate magnifying power, the eye dwells rather on the two parallel dark *lines* than on the blank *space* they enclose. The general outline, also, of the valve is not variable, as in *N. Lyra,* being never, as far as I have seen, produced at the ends, but always presenting an uninterrupted symmetrical curve. The Northumberland examples are the finest which have come under my notice; those from the Clyde are, for the most part, much smaller,—many of them even minute,—thus exhibiting a range of size as extensive as in *N. Lyra* and its allies.

7. *Pinnularia semiplena,* Grev.

Valve linear-elliptical, subacute; costæ radiate, distant, very short in the middle, and becoming gradually longer towards the extremities, leaving an elongate, lozenge-shaped, centrical, blank space; length ·0024″; breadth about ·0006″; costæ 15 in ·001″. (Fig. 12.)

Navicula angulosa, var. β. Greg. 'Trans. Mic. Soc.,' v. iv, p. 42, Plate V, fig. 8*.

Marine. Glenshira sand, Professor Gregory. Lamlash Bay, dredged by Professor Balfour.

Having had abundant opportunities of observing this form, especially in my recent examination of many of Professor Gregory's slides, I feel quite convinced that it is distinct from *Navicula angulosa.* I have not seen any approach towards an intermediate state. Indeed, I do not know any species more constant in regard to size and every other character.

8. *Achnanthes gregoriana,* Grev.

Front view of frustule broadly linear; striæ very fine; length ·0060″ to ·0080″; breadth ·0010″ to 0015″. (Figs. 13, 14.)

Marine. Lamlash Bay; dredged by Professor Balfour, 1857.

Although a considerable number of the scattered frustules of this species have occurred both to Professor Gregory and myself, no other view than the one represented in the plate has been observed. In point of size it rivals *A. longipes,* but is widely separated from it in the character of the striation alone, to perceive which, requires not only a good object-glass, but delicate manipulation. As in many of its congeners the frustules vary greatly in both length and breadth. In Canada balsam they become so transparent as to be easily overlooked. *A. gregoriana* must be accounted rare, for among the many dredgings and gatherings which have been made in Lamlash Bay and its immediate neighbourhood, one alone, so far as I know, contains it; nor is it abundant even in that, as seldom more than three or four examples are found to occur in a slide. At the same time, there is every reason to conclude that its habits must be similar to those of the other species, and that a diligent search along the coast might be rewarded by its discovery in a living state—parasitic probably on other Algæ.

9. *Podosira lævis*, Greg. MSS.

Filaments composed of two (?) frustules, which are pale yellowish, transparent, glassy, somewhat compressed at the poles, very delicately and obliquely striated, and remotely and very finely punctate; cingulum firmly siliceous, distinctly striated; diameter of frustule ·0018″ to ·0021″. (Figs. 15, 17.)

Marine. Lamlash Bay; dredged by Professor Balfour, 1857.

This conspicuous, although minute little Diatom, was considered by my late friend, Professor Gregory, as a *Podosira*, and a few specimens, I believe, were distributed by him under the name now adopted. Like *P. Montagnei*, the filaments are probably composed of only two or three frustules; but none of the numerous discs or loose valves which I have examined, exhibit any indication of the absence of silex, or even of imperfect siliceous structure at the apex of the valves. Some doubt may therefore be entertained regarding its true generic position. The structure, when carefully examined under a good objective, is very beautiful, being singularly glassy and brilliant, and most delicately striate and punctate; characters best seen in the dry-mounted slide. In balsam they are not readily perceived. The puncta are equally scattered over the whole frustule, and resemble excessively minute prominent glands. The peculiarly brilliant manner in which the frustules transmit the light renders them conspicuous objects in the field of the microscope. The species appears to be scarce, having been observed, like the preceding one, in a solitary gathering. From three to half a dozen frustules not unfrequently occur in a slide; but very rarely accompanied with the cingulum. In this case, again, we may look forward with some confidence to its being found in a living state, parasitic on some of the smaller sea-weeds.

On the PECULIAR APPENDAGE *of* APPENDICULARIA, *styled* "HAUS" *by* MERTENS. By Prof. ALLMAN, F.R.SS. L. & E.

(Read at the Royal Society of Edinburgh, December 6th, 1858.)

WHILE using the towing-net in the Clyde, near Rothesay, during the last week of April, 1858, I observed among the contents of the net numerous specimens of an *Appendicularia,* which I cannot, without some doubt, refer to any described species, but which I shall not at present venture to name as distinct, for my attention was at the time rather turned to other points in its economy than to the determination of its specific characters.

In no one instance did any of these specimens present traces of the remarkable appendage described by Mertens under the name of "haus,"* an appendage hitherto never witnessed by any naturalist save Mertens himself. The day, however, was bright and the water smooth, and while looking into the sea over the side of the boat, my attention was arrested by some singular bodies swimming at the depth of a few inches below the surface.

With these bodies I was altogether unacquainted, and my efforts were accordingly at once directed to the capturing of some of them. In this I soon succeeded by means of a basin carefully introduced beneath them, and to my great pleasure I found that I had the identical species of *Appendicularia* just taken in the towing-net, but now invested with a most singular and elegant appendage, which was easily recognised as the "haus" described nearly thirty years ago by Mertens as occurring in specimens of *Appendicularia* taken by him in the neighbourhood of Behring's Straits, and never since seen, though thousands of individuals of different species of this genus had fallen under the observation of such able investigators as Müller, Huxley, Leuckart, and Gegenbaur.

There was no difficulty, however, in perceiving how it was

* 'Mém. de l'Acad. Imp. des Sc. de St. Petersbourg,' 1831.

that these naturalists had never got a sight of so remarkable an object, for I soon found that it required the greatest possible care to prevent its detaching itself; and that, even with every precaution, it remained but a very short time after capture in connexion with the body of the *Appendicularia*. The irritation caused by transferring the contents of the basin into a glass jar for more effective examination caused, in most cases, its separation, and it was only in very few instances that I succeeded in bringing home a perfect specimen. Even then I had generally the mortification of seeing the active Appendicularia break away from its "haus" almost immediately after arrival; and when it is further borne in mind that the separation of this appendage is almost instantly followed by its collapse, and by the consequent losing of all its most striking characters, the difficulty attending its examination will be easily conceived.

To transfer the animal in a perfect state into a small trough for investigation under the compound microscope was impossible, and I was therefore obliged to keep it in a large-sized glass jar, and content myself with such observations as a simple hand-lens would enable me to make.

A correct idea of the "haus" of the present species of *Appendicularia* may perhaps be best obtained by imagining a clear gelatinous oviform body, which in full-sized specimens has its greater diameter about five lines in length and its smaller about four (Plate VI). That plane of the greater diameter which passes vertically through the body of the animal will divide the "haus" into a right and a left half, and the common plane of any two lesser diameters will divide it into an anterior and posterior half.

Within the gelatinous mass, and chiefly occupying the anterior half, are two remarkable structures, each shaped like a double fan, whose general form may be best understood by imagining a semicircular membranous lamina to be folded upon itself along a line uniting the middle points of its curved and straight margins. There will thus be formed a double fan, constructed of two single fans, united along one edge, but open along the other two. The two double fans thus constituted are situated symmetrically in the gelatinous mass, to the right and left of its greater diameter, their bases or convex edges being directed towards its surface, and their apices nearly meeting one another at a point in the greater diameter a little in front of the centre, while their axes (a line drawn from the apex to the centre of the base) will lie nearly in the horizontal plane passing through the greater diameter. The closed edge is directed forwards and inwards, the open convex edge or base outwards, and the remaining open edge backwards and inwards.

The convex edge of each fan nearly reaches the surface of the gelatinous mass, to which it then runs almost parallel, extending forwards upon each side to within a short distance of the anterior extremity of the greater diameter, and backwards to a point nearly opposite to the junction of the posterior and middle third of this diameter.

The surface of each of the double fans is marked with numerous regular corrugations, apparently formed by folds of the membrane, which converge from the whole of the convex margin towards the apical angle where they gradually die out.

Towards the convex margin the fans are colourless and transparent, but towards the apex they lose their transparency and assume a light-yellow colour.

About midway between the apices of the fans and the posterior extremity of the greater diameter, and in a vertical plane passing through this diameter, is situated the body of the *Appendicularia*. So far as I could make out it seems to be simply imbedded in the gelatinous mass, having its respiratory aperture directed towards the apex of the fans, while its tail alone is free, and by the constant vibrations of the latter the whole structure is carried about through the surrounding water.

On each side of the spot in which the body of the *Appendicularia* is imbedded the gelatinous investment presents an elliptical superficial patch of a yellowish colour, to which there invariably adhered Naviculæ and other minute bodies.

Beyond the points now described in this most curious appendage I have not succeeded in detecting any other structure; no trace of the vascular network described by Mertens was observed, and we must assuredly deny the respiratory function ascribed to the appendage by its original discoverer. I must also add that I never witnessed its renewal after destruction, which Mertens mentions as occurring within so short an interval as half an hour.

A comparison of the body described in the present communication with that noticed by Mertens will show that, besides the total absence of the vascular network, it differs considerably in detail from the corresponding appendage of the Behring's Straits specimens. In these it is considerably larger than in the specimens from the Clyde, while Mertens describes and figures under the name of "horns" two pairs of folded laminæ, represented in the present species by the single pair of fan-like structures; and the shape of these, in

Mertens' species, differs considerably from that of the fans in the present one. Still there can be no doubt that the "haus" of Mertens is the exact equivalent of the body now described, and the differences seem to be merely traceable to a difference of species.

If I might offer an opinion as to the real import of the "haus," I would suggest the probability of its being a definitely shaped secretion, destined to act as a nidamental covering for the ova. I do not wish, however, that this suggestion should be taken for more than it is worth, for it is chiefly based on the circumstance that it is difficult to offer any other explanation, and on the fact that in one instance I found numerous minute and evidently young, though nearly fully developed, *Appendicularìæ* immersed in the gelatinous mass of the *haus*. Beyond this I shall not venture even a guess at its physiological or morphological significance.*

Dr. Walker-Arnott, *in* Reply *to* Dr. Donkin.

In the last number of the Journal appeared an article purporting to be a reply to me by Dr. Donkin, but which contains, in fact, a repetition of some observations respecting *Ampiphrora Ralfsii*, published by him in the 'Transactions of the Microscopical Society' in January, 1858, p. 33. I allude more particularly to what he erroneously states with regard to the name of *Amphiprora Ralfsii* being mine generically as well as specifically.

It might be sufficient to indicate that I communicated the *specific* name to Mr. Ralfs; that Dr. Donkin's information was not obtained from me, but must have been derived directly or indirectly from Mr. Ralfs; and that every one acquainted with Mr. Ralfs' writings knows that his

* The above account was drawn up immediately after the observations which it records were made. I however delayed its publication under the expectation that I might have an opportunity of obtaining fresh examples which would enable me to supply some of the many deficiencies which exist in it. No such opportunity has since occurred, and I have, therefore, notwithstanding its imperfect form, thought it better to publish it as it is, with the hope that it may be of some use in enabling other naturalists to render more complete our knowledge of a structure which at best is highly enigmatical. Dr. Strethill Wright, of Edinburgh, informs me that during the past autumn he obtained in the Frith of Forth specimens of an Appendicularia invested with its "haus."

sentiments are thus expressed ('British Desmidiaceæ,' Preface, p. vi): "the name appended to a species merely indicates the author of the specific name, and *has no reference* to its *genus*." But as this would hardly be enough, I am compelled, in self-defence, to allude to some antecedents with which the public have otherwise no concern.

Mr. Ralfs, in September, 1857, sent me a slide, prepared in balsam, of what he supposed to be '*Amphiprora didyma*" of Smith. In it I did not detect the F.V., nor could I observe distinctly the carination of the valve characteristic of *Amphiprora;* and, in my reply, I gave my opinion that it was a *Pleurosigma,* and, if so, that it might prove a broad variety of *P. obscurum.* In his next letter (early in October), he says most justly, that "the front view is very unlike a *Pleurosigma,*" and that he was not aware of any *Pleurosigma* having the F.V. constricted, or being as broad or broader than the S.V. In consequence of receiving also from Mr. Ralfs some of the material in a tube, and being thus enabled to study its F.V. as well as S.V., I readily acknowledged the force of Mr. Ralfs' objections to its being a *Pleurosigma.* But while I yielded on that point, I could not consent to its being *A. didyma,* unless Professor Smith or the printer had made a great mistake as to the striæ; and as I understood that Mr. Ralfs was about to publish it as an Amphiprora in the forthcoming edition of Pritchard's 'Infusoria,' I proposed to him to allow me to name the species after himself.

The name of the *species,* therefore, was mine; the *merit* (or, in Dr. Donkin's estimation, the demerit) of its being referred to *Amphiprora* rested with Mr. Ralfs, and on the numerous accurate observations he had made on it when recent and in motion. It was not until December, when preparing my notice on *Rhabdomena* for the Journal of January, 1858, that, having an opportunity, and wishing to obviate the apparent indelicacy of Mr. Ralfs being the first to publish the name *Ralfsii,* I revised the subject with greater care, and drew up a diagnosis sufficiently explicit for all who are conversant with such topics, and so general as to include several forms. Then only could it be said that I was responsible for the genus; but, even then, only in the same way that Smith is responsible for the genus of *Amphiprora alata* or *constricta,* these having been previously referred to that genus by others. Dr. Donkin's remarks appeared in the same number of the Journal, and seem to have been penned before I myself had formed a decided opinion on the point, and at a time when I was *no way* responsible for the generic name. Had he wished to ascertain the facts of the case, he could have applied to me previously, instead of receiving his information second-hand from others, whether by letters, or by slides which I had not examined or named. In my reply to him, at p. 196, I stated my belief that, had he applied to me, the paragraph would not have been written: although he has had ample time since then to obtain from me privately full information, he has preferred repeating the mistake. He now introduces Dr. Montgomery's name; in consequence of which I considered it proper to apply to that gentleman for an explanation. His answer (6th November) is quite satisfactory and explicit: "I am exceedingly sorry that Dr. Donkin has made a mistake about *A. Ralfsii.* In my letter *many months ago, I gave him distinctly to understand that merely* 'Ralfsii' *had been suggested by you.*" It only therefore remains for me to state that Dr. Donkin's attribution of the generic appellation to me was without foundation; and now to *close* this very disagreeable discussion into which I have been forced against my wishes.

On the Calcareous Corpuscles *of the* Trematoda; *and on the* Genus Tetracotyle. By E. Claparède, of Geneva.

(Siebold and Kölliker's 'Zeitsch. f. w. Zool.,' vol. ix, p. 99.)

The calcareous corpuscles of different entozoa have frequently attracted the attention of observers. For a long time regarded as ova, their calcareous constitution was at length recognized, and at present they are universally looked upon as an earthy deposit in the integument. Siebold, for instance, compares them with the calcareous bodies found in the integument of the Holuthuriæ and in the soft parts of many polypes. I have, however, for some time, been aware that these corpuscles, in some Trematoda at any rate, have a certain relation to the excretory apparatus. This observation was first made in April, 1855, in *Diplostomum rachiæum,* Henle, from the spinal canal of the Frog. In this instance, it was obvious at first sight that a minute vessel proceeded from each corpuscle. Closer examination showed that each corpuscle is contained in a capsule fitting pretty closely around it, and whose wall is continuous with that of the tubule. Several of these vessels unite into a single branch, which communicates again with one of the ramifications of the excretory system. This system in *D. rachiæum* is constituted of a slender, gradually enlarging trunk, which runs from behind forwards in the middle line of the body, and is connected, at the anterior extremity of the animal, by a branch on either side, with the lateral trunks. The latter descend nearly parallel with the border and, gradually enlarging, open at the hinder end into the two-pointed contractile vesicle. From each of these three main trunks numerous vibratile vessels are given off; and besides these they are connected with each other by numerous transverse branches; one of which, in particular, may always be remarked passing across immediately in front of the abdominal acetabulum. As is well known, Leydig* has regarded this excretory system as a ramified intestine, considering, on the other hand, the true intestine as a bifurcate excretory apparatus.

Each ramuscule terminates cæcally, becoming expanded into an oviform vesicle, uniformly occupied by a calcareous corpuscle. These bodies, however, are never met with in the

* 'Zeitschrift für Wissensch. Zool.'

main trunks or in the course of the vibrating vessels. Occasionally, individuals may be noticed presenting no corpuscles, which may be owing to the circumstance either that they were never formed, or that they had been discharged. The oviform enlargements of the vessels, however, always exist.

Having made this observation, I had the pleasure of satisfying Johan. Müller, Dr. De la Valette, Professors Weinland and Lachmann of its correctness; and more recently I have had the satisfaction of showing the connexion between the calcareous corpuscles and the excretory system to Professor Virchow.

Dr. De la Valette thinks he has observed minute twigs given off from the oviform sacs, but of this I have been unable to satisfy myself.

In *Diplostomum rachiæum* it is so easy to perceive that the calcareous corpuscles are situated within the excretory system, that it is surprising this relation has not been earlier noticed; but its occurrence in this case having been established, it naturally suggested itself to suppose that a similar condition was not limited to *D. rachiæum*, but would also be found in other Trematoda. The first to be examined were of course other species of *Diplostomum*. *Diplostomum volvens*, and *D. clavatum* from the lens and vitreous humour of several fresh-water fishes, were examined, and afforded the expected results. The excretory system in these two species having been sufficiently described by Nordmann,* it is only necessary to remark in addition, that in them also the vessels terminate in globular dilatations and enclose the corpuscles. In the three species of *Diplostomum* examined, one particular part of the body was found especially adapted for the exhibition of the condition in question—the region, viz., behind the hindermost acetabulum. In this situation the corpuscles are only sparingly distributed, and the connexion between the cavities containing the corpuscles and the vessels is readily seen when the animal is quiescent.

The calcareous corpuscles of the *Diplostomata* are thus in all respects similar to those which are found in the main trunks of the excretory system in many *Cercariæ* and certain *Distomata*. I am unable therefore to agree with M. Moulinié† in viewing the two kinds of corpuscles as distinct from each other. According to this author, the corpuscles which occur, as he thinks, not in the vascular system but in the paren-

* 'Micrograph. Beiträge zur Naturgesch. der Wirbellosen Thiere,' p. 37 *et seq.*

† 'De la reproduction chez les Trématodes endo-parasites.' Genève, 1816, p. 223.

chyma of the animal, would appear to represent the first stage of a process of calcification. They are regarded by him therefore as a pathological product; but I see no reason for looking upon them in any other light than as being altogether normal.

Upon my communicating, a short time since, to Dr. G. Wagener, my observations on the calcareous corpuscles of the *Diplostomata*, he told me that he had been long acquainted with their relation to the excretory system, but that he had not made it known; showing me also some drawings of the appearances he had observed. At the same time he encouraged me to investigate other species. The first subjects which suggested themselves were the immature forms of *Holostoma*, the *Diplostomata* themselves being manifestly nothing more than Holostomatous larvæ. Steenstrup had already pointed out the relationship between the *Holostomata* and the *Diplostomata*, and propounded the view that *Diplostomum clavatum*, *Holostomum cuticola*, and *Diplostomum volvens* are one and the same species, of which the two former would represent the immature, and the latter the mature animal. But this association appears to be the less maintainable since *Diplostomum volvens* is as much an immature form as *Diplostomum clavatum*. Nevertheless, it is indubitable that the mature forms of these various animals must belong to the genus *Holostomum*. Several immature Holostomata are, as is well known, characterised by a network composed of calcareous corpuscles disposed in regular order in the integument, as for instance *Holostomum cuticola*. As the latter species was not at the moment obtainable, I directed my attention in the first instance to some Trematode-cysts from the peritoneum of the Stone-Perch (*Acerina cernua*). The cysts, of an oval form, were about 0·50—0·60 mm. in length, and easily lacerable. The animal contained in them, presented in many respects an unmistakeable resemblance to the Holostomum-type, though differing considerably in several points. The excretory system consisted of two principal trunks running down each side of the body, and opening into a double contractile vesicle, closely resembling that of *Diplostomum volvens*. These lateral trunks were of extraordinary dimensions; so that the internal organs were separated by a wide interspace from the wall of the abdomen; they presented a chambered or moniliform appearance, owing to the circumstance that numerous bands proceeded from the external wall of the body to the internal organs, and served to retain them in their situation. The lateral trunks were filled with minute calcareous particles.

which were kept in continued motion backwards and forwards, and they also gave off branches which went to form a network in the anterior and lateral parts of the body. The calcareous corpuscles were lodged in these branches, and were not unfrequently pushed into the lateral trunks. No ciliary movement could be perceived in the vessels. In this case therefore no doubt can be entertained that the corpuscles are lodged in the excretory system, and that the arrangement is precisely like that which is witnessed in the Holostomata with a plexiform disposition of the calcareous corpuscles; as, for instance, in *Holostomum cuticola.* The calcareous corpuscles exhibited great diversity of aspect. Some were perfectly homogeneous; others presented a distinct concentric structure; whilst others again consisted in reality of several corpuscles united by a common enveloping calcareous layer. There were sometimes noticed in the lateral trunks, cell-like bodies, enclosing calcareous corpuscles and minute particles.

With respect to the chemical composition of the so-termed calcareous corpuscles of the Trematoda and Cestoda we at present possess very insufficient information. In *Echinococcus veterinorum,* Huxley* asserts that they consist at first of an albuminous substance, but that they may afterwards become cretified; a statement which is disputed by Leuckart.† I should not be disposed at once to reject Huxley's view, seeing that the chemical composition of the corpuscles differs in different species, and it is very possible that it may vary according to circumstances in one and the same species. At any rate, the organic substance which serves as a matrix to the inorganic constituent, greatly predominates. The corpuscles in *Diplostomum rachiæum, volvens,* and *clavatum* appear at first sight to be dissolved by caustic potass. This appearance, however, depends simply upon the circumstance that they are rendered transparent by that reagent, the transparency gradually advancing from the periphery towards the centre; the refractive power of the corpuscles is considerably increased, but in other respects they remain as before. This change obviously depends upon the solution of the organic matrix by the potass. The incrusting matter in some animals is always carbonate of lime, as for instance in *Diplostomum rachiæum, Echinococcus veterinorum, Triænophorus nodulosus,* &c.; but in others, as in *Diplostomum volvens* and *clavatum,* I have been unable to detect any carbonate of lime in the corpuscles, which in these cases are dissolved in acids without effervescence. It is possible that in these instances the

* 'Annals and Magazine of Nat. Hist.,' 2d series, vol. xiv, p. 381.

† 'Die Blasenbandwürmer.' Giessen, 1856.

incrusting material is phosphate of lime. The concentrically laminated corpuscles of *Distoma nodulosum* are soluble in acids without effervescence; the solution, on the other hand, being preceded by a swelling up of the substance, so that the presence in them of phosphate of lime can hardly be supposed; the swelling being due solely to the organic basis. It has already been remarked by Küchenmeister, that the so-termed calcareous corpuscles in *Tænia solium,* and *denticulatum, Bothriocephalus latus, punctatus,* and *claviceps,* dissolve in acids without effervescence. From this it is evident how insufficiently the true nature of these corpuscles in the Trematoda and Cestoda has been investigated. It is a point, however, well worthy of investigation, since the accurate knowledge of the chemical conditions of these bodies is calculated to throw a clearer light than we yet possess upon the function of the excretory system.

[M. Claparède's paper, besides his observations upon the "Calcareous corpuscles," contains some upon the relations of the animal found in the Trematode-cysts from the Stone-Perch, and which is regarded by him as belonging to the genus *Tetracotyle* of Filippi—to the Distomata and Cestoid worms. He expresses the opinion, that *Tetracotyle,* like *Diplostomum,* represents a division of an immature Trematode, and that it appears very probable that the corresponding mature forms are to be sought among the Holostomata.]

On the Reproduction *of* Nassula elegans (Ehr.) By Dr. Ferdinand Cohn, of Breslaw.

(Siebold and Kölliker's 'Zeitsch. f. w. Zool.,' vol. ix, p. 143.)

Although the reproduction of the Infusoria by a motile internal progeny (schwärmsprösslinge) is well established in the case of several species, the number of forms in which the production of endogenous embryos has been observed is so limited, that we are not at present justified in expressing a decided opinion as to the universality of this mode of reproduction, and it remains therefore a matter of interest still to collect new facts respecting it. In the course of the last summer I had an opportunity of ascertaining the existence, besides some incompletely observed instances, of a decided, though peculiarly modified case of embryo-formation, in the interesting Infusorium described by Ehrenberg as *Nassula elegans.*

I found this rare animalcule at the same time with *Ophryoglena atra* and *Bursaria truncatella*, lately investigated by Lieberkühn. In form it resembles *Paramecium Aurelia*, though rather narrower, and, like *Paramecium*, it is surrounded with a lattice-marked cuticle, supporting the cilia which are uniformly distributed over the surface. The interior of the animal presents yellowish-brown and violet-coloured pigment-masses, which are sometimes few in number and isolated, and at others aggregated into masses, and so numerous as to fill the entire body. At the posterior part of the animal, near the anal orifice, is situated a large violet-coloured substance, which appears to be rendered of a deeper colour from the presence of innumerable dark-blue granules. And occasionally a similar substance may be observed at the opposite end of the body. Various opinions have been entertained with respect to the nature of these masses. Ehrenberg refers them to a class of bodies, the knowledge of which has suddenly thrown a clear light upon many hitherto obscure and doubtful points; he sees in them, in fact, a special system, destined for the secretion of a violet-coloured juice, visibly subservient to digestion, and therefore of a biliary character. He describes an aggregation of beautiful violet-coloured vesicles on the back of the animal, from which is prolonged a series of violet or clear and colourless vesicles along the dorsal region towards the anus. The mixture of the coloured secretion with the contents of the gastric cells, takes place in the posterior third of the body; and both are expelled at the same time. I am not, myself, as yet quite clear as to the nature of these pigment-masses; though it seems to me scarcely to admit of doubt that they belong to that class of colouring matters met with so extensively in the microscopical Algæ, and more especially in the Oscillarinæ and Nostochineæ, and named by Nägeli *phycochrom.*

The characteristic property of this colouring matter resides in the circumstance, that either in the course of the vital processes, or during the decomposition of the tissues, it undergoes various changes of hue, such as into bright-green, indigo-blue, violet, purple-red, olive-green, and brownish-yellow. Among the *Oscillatoriæ* we meet with species exhibiting all these modifications of the phycochrom. It is a peculiarity also of this material, that in the living plant it exists apparently in a solid form (mixed with the protoplasm), but that during the slow decomposition of the tissues it is gradually dissolved in the water, to which it communicates a blue colour. Whence it happens that the water in which *Oscillatoriæ* decay assumes a violet or blue colour, and the paper upon which specimens of these plants have been dried, exhibits a deep-blue border. The same colouring principle occurs, beyond doubt, in all the Infusoria which are distinguished by their variegated colours, changing from blue to bright green and yellow, as in the odontophorous genera *Nassula, Chilodon, Prorodon,* and *Chlamydodon.* The only doubt which can arise with respect to the occurrence of phycochrom in these animals, is, whether it reaches their interior simply as the result of the digestion and assimilation of the Oscillatoriæ, which notoriously constitute the principal aliment of these genera, and fragments of which may usually be noticed in the cavity of the body, or whether, like the chlorophyll-vesicles of *Loxodes bursaria, Spirostomum,* or *Vorticella viridis,* &c., it is not formed, in part at least, within the animal, as a peculiar pigment. At present, I regard the former supposition as the more probable. However this may be, the masses of phycochrom are, after a time, removed, collecting themselves, in *Nassula elegans,* previous to their ejection, into large masses close to the anal region; constituting in fact the violet-coloured masses composed of numerous blue globules, noticed above as being contained in the posterior part of the animal. That the blue globules are only drops of fluid phycochrom, is evident from the circumstance that when a *Nassula* is allowed to liquefy, the globules suddenly coalesce into a blue fluid, which immediately afterwards loses its colour. It is manifest that in this case the water penetrates from without into the interior of the animal, and that in this water the droplets of phycochrom are immediately dissolved. The ejection of the globules of phycochrom through the anus and their sudden decoloration in the water has already been figured and described by Ehrenberg. I can see no reason for assigning to these blue masses any function of a special kind in the nutritive system. Nor on the other hand do I agree with Stein in regarding them as fragments of *Oscillatoriæ,* considering rather that they represent fluid particles of phycochrom extracted from the *Oscillatoriæ* which have been devoured, and are in process of digestion. Their assemblage on the back of the animal does not seem to me to be a constant occurrence.

Other points of interest in the organization of *Nassula elegans* are: the reel-like, funnel-shaped *dental apparatus* long since accurately described by Ehrenberg, and in which that observer counted twenty-six teeth; and the *nucleus* contained in the interior of the body. This *nucleus* is of an elliptical shape, is 1-40''' in length, and has a groove at one end, in which is lodged a minute *nucleolus*. The entire mass is surrounded by a closely fitting vesicle, and in structure corresponds very exactly with the *nucleus* formerly described by me in *Loxodes bursaria*.

Three contractile vacuoles are described by Ehrenberg in *Nassula elegans*, two of which are said to be situated near the oral orifice, and the third upon the "central gland" or nucleus. I have, myself, only noticed two corresponding to the first and second thirds of the animal; the occurrence of a rosette-form in these vacuoles, as stated by Stein, to take place in *Nassula ambigua*, I have not perceived.

In the spring of the past year I met with several specimens of *Nassula elegans*, in whose interior might be observed a large central cavity of an elliptical form and sharply defined from the rest of the contents of the body. At the point where the cavity most nearly approached the external wall, the body of the animal presented a flask-shaped depression, and an elongated fissure, bounded by parallel walls, leading from within to without. In the interior of the cavity I observed one or two large spherical bodies 0·001''' in diameter, but never more than two. These spherical bodies slowly entered the fissure through which the cavity communicated with the outer world, and in this way escaped into the water. Having thus escaped, the spherules appeared motionless and colourless, having a granular texture with a central nucleus and an excentric contractile vacuole. It is a remarkable circumstance, that in these spherical bodies I observed no trace of the ciliary covering by which the movements of the embryos of *Loxodes bursaria* are effected; on the other hand, however, the short, radiating capitate filaments figured by Stein and myself in Loxodes, were visible. No doubt, therefore, can exist as to the morphological correspondence of the Nassula-spherules with the "swarm-offspring" of *Loxodes*, notwithstanding the absence in the former of any motion which might possibly be owing to the circumstance of their having been prematurely born into the cold. I have unfortunately neglected to ascertain whether the spherules in *Nassula* have any relation to the nucleus, as asserted by Stein in other cases. The formation of the reproductive spherules might even be observed in individuals which, having but just undergone division, had not attained to half their normal size. It is to be remarked that Stein has also observed the development of endogenous embryos in *Chilodon cucullulus*, a near ally of *Nassula;* in this case, however, the embryos were developed in the *encysted* animals, made their way through the cyst in escaping, and moved with the aid of long cilia; resembling the *Cyclidium glaucoma* of Ehrenberg.

At the thirty-second meeting of German naturalists at Vienna, Stein presented a series of remarkable observations on the Acineta-formation from the swarm-offspring of *Loxodes bursaria, Stylonychia mytilus, Urostyla grandis,* and *Bursaria truncatella* ('Tageblatt de Versamml.' No. 3, p. 53). Without any desire of forestalling Stein's more exact exposition, I cannot avoid remarking that the reproductive spherules of *Nassula elegans,* in their tentacular processes, do, in fact, present an Acineta-like character, and the more so that they are also deficient in vibratile cilia.

In his interesting memoir on the process of Encysting in the Infusoria, Cienkowsky (S. and K. 'Zeitsch.' Band vi, p. 301) has given us the developmental history of a nearly allied species of *Nassula,* which he had previously termed *N. viridis,* Duj. He and Stein have both observed the process of encysting in this species, and Cienkowsky states that after some time the body of the encysted Infusorium breaks up into numerous sharply defined cells, neck-like prolongations from which perforate the wall of the cyst; the contents of each cell then divide into a great number of monadiform corpuscles (*microgonidia*), which escape through the neck-like prolongation, and disperse themselves into water. Should these observations, which fully correspond with those of Stein on *Vorticella microstoma,* (Stein, "Infusor." tab. iv, fig. 53—56, p. 194), really indicate a mode of reproduction in *Nassula,* that Infusorium would appear, besides transverse scission, to possess two wholly different kinds of reproductive bodies, whose further development, however, it must be confessed, is quite unknown.

It is very remarkable how closely the microgonidia observed by Cienkowsky and Stein in the cysts of *Vorticella* and *Nassula,* together with their flask-shaped parent-cells, resemble the parasitic *Chytridia* met with in the interior of many plants. These are microscopic, unicellular fungi whose "swarm-spores" penetrate the wall of a *Conferva-Spirogyra-,* or *Achlya*-cell or of a *Closterium,* and afterwards expand in the interior of these plants into spherical vesicles, which subsequently throw out neck-like processes, with whose aid they break through the organism in which they are nourished, whilst the contents of the fungus are transformed into innumerable swarm-spores, which are discharged through the neck-like process. The history of the development of these parasites has been cleared up in the course of last year, (1856), by the observations of A. Braun, Pringsheim, Naegeli, Klos, and Cienkowsky. And on this subject should be consulted the memoirs of Braun on *Chytridium* in the 'Reports and Memoirs of the Berlin Academy' for 1856, and of Cienkowsky on *Rhizidium Confervæ glomeratæ* contained in the 'Botanische Zeitung' for 1857.

REVIEWS.

Zur kenntniss des generationswechsels und der Parthenogenesis bei den Insecten. Von Rud. Leuckart. Mit 1 Tafel.

(From Moleschott's 'Untersuchungen zur Naturlehre des Menschen und der Thiere,' 1858.)

The author commences with some general remarks on the bibliography and history of the subject,* and proceeds to describe the ovaries of the oviparous and viviparous Aphides. His observations on these insects, though not carried so far, agree very closely with those previously made by Professor Huxley.

In the Coccidæ, Leuckart has examined species belonging to the genera *Coccus, Lecanium,* and *Aspidiotus.* As to the general form of the female generative organs in *L. hesperidum,* he confirms the observations of Professor Leydig. The type of egg-formation in this species much resembles that found in Aphis, and the egg is truly agamic.

Prof. Leuckart differs in many respects from the observations made by Professor Leydig. He states that the germinal vesicle, though easy to be overlooked, is really present; that the vitellogenous cells take no part in the formation of the embryo; and that the ovarian product is a true egg, which, however, when laid, contains an almost mature embryo, which is very soon hatched. In *C. adonidum* the embryo is less developed at the time when the egg is laid.

Prof. Leuckart concludes with some general remarks on agamic reproduction, and proposes to restrict the term 'Parthenogenesis' to those cases where the egg, which is capable of spontaneous development, is also susceptible of impregnation.

It is impossible, without exceeding our limits, to do more than glance at the interesting and valuable observations contained in this paper, the excellence of which will be fully appreciated by those who have made this branch of science their peculiar study, and which will fully sustain the reputation of its author.

* In referring to the Daphniæ he uses the term "agamic eggs," as synonymous with the so-called "winter eggs." Mr. Lubbock, however, has shown that while the common sort of egg is in Daphnia certainly agamic, the winter- or ephippial-eggs require impregnation.

As far as concerns the Hive Bee, Prof. Leuckart confirms generally the extraordinary facts related by Professor v. Siebold. He examined several queen-bees which only produced drone-eggs, and found generally that they were either virgins, or that the supply of semen was exhausted. One or two specimens, however, still contained spermatozoa, but they were rolled together in a compact mass, so that apparently the compression of the spermatheca did not eject any of them. Küchenmeister has endeavoured to show that the impregnation or non-impregnation of any egg depends on the relative position of the spermatheca and oviduct, at the time when the egg is passing through the latter, and in fact that the semen flows out of the spermatheca, as water out of a flask. In this manner Küchenmeister thinks that by the form of the cell alone he can explain the impregnation or non-impregnation of the egg. Thus when the queen inserts her abdomen into the narrow cell of a worker, the pressure of the cell-walls alters the position of the spermatheca, some of the semen escapes from it, and the egg is impregnated. In laying an egg in a drone-cell on the contrary, no pressure is exerted on the abdomen of the bee, and consequently the egg remains unimpregnated.

If this were so, however, the number of queen-bees which only produce drones would be much larger than it is, since there are many which could insert their abdomen into a worker's cell without undergoing any pressure. Moreover, the spermatheca is so deeply seated, and so much protected by the other organs, that very considerable pressure would be required. Finally, the spermatheca is bound down in its place by numerous tracheæ, so that it cannot alter its position unless these are torn.

M. Kuchenmeister was led to adopt this opinion from an indisposition to admit that the queen-bee had the power of determining the sex of her offspring, and of deciding whether each egg should be impregnated or not. M. Leuckart, however, seeks for an explanation of the facts in a reflex action of the muscles, produced by the influence of external circumstances, rather than from any exercise of the will.

He is inclined to attribute the fertility of certain working bees to the nature of their food. In support of this theory he mentions an experiment made by Dr. Dondoff, who fed certain workers on eggs in honey. M. Leuckart dissected eighteen of these bees, and found swollen ovaries in four of them. None contained completely developed eggs, but this was supposed to be from the short space of time during which this food had been continued.

Fertile workers are far more numerous in the Ants, Wasps, and Humble Bees; so much so that one can scarcely examine a dozen specimens without finding several in this condition. Indeed, in one nest of *V. germanica*, about half the workers were fertile. They appear also to be more numerous in autumn than in summer.

As in the bee, so also in the ants, the ovary of the fertile workers has much fewer egg-tubes than that of the queen; in the humble bees, on the contrary, there is no such difference. The author, however, never met with a worker wasp or humble bee which had been impregnated.

Huber long ago observed that in the Humble Bees the eggs laid by workers always produced males. M. Leuckart has convinced himself that the eggs of worker wasps are fertile, and Gundelach ('Nachtrag zur Naturgesch. der Honigbiene,' § 2) has observed the same in the Hornet, but in these two cases the sex of the offspring was undetermined.

In the small moths belonging to the genera *Psyche* and *Solenobia* there seems no doubt that parthenogenesis frequently occurs; and, indeed, the male of *Psyche helix* is not yet known. As, however, in the Aphides and Coccidæ, so also in this group, many differences of habit occur in different species; thus in *S. triquetella* parthenogenesis appears to occur much less frequently than in *S. lichenella.*

The generative organs of these little moths are formed on the same type as those of other female Lepidoptera, and even possess a spermatheca. Neither is there anything in the mode of formation or structure, of the eggs to indicate their agamic nature. Not only do they possess a germinal vesicle and vitellogenous cells, but they are also provided with a micropyle consisting of sixteen to eighteen radiating canals, and are therefore probably capable of impregnation, like the pseud-ova of bees.

On the Recent Foraminifera of Great Britain. By William Crauford Williamson, F.R.S. London: Ray Society.

The publication of Professor Williamson's work is a triumph for the microscope that we must not pass over without notice. This beautiful volume, which has been published by the Ray Society presents for the first time, to the British naturalist a full account of the living Foraminifera found on our coasts. It embraces a very accurate description of each species, with a delineation by Tuffen West. The only complaint we could possibly make about the book is that the Ray Society has chosen to publish it in a quarto form, when it would have been so much more convenient as an octavo, or even duodecimo. In these days of locomotion, when we pack our microscopes into the smallest possible space, we also want our books small, if they are to travel with us. It was all very well for our forefathers to publish quartos and folios, for they had leisure to admire the grandeur of their tomes; but we have the greatest difficulty in keeping up with our day, and everything that spares time must be accepted as a boon.

Mr. Williamson has given an interesting history of the discovery of the Foraminifera. From this we learn that Hooke, the father of microscopical science, was the first to describe a species of this family. In his "Micrographia" there is figured apparently a *Rotalia*, which had been found in some sea sand. This was in 1665. There it remained in solitary grandeur, the only representative of this extensive family, for upwards of a century. About this time, Mr. Boys published his "Testacea minuta rariora," in which he gave drawings of twenty-two supposed species. it was not, however, till Montague published his "Testacea Britannica," in 1803, that the Foraminifera began to receive that attention which their varied forms and curious nature claimed. Still the group remained chaotic and misunderstood, until D'Orbigny, in 1826, attempted to reduce it to something like order; who, however, committed the great error of referring these simple creatures to the group of Cephalopodous Mollusks. In 1835, Dujardin showed the absurdity of this classification, and placed the Foraminifera in his order Rhizopoda. The labours of Professor Williamson himself and of Dr. Carpenter, and particularly of Schultze, have more recently added much to our knowledge of them. Their position is no longer a matter of doubt, and they are placed by the zoologist amongst the lowest groups of the animal series.

The Introduction contains much matter of interest that we might present to our readers, but we must content ourselves with one extract on the method of collecting the Foraminifera:

"*Localities and Modes of Collection.*—A pocket-lens of moderate power usually enables us to discover Foraminifera in *shelly* sand from any part of our coasts, but these are usually worn and imperfect specimens. The common sand of our beaches is rarely productive in any degree. The home of these objects is in the deeper parts of the ocean, commencing with the Coralline zone of Forbes, where there is always a few fathoms of water, though a few occur in the shallower Laminarian zone, especially towards its outer border. In the latter instance they are to be found amongst the interlacing roots of the Laminariæ, and especially amongst the tufts of corallines with which those roots are so frequently surrounded. How far their habitat extends into deeper water we have as yet no means of determining, since it is difficult to say whether the shells brought up from such vast depths in the middle of the Atlantic* were living or dead at the time they were collected. The same remark applies to the majority of the specimens that have been forwarded to me by my dredging friends. I have found such numerous examples of corallines with the sessile Foraminifera abounding upon them as clearly prove that they both lived on the same ground. The Foraminifera do not appear to affect districts where the ocean bed consists of gravel or coarse clean sand, but prefer localities where there is much fine-grained oozy sediment. This especially applies to the more delicate, minuter varieties.

"The method of obtaining specimens must vary according to the object in view; if the collector merely seeks dried shells for his cabinet, indifferent whether living or dead, the process of floating them is by far the most productive. A few pints of the sand must be collected from beneath, at least, two or three fathoms depth of water, and thoroughly dried; it should then be passed through a coarse conchologist's-sieve, or through a piece of coarse net, so as to eliminate all the rough material. The finer portions passed through the sieve must be poured into a bowl containing cold water, and well stirred up, so that the whole may become saturated. On being allowed to stand a few moments the more delicate of the concamerated shells, rendered buoyant by the air contained within their chambers, readily float to the surface, whilst the sand and mud settle to the bottom.† A little manipulation enables the collector to blow off this scum, so rich in treasures, into an empty vessel, and the addition of fresh water further cleanses the objects from impurity; the *creaming* of the bowl being repeated so long as any sediment or impurity remains. The water may now be drawn off by means of a syphon, and the objects dried, when they are easily collected for examination. I have found it desirable to carry the process a stage further before drying the shells, in order to obtain the cleanest specimens: sweeping them off the moist sides of the bowl by means of the forefinger, I transfer them to a small evaporating dish containing a solution of caustic potass,‡ in which I allow them to boil over a spirit-lamp for some moments, thus dissolving the organic matter and leaving the calcareous shells free from impurity. The moment the lamp is removed the shells settle to the bottom of the vessel, since the fluid has filled all the chambers of each shell, displacing the air. The solution must now be poured off, and the shelly residue be well washed in clean water; otherwise drying will leave an efflorescence of alkaline matter on the specimens, marring their beauty. After washing they may be dried, when they are ready for examination.

"The advantage of the process here recommended lies in the facility with which very unproductive sands are made to yield their tribute of specimens. I have often obtained but a few hundreds of shells from several pints of sand. It is obvious that the examination of such large quantities of ma-

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* See Dr. Bailey's Memoir in the 'Smithsonian Contributions,' vol. ii, 1851.

† Care must be taken at this stage to break up the air-bubbles floating on the surface, since these buoy up numerous inorganic particles which require to be precipitated.

‡ The Liq. Potassæ, P.L., is a convenient form for this purpose.

terial under the microscope would involve a labour which the results would not repay; but the above operation effects the purpose in a few minutes. At the same time it is only the smaller and more delicate objects that can be thus collected. The larger and heavier ones sink to the bottom of the water along with the refuse sediment: by placing the *wet* sand on a flat plate or dish, and gently shaking it, the shells rise to its surface, where they are readily discovered by means of a pocket-lens. The superfluous water should first be drawn off, with as little disturbance as possible, and the sand dried, otherwise the glistening moisture interferes with the search.

"When specimens are wanted in a living state an entirely different process must be adopted. On parts of the coast where the sand is coarse and gravelly there is nothing for it but dredging up the smaller corallines and seaweeds, and picking out the specimens one by one; but where the sea-bottom is muddy and fine-grained the process applied by Mr. Warrington to the oyster-ooze of Feversham is the best. It is just the reverse of the floating process just recommended, since the chambers of the shells are occupied with animal sarcode; consequently they cannot be rendered buoyant. The mud is put into a vessel containing water and well stirred up. The fine inorganic particles are floated off, whilst the shells, from their greater density and larger size, sink to the bottom; a repetition of the washings leaves them perfectly clean." (Pp. xii, xiii.)

We cannot close our notice of this book without recommending the Ray Society and its publications to our readers. This Society has been the means of giving to the public some of the most important works on natural history that have been published during the present century. Its labours are only limited by its want of funds; and we hope that, if it be only for the sake of encouraging the publication of such valuable works as this, that our microscopic friends will be induced to join its ranks. The present work is to be followed by one from Dr. Carpenter, on the physiology and general history and arrangement of the Foraminifera.

We may also add that Dr. Bowerbank is now engaged in the preparation of a work on the British Sponges, to be published by the same Society; and that little will then be left to complete the history of the British Protozoa.

A Descriptive Catalogue of the most instructive and beautiful objects for the Microscope. By L. Lane Clarke. London: Routledge.

The idea of this book is a good one; and, on the whole, it is very well carried out. It is, as the title-page indicates, a description of microscopic objects. It supposes the reader possessed of a microscope, and that he has access to microscopic objects by purchase or preparation. These objects are arranged in something like a systematic manner, beginning with general "objects from the vegetable kingdom." Then follows "sections of wood" and "infusorial earths." After these come objects from the animal kingdom, in which the author commences with spiders, and goes through groups of insects capable of affording interesting matter for the microscope, and leaves off with the "spicules of sponges." "Slides of crystallization" finish the work. The remarks under these different heads might have been shorter, with advantage. The author has rather a tendency to write, which is a damaging propensity where conciseness is of value. Nevertheless, we think it will be found a useful book.

A very short chapter "On the Use of the Microscope," introduces this instrument to the reader, and as the author has here fallen into an error we must correct it. He recommends to the reader "the Society of Arts Microscopes," and says—

"They are made by Mr. Baker, 244, High Holborn, and only cost £3 3*s.*, complete in a neat mahogany cabinet. They are excellent working instruments, and, for their utility and cheapness combined, were awarded a prize medal by the Society from which they derive their name" (page 2).

Now we think most people would gather from this that Mr. Baker gained the prize of the Society of Arts for his microscopes, and they will perhaps be astonished when we tell them he did not do so. The microscope to which the Society of Arts gave their prize medal was one manufactured by Mr. Field, of Birmingham, to whom the public is indebted for this cheap and efficient instrument. We know that Mr. Baker may reply that his microscopes are of the same pattern as the one which obtained the Society of Arts' prize, but we hardly think that this justifies him and his friends in speaking of any instrument he makes as the "Society of Arts Microscope," much less in claiming for him the award of a medal which was given to another microscope-maker. We do not say this to depreciate Mr. Baker's microscopes, —for aught we know they may be better than Mr. Field's,— but we think that the public ought, in fairness, to know who is really the inventor and original maker of the "Society of Arts Microscopes."

On the Mode of Formation of Shells of Animals, of Bone, and of several other Structures, by a process of Molecular Coalescence, demonstrable in certain artificially formed products. By GEORGE RAINEY, M.R.C.S. London: John Churchill.

MOST of our readers will recollect a paper read by Mr. Rainey before the Microscopical Society, and which appeared in the 'Transactions,' on the subject of this work. In that paper Mr. Rainey pointed out the remarkable fact that many of the appearances presented by the hard structures of animals, and which had been usually referred to cell-development, were really produced by the physical laws which govern the aggregation of certain salts when exposed to the action of vegetable and animal substances in a state of solution. The paper to which we allude succeeded one which he had previously published in the 'British and Foreign Medico-Chirurgical Review,' and the present work consists of the observations contained in these two papers, with much new matter, both physical and anatomical. We need not repeat or discuss here Mr. Rainey's views, but we give an extract from his Preface:

"What in this treatise I consider to have entirely originated with myself, are—First, a process by which carbonate of lime can be made to assume a globular form, and the explanation of the nature of the process, 'molecular coalescence,' by which that form is produced. Secondly, the explanation of the probable cause of crystallization, and the manner in which the rectilinear form of crystals is effected. Thirdly, the discovery of a process of 'molecular disintegration' of the globules of carbonate of lime by inverting the mechanical conditions upon which their previous globular form had depended. Fourthly, the recognition, in animal tissues, of forms of earthy matter analogous to those produced artificially. And fifthly, the deduction from the above fact, and considerations of the dependence of the rounded forms of organized bodies on physical and not on vital agencies. Being anxious to present the results of my experiments and observations to the public in as demonstrable a form as possible, I have, for the convenience of those who wish to repeat and to extend them, given in detail all my processes and formulæ; and in the Physiological Section of this work I have indicated the animals and parts best fitted for displaying the facts here described, with the best way of preparing them for microscopical examination. And in conclusion I may add, that I shall be glad to show, to such as are interested in the subject, those preparations in my possession which have been frequently referred to in the body of this work." (Pp. vi, vii.)

The importance and interest of this subject can hardly be over-rated. Mr. Rainey's conclusions are directly opposed to the views of many of our most distinguished histologists, and they demand further investigation. The subject is one with which the microscopic observer alone can deal, and we shall be glad to find it exciting the attention of our contributors.

The Microscope in its application to Clinical Medicine. By LIONEL BEALE, M.B. Second edition. London: John Churchill.

ON the appearance of the first edition of this work (vol. ii, p. 267) we gave it our highest commendation; and the fact of its having so soon reached a second edition shows that our high estimation of its value was correct. Short, however, as has been the time since the publication of the first edition, it has been one of great advancement in the direction of microscopical research. Hasty generalizations have been corrected, incorrect observations have been exposed, increased facilities for investigation, by the improvement of the microscope, have been introduced, new methods of research have been employed, and a large addition has been made to our knowledge of minute structure, during the last four years. For many of these results we are not a little indebted to Dr. Beale's book, and to the unwearied industry and singleness of purpose with which Dr. Beale has worked with the microscope. When we see how much work Dr. Beale has done the last four years, and recollect that during that time he has performed the duties of Physician to King's College Hospital, and Professor of Physiology in the College, we cannot but marvel at the extent of his labours, and hope that he is not taxing his physical powers to an extent which he or his friends may have occasion to lament.

This second edition has been everywhere improved and brought up to the time. Many new observations of importance, and much matter entirely new are added. Many new woodcuts are given. We must also offer our thanks to Dr. Beale for another improvement, and that is, a copious quotation of authorities. This is done not only in the text, but at the end of every chapter there is a list of the works to which either the author is indebted for his information, or which the student may consult for a more complete knowledge of the subject.

The whole work has been re-cast, the arrangement is new, the type is larger, and the volume bigger than the last. We can only repeat what we said of the first edition, with greater emphasis, that "we should be glad to see a copy in the hands of every medical student and every medical practitioner in the kingdom."

The Aquarian Naturalist; a Manual for the Sea-side. By THOMAS RYMER JONES. London: Van Voorst.

HAVING been indebted to the politeness of the publisher for a copy of this elegant drawing-room volume, we have pleasure in directing the attention of those for whose benefit it is intended to its numerous attractions, though unable to perceive that the Author has made much use of the microscope in any researches which can be regarded as novel in it.

From anything contained in the volume we should be inclined to suppose that the greater part of the more recent results of microscopic research has remained unknown or unnoticed by Professor R. Jones. We regret, also, to have to remark a general absence of that due acknowledgment of the source whence much of his matter and many of his illustrations are drawn, which should always be made even in a popular work. Sir J. G. Dalzell's name, though occasionally noticed, certainly does not occur so frequently as it ought, nor, as it seems to us, have his figures been much improved in their transference to Professor Jones's pages, effected, though it has been, by the usually very skilful hand of Tuffen West.

It is "splitting straws" to cavil about the title of a professedly popular work like the present; but we may, at least, be allowed to remark, that even Professor Jones is paying his "lady friends" a poor compliment, in supposing that they will not be sufficiently alive to the fact, that the 'Aquarian Naturalist' does not contain what might at least be expected in it, some instructions as to the proper way of treating the inhabitants of a marine Aquarium; and that his book, in fact, contains merely a series of remarks upon certain creatures selected apparently at random among the numerous tribes which inhabit the ocean; some of which are more or less fitted to become the pets of an Aquarium, whilst others are wholly incapable of such domestication. But those who covet only an amusing book, prettily illustrated, on sea-side animals, will find this volume to their taste. Professor Jones is a charming writer, and few men have a greater gift of conveying information in a clearer or more graceful style.

Manual of Technical Analysis, a guide for the testing and valuation of the various natural and artificial substances employed in the Arts and Domestic Economy, founded upon the 'Handbuch' of Dr. P. A. Bolley. By BENJAMIN PAUL, Ph.D. London: Bohn.

IN the examination of the structure and composition of the various natural substances used by man in the Arts and Domestic Economy, it is frequently necessary to use more than one instrument of investigation. Where chemical analysis fails the microscope succeeds, and where the microscope is valueless the chemical reagents will frequently establish facts of the first importance. It not uncommonly happens that these two means of investigation are necessary to arrive at correct conclusions. Substances which cannot be obtained in sufficient quantities to be analysed with the naked eye may be chemically manipulated with the greatest success under the microscope. It is on this ground that the microscope and chemical experiment frequently meet, and the investigator of nature and the man of business must appeal to both.

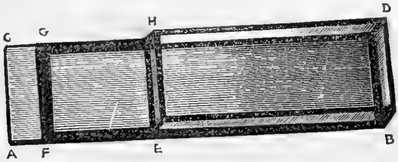
This volume deals principally with the application of chemistry to the testing of natural substances, but in doubtful cases the aid of the microscope is called in. Thus, in giving directions for the examination of milk, starch, vegetable and animal fibres, the results of microscopic research are presented. It is not, however, from this side of the question that the principal facts of the book are presented, but from the chemical side; and we call the attention of our readers to it, as a volume full of information on facts which they will find of great service in those researches with the microscope which have an immediately practical end in view.

NOTES AND CORRESPONDENCE.

Description of a Trough for exhibiting the Circulation of the Blood in a Fish's Tail.—During the meeting of the British Association in Leeds last September there was an exhibition of microscopes and microscopic objects at one of the *soirées*, when I showed the circulation of the blood in the tail of a small gold fish, using for that purpose a trough invented and made by Mr. T. Walker, a surgeon of this town.

The trough appeared at the time to excite some attention from its convenience and efficiency, and as I have since received several applications on the subject, I am induced to think that a description of it may be of service to some of the readers of the Journal.

As a proof of its efficiency, I may mention, that only one fish was used during the evening, and that, although it was kept for more than three hours under observation, it sustained no injury, and is still living. The trough consists of a piece of plate glass (A B C D), about six inches long, and two inches wide; upon this three pieces of plate glass, about half an inch wide (E B, B D), and D H, are cemented



with marine glue. Three pieces of strong covering glass, about a quarter of an inch wide (E F, F G), and G H, are also cemented on to the plate. A piece of moderately strong covering glass (E, F, G, H,) is then cemented on to the top of the thin slips, and a piece of plate glass (E H) cemented to the top of the thin glass(E F G H), and abutting on the ends of the slips E B, H D.

The whole then forms an open trough (E B H D), terminating in a cell (E F G H), which is closed everywhere except where it communicates with the bottom of the trough at the line E H.

The fish, wrapped in a little wet linen, is placed in the trough, so that the tail lies in the cell E F G H, a small quantity of water is placed in the trough, and the fish kept in its place by one or two elastic bands or strips of thin sheet lead passing round the glass, and over the body of the fish.

The advantages of this arrangement are—

1st. The fish cannot throw up his tail and splash the object-glass with water.

2d. In consequence of the tail being kept flat in the cell the view is very good, and there is little risk of the object getting out of focus.

3d. If the tail is not pushed too far into the cell the vessels at its root are not compressed, and the circulation goes on very freely.

4th. The fish may be kept on the stage of the microscope for two or three hours without injury.

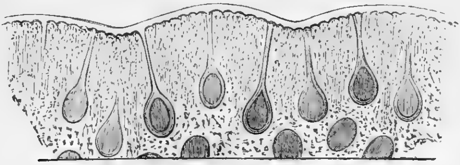
Mr. Macaulay, a philosophical instrument-maker in Leeds, has suggested, as an improvement, that the three sides E B, B D, and D H, should be made of a single slip of plate glass bent to the shape required.—W. R. Milner, Wakefield.

On a mode of Illumination for High Powers.—Making pretty frequent use of a one-quarter-inch objective by artificial illumination, I found it a point of some importance, to be able to get rid of the glaring fog, which often occurs, in a ready and expeditious manner. The ground-glass screen for use with the lower powers seemed to me to be the readiest cure for the evil complained of; but, as usually mounted beneath the stage of the microscope, it is inapplicable in the case of the higher powers, from its diminishing the light too much; and the only plan seemed to be to place it immediately under the glass slip carrying the object. I accordingly ground, with fine emery and water, the surface of a polished slip of glass 3×1 inches, and placed it on the stage of the instrument, throwing a moderately strong light up from the mirror in the usual way. I then tested the arrangement with several mounted slides of objects calculated to try its efficiency, and I am glad to say that it succeeded perfectly. Besides the freedom from glare, and the rendering of the light very pleasant to work by, the thorough dispersion of the rays imparts a very valuable property to this method of illumination, which is at once apparent in the manner in which it shows objects of high refractive power. The sheathing scales on hair and wool, for instance, are brought out remarkably well; the discoid Diatoms in guano, sponge-spiculæ, starch-granules, spiral and scalariform tissue, the cell-contents in Algæ, are also shown very well. The action of the roughened glass is similar to that of the paraboloid, but not to the same degree. The screens are prepared in a few minutes, by rubbing two glass slips together with emery powder and water between them. It is well to have two screens, one finely, and the other more roughly ground, so as to vary the effect according to the subject under examination. The instrument used is one of Smith and Beck's largest size; the objective by Ross.—JOHN KEATES, Liverpool.

Notes on the Calcareous Corpuscles of Tricuspidaria.—By T. SPENCER COBBOLD, M.D., F.L.S., Lecturer on Botany, St. Mary's Hospital, London.

The clear manner in which Claparède appears to have demonstrated a relation subsisting between the calcareous corpuscles and the excretory system of vessels in the *Trematoda,* induces me to call attention to these bodies in the *Cestoda,* and especially in *Tricuspidaria nodulosa.* It would seem that Dr. Guido Wagener had long ago discerned this connexion in the Flukes; but as he had not published his views on that point, it is to the former observer that we are mainly indebted for this interesting discovery.

In the Cestode *Tricuspidaria*—often synonymised *Triænophorus nodulosus*—narrow vessels may be easily recognised, passing off continuously from the membranous capsules investing the sclerous corpuscles; these vascular prolongations, however, instead of forming inosculations, as in Trematodes, are single, and have their very limited course directed outwards towards the clear structureless epidermis. It is highly probable that they open at the surface, but I have never been able to detect the slightest indication of such an aperture.

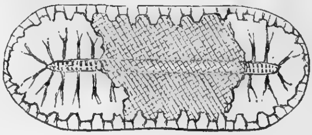


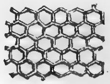
Portion from the margin of the head of *Tricuspidaria nodulosa.* The vascular prolongations connected with those corpuscles which are not in focus are either only partially seen or cannot be observed at all. This specimen was removed with others from the intestine of a Pike. Drawn with the aid of a camera; × 300 diameters.

Dr. Wagener figures a structure precisely analogous to this in plate xxix, attached to his Haarlem Prize Essay, the interest of the phenomenon being enhanced by the circumstance of its occurring in the tail of a larval Trematode—*Cercaria macrocerca* of Filippi. I do not find any explanation of this structure in the essay itself, nor in Wagener's more recent 'Helminthologische Bemerkungen,' published in the same number of Siebold and Kölliker's 'Zeitschrift,' as that in which Claparède's memoir is contained.* In Professor Van Beneden's 'Vers Cestoïdes' mention is made of these tubular extensions, in the detailed and accurate description of this Cestode there given; and I have not yet received (December 1st) his great Prize volume—only a few copies having at present crossed the Channel.

Although I have elsewhere expressed my adhesion to the views of Siebold and others as to the dermo-skeletal character of the calcareous bodies, I suppose we must—if Claparède's observations are correct—henceforth regard these flask-shaped capsules, with their contained sclerous particles, as excretory organs, notwithstanding that they do not appear to have any connexion with the water-vascular system.

Note on a Structure observed in Surirella.—In the course of a recent examination of some slides of Californian guano, the material of which was communicated to me by Mr. J. T. Norman, I observed an example of a species of *Surirella*, exhibiting an appearance of considerable interest. The frustule (which presents the side view) is injured, a considerable portion of the valve nearest to the eye being removed; the result is the exposure of a structure which, so far as I





Length ·0040″. Breadth ·0019″. Canaliculi 4 in ·001″. Areolæ 15 in ·001″. Striæ of median line 25 in 001″.

know, has not hitherto been noticed. This structure is a strong, areolated septum or valve of a yellowish colour, stretching across the entire frustule, distinct from, and

* See Translation, in another part of the present number of this Journal.

separating the two external valves. The areolæ are by no means very minute, being only about 15 in ·001″, and they are regularly hexagonal. The portion of the valve which remains entire exhibits part of a narrow transversely striated median line; and, arising from it, canaliculi, as in *S. lata* and *fastuosa*, very conspicuous at the base, but suddenly becoming inflated and faint. These characters are strictly confined to the valve; for on accurately focussing the interior organ, nothing whatever is perceptible but the beautiful and uniform areolation. On slightly changing the focus, the median line and canaliculi of the valve beneath are then shadowed through. What is this interior organ? It does not appear to have any intimate connexion with the valves, for if that were the case, *some* trace of so marked a structure would be visible by means of a strong transmitted light. Like the valves, it is highly siliceous. At first sight, this remarkable arrangement would appear to be irreconcileable with the views at present entertained relative to the character of the Diatomaceous cell, and the process of self-division. I must content myself at the present moment in merely recording the fact, and in drawing the attention of students of the *Diatomaceæ* towards it.

The larger figure is × 400. The smaller one, more highly magnified, represents the areolated structure. — R. K. Greville, Edinburgh, Nov. 24th.

Microscopic Hints from Australia.— I have only lately received the number of this Journal (No. XVI, p. 299), in which appears an extract from a paper read by me before the Victoria Institute, on some microscopic contrivances; and the new edition of Mr. Hogg's excellent work, in which some of my processes are noticed; and beg now to supply two or three memoranda necessary to make them more intelligible. In the description of my steam-bath, the word "earth" appears instead of "cork," and is rendered by Mr. Hogg "clay or luting." The escape-pipe for the steam is simply fitted in a wide cork, which is more cleanly and convenient than luting would be. I seem to have omitted mention of the uses of this bath. It is designed to soften objects which have been long kept in a dry state, or which are naturally too hard to be readily mounted; also to prepare woods for cutting sections, and to flatten the sections themselves when they have curled in drying. The word "eventually," in the mention of cyanide of potassium as a killing agent, should be "eminently;" but this is a trivial error, as the sense is evident. I have, since that paper was written, used the cyanide of potassium with success. My plan is to expose the animals to the vapour. I take a wide-mouthed glass jar, or a close box with a glass lid, and introduce a false bottom of perforated card; below this I place a fragment of the cyanide, which soon fills the chamber with its vapour. The jar or box being kept closed, is always ready for the introduction of insects, which immediately yield to its influence. Even the Tarantula, which is remarkably tenacious of life, dies in a few minutes. The animal is thus protected from the injury which would be caused by contact with the deliquescent and corrosive salt.

The animalcule-nets are round instead of pointed as figured, they are thus both handier and more easily made.—W. S. Gibbons, Melbourne, Australia.

Microscopic Society of Victoria.—The Melbourne papers notice the formation of a Microscopic Society on the proposition of Mr. W. S. Gibbons, the honorary secretary. Of course, in a new country, where all are absorbed in money-getting, or, in the present critical times, in money-keeping, there is considerable difficulty in getting people to work together in scientific pursuits. The number of members is therefore small, and the desired limitation of membership to workers can hardly be strictly adhered to. Microscopists there are few, and need to supplement their forces by the training of observers; this is being done. The Society numbers about fifteen members, of which several are provided with good instruments, and are "doing." Several interesting objects, many of them new, have already been forwarded to England. The Society meets monthly at the residences of members. A register is kept of colonial microscopists, their instruments, libraries, collections, and pursuits. The subscriptions are devoted to the importation of books and appliances for the use of members. The honorary secretary invites communications from all sources, and will gladly reciprocate with observers elsewhere.

Communication from Frankfort-on-the-Main.—You will know already from my letter I sent you some time ago, that in Germany a mutual wish exists amongst microscopists, to establish an interchange of preparations. For this purpose, however, it is above all things desirable that one and the same shape of making and getting up the preparations ought to be agreed upon. In the enclosed paper you will find the shape, as proposed by the Microscopical Society of Giessen, and the other as thought best by our Society. You will see why we ascribe a great value to it, and why we desire that our shape should be adopted. We consider it very desirable that you should become well acquainted with the subject concerning the interchange of preparations, as we hope it might be possible that one day or the other we should see realised our much felt wish—to establish in this way a close communication between the microscopists of Great Britain and Germany.

I am commissioned by our Society, to beg of you to insert the paper in one of the next numbers of the 'Microscopical Journal.'—F. Funck, M.D., Frankfort-on-the-Main.

"The Microscopical Society of Frankfort-on-the-Main is fully aware of the paramount importance of establishing a mutual interchange of microscopical preparations, as proposed by the Microscopical Society of Giessen, and are very desirous of participating in it. Every one interested in the subject will feel much indebted for the great activity displayed by that society, and we do not doubt that the same will lead to the best results for science.

"Above all, we acknowledge how necessary it is for the different societies to adopt the same form for the object-glasses. Our society, however, is not of opinion that the shape proposed at Giessen (37 to 28 millim), is a fortunate one, as it does not answer general requirements; we, therefore, doubt whether it will be universally adopted, especially in England, where, up to this moment, the greatest amount of microscopical preparations exist. For this reason we have deemed it advisable to employ every possible effort to introduce a more useful shape, and we propose the object-glasses, as introduced in our collection (55 to 25 millim, with protecting side glasses of 12 millim). At the same time, however, we declare ourselves prepared to adopt any shape proposed by the majority of microscopists. But, before the interchange begins, is the most favourable moment to institute with the different societies inquiries upon this subject; this would be almost impossible when once any particular shape has found an extensive general adoption. The reasons against the shape proposed by the Giessen Society, as well as an accurate description of ours, will be found in a paper by one of our members, Dr. Adolfus Schmidt, published in the 'Archiv für gemeinschaftliche Arbeiten,' iii, 2. It may be of some utility to annex a short extract from it, as, perhaps, many a microscopist, especially botanists and zoologists, may not have seen it.

"1. The shape proposed by the Giessen Society is neither convenient nor pleasing.

"2. The object-glasses are somewhat too large to be used conveniently on the tables of the small microscopes of Oberhäuser, Schiek, &c., most commonly in use (at least in Germany).

"3. The space for the label is too small.

"4. They require very small side-glasses, which are difficult to be made in the thickness required by many preparations.

"5. The main objection to this shape is, that it requires object-glasses of twofold size, one for marking purposes and one for the preparations. Dr. Welker, who first introduced and recommended this shape, mentions himself this deficiency in his well-known pamphlet, 'Ueber Aufbewahrung mikroscopischer Praeparate,' &c., von Dr. Herrmann Welker, Giessen, 1856, T. Riekersche Buchhandlung (page 7, note)."

"The shape, as proposed by us, does not, in our opinion, possess any of these inconveniences; it is of the smallest size possible for every use, is easily managed, and has sufficient space for the label. The reasons alleged against the use of long-shaped object-glasses (including ours), as mentioned in the paper published by the Giessen Society, are not applicable to the shape proposed by us.

"1. They do not protrude over the margin of the tables in any of the microscopes known by us.

"2. Neither our object-glasses, nor those of the Giessen Society, can be turned round upon the small microscopes in most common use; in this respect both have indeed the same defect.

"3. The Giessen Society itself agrees that the labels used by them are very small; at the same time, they say, that they can be read while in the boxes. It is exactly the same with our collection, as anybody may find in the description given in the above-mentioned paper.

"4. The fourth objection fails of itself, as there are two protecting borders in our object-glasses.

"5. With respect to the space left for the preparation itself, ours is more than 100 □ millim larger than the Giessen one, and it is a great advantage that it has one longer diameter, in order to preserve longer preparations.

"We, therefore, solicit every microscopist taking an interest in the mutual interchange, to decide for one of the above-mentioned shapes, after having carefully examined everything in their favour, or against them; and we should deem it advisable for him to give his opinion, when sending in his first preparations. As for the present, we cannot deviate from the shape which we have found most to answer the purpose.

"Dr. Mettenheimer, President.
"Dr. Getz, Secretary.

"Frankfort-on-the-Main, 26th January, 1857."

[We have inserted this communication at the request of Dr. Funck, but we cannot but feel that it is too late to make any alteration in the size or form of the slips used in England. The Microscopical Society have decided that the size of three inches by one is the simplest and most convenient. And as already thousands of preparations exist in this form, and thousands of slides are in daily use, both in England and in France, it is to be hoped that German microscopists will see the advantage of conforming to the same standard. Their doing so would much facilitate the international exchange of specimens, which is obviously so desirable.—Eds.]

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *October 28th*, 1858.

Dr. Lankester, President, in the chair.

Eighteen presents of books were announced, and the thanks of the Society returned to their respective donors.

Mr. Jackson presented eleven microscopical photographic portraits, with the accompanying letter:

Sir,—Some of the learned and scientific societies of this metropolis have ornamented the walls of their meeting rooms with portraits of their distinguished members.

The Microscopical Society, having neither walls to ornament nor funds to expend, cannot in this way follow the example of their more opulent and longer established brethren; and the next generation of members would seem to be precluded from the pleasure of contemplating the countenances of the *eminent* persons who founded the Society, and watched over its infancy.

Thanks, however, to the researches of one of our body, this pleasure may still be secured to them; for, although we cannot hang our rooms with portraits, these may be so reduced as to occupy but a small space in our cabinet, and our microscopes will always render them available for examination.

I therefore propose that one of our drawers be appropriated to the reception of likenesses of our past and present members; and as the art of taking these portraits, of a microscopic size, is now practised by several persons, I do not despair of seeing a respectable collection formed in a short time. As a commencement I beg to present eleven of these photographs, and I only regret that the number is so small. I have made no invidious selection, not having omitted a single member that has favoured me with a sitting; and if Mr. Shadbolt, Mr. Hislop, Mr. White, and any other of our friends who have taken up this branch of photography, will each do his best, we may expect to see in our possession, within the next twelve months, a larger number of authentic portraits than most other societies can boast of.

In contemplating the progress and *possible* results of microscopical investigation, one may be allowed to indulge in a little speculation on the purpose which this collection may serve.

While some microscopists are endeavouring to determine the exact boundary between the animal and vegetable kingdoms, and are classifying with rigid accuracy the minute organisms which border each side of that line, others, who probably think with the poet, that

> "The proper study of mankind is man,"

are carefully investigating the structure of the nervous system in the higher animals. Should their researches ultimately afford some insight into the operation of matter upon mind, they may be disposed to carry them still farther, and, studying the *reflex action* of mind upon matter, may reconstruct the science of Lavater on a microscopic basis.

It is generally agreed that the physiognomy is modified by the prevailing habits of thought. If this be true, there should be found in every one of the portraits in our cabinet some trait which would indicate a propensity to pry into minute matters, for that tendency may fairly be presumed to exist in all of us. To discover this general trait will be the first object of inquiry, and will probably occupy the attention of observers for a long time before it is clearly determined.

Some of these members have contributed papers to our 'Transactions,' and have thus afforded particular indications of their peculiar mental operations. The subjects they have taken up, the manner of treating them, and even the style of composition, show so many points of character, as to render the study of these individual cases highly interesting to the scientific investigator; and the circumstance that the minute size of the pictures will oblige him to pursue it by the aid of his favorite instrument, cannot fail to make it peculiarly pleasing to the microscopist.

To pursue this speculation further would be a very unprofitable occupation of your time, and I think I have already said enough to give some idea of the immense field of research which a single drawer of our cabinet may perchance afford, when filled with objects which most of us will be inclined to regard merely as amusing curiosities.—I am, &c.

GEORGE JACKSON.

A report from the Library Committee was read and approved.

A paper on "*Chlorosphæra,*" by A. Henfrey, Esq., was read (Trans. p. 25.)

November 24th, 1858.

Dr. LANKESTER, President, in the chair.

The following presents and purchases were announced, and the thanks of the Society voted to their respective donors:

PRESENTATIONS.

BOOKS.

	Presented by
Proceedings of the Academy of Natural Sciences of Philadelphia	The Society.
Journal of the Proceedings of the Linnean Society, Vol. II, Nos. 8—10. . . .	Ditto.
Annuaire de l'Academic Royale . . .	
Bulletins ditto ditto . . .	
Notice of Remains of Extinct Vertebrata from the Valley of the Niobrata River. By Joseph Leidy, M.D.	The Editor.
Report of Natural Sciences of Philadelphia, 14 .	The Society.
Quarterly Journal of Geological Society, Nos. 55, 56	Ditto.
Proceedings of the Literary and Philosophical Society of Liverpool, No. 12 . . .	Ditto.
Transactions of the Tyneside Naturalists' Field Club, Vol. III, Part 4	The Editors.
The Canadian Journal of Industry, Science, and Art, Nos. 15—17, New Series . . .	Ditto.
The Microscope; being a Popular Description of the most Instructive and Beautiful Objects for Exhibition. By L. Lane Clarke . . .	Jabez Hogg, Esq.
Notice of some Remarks by the late Mr. Hugh Miller, Philadelphia	
Traité Pratique du Microscope et de son Employ dans l'Etude des Corps Organises. Par le Doctour L. Mandl; suive de Recherches sur l'Organisation des Animaux Infusoires, par D. C. G. Ehrenberg .	F. C. S. Roper, Esq.
An Account of some New Microscopical Discoveries, founded on an Examination of the Calamay .	Ditto.
Des Microscopes et de leur Usage—Manuel Complet du Micrographie. Par Carles Chevalier .	Ditto.
Microscopic Objects, Animal, Vegetable, and Mineral; with Instructions for Viewing and Preparing them. By A. Pritchard	Ditto.
Micrographia Illustrata; or, the Microscope Explained. By George Adams . . .	Ditto.
Dissertations relative to the Natural History of Animals and Vegetables. Translated from the Italian of the Abbé Spallanzani. 2 vols. . .	Ditto.
Nervous System of the *Sphinx Ligustri*, Linn. By George Newport	The Author.

	Presented by
Journal of Photographic Society, Nos. 66—73 .	The Society.
Journal of the Society of Arts, 28 Nos. . .	The Editor.
Micrographia: containing Practical Essays on Reflecting, Solar, Oxyhydrogen Gas, Microscopes, Micrometers, Eye-pieces, &c. . . .	Geo. Jackson, Esq.
Schleiden's Principles of Botany . .	Dr. Lankester.
Küchenmeister's Manual of Parasites, Vols. I, II. Sydenham Society, 1856-57 . . .	Ditto.
Mémoires pour servir à l'Histoire d'un genre de Polypes d'eau douce à bras en forme de cores. Par A. Trembley, de la Société Roïale . .	G. Busk, Esq.
Dr. Carpenter on the Microscope . .	The Author.

MICROSCOPIC OBJECTS.

Two slides of Polycystina, from the bottom of the Indian Ocean at 2200 fathoms . .	James Hilton, Esq.

MICROSCOPIC PORTRAITS. *Presented by Geo. Jackson, Esq.*

Joseph Gratton, Esq.	J. Shuter, Esq.	J. Luke, Esq.
R. J. Farrants, Esq.	J. N. Furze, Esq.	Rev. W. Quekett.
C. Varley, Esq.	R. Warrington, Esq.	G. E. Blenkins, Esq.
H. Peragal, Esq.	G. Jackson, Esq.	

PURCHASES.

A Monograph of the Cirripedia. Darwin. Ray Society, 1851. 8vo.

Bibliographia Zoologiæ. Agassiz. Vols. III, IV. Ray Society, 1852, 1854. 8vo.

A Monograph of the Cirripedia—Balanidæ. Darwin. Ray Society, 1853. 8vo.

Botanical and Physiological Memoirs. Ray Society, 1853. 8vo.

Alder and Hancock. Nudibranchiate Mollusca. Parts 6, 7. Ray Society, 1855. 4to.

Microscopic Illustrations of Living Objects, with Researches concerning the Methods of constructing Microscopes, and Instructions for using them. 3d edition. By Andrew Pritchard. 8vo.

T. T. Gray, Esq., Bedford; T. Thompson, Esq. Wakefield; and P. Gray, Esq. St. Paul's Villas, Camden Town, were balloted for, and duly elected members of the Society.

Two papers, by W. S. Gibbon, Esq., Melbourne, Australia, were read—one on the Infusoria of the water of Tan Teen, a large artificial reservoir in Australia, and the other on a new method of Micrometry.

British Association for the Advancement of Science.

Leeds Meeting.

September 23d, 1858.

Section D.

On the Death of the Common Hive Bee, supposed to be occasioned by a Parasitic Fungus. By the Rev. H. H. Higgins.*

On the 18th of March last a gentleman of Liverpool communicated to me some circumstances respecting the death of a hive of bees in his possession, which induced me to request from him a full statement of particulars. He gave me the following account: "In October last I had three hives of bees, which I received into my house. The doorway of each hive was closed, and the hive was placed upon a piece of calico; the corners were brought over the top, leaving a loop, by which the hive was suspended from the ceiling. The hives were taken down about the 14th of March; two were healthy, but all the bees in the third were dead. There was a gallon of bees. The two hives containing live bees were much smaller; but in each there were dead ones. Under whatever circumstances you preserve bees through the winter, dead ones are found at the bottom of the hive in the spring. The room, an attic, was dry; and I had preserved the same hives in the same way during the winter of 1856. In what I may call the dead hive there was abundance of honey when it was opened; and it is clear that its inmates did not die from want. It is not a frequent occurrence for bees so to die; but I have known another instance. In that case the hive was left out in the ordinary way, and probably cold was the cause of death. I think it probable that my bees died about a month before the 14th of March, merely from the circumstance that some one remarked about that time that there was no noise in the hive. They might have died earlier, but there were certainly live bees in the hive in January. I understand there was an appearance of mould on some of the comb. There was, I think, ample ventilation, indeed, as the hives were suspended they had more air than through the summer when placed on a stand. When the occurrence was first made known to me I suggested that the bees might probably have died from the growth of a fungus, and requested some of the dead bees

* This paper was printed in the 'Proceedings of the Linnean Society,' vol. iii, p. 29, August 20th, 1858.

might be sent to me for examination. They were transmitted to me in a very dry state, and a careful inspection with a lens afforded no indication of vegetable growth. I then broke up a specimen and examined the portions with a compound microscope, using a Nachet No. 4. The head and thorax were clean, but on a portion of the sternum were innumerable very minute linear slightly curved bodies, which, when immersed in water, showed the well-known oscillating or swarming motion. Notwithstanding the agreement of these minute bodies with the characters of the genus Bacterium of the Vibrionia, I regarded them as spermatia, having frequently seen others indistinguishable from them under circumstances inconsistent with the presence of confervæ, as in the immature peridia and sporangia of Fungi. In the specimen first examined were no other indications of the growth of any parasite; but from the interior of the abdomen of another bee I obtained an abundance of well-defined globular bodies resembling the spores of a fungus, ·00012—00016 inch in diameter. Three out of four specimens subsequently examined, contained within the abdomen similar spores. No traces of mycelium were visible; the plants apparently had come to maturity and withered, leaving only the spores. The chief question then remaining to be solved was, as to the time when the spores were developed, whether before or after the death of the bees. In order, if possible, to determine this, I placed four of the dead bees in circumstances favorable for the germination of the spores, and in about ten days I submitted them again to examination. They were covered with mould consisting chiefly of a species of mucor, and one also of Botrytis or Botryosporium. These fungi were clearly extraneous, covering indifferently all parts of the insects, and spreading on the wood on which they were lying. On the abdomen of all the specimens, and on the clypeus of one of them grew a fungus, wholly unlike the surrounding mould. It was white and very short, and apparently consisted wholly of spores arranged in a moniliform manner like the filaments of a Penicilium. These spores resembled those first found in the abdomen of the bees, and did, I think, proceed from them. The filaments were most numerous at the junction of the segments of the abdomen. The spores did not resemble the globules in *Sporendonema muscæ*. The Rev. M. T. Berkeley, to whom I sent some of the bees, found, by scraping the interior of the abdomen with a lancet, very minute curved linear bodies, which he compared to vibrios. He found mixed with them globular bodies, but no visible stratum of mould. From the peculiar position of the sphores within the abdomen of the bees, and from the growth of a fungus from them unlike any of our common forms of Mucedines, I think it probable that the death of the bees was occasioned by the presence of a parasitic fungus.

On the Liability of Shells to Injury from the Growth of a Fungus. By the Rev. H. H. Higgins.

It has often been observed that shells kept for a considerable time in cabinets are apt to lose much of their original freshness and beauty of appearance. This kind of injury chiefly affects such specimens as have a bright, enamelled surface, which at length becomes dull and less pleasant to the touch. Several suggestions have been made with reference to the probable cause of the change, which has often been attributed to the efflorescence of saline matter absorbed by the shell. But, so far as I have observed, the specimens most liable to injury from saline incrustation belong to genera in which the shells are without enamel, as Littorina, Turritella, &c., and many collectors are in the habit of steeping their specimens in fresh water for some days before placing them in their cabinets—a process which is said to be an effectual preservative from injury by saline efflorescence. Mr. Denison, of Woolton, attributed the loss of lustre in enamelled shells to the ravages of a minute insect, but had not been able to detect the depredator. "Many of the shells in my own cabinet suffered such serious injury during last winter that I was led to investigate the cause, which, indeed, became obvious enough by the use of a microscope. An ordinary lens showed the enamel of the shell to be beset with small bristly points, and when a portion of the surface was scraped off and submitted to a higher magnifying power, the forms of at least two species of Fungi became apparent, one resembling an ordinary Mucor with a globose sporangium, the other and much more common form, exhibited both simple and moniliform filaments, with an abundance of minute spores, seemingly quite free. After having been carefully washed, the surface of the shell was found to be as if it were engraved in some places with stellular marks, in others with striæ forming irregular reticulations, caused no doubt in each instance by the spreading mycelium of the fungus. It is scarcely necessary to add, that attacks of this nature need not be apprehended where shells are kept in a perfectly dry or well-ventilated place. A slight deposition of moisture does, however, frequently occur upon their surfaces whilst shells are undergoing examination, in which case it would be a safe precaution to allow them for awhile to remain exposed to the air before returning the drawer to the cabinet."

September 25th, 1858.

On the Anatomy of the Spinning Organs of the Araneidæ.
By Mr. R. H. Meade.

The tegumentary covering of the abdomen in true spiders consists of three layers, viz.: 1st, an external, horny, transparent membrane, more or less densely clothed with hairs; 2d, an intermediate soft stratum of pigmentary matter; and 3d, an expanded network of muscular fibres, which will enable the spider to compress the contents of the cavity. The spinnarets, seated near the apex of the abdomen, at the under side, are mostly six in number, placed in three pairs—an anterior, a posterior, and an intermediate pair. The posterior pair is often prolonged and tri-articulate, when the spinners composing it have been called *anal palpi*. There is a fourth pair of spinnarets in Mr. Blackwall's family of the "Cinifloridæ," situate in front of the ordinary anterior pair. They are short, compressed, and inarticulate. The spinnarets are connected with the surrounding integument by means of diverging bands of muscular fibres, which enable them to move in various directions. In the interior of the abdomen, nearer the base than the apex, there is a point (opposite the orifice of the oviduct in the female), from which several muscular bands radiate in various directions, keeping the different abdominal organs in their places. Some are inserted into the integument on both the dorsal and ventral surfaces of the abdomen; others run backwards in straight parallel bundles, and pass into the interior of the spinnarets. These last bundles have their fibres strongly striated, like the strong muscles connecting the legs with the cephalo-thorax. The other muscles mentioned are only faintly marked. The interstices between the organs in the abdomen are filled with adipose matter, connected into lobules by fine cellular tissue. This serves as a reservoir of nutriment, and enables spiders to bear very long abstinence. The glandular organs, which secrete the silk, consist of a number of sacs or bags and convoluted or branched tubes, of various sizes and shapes—each furnished with a distinct excretory duct, which terminates separately on the surface of the spinnaret, so that there is no communication between one and another. The spinning glands may be divided into four varieties. The first consists of a large number of exceedingly minute cells, each containing a kind of nucleus, and furnished with a very fine duct. These are only found in the family of the Ciniflorideæ, and are placed immediately beneath the integument, near the supplementary spinnarets, with which they are connected. These glands evidently secrete the fine silk, which forms the flocculus in the web of *Ciniflo* (*Clubiona*) *atrox* and *ferox*. The next group of spinning glands is the most numerous and most constant of all the varieties. It consists of an immense collection of small oval, or fusiform, cells, with fine elastic ducts, which terminate principally in the anterior and posterior pairs of spinners. These probably secrete the fine threads, which weave the more delicate parts of the webs, and construct the cocoons in which the eggs are deposited. The third variety of silk glands contains several cartilaginous sacs, or convoluted tubes, of a firm or even hard consistence, but brittle and transparent. These are often of a large size, especially in the different species of *Epeira*. They have fine inelastic ducts. Perhaps these secrete the adhesive lines which are placed on the geometric webs of spiders. The last and most interesting kind of glands are membranous sacs and tubes, some vermiform, others clavate, others furnished with branched cæca. They vary in size, some being very large. All have thickened and apparently fibrous walls, and they are all furnished with elastic ducts, having a fibrous external coat, composed of distinct rings, which break up into separate pieces when the duct is stretched. From their construction, these sacs and ducts must possess a strong contractile and expulsive power. They probably secrete the stronger threads, which are stretched between distant points, and form the framework of the webs; and they must also produce the gossamer of the aëronautic spiders, for they are exceedingly large and numerous in *Lycosa saccata* and *Thomisus cristatus*—common aërial species—which require them for no other purpose, as they do not spin ordinary webs, being erratic in their habits. In most other species of *Lycosa*, also, the spinning organs are very slightly developed. The ducts from both the cartilaginous and membranous glands terminate in all the three ordinary pairs of spinnarets; several from the latter may be traced into the long triarticulate spinnarets of *Agelena labyrinthica*.

September 27th, 1858.

On a new Species of Laomedea; with Remarks on the Genera Campanularia and Laomedea. By the Rev. T. Hincks, B.A.

A new British species of Laomedea was described under the name of *L. angulata*, which is remarkable as being the only member of this genus yet discovered in which the reproductive capsules are not axillary, but originate from the creeping fibres. Mr. Hincks also described a remarkable variety of *Campanularia Johnstoni* (Alder), which is branched, and bears capsules on the pedicel as well as on the fibre. In these two forms, the supposed distinctive characters of *Laomedea* and *Campanularia* are intermingled. There was not, indeed, a single constant character that could be relied upon for the separation of the two genera, and he therefore proposed, with Van Beneden, to range both branched and simple forms under *Campanularia*, abandoning the genus *Laomedea*. One section, however, of *Campanularia* seemed to him entitled to distinct generic rank, that which includes the small and (for the most part) Sessile species, and for this he proposed the name *Calicella*.

On some new and interesting Forms of British Zoophytes. By the Rev. T. Hincks, B.A.

A new species of *Plumularia* was characterised under the name of *P. similis*, closely allied to the *P. echinulata* of Peach. Two new species of Polyzoa were also described, one as *Avenella dilatata*, the other, which exhibits a new generic type, as *Arachnidia hippothöoides*, a delicate ctenostomatous Polyzoon, curiously resembling in general appearance the well-known *Hippothoa*. Mr. Hincks also drew attention to the remarkable difference in the form of the male and female capsule in *Halecinum Beanii* and *H. halecinum*.

The Rev. W. Hincks read a paper from Mr. Alder of Newcastle-on-Tyne, "On three New Species of Sertularian Zoophytes." The first, taken on the Durham coast, was *Campanularia halæcioides*; the second, taken off the Northumberland coast, *Halecium labrosum*; the third, a foreign species, *Halecium nanum*, found amongst the Gulf weed.

Mr. Warington read a paper "On the Multiplication of Actiniæ in his Aquaria." He described a process of reproduction occurring amongst these creatures, in which a portion of the base becoming separated from the Actinia, split up into three or four portions, each giving rise to a new Actinia.

Mr. WARINGTON described some additions which he had made to his portable microscope, by which living objects contained in glass bottles or small aquaria could be examined with greater ease.

Mr. C. BROOKE exhibited a microscope and case very completely fitted up, but having a stand of so simple and light a character as to render it very portable and easily worked, even in the open air, at the seaside or elsewhere.

Mr. LADD exhibited a microscope with an improved magnetic stage. The improvements in the structure of the microscope exhibited by these instruments were commented on by several speakers. The facility of moving objects delicately by the hand, afforded by the magnetic stage, was remarked upon as a great advantage. Mr. Brooke's instrument was fitted with a double lens, so that the power could be changed from a high to a low one without unscrewing the glass, and was regarded as an improvement that ought to be more frequently employed in the construction of microscopes.

September 28th, 1858.

SECTION A.

On a New Law of Binocular Vision. By the Rev. J. DINGLE.

THE object of the law in question is to obviate the imperfect vision which would sometimes arise from the difference of the pictures in the two eyes. In some cases this difference would lead to great inconvenience and confusion. It sometimes happens, for instance, that in looking at a field of view at some distance, objects considerably nearer are so interposed as to present themselves in the picture formed in one eye and not in the other. Thus, in looking at a landscape, if the finger or any other object is held before one eye, the image of it from the one retina is superposed in the *sensorium* on a part of the landscape formed in the other eye. On mere physical principles, this might be expected to blot out or greatly confuse that part of the landscape upon which it was placed; but upon trial this is not found to be the case, as that part is merely a little dimmer than the rest from being seen only with one eye, but is equally distinct and as truly coloured. By various experiments the author had ascertained that this was the result of a peculiar power of the will, by means of which the mind is enabled, when two different images are superposed in the *sensorium*, to select whichever it pleases, to bring that object into view, and entirely to obliterate the other; it sees, in fact, whichever it wills to see, and the other image, simply by being neglected, becomes invisible. In ordinary vision, the determination of the image to be seen is effected by the same act of the will which determines the position of the optic axes; but by certain arrangements which were indicated both images may be made to have the same relation to the optic axes; and as the predisposition to select one or the other is thus obviated, it is made indifferent to the mind which of the two images that occupy the same place in the *sensorium* it shall see. When these arrangements are made, it is found that mere efforts of the will can easily bring either the one or the other into view. The importance of the law, which enables the mind to select its image, was pointed out in different cases of ordinary vision. It obviates the difficulty already adverted to, of having two different pictures on the same spot; it has not improbably an important influence in producing the general stereoscopic effect; it also, to some extent, remedies the effect of squinting, by obliterating the picture in the imperfect eye, which could not be else done without shutting it. The effect of the law, in some extraordinary cases, was also noticed, especially in the power of the will to fix images on the sight, as Sir Isaac Newton instances in his own case (see his 'Life,' by Sir David Brewster). The author pointed out the great interest of the subject, not only in its practical aspect, but also as having an important bearing on the connexion between mind and matter.

Dublin University Zoological and Botanical Association.

April 16th, 1858.

Supplementary Catalogue of Desmidiaceæ found in the neighbourhood of Dublin, with Description and Figures of a proposed New Genus, and of Four New Species. By William Archer, M.R.D.S.

Class.—ALGÆ.

Order.—Chlorosporeæ or Confervoideæ.

Family.—Desmidiaceæ.

Leptocystinema, n. g.

Plant an elongated jointed filament (often separating); joints straight, much elongated and slender, without a central constriction or inflation, entire, ends simply truncate, or dilated and truncate (no evident gelatinous sheath).

1.—*Leptocystinema Kinahani*, n. sp.

Filaments attached, frequently breaking up into separate joints, which are slender, extremely elongate, linear, cylindrical, and smooth, their ends abruptly truncate; the junction of the halves marked by a pale transverse interruption of the cell-contents; endochrome forming a compressed longitudinal band, its broader diameter extending the entire width of the joint—the narrower not filling more than one third, and presenting an undulating outline—at the extremities of the joint more or less retracted from the end of the primordial utricle, leaving a clear space, in which are active granules; the endochrome also having immersed within it a single longitudinal central series of light-coloured, well-defined, globular, dense corpuscles, one of these bodies occupying the centre of the transverse pale space.

Length of joint varying from $\frac{1}{200}$ to $\frac{1}{50}$ of an inch (averaging about $\frac{1}{100}$ in.); diameter of joint $\frac{1}{1900}$ in.

It affords me much gratification to have it in my power to connect the name of my friend Dr. Kinahan with this species, while I feel it a privilege to be permitted to employ this slight tribute of regard, and very unworthy recognition, on my part, of many marks of consideration.

2.—*Leptocystinema asperum* = *Docidium asperum.* Bréb.

Filaments fragile; joints "slender, cylindrical, rough with minute scattered granules;" "ends dilated;" endochrome disposed in an irregularly narrowed, somewhat undulatory, or sub-spiral manner, sometimes bifid at the extremities, (or "scattered"?), and having immersed in it a single median series of globular corpuscles, and usually with a pale space at the centre.

Length of joint, $\frac{1}{97}$ to $\frac{1}{64}$ of an inch; breadth, $\frac{1}{2356}$; breadth at end, $\frac{1}{2272}$. (These are the measurements given by Ralfs, "British Desmidiæ," p. 159, with which my own have agreed very closely.)

3.—*Leptocystinema Portii*, n. sp.

Filaments very fragile; joints very slender, fusiform, very gradually tapering to the ends, where they become dilated, giving to the apex a sub-capitate appearance, rough with minute scattered granules; endochrome disposed in an irregularly contracted manner, having immersed in it a single median series of globular corpuscles, and usually with a pale space at the centre.

Length of joint varying from $\frac{1}{200}$ to $\frac{1}{105}$ inch; diameter at the middle of the joint, $\frac{1}{3500}$; just under the dilated extremity, $\frac{1}{5630}$; and of the extremity itself, $\frac{1}{4600}$ in.

Although the compliment may be but an unpretending one, it affords me great pleasure to have the opportunity of associating the name of my friend, George Porte, Esq., with this species—a gentleman whose manipulative skill in its use is only equalled by his admiration of the many beautiful objects brought to view by the microscope—while it will be commemorative, too, of the origination and initiation by him of a series of pleasant re-unions, at once scientific and social, on the part of a limited little circle, in the number of whom it is my own esteemed privilege to be counted a unit.

Another form to which I would next direct attention is one in which I find a single, but important, difficulty, in referring it to the genus Sphærozosma, and it is the following: I cannot find either one or two "glandular processes" between the joints of the filament, the presence of which is one of the characters of the genus Sphærozosma (Corda). The filament, which is very minute, is, however, plane and fragile; while the joints, which are about as broad as long, are constricted by a sharp, not deep notch at each side between the projecting lateral inflations at the base of the segments, giving a pinnatifid appearance to the margin of the filament, which thus possesses all the characteristics of Sphærozosma, save the one above noticed. Surrounding this form I do not think there exists a gelatinous sheath; but I am not able to affirm this at all confidently. The ends of the segments are straight and abruptly truncate, each in close apposition to the truncate end of the neighbouring joint, without the apparent intervention of any "glandular processes." This form is very minute, and is very fragile; hence seldom found having more than fifteen or twenty joints in the filament, generally less; often one single cell only is met with. The endochrome is light green, and possesses a single "vesicle" (or corpuscle) at the centre of each segment. Its minute size, the absence of the conspicuous central solitary "gland," its truncate and square-angled (not rounded) ends, and the lateral pouting projections of each joint at the base of the segments, readily distinguish this form from *Sphærozosma vertebratum.* It differs from *Sphærozosma excavatum,* which it more nearly approaches in size, by its square ends and lateral protuberant inflations, with a sharp notch at the constriction at each side, and in being wider at the basal inflation of the segments than at the ends, not, as in *Sphærozosma excavatum,* with rounded ends wider there than at the centre, and having a deep, wide sinus at both sides of the joint. I may add that, so far as my humble experience goes, the "junction-glands" of *Sphærozosma excavatum* are often very obscure. The separated joints of the form of which I have tried to convey a conception, closely resemble a minute form of *Cosmarium,* and such I thought a single joint was till I met it in lengthened filaments. To obviate the difficulty here met with, two courses may appear to be open: either to allow this plant to remain as an aberrant member of the genus Sphærozosma—an unadvisable course if it could be avoided—or else to alter the characters of the genus by omitting the "junction-glands" as essential to it, for it appears, I think, that the plane or compressed filament is itself enough to distinguish Sphærozosma from the cylindrical or angular filamentous genera, except, perhaps, *Aptogonum desmidium, β,* which, however, is distinguished by the foramina between the joints. This view I would, then, very submissively put forward. In any case I do not see I have an alternative but to describe this form as a Sphærozosma, as follows:—

Sphærozosma pulchellum, n. sp.

Filament very minute and fragile; joints (including inflations) about as broad as long; ends truncate, with square angles; segments suddenly inflated at the base, and separated from each other by a shallow acute notch, thus giving to the margin, at each side, a pouting appearance at the central constriction, each segment of the joints containing a single central light-coloured corpuscle.

Length of joint, $\frac{1}{2330}$ in.; diameter of joint at the end, $\frac{1}{4650}$; diameter at widest part of inflation, $\frac{1}{2330}$ in.

I have also to bring to notice a species of *Staurastrum,* which, though minute, and not very striking in appearance, there can be no doubt is undescribed. In the front view this little organism might possibly be taken for a small form of *Arthrodesmus incus*; but the central constriction is not so deep, nor is the constricted portion so narrow, nor are the segments comparatively so dilated at the ends, nor is the gibbous appearance at the base of the segments often seen in *Arthrodesmus incus* present in the form in question; however, an end view, showing its four, or frequently three angles, dispels all doubt, and at once proclaims the plant a Staurastrum. It differs from *Staurastrum dejectum* (Bréb.) by its much smaller size and less deep constriction, and angles not inflated in the end view; from *Staurastrum cuspidatum* (Bréb.), the end view of which the triangular variety most approaches, by its much smaller size, straight sides in end view, and non-inflated angles, and by the want of a connecting band in the front view. It resembles more nearly *Staurastrum minus* (Kütz.), an end view of which is figured in Ralfs' Monograph, but which has not yet (I believe) been found in Britain; but that species presents five angles, not three or four, as in this species. I do not think I need contrast it with any other species. The angles in the end view of the quadrangular form are right angles, and the sides straight; in the triangular form the end view is equilateral and straight-sided, both forms possessing a single awn or acute spine at each angle. The awns are a little longer in the triangular variety than those of the quadrangular. I was fortunate enough to meet with the sporangium of this species; it is spherical and acutely spinous; in fact, very like that of *Arthrodesmus incus.* That this form is a sort of connecting link, as it were, between *Arthrodesmus* and *Staurastrum* seems probable, from the remote likeness in the front view to *Arth. incus*, as well as from the similarity of the sporangium in each. I would, therefore, venture to put forward the following to serve as a description of this species:

Staurastrum O'Mearii, n. sp.

Frond very minute; segments smooth, ends truncate (in the quadrangular variety slightly convex); central constriction not deep, forming an obtuse angle; constricted portion very short; a single awn at each angle; awns diverging in the front view, acute.

End view quadrangular or triangular; sides straight; angles not inflated.

Sporangium orbicular, spinous; spines at first subulate, afterwards slightly inflated at the base, acute.

Length of frond of quadrangular variety, $\frac{1}{8666}$ of an inch; breadth at end (exclusive of spines), $\frac{1}{2500}$; diameter at isthmus, $\frac{1}{3110}$; length of spine, $\frac{1}{5500}$.

Length of frond of triangular variety, $\frac{1}{1750}$th of an inch; breadth at end (exclusive of spines), $\frac{1}{2300}$; diameter at isthmus, $\frac{1}{3500}$; length of spine, $\frac{1}{3400}$.

Diameter of sporangium, without including spines, $\frac{1}{1750}$ of an inch; including spines, $\frac{1}{870}$th of an inch.

It is with very great pleasure I am permitted to call this species after my friend, the Rev. Eugene O'Meara, to whom I trust it may afford some gratification to have his name associated with this species of a group kindred to his favorite and beautiful Diatomaceæ.

Penium Berginii, n. sp.

Frond minute, about three or four times longer than broad, smooth, fusiform; segments cuneate; ends roundly pointed; endochrome irregular, or sometimes with more or less evident longitudinal fillets, also with a transverse pale band, and having close to each end of the frond a conspicuous, well-defined circular cavity, containing moving granules, and each half usually having immersed in the rest of the endochrome a single central spherical corpuscle.

Length of frond, $\frac{1}{420}$ to $\frac{1}{310}$ of an inch; greatest breadth, $\frac{1}{1750}$ of an inch; diameter at the ends, $\frac{1}{4660}$ of an inch.

I feel very happy in being accorded the privilege of naming this species after the well-known microscopist, Thomas F. Bergin, Esq., M.R.I.A, President of the late Microscopical Society of Dublin; while I trust that gentleman may look upon this trifling compliment as a mark of unaffected, but sincere respect for his numerous scientific attainments, and more especially in regard to microscopy, the active pursuit of which has been interrupted owing to delicate health, at once greatly to be lamented for his own sake, as well as much to be regretted for the cause of science.

The following is the Supplementary Catalogue of Desmidiaceæ found near Dublin (for preceding one *vide* 'Natural History Review,' "Proceedings of Societies, vol. iv, p. 36):"

Didymoprium Grevillii (*Kütz.*), rather rare; though (like other filamentous species) when met with, sometimes plentiful.

Leptocystinema Kinahani (*mihi*), n. g., very rare.

[Hitherto met with but in a single pond on the Shankhill road, about a mile beyond Ballinascorney Bridge.]

" asperum = Docidium asperum (*Bréb.*), not rare.

" Portii (*mihi*), not rare.

Sphærozosma vertebratum (*Bréb.*), rare.

" pulchellum (*mihi*), very rare.

Micrasterias Jenneri (*Ralfs*), rare.

Euastrum cuneatum (*Jenner*), rare.

" insigne (*Hass.*), not uncommon.

Cosmarium Ralfsii (*Bréb.*), not uncommon.

" tinctum (*Ralfs*), rare.

Staurastrum O'Mearii (*mihi*), rare.

" brevispina (*Bréb.*), rare.

" monticulosum (*Bréb.*), rare.

[Of this rare and pretty species, I have found a quadrangular variety (plate xi, fig. 16, exhibits an end view), as well as the triangular form recorded in Ralfs. The former differs from the latter only in possessing an additional side and angle, and in the gatherings in which it occurred the quadrangular variety was rather the more numerous; both are rare, however. I do not think there can be any doubt as to the form of which the end view is figured (fig. 16), being the *Staurastrum monticulosum* (Bréb.), yet as the drawing after M. de Brébisson in Ralfs appeared to me as not quite characteristic, especially as to the end view, at least so far as my plant was concerned, having the opportunity, I have thought it might be worth while to introduce a sketch. The diameter of end view is 1-700th of an inch; extreme length of front view, 1-500th of an inch.]

„ gracile (*Ralfs*), rare.
„ tetracerum (*Kütz.*), rare.
„ cyrtocerum (*Bréb.*), rare.
„ asperum (*Bréb.*), rare.
„ enorme (*Ralfs*), very rare.
„ spongiosum (*Bréb.*), very rare.
„ aculeatum (*Meneghini*), rare.
„ spinosum (*Bréb.*), common.
„ vestitum (*Ralfs*), rare.
Tetmemorus lævis (*Kütz.*), not rare.
Penium interruptum (*Bréb.*), rare.
„ Berginii (*mihi*), very rare.

[Sparingly, in a dyke above the Devil's Glen, between the Waterfall and the high road; also in a pond on the "Piperstown road," rather more than a mile beyond Ballinascorney chapel.]

Closterium Ehrenbergii (*Menegh.*), not uncommon.
„ moniliferum (*Ehr.*), not uncommon.
„ Jenneri (*Ralfs*), rare.
„ intermedium (*Ralfs*), rare.
„ angustatum (*Kütz.*), not uncommon.
„ lineatum (*Ehr.*), not uncommon.
„ setaceum (*Ehr.*), not rare.
„ acutum (*Bréb.*), not rare.
„ juncidum β (*Ralfs*), rare.
Spirotænia obscura (*Ralfs*), rare.
Pediastrum pertusum (*Kütz.*), rare.
Scenedesmus acutus (*Meyen*), not rare.

ROYAL SOCIETY.

June 18*th*, 1857.

On the Early Stages of Inflammation.

By Joseph Lister, Esq., F.R.C.S.

(*Abstract.*)

In this communication the author gives an account of an investigation with which he has been recently occupied, into the process of inflammation in the Frog's foot. The paper is divided into four sections, with an introduction and conclusion.

The first section of the paper is devoted to the discussion of the aggregation of the corpuscles of the blood. It is shown by the author that the *rouleaux* "are simply the result of the disc-form of the corpuscles, together with a certain, though slight degree of adhesiveness, which retains them pretty firmly attached together when in the position most favorable for its operation, namely, when flat surface is applied to flat surface, but otherwise allows them to slip very readily upon one another." The aggregating tendency of the red discs is thus regarded as a phenomenon similar in kind, though inferior in degree, to the well-known adhesiveness of the white corpuscles. It is further shown, from numerous experiments, that the red corpuscles vary remarkably in adhesiveness, in consequence of changes in physical circumstances, or very slight chemical action.

Section II is on the structure and functions of the blood-vessels.

The thinness of the capillary wall is believed to favour the mutual interchanges between the blood and the tissues, but the consideration of some facts of physiology leads the author to the conclusion, that notwithstanding the distending force of the current of blood, the liquor sanguinis is not effused as a whole among the tissues in a state of health; and this is thought to imply that there subsists a mutual repulsion between the materials of the capillary wall and the elements of the liquor sanguinis, preventing the passage of the latter into the pores of the former, except in so far as they are attracted by the tissues for the purposes of nutrition.

The heart is believed by the author to be the sole cause of the circulation of the blood in the frog's foot, and it is proved experimentally that other sources of movement cannot have more than a very trivial influence, and that their cessation, supposing them to exist at all, does not give rise to arrest of the blood or accumulation of corpuscles in the capillaries.

Distinct evidences of muscularity and contractility have been detected in the veins of the frog's foot, but compared with the arteries, the veins show very little spontaneous contraction.

Regarding the influence of changes in arterial calibre upon the blood in the capillaries, the author is led to conclude that "the arteries regulate by their contractility the amount of blood transmitted in a given time through the capillaries, but neither full dilatation, extreme constriction, nor any intermediate state of the former is capable *per se* of inducing accumulation of corpuscles in the latter."

The influence of the nervous system upon the arteries has formed the subject of a special experimental inquiry, the results of which are given in a supplement to the paper. It is there shown that the contraction of the arteries of the frog's web are regulated by a part of the spinal cord, the irritation of which induces complete constriction of the vessels, while its destruction is followed by permanent dilatation. Neither stimulation nor removal of the nervous centre for the arteries produces any perceptible change in the quality of the blood, as respects adhesiveness of its corpuscles or otherwise.

Section III. "On the Effects of Irritants upon the Circulation in the Frog's Web," commences with an account of some experiments performed with tepid water applied for a brief period to the foot.

Subsequent experiments with a variety of other irritating agents showed that the corpuscles, both red and white, were obstructed in their progress through the irritated part in consequence of their tending to adhere in an abnormal degree to one another and to the walls of the vessels. The effects upon the blood were always similar, although the means employed to produce irritation were exceedingly various, such as solutions of salts, mustard, essential oils, chloroform, heat, galvanic shock, mechanical violence, &c.

The well-known adhesiveness of the white corpuscles within the vessels does not occur, according to the author, unless some degree of irritation is present, and never exceeds that which is always seen in blood outside the body. Hence the inference is drawn, that the tissues of a healthy part exert an influence on the blood in their vicinity, by means of which the corpuscles, both red and white, are preserved free from adhesiveness; but that in an inflamed part this influence is more or less in abeyance.

At the commencement of Section IV, "On the State of the Tissues in Inflammation," it is stated that "the conclusion arrived at in the latter part of the last section, that blood flowing through an inflamed part, behaves itself in the same way as when separated from the living body, naturally leads us to infer that the tissues of the inflamed part are in some degree approximated to the condition of dead matter, or; in other words, have suffered a diminution of power to discharge the offices peculiar to them as components of the healthy animal frame. This inference is strongly supported by considering what common effect is likely to be produced upon the tissues of the frog's web by all the various agents known to cause inflammatory disturbance of the circulation." It is then pointed out that all these agents, though differing greatly in their nature, agree in their tendency to inflict a lesion on the part to which they are applied, and impair the functional activity of the tissues. "But strong as are the arguments thus obtained by inference, it would be very desirable to confirm them by direct observation of the tissues. It fortunately happens that the pigmentary system of the frog is a tissue which, from its peculiar form and colour, is very apparent to the eye, so that it is easy to trace the remarkably active functions with which it is endowed, and their modifications under the influence of irritation."

The author concludes: "Thus, direct observation of the structures of the frog's web which discharge functions apparent to the eye, furnishes unequivocal support to the inference derived from other considerations, that in inflammation the tissues of the part, the primary seat of the affection, are in a state of diminished functional activity."

ZOOPHYTOLOGY.

In the 'Dublin Natural History Review,' for July, 1858, Professor Wyville Thomson has described several new genera and species of Marine Polyzoa, collected for the most part by Professor W. B. Harvey in the Australian seas, but with which, with a view to the important subject of geographical distribution, Professor W. Thomson has incorporated one or two smaller collections sent to Professor Harvey with Algæ from various parts of the world.

Of this valuable contribution to Zoophytology we proceed to give the following abstract, containing the description of the new genera and species established by Professor Thomson; premising that the arrangement followed by him is pretty nearly the same as that adopted by ourselves in the British Museum Catalogue.

The new species are all figured, and of them we hope shortly to be able also to give representations from original drawings from specimens kindly furnished by Professor W. Thomson.

Class.—POLYZOA.

Order 1. P. INFUNDIBULATA.

Sub-order 1. CHEILOSTOMATA.

Sect. 1. Articulata.

Subsect. 1. Uniserialaria.

1. Fam. CATENICELLIDÆ, Busk.

1. Gen. *Catenicella*, Blainville.

As usual in collections from the other side of the equator, the Catenicellæ are prominent and abundant. Most of the species in the "Rattlesnake" collection are repeated, and seven undescribed forms occur. One new species belongs to the fenestrate division; the second differs so completely from every described form as scarcely to be referable to any of the formerly characterised groups, though occupying a position to a certain extent intermediate between the two first: four are vittate; and the seventh, though distinctly a Catenicella, and closely allied to *C. aurita* (Busk), simulates to a certain extent the structure of the remarkable genus *Calpidium*.

In this genus, notwithstanding the numerous additions to it, Mr. Busk's original subdivisions retain their natural integrity. *C. alata* fraternises with the typical Fenestratæ. Busk's specimen of *C. aurita* must have been poor. A good example differs so much from the Fenestrate group, and so closely approaches *C. geminata*, which could not possibly be associated with them, that it has been deemed advisable to put the two species provisionally at the end of the list, thus indicating the tendency of *C. geminata* towards the structure of the next genus.

C. Harveyi stands alone a representative of the "Fasciatæ." The position of the ovicell is very characteristic.

The new "Vittatæ" are all normal. In this group there are two modifications of the ovicell: in the greater number it is galeriform and superior, encroaching on the cavity of the cell above it, which is sessile, by a broad base on the ovicelligerous one. Two, *C. taurina* and *C. perforata*, have a globular vesicle sessile on the older cell of a geminate pair.

a.—Catenicellæ fenestratæ, Busk.

1. *C. lorica*, Busk.
2. *C. ventricosa*, Busk.
3. *C. hastata*, Busk.
4. *C. cribraria*, Busk.
5. *C. alata*, n. sp.

Cells pyriform. Fenestræ 5—7.

Irregular grooves pass inwards from the fenestræ, giving the space within a somewhat granular appearance. Lateral processes enormous, consisting of a large hollow conical ascending process, with a pyriform opening in front, a nearly tubular "avicularian chamber" passing outwards opposite the upper third of the cell-mouth, and ending in a minute avicularium; and a wide hollow fringe continued down to the base of the cell, and iregularly perforated in front. Ovicell (?).

The specimen figured is somewhat smaller and more delicate than usual. The cœnœcium does not appear to attain a great size. All the specimens in the collection are parasitical on other Polyzoa, and on red Algæ. Old specimens have often lost their large ascending processes, which gives them a very different appearance.

Bass's Strait; Dr. Harvey. Port Fairy; J. Dawson, Esq.

6. *C. plagiostoma*, Busk.
7. *C. margaritacea*, Busk.

β.—Catenicellæ fasciatæ, Wyv. T.

8. *C. Harveyi*, n. sp.

Cœnœcium forming loose, handsome, curling, brown tufts. Cells large, purely horny, vase-shaped; expanded superiorly by moderately large lateral processes, usually bearing large sublateral avicularia. External membrane thin, loosely investing the inner, and raised into conical papillæ on the front of the cell. Inner membrane strengthened by a raised strap of chitine, continuous with the thickened rim of the cell-mouth, dividing immediately below the lower lip, and forming a ring, again uniting and passing down the middle of the front of its cell to its base; and by similar straps spreading, apparently irregularly, over the avicularian processes, and over the back of the cell. Ovicell calyptriform; sessile by a broad base in the position of one of the avicularian processes of a cell, which it replaces. Back of ovicell furnished with a very large sessile avicularium.

Bass's Strait; Dr. Harvey. A single tuft. This is a remarkable and most distinct species. The cells are nearly as large as, and resemble in form, those of *C. amphora.*

The cell-walls are very evidently formed of two membranes, which remain distinct.

In dried specimens the inner and stronger coat retains its form, while the outer appears to invest it in loose, wrinkled folds, expanding into an irregular projecting frill round the mouth. When the cœnœcium is boiled, to expel the air and expand the tissues, the water passes freely between the two layers, raising the outer wall into distinct papillæ, and showing it loosely hung round the cell.

The true avicularian chamber is a continuation of the inner cell-wall, but the hollow lateral processes, whether cups or spines, are formed of the thin outer membrane alone.

γ.—Catenicellæ vittatæ, Busk.

9. *C. formosa*, Busk.
10. *C. elegans*, Busk.
11. *C. Dawsoni*, n. sp.

Cells rounded, gibbous; lateral processes large, curved forwards and outwards, blunt, with usually a little depression, apparently an abortive avicularium at the apex. Cell-mouth rather small, rounded; operculum prominent. Surface of cell irregularly dotted with minute papillæ. Vittæ broad and short, sublateral near the base of the cell. Ovicell (?).

This species does not seem to attain a large size. There appear to be two varieties, a broader and a narrower, but agreeing in all essential characters.

The broad form occurs of a fine yellow-brown colour, and in great beauty on Algæ from the Freemantle district, Western Australia (Harvey); and the narrower is abundant, of a cinereous gray, on *Ballia* sent from Port Fairy by James Dawson, Esq., of Kangatong, to whom I am indebted for many Australian rarities, and for much curious information.

12. *C. castanea*, n. sp.

Cells ovate, elongated. Superior lateral processes small and rounded; united above the cell-aperture by a *smooth* prominent ridge; the lateral processes continued round the lower angles of the mouth, so as almost to form a corresponding ridge beneath.

Cell-mouth small and round. Operculum very thick. Avicularia small, lateral; vittæ linear, lateral, extending nearly the whole length of the cell. Ovicell (?).

Cœnœcium forming graceful curling tufts. Cells of a rich chestnut hue, contrasting well with the bright red of the fibrous compound stem. Allied to *C. gibbosa* (Busk), which does not occur in the collection.

Bass's Strait; Dr. Harvey.

13. *C. umbonata*, Busk.
14. *C. crystallina*, n. sp.

Cells subglobular, pyriform, fringed on either side by a wide hollow border, spreading upwards, outwards, and slightly forwards, into large lateral processes, frequently furnished with small lateral avicularia, seated in cup-like depressions.

Two arched markings, very constant in form, traverse this wide portion of the lateral process, which is continued downwards in a hollow fringe to the base of the cell.

Cell-aperture large; rim slightly prominent. Vittæ long and well marked, sublateral, and extending nearly to the level of the lower lip. Front of cell studded with elevated papillæ, and whole surface ornamented with delicate diverging lines, which give the cœnœcium a beautiful glistening appearance. An elevated ridge runs down the middle of the back, the lateral portions falling off like the roof of a house, giving the transverse section of the cell a somewhat triangular outline. Ovicell unknown.

Parasitical in delicate glassy tufts on Polyzoa.

Bass's Strait; Dr. Harvey.

A very distinct and beautiful form. The arches in the hollow wings seem to be lines along whose course the membranes of which the opposite walls of the wings are composed are in contact. In the Vittatæ generally the double cell-wall is by no means so distinct as in the fenestrate group. There are, however, frequent indications that the structure is the same.

The vittæ seem to be rows of bead-like spaces between the layers.

15. *C. Buskii*, n. sp.

Cells almost cylindrical, slightly contracted towards the truncated base. Connecting horny tube very short. Superior lateral avicularian processes represented by longer or shorter slightly retrocedent spines, or by open lacerated cups usually bearing small avicularia at the base. Spines longer in the newer cells towards the ends of the branches. Cell-mouth small and round. Vittæ linear, sublateral, extending nearly the whole length of the cell. Front of cell slightly tubercular. Ovicell galeriform, superior; anterior surface slightly concave, bordered above by a projecting crescentic beaded rim; posterior surface convex, encroaching on the cavity of the next cell, against which it is cemented, and which is sessile on the ovicelligerous cell.

Probably allied in habit to *C. taurina* (*Busk*), as its resemblance to *Thuiaria thuia* is remarkable. Cœnœcium very calcareous.

Bass's Strait; abundant; Dr. Harvey.

16. *C. perforata*, Busk.

Bass's Strait; abundant; Dr. Harvey.

The ovicell of this pretty species resembles that of *C. taurina* (Busk). It is galeate, tuberculate, sessile on the apex of one of the cells of a germinate pair.

δ.—*Catenicellæ simplices*, Busk.

17. *C. carinata*, Busk.

New Zealand; Dr. Joliffe.

ε.—*Catenicellæ auritæ*, Wyv. T.

18. *C. aurita*, Busk.

Bass's Strait and Fremantle; Dr. Harvey. Port Fairy; J. Dawson, Esq. New Zealand; Dr. Joliffe.

Fine specimens have the front richly tuberculated. Three or four tubercles below the mouth are perforate; but there is no approach to the true fenestrate character.

19. *C. geminata*, n. sp.

Axial cell geminate. The secondary cell developed alternately on either side of the axis. Axial cells pyriform; a large gaping avicularium on the angle opposite the secondary cell. Secondary cell giving off by a terminal horny tube a single wedge-shaped peripheral cell. Cell-mouth large; a deep notch in the centre of the lower lip. In the primary and secondary axial cell four or five blunt spines surround the upper margin of the mouth, which is surmounted in the peripheral cells by two longer ear-like processes. Front of cell tuberculated. Ovicell unknown.

A small species, apparently generally distributed in the Australian seas. Epiphytic on red Algæ.

Bass's Strait and Fremantle; Dr. Harvey. Port Fairy; Mr. Dawson. New Zealand; Mr. Joliffe.

Had it not been for its close resemblance to *C. aurita* (Busk), evidently a true Catenicella, and with which it often grows associated, one might have almost been inclined to consider this curious little form the type of a new generic group, or an aberrant species of the genus Calpidium. As in Calpidium, the cells have two "key-holes;" but a single glance must satisfy us that the cell consists of a primary and a secondary chamber, bearing the same relation to one another that the two cells of a germinate cell bear at a bifurcation in any of the other species of the genus. *C. geminata* bifurcates at every cell, so that all the axial cells are germinate. The septum between the cells is traced on the back of the cell by a deep groove in the usual position. The back of the primary cell, both in this species and in *C. aurita,* is frequently perforated to give origin to a horny, tubular tendril. The secondary cell sometimes gives off a secondary axis, but more usually only a single wedge-shaped cell, apparently partially abortive. The cœnœcium is very calcareous, and becomes very thick with age, a calcareous deposit obliterating all the markings. The horny connecting tubes between the cells are unusually long.

2.—Cothurnicella, n. g.

Cells in simple rows, each row arising from the side of a joint of an articulated stem, each cell springing from the upper and back part of another by a short horny tube. Cells all facing the same way.

Cell-mouth provided with a moveable operculum. Ovicell an ordinary cell of a series, much enlarged, but scarcely modified in form.

C. dædala, n. sp.

The only known species.

This genus seems to have a sufficient number of characters in common with Catenicella to warrant its admission into the same family. It is, however, at once distinguished from the rest of the Catenicellidæ by its simple rows of cells arising regularly from the joints of an articulated stem. The joints of this stem appear to be abortive cells. The last joint of one branch is often dilated into a cell, while the other branch ends in a single or double tendril of narrow joints, and the final cell of a row is frequently capped by a similar tendril, representing a continuation of the series. In *C. dædala* the stem is at first simple, then makes a single bifurcation, and the cells start in straight rows, a row from the inner aspect of each joint of each branch, so that the triangular space within the fork is closely strung, like a harp, with parallel strings of cells. The anterior aspect of the cell is narrow and slipper-shaped.

The mouth is placed near the top of the cell, large and crescentic, with a thin projecting upper rim. A movable semicircular operculum, with a raised edge, covers, or hangs below, the cell-mouth. The operculum has at its base on either side a projecting triangular catch, which fits into a notch in the lip. One would almost expect this apparatus to shut with a snap like the clasp of a purse, it is so nicely fitted, and so eminently mechanical-looking.

Below the cell-aperture a long, depressed area stretches nearly to the base of the cell. The cell is much compressed laterally; the side view is much broader, and almost reniform. The cell-wall is double throughout, with a wide space between the layers, thus forming two distinct chambers, the inner not even resembling the outer in form. The anterior depressed area is formed by the outer layer alone, so that beneath there is still another space before reaching the inner wall. In the centre of the area a tube passes through this space, uniting two corresponding apertures, one in either membrane, and thus communicating directly with the interior of the cell. The side view shows the inner chamber as a doubly bent expansion of the common tube of the cœnœcium.

Here and there one of the cells of a row is about double the size of the rest. These large cells have their opercula always closely shut. They are slightly more gibbous than the others, but scarcely differ from them in form. They are, doubtless, the ovicells.

The cœnœcium is small and delicate, very calcareous, with a beautiful pearly lustre. Parasitical on Fucoids.

Fremantle District, Western Australia (Dr. Harvey).

Subsect. 2 Bi-Multiserialaria.

2. Fam. Salicornariadæ, Busk.

1. *Salicornaria*, Cuv.
   1. *S. tenuirostris*, Busk.

2. *Nellia*, Busk.
   1. *N. oculata*, Busk.

3. *Onchopora*, Busk.
   1. *O. hirsuta*, Lamx. sp.?

3. Fam. Cellulariadæ, Busk.

1. *Cellularia*, Pallas.
   1. *C. cuspidata*, Busk.

Abundant; Bass's Strait; Dr. Harvey. New Zealand; Dr. Joliffe.

A very variable species. In one form the spine on the median cell at the bifurcation is absent, and in another there are two to three orifices in the back of the cell.

2. *Menipea*, Lamx.

Cells oblong, abbreviated, or elongated and attenuated downwards; imperforate behind with a sessile lateral avicularium (frequently absent), and with one or two sessile avicularia (also frequently absent) on the front of the cell. Ovicell globular, immersed in the internode.

This genus requires careful revision. It is said to be distinguished from Emma (Gray) by the structure of the cell-mouth, which is subtriangular in the latter genus, the opening being partially filled up by a tubercular calcareous plate; and by the position of the lateral avicularium, which in Emma is entirely below the cell-aperture; while in Menipea it is seated, when present, on the upper and outer angle of the cell.

The two new species are so completely intermediate that I believe I am justified in uniting the Emmæ with the true Menipeæ into what I conceive to be a most natural generic group. *M. ternata* (Ellis) may be taken as a type of the genus thus constituted. *M. Fuegensis* (Busk) approaches it closely. The avicularia are still at the upper angle of the cell, and the cell-lip is still simple. The operculum, however, is reduced to a curved spine. In *M. Buskii* the lip is more projecting, and the calcareous plate which partially covers the cell-mouth is tuberculated. The lateral avicularium is slightly depressed, though still opposite the upper third of the aperture. The opercular spine is again expanded.

M. tricellota closely resembles the last in habit, but the tuberculated plate round the mouth is still more fully developed, the lip is more elevated, and the much smaller lateral avicularium is below the cell-mouth. The operculum is again reduced to a rudimentary spine.

M. cyathus is binate, the cell-mouth large and simple, as in *M. ternata;* the lateral avicularium very large half way down the cell-mouth. The operculum once more expanded and branched. It almost requires a microscope to distinguish *M. crystallina* (Gray) from the last—they are so similar in habit and general appearance; but in *M. crystallina* the expanded operculum is again absent, the lateral avicularia are reduced in size, and seated near the base of the cell, and the cell-mouth is again contracted by a granular calcareous plate.

The right of this genus to the name of Menipea depends upon the retention in it of the six-celled species, *M. cirrata* (Lamx.), of the propriety of which I think there can be little doubt. The general character is still remarkably the same. In *M. cirrata* a smooth plate covers the cell aperture, the lower part calcareous and fixed, the upper portion a movable, crescentic, horny operculum, closing over the true opening. I have not seen *M. Patagonica* (Busk), and from the figure I am more doubtful as to its position. All the species are distinguished by the presence of one or more sessile avicularia on the front of the cells, and by the remarkable hollow curved spines attached round the upper lip of the cell-mouth by horny joints.

This group does not seem to "fruit" freely. I do not know the ovicell even in our common British species, *M. ternata* (Ellis); but fortunately Dr. Harvey's collection contains a branch of *M. Buskii* from Bass's Strait, bearing several; globular, the surface granulated, immersed among the cells in the middle of the internode. One can scarcely doubt that all these closely allied forms have similar reproductive organs, and, if so, the ovicells will give an excellent generic character.

M. triseriata (Busk) and *M. multiseriata* (Busk), which have their ovicells galeate and superior, like those of Scrupocellaria, must seek other congeners.

I do not consider it necessary to subdivide the genus.

1. *M. cyathus*, n. sp.

Cells very short and round; two in each internode, one a little above the other; cell-mouth large, oval, oblique; rim slightly thickened, five to six spines round the upper and outer margin; the lower three, large, curved, hollow, and pod-like, attached by a horny joint to the thickened lip. Opercular spine expanded, branched, spreading downwards and outwards from the upper and inner lip of the cell-mouth. A large sessile lateral avicularium opposite the centre of the cell-aperture. Frequently an anterior sessile avicularium between the two cells of the internode. Internodes distant, a connecting horny tube extending from the apex of a pair of cells, upwards and backwards, and slightly dilating as it enters the lower cell of the succeeding pair by its anterior aspect.

There is constantly on the front of the upper of the two cells a ring-like marking, usually filled up with a calcareous plate, but frequently giving off a horny, tubular tendril. At a bifurcation of the cœnœcium a third cell is introduced into the primary internode between the two secondary branches. Ovicell unknown.

A delicate parasitical species, twining its long tendril-like branches round zoophytes and red sea-weeds.

Bass's Strait; Dr. Harvey. Port Fairy; Mr. Dawson.

2. *M. crystallina*, Gray.
3. *M. Fuegensis*, Busk.
4. *M. Buskii*, n. sp.

Cells elongated, attenuated downwards, three in each internode. Cell-mouth large, oval, oblique, the lower third filled up by a tuberculated calcareous plate; upper lip prolonged, and fringed with from four to five spines, attached to the lip by horny joints, and one of them, usually the second from the outer edge, very long, curved, and pod-like. There is often an additional spine on the upper and inner margin of the cell-mouth. Operculum spine strong and clavate, stretching upwards and outwards from the lower and inner lip of the cell-aperture. Connecting horny tube between the internodes double. Ovicell spherical, with a richly granular surface, imbedded among the cells, on the cavities of two of which it encroaches.

Van Dieman's Land; rather abundant, and in fine condition: Dr. Harvey. New Zealand; abundant; Dr. Joliffe.

5. *M. tricellata*, Busk.

3. *Scrupocellaria*, Van Beneden.

a.—Operculatæ.

1. *S. scrupea*, Busk.

Frequent on Algæ and Polyzoa.
Bass's Strait; Dr. Harvey. New Zealand; Dr. Joliffe.

2. *S. ornithorhyncus*, n. sp.

Cell-mouth rather small, oblique, a tuberculated crescentic plate below the lower lip. Upper margin fringed with four to five long spines; pedunculate operculum prolonged upwards into a spine, which, with the superior spines, almost completes the circle round the true opening of the cell. Lateral avicularia very large. Vibracula small and obscure. Ovicell smooth.

A delicate transparent species, frequent, in small tufts, on sea-weeds and Polyzoa.
Bass's Strait; Dr. Harvey.

4. *Canda*, Lamouroux.

1. *C. arachnoides*, Lamx.

Sect. 2. Continua.

Subsect. 1. Uniserialaria.

4. Fam. Scrupariadæ, Gray.

1. *Scruparia*, Oken.
   1. *S. chelata*, L.

2. *Hippothoa*, Lamouroux.
   1. *H. Patagonica*, Busk.

3. *Ætea*, Lamouroux.
   1. *A. anguina*, L.
   2. *A. ligulata*, Busk.

Subsect. 2. Bi-Multiserialaria.

5. Fam. Farciminariadæ, Busk.

1. *Farciminaria*, Busk.
   2. *F. aculeata*, Busk.

6. Fam. Gemellariadæ, Busk.

1. *Didymia*, Busk.
    1. *D. simplex*, Busk.

2. *Dimetopia*, Busk.
    1. *D. spicata*, Busk.
    2. *D. cornuta*, Busk.

3. *Calwellia*, n. g.

Cells in pairs, joined back to back. Each pair of cells arising by tubular prolongations from the pair next but one below it. Each pair having a direction at right angles to the next. At a bifurcation each cell of the primary pair giving off a secondary pair. Ovicell subglobular, placed immediately above and behind the posterior margin of the cell-aperture.

1. *C. bicornis*, n. sp.

The only known species.

This genus supplies another link in the beautiful chain of modifications in the arrangement of cells in pairs furnished by the Gemellariadæ. By combining one of the peculiar characters of Notamia with a genera, appearance closely resembling Dimetopia, it affords another reason for retaining Notamia in the group, bearing, in fact, with the exception of the total absence of avicularia, the same structural relation to Notamia which Dimetopia bears to Gemellaria. The lower half of each pair is contracted and tube-like, the two lobes of which it is composed separating and curving over the walls of the inflated triangular upper half of the pair immediately beneath it. The cœnœcium is thus formed of two incorporated, independent rows of pairs of cells, all the cells of each row being in the same plane, but at right angles to all the cells of the other row. This somewhat complicated structure might be better understood, as the author states, if the reader would imagine another exactly similar double-stem incorporated at right angles with fig. 2*a*, Plate IX of the original memoir.

The cell-mouth is small, nearly horizontal on the upper surface of the cell. The margin is thickened, rising at the outer angles of the nearly straight lower lip into a pair of strong, incurved, blunt spines. The cell-wall seems to consist of two membranes, and round the lower lip and at the base of the spines there are a few small, oval and round, fenestræ, passing apparently through one layer only. A small, granular, perforated papilla rises immediately below the cell-mouth, the oval aperture passing right through the cell-wall.

The ovicell is immediately above and behind the m oh of the cell, cemented against the triangular side of the pair of cells above, subspherical, slightly compressed, and beautifully marked, as if stamped with a miniature clam-shell.

The cœnœcium is very calcareous, forming delicate pure white, bushy tufts, about half an inch high.

It occurs sparingly with *Cellularia cuspidata* and *Dimetopia cornuta*, parasitical on *Catenicella ventricosa*.

Bass's Strait; Dr. Harvey. And on *Catenicella hastata*. New Zealand; Dr. Joliffe.

ORIGINAL COMMUNICATIONS.

Descriptions of Diatomaceæ *observed in* Californian Guano. By R. K. Greville, LL.D., F.R.S.E., &c.

It is well known that in studying *Diatomaceæ* as they occur in guano and in deposits, the observer labours under great disadvantages. The materials he has to work upon are often scanty, and forms which attract his attention are sometimes so scarce that he is obliged to review with the utmost care a multitude of preparations before he can arrive at a satisfactory conclusion regarding them. The conditions so well laid down by Professor Smith, as requisite for the determination of species, are in such cases, to a considerable extent, beyond his reach. It has consequently been a question whether any Diatom ought to be described except from recent, and, in some genera, actually living individuals. Undoubtedly it would be always desirable to conform to such a rule when practicable; but so many justifiable exceptions present themselves, that it can never be enforced as a positive law. The best writers on this most interesting order, even Professor Smith himself, occasionally deviate from it. Witness his description of *Himantidium* (?) *Williamsonii,* made from specimens insufficient to determine even the genus; for he had only the front view of the frustules before him. Professor Gregory supplied the deficiency by figuring the side view, and still the genus is not settled. Nevertheless, it was unquestionably desirable that we should possess good representations of so very curious a production. Were we rigidly to confine ourselves to those species only, whose history as living vegetables we have the means of tracing, many of the most curious and beautiful forms on record—even entire genera—would have to be expunged from our books; such, for example as *Heliopelta, Asteromphalus, Asterolampra,* &c. The truth is, that while many frustules occurring in deposits require to be described—if described at all—with extreme caution, numerous others, especially of disciform genera, exhibit at least sufficiently marked distinctive characters. All that can be said, I apprehend, against the description of such diatoms is that from the very nature of the case we are unacquainted with their history. Something, nevertheless, it must be admitted, is gained by the publication of accurate figures; for even if they fail in some cases to establish species, they will at least assist to indicate the range of variation, a point in itself of no small importance.

The prepared material of the Californian guano — the richest in diatomaceous forms which has come under my notice, and which has yielded, among many others, the species described in this paper—was kindly supplied to me by Mr. J. T. Norman, of Fountain Place, City Road, London.

Cocconeis, *Ehr.*

C. regalis, n. sp., Grev.—Frustule orbicular; striæ moniliform, 5 in ·001″, occupying an elliptical space in diameter about a third of the entire valve, the rest of the valve filled with several rows of large granules concentric with both the sides and extremities; diameter ·0030″. (Pl. VII, fig. 1.)

In Californian guano.

The most splendid species perhaps of the beautiful genus to which it belongs. The elliptical space occupied by the few coarse striæ stops considerably short of the margin of the valve at each end, so as to admit of the rows of granules, which diminish in size as they approach the extremities, being continued round the whole valve. The granules are very large and prominent, and have much the effect as if they were the terminations of successive series of striæ curving up from below to the surface. Some of the granules in the outer row are double and occasionally irregular. This fine species seems to be most nearly allied to *C. Grevillii*, a cosmopolitan Diatom, to which, in the structure of the upper valve, it bears a considerable general resemblance.

Aulacodiscus, *Ehr.*

A. Oreganus (fig. 2), Harv. and Bail., 'Proceed. of Acad. Nat. Sc. of Philadelphia,' vol. vi. p. 430.

At Puget's Sound, Oregon, U.S., Exploring Expedition under Captain Wilkes. In Californian guano.

Of this exquisite disc no figure has been published. The single example I have found in Californian guano agrees minutely with specimens received from Professor Bailey in 1856, except in the number of radiating lines and nodules. Professor Bailey, in the specific character given in the work above quoted, fixes the number at thirteen. But of the two specimens which occur in the slide he sent me, one has nine nodules, the other fifteen; while the individual I have drawn contains twelve, a striking instance how little dependence can be placed on this character. Some species whose normal number of nodules is four, occasionally show, as is well known, three or five. Professor Bailey defines the structure in the present species as "minute punctata;" but when magnified to the scale adopted in the accompanying illustration, it is, although minute, distinctly areolate to the eye. The diameter of the valve is about ·0045″.

Campylodiscus, *Ehr.*

C. stellatus, n. sp., Grev.—Valve orbicular; canaliculi numerous, forming a narrow marginal band; striæ radiating in fasciculi from the centre, and interrupted about half-way to the margin by an angular ridge and a row of very minute puncta; diameter ·0044″; canaliculi 10 in ·001″. (Fig. 3.)

In Californian guano.

Few genera exhibit more varied sculpture than *Campylodiscus*; as may be seen by glancing at the species figured in the 'Synopsis of the British Diatomaceæ,' at those described by Professor Gregory in the 21st volume of the 'Transactions of the Royal Society of Edinburgh,' and at the two very remarkable ones given by myself in Pl. III of the 5th volume of this journal. The present species differs from them all in the peculiar ornamentation of the centre of the valve. I have called the centrical radiating lines striæ, as they seem to be of a different nature from the canaliculi which form the external border; it must be admitted at the same time that they appear to pass into the broad band intermediate between them and the border. As the striæ proceed from the centre others originate at irregular intervals between them; and at about half-way between the centre and the circumference an interruption occurs in the shape of a rather sharp ridge, on which is disposed an irregular row of very minute puncta, which require careful focussing to bring out. The more definite striæ (canaliculi?) which compose the intermediate broad band, are transversely undulated, giving them a semi-moniliform character, in this respect resembling the corresponding band in *C. limbatus*. Indeed, were the central radiating striæ absent, the frustule would approach very near to that species.

Asteromphalus, *Ehr.*

The genus *Asteromphalus* was described by Ehrenberg in 'Berlin Monatsberichte,' 1844, p. 198, where he defines seven species, all collected in the Antarctic regions during the voyage of H.M. Discovery ships Erebus and Terror, by Dr. Joseph Hooker, the talented and indefatigable naturalist of the expedition. The specific differences are founded by Ehrenberg, and subsequently by Kützing ('Sp. Alg.,' 1849), on the number of "marginal rays" and on the straight or crooked direction of the "umbilical rays." In 1856 another species was described by the late Professor Bailey ('Amer. Journ. of Science and Arts,' vol. xxii, p. 1), and named by him *Brookei* in compliment to Lieutenant Brooke of the U.S. Navy, who obtained it from a depth of 1700 fathoms in the Sea of Kamtschatka. Professor Bailey derives his specific character from the "umbilical rays," placing no dependence whatever on *number*, either in the present genus or in the "allied forms of *Asterolampra, Heliopelta, Actinoptychus, Actinocyclus*, &c."

If this view regarding number be correct, and it is now being very generally adopted, the Antarctic species of *Asteromphalus* will probably have to be reduced; but in the absence of authentic specimens it is impossible to speak with any certainty. In his 'Mikrogeologie,' tab. xxxv (xxi), Ehrenberg has figured four out of his seven species, and it is remarkable that in every instance the "umbilical rays" are represented as all given off from the very extremity of the "base of the median line," or, if De Brébisson's view be received, who does not recognise "umbilical rays," the enlarged bases of the rays meet at one point, however numerous they may be, and are not planted along the sides as well as on the apex of the base of the median ray, as is the case in every species more recently discovered. It would be interesting to know whether, in all the Antarctic species, the apex of the base of the median ray is precisely centrical as represented in the 'Mikrogeologie;' and whether the "umbilical rays" invariably arise from that point.

Early in 1857 De Brébisson proposed his new genus *Spatangidum* ('Bulletin de la Société Linnéene de Normandie,' vol. ii), for the reception of certain forms nearly allied to *Asteromphalus*, which he had observed in Peruvian guano. His character is in the following terms:

"SPATANGIDUM, Bréb.—Lorica simplex, bivalvis, suborbicularis, valvula una convexiore. Discus cellulosus vel granulosus, uterque stellæ excentricæ radiantis notatus, radiis (ambulacris) lævibus."

His great mark of distinction is the excentrical position of the rays; but I fear that this character cannot in every case be relied on. I have seen various discs where it was scarcely possible to determine whether the rays were centrical or excentrical. The outline also of the valve is subject to variation. When it is more or less ovate, the rays are excentrical; but when the valve (in the same species) becomes more nearly orbicular, the rays then become more centrical. I am now speaking more particularly of those species which have a granulated structure and general diaphanous appearance. In *Spatangidum Arachne* and *S. heptactis* of Brébisson, the rays are always more or less excentrical, and seem to constitute a really permanent character, which, taken in connexion with the more important difference of structure, viz., the distinct areolation, will justify, I think, the separation of these two species from *Asteromphalus.*

With regard to the parts of the valve on which specific value may be placed in the two genera, we must be guided by the results of extended observation. I am inclined to believe that, closely as these genera are allied, the same parts are not of equal value in both. In *Spatangidum,* as I propose to restrict that genus, the number of the rays in the several species seem to be constant. The rays themselves afford good characters, as well as the lines of the hyaline area (umbilical rays of authors). In *Asteromphalus,* on the other hand, the radiating lines of the hyaline area (including their insertion on the nucleal line) seem alone to furnish reliable distinctions. In studying the composition of these beautiful discs, of both *Asteromphalus* and *Spatangidum,* I have been led to take the view of Kützing, who considers these radiating lines as "sepimenta imperfecta." They terminate abruptly, precisely as in *Asterolampra.* The true rays may be said to commence from the outer edge of the hyaline area, for they are merely blank spaces in the areolation or granulation of the disc. It is true that as the intervals between the lines of the hyaline area are a sort of continuation of these blank spaces, they may, in this point of view, be considered as the "enlarged bases" of the rays, and thus, according to De Brébisson's idea, be directly imposed on the "base" of the median ray, or, as I prefer to call that part, the nucleus or nucleal line. In *A. Brookei,* however, such an arrangement can take place to a very partial extent, as Professor Bailey describes the "umbilical rays" as "flexuose, some simple, others branched, or two or more uniting before reaching the centre." These lines are also occasionally forked in a species I have found in South African guano. It seems to me, therefore, advisable to take such characters as the lines of the hyaline area afford independently of the rays.

In accordance with the views which I have expressed, I now propose the following modification of the generic character of *Asteromphalus.*

Asteromphalus, Ehr.—Frustules simple, two-valved, disciform, finely granulated; each valve marked with acuminated rays, proceeding from a centrical or excentrical hyaline area, the median ray very narrow.

I would here place the species described by Ehrenberg and Bailey, and also *Spatangidum flabellatum* and *S. peltatum* of De Brébisson. There is, in fact, no character whatever to separate the last two from this genus, except the excentrical hyaline area, which, as I have already stated, is sometimes an extremely ambiguous distinction. The *Asteromphali* are very hyaline and delicate, the rays acuminate, and the structure minutely granulate. In natural habit they all agree. I have detected in Californian guano certainly two species; one new, the other possibly a variety of *A. flabellatus;* but I speak on this point with considerable hesitation. Indeed, I find it difficult to draw a satisfactory line between *A. flabellatus* and *A. peltatus.* The former, according to De Brébisson, has some of the rays subarcuate. The specimen (fig. 4) appears to be identical, only the rays are all straight. I have also represented, at fig. 5, another more perplexing form. It will be perceived that it is nearly quite orbicular, and that the hyaline area is very nearly centrical, and, as in the last illustration, the rays are all straight. I cannot, however, see how this can be separated from *A. flabellatus,* because the previous variety seems to form the connecting link. I may here mention, that I have a beautiful frustule, origin unknown, ovate in outline, with a very excentrical hyaline area, and eight rays, one of them short, and opposite to the median ray, as in *A. peltatus;* the rest decidedly arcuate. If the number of rays be immaterial, this will also have to be referred to *A. flabellatus,* as well as another now before me with nine rays. In two specimens of a fine species obtained from South African guano, the frustules of which are very nearly orbicular, and the hyaline area not far from being centrical, there are ten rays, all of which are straight; but the two lower lateral lines of the hyaline area on each side are *arched* downwards (the median line being directed towards the spectator). The granulation of the disc is also larger. This is probably a distinct species. I would not venture, in the absence of authentic examples, to say anything further regarding *A. peltatus.* The short ray being in the same direction with the median ray and nucleal line, contributes to give the "subpinnate" character to the four pairs of lateral rays which De Brébisson has noticed; but we must keep in mind that, if instead of the short middle ray, *two* were introduced, as in figs. 4 and 5, the subpinnate character would be lost.

A. elegans, n. sp., Grev.—Radiating lines of the hyaline area with an angular bend in the middle, and inserted on the end and sides of the nucleal line; diameter of disc ·0030″. (Fig. 6.)

In Californian guano.

I have only seen one example of this most beautiful species. It is very nearly, though not quite perfectly orbicular, and the hyaline area is almost centrical. The rays, thirteen in number, are equidistant. As, however, all these features are liable to variation, I have not introduced any of them into the specific character.

Spatangidium, *Bréb.*

It is with no trifling degree of hesitation that I venture to dissent, in some measure, from so eminent an authority as De Brébisson; and it will afford me much satisfaction if, on a revision of the subject, he shall approve of the manner in which I have modified his genus.

Spatangidium, Bréb.—Frustules simple, two-valved, disciform, distinctly areolated; the valves marked with rays proceeding from an excentric hyaline area, the median ray very narrow.

In this genus I retain *S. Arachne* and *S. heptactis* of De Brébisson, both having a distinctly areolated structure. The former has a broadly ovate form, the rays five, and very excentric; the latter, according to De Brébisson's figure, being slightly larger, more orbicular, but still somewhat ovate, with seven rays, "subarcuatis obtusis," which are as decidedly excentric as those of the other species.

I have now to describe an additional species of great beauty which I find not unfrequently in Californian guano; it has also been obtained from Peruvian (Bolivian) guano by Mr. George Norman, and it also exists in slides of Peruvian guano kindly communicated by Professor Walker-Arnott. Mr. Norman having named it in MS. in honour of our mutual friend Mr. Ralfs, I gladly give him due precedence.

S. Ralfsianum, n. sp., Norman.—Greatest diameter of the valve transversely to the median ray; rays seven, six of them broad linear, terminating at the margin in a narrow, lunate fold of the valve. Diameter ·0018″ to ·0070″. (Figs. 7, 8.)

In Californian and Peruvian guanos.

This noble Diatom is of a pale-yellowish colour, somewhat variable in outline, but, as a general rule, the transverse diameter is the greatest, so that one pair at least of the lateral rays are longer than the median ray, the length of the latter, as well as the former, being calculated from the edge of the hyaline area to the margin of the disc. The rays are uniformly seven in number, and (excluding the median ray) of equal width to the very ends, where they terminate abruptly under a narrow lunate fold of the valve. The median ray, before reaching the margin, passes along a broad shallow groove or channel, and terminates in a similar, though deeper fold of the valve. The rays, though typically somewhat arcuate, are occasionally straight; and although their excentrical position can always be traced, the fine individual I have drawn at fig. 7 will serve to show how nearly centrical they sometimes become, and how nearly the valve may approach to an orbicular outline. Each ray is bordered with a row of areolæ larger than the rest, especially the median ray, where they increase in size towards its extremity. The areolation is very distinct, coming out strong and hexagonal under a sufficiently magnifying power.

In certain characters this species comes near to *S. heptactis*, viz., in the number of rays, in their being linear and subarcuate, and in the "angular sinuosity" of the lines of the hyaline area; a character referred to by De Brébisson, although not introduced into his figure. On the other hand the form of the valve is the reverse of that of *S. heptactis*; as I have never seen it otherwise than broadest in the transverse direction and consequently with the median ray *not* the longest. Fig. 8 represents this typical form. A more important differential character lies in the singular termination of the rays in a marginal recess or fold of the valve, which would scarcely have escaped so acute an observer as De Brébisson had it existed in *S. heptactis*. It will be seen from the figures that the radiating lines of the hyaline area are curiously ramified; the main lines being sharp and strong, while an obscure branch proceeds from each angle to the base of the ray next to it. In bringing these remarks to a close, I may state that, although size is of little consequence in a rigid diagnosis of Diatomaceæ, *S. Ralfsianum* is a gigantic form as compared with *S. heptactis*.

ACHNANTHES, *Bory*.

A. angustata, n. sp., Grev.—Front view of valve very narrow; length ·0060″; breadth ·0004″; striæ 24 in ·001″. (Pl. VIII, fig. 9.)

In Californian guano.

I regret that I have had no opportunity of examining the side view of the frustule; but there can be, nevertheless, little doubt of the species being distinct from any of those previously described. The striæ agree in number with those of *A. subsessilis*; the relative length and breadth, however, of the valve, as seen in the front view, is so widely different from the proportions of the species above mentioned, that the possibility of its being a variety cannot be entertained.

BIDDULPHIA, *Gray*.

B. longicruris, n. sp., Grev.—Valve on front view with a central inflation, bearing a solitary, very long spine; angular processes very long, awl-shaped; structure minutely granulate. (Fig. 10.)

In Californian guano.

After the warning contained in the admirable Monograph of *Biddulphia* so recently published by Mr. Roper, not to multiply species without having seen the frustule under its various aspects, how shall I venture to transgress so wholesome a rule in the present instance? All I can say is, that the frustule of which I now offer a figure is so far removed from any of the species now established, that I find it quite impossible to refer it to any of them. *B. aurita* is its nearest ally; but if we adopt the character of that species as laid down by Professor Smith and Mr. Roper, we find the valve to possess a central elevation or inflation, on which are situated two or three or more spines. The angular processes, according to Smith, are "horn-like, obtuse, inflated at the base." In the frustule now before me, the central elevation bears only a single spine, and that much longer and stronger than it ever occurs in *B. aurita*; in fact, it is as long as the diameter of the entire frustule. Then the angular processes are also very long, somewhat acute, awl-shaped, without any inflation at their base. These distinctive marks, which, being as well seen in the front as in the side view, will, I trust, justify me in giving it at least a provisional place until materials for a more perfect description shall be obtained.

B. Roperiana, n. sp., Grev.—Valve elliptical-oval, with a central elevation, which, as seen in the front view, is depressed or sometimes bilobed, punctate, unarmed; angular processes very short and obtuse, largely inflated at the base; connecting membrane with rows of minute dots parallel with the suture of the valve. (Figs. 11—13.)

Monterey, California; George Norman, Esq. In Californian guano.

This species appears to be removed from all the varieties of *B. aurita* by the absence of spines, and by the very depressed, often two-lobed central elevation of the valve. It differs also in the more distinctly punctate structure; in the more conspicuous rows of dots in the connecting membrane, and in the angular processes being much shorter and more obtuse or rounded; they are, indeed, sometimes so short, as to scarcely rise above the level of the central elevation, in which case the process and its inflated base appear almost like two lobes of the same organ (see fig. 12). The species has, like some of its congeners, a large range with regard to size, and the punctate structure is fine or coarse in proportion to the development of the frustule. Fragments of individuals have occurred to me considerably larger than those I have represented. At all times it appears to be a much larger form than *B. aurita*.

Since these observations were written, Mr. George Norman has kindly sent me a slide of *Diatomaceæ*, from Monterey, which he believes to have been collected from sea-weed. It contains, besides *Biddulphia turgida* and other things, several frustules of *B. Roperiana*, agreeing minutely with those I had found in the guano.

I have much pleasure in dedicating to the acute and judicious expositor of the genus *Biddulphia* this very beautiful new species.

Cresswellia, *Arn.* and *Grev.*

In the 'Transactions of the Royal Society of Edinburgh,' vol. xxi, I have assigned the reasons which led my friend Professor Walker-Arnott and myself to propose a new genus for the reception of the Diatom we there described and figured under the name of *Cresswellia turris*. I may here briefly state that Ehrenberg, having found that his original definition of the genus *Pyxidicula* ('Die Infusionsthierchen,' p. 165) required revision, constituted three sub-genera, *Dictyopyxis*, *Stephanopyxis*, and *Xanthopyxis* ('Bericht. der Berl. Akad.,' 1844, p. 262, et seq.) It must be admitted, however, that so very little was known of the forms thus associated, that these sub-genera resembled artificial sections, adopted for mere convenience, rather than well-defined genera; and

Kützing seems to have been under this impression, when he reunited the whole under the old name ('Sp. Alg.,' 1849). But this proceeding had only the effect of perpetuating for a time the union of a number of objects whose history and habits continued to be enveloped in mystery, and many of which had manifestly no real affinity with each other. Were we now constrained to select one of Ehrenberg's sub-genera as a resting-place for *Cresswellia turris*, and another species to be immediately described, we should have to take *Stephanopyxis*, of which the author gives the following character:

"*Pyxidiculæ* generis bivalves turgidæ aut subglobosæ formæ, quæ valvularum testæ structura cellulosa insignes sunt et denticulorum, aculeorum aut membranæ coronam in media quavis valvula gerunt in hoc *Pyxidiculæ* subgenere colliguntur."

Now this character was prepared with special reference to certain existing forms; and if we examine these forms, we shall perceive how indefinite the character becomes. *St. appendiculata* ('Mikrogeol.,' tab. xviii, fig. 4) is distinguished by the valves being furnished with only a single short blunt horn "extra medium posito." *St. cristata* (l. c., tab. xviii, fig. 6) appears to have a sort of limbus surrounding the whole frustule,—nothing in the shape of a "corona" of any kind. *St. aculeata* is said to be "undique parvis aculeis hispida, nec cellulosa." With regard to the only remaining species, *St. diadema*, of which no figure has ever been published, it would appear to come generically nearer to our *Cresswellia turris*, but we are not aware that it has been seen in a perfect state or whether the frustules are united in chains. Kützing, in his generic character, says positively of all the *Pyxidiculæ* that they are "non-concatenata," thereby excluding *Cresswellia*. Upon the whole, therefore, seeing how ill the species of *Stephanopyxis* agree generically among themselves, and that we do not even know which of them was regarded as the type, we think that by establishing the genus *Cresswellia* we have adopted the only course open to us. It was impossible for us to place our new Diatom in *Stephanopyxis* without altering the character to such an extent, that while the new species was admitted, all those for which it was actually constituted would be either excluded, or at best doubtfully retained. Such a proceeding would have been, of course, inadmissible.

C. turgida, n. sp., Grev.—Frustules cylindrical oblong, obtusely truncate; connecting processes dilated; length about ·0032″; breadth ·0021″; areolæ 11 in ·001″. (Fig. 14.)

In Californian guano.

This very interesting species is nearly related to *C. turris*, but differs in the larger, more truly cylindrical and truncate frustules, and in the considerably smaller areolation; the areolæ in *C. turris* being 7, in *C. turgida* 11 in ·001″. In both they are beautifully hexagonal. At the time my drawing was made I had only met with isolated frustules, but I have since seen them in union. The colour (in balsam-mounted slides) is very pale yellowish-brown; and the substance is so transparent, that it is easily overlooked.

C.? ferox, n. sp., Grev.—Frustules oblong; valves subglobose, campanulate, thin and hyaline at the suture; connecting processes spine-like; areolation large, hyaline, walls of the areolæ passing at the angles into short spinous processes, so as to give a hispid character to the frustules; length ·0020″ to ·0025″; breadth ·0012″ to ·0015″; areolæ 5 in ·001″. (Figs. 15, 16.)

In Californian guano.

Single valves of this species are common, generally presenting themselves in a vertical position, in the form of a disc, when the connecting processes are lost sight of, but the campanulate or expanding margin is well seen. Occasionally entire frustules are observed; but I have only twice had an opportunity of examining them in connexion. The species is so very different in habit from the other *Cresswelliæ* that it may eventually prove to belong to a distinct genus. The comparatively very large and strong areolation, suggestive of *Polycystineæ* rather than *Diatomaceæ*,—the spine-like connecting processes, and the expanded margin of the valves forming a sharp keel at the line of suture, indicate other affinities. There seems also to be a striking difference in the substance. *C. turris* and *turgida* have a more flexible appearance, the latter especially; while the present form is hyaline, and rigid, as if it would be readily fractured under pressure. The most remarkable feature about it, however, is the hispid character of the frustule when seen in profile, and which at first sight is exceedingly difficult to account for, as there are no traces of genuine spines. A minute examination has brought me to the conclusion that the effect is owing to the walls of the hexagonal areolæ being produced at the angles into spine-like processes.

After a careful study of the very brief characters given of the *Pyxidiculæ* by Ehrenberg and Kützing, I am quite unable to identify the species now described with any one of them.

Method *of* Cleaning Diatomaceæ.

By Arthur M. Edwards, New York, U. S.

Though there are many methods that have been devised for cleaning deposits of Diatomaceæ, none has proved to be perfect in all its details; that one that appears nearest so being that which I give below. It is well known that the ordinary method given in the books, of boiling in nitric acid alone, is extremely unsatisfactory, as it does not remove all the organic matter that may be present in the deposit, and this is more particularly apparent when treating guanos for the purpose of obtaining the forms contained in them. Some few years back Bailey published, in the 'American Journal of Science,' a plan which seemed to meet all the wants of microscopists. This method was by removing all the organic matter through the agency of sulphuric acid and chlorate of potassa. In this process, however, at first a bisulphate of potassa is formed, which, when we attempt to wash it out with water, is converted into neutral sulphate and free sulphuric acid. The neutral sulphate of potassa is a salt soluble only with difficulty, so that it becomes almost impossible to remove it entirely and leave the Diatomaceæ perfectly clean. It is to obviate this trouble that the following method has been devised, and, as it has been in constant use for over two years, with invariable success, it can be confidently recommended to microscopists.

It was first used in the case of guano, about the most difficultly manageable of all Diatomaceous deposits, and, therefore, will be given here as used for that substance, the difference of manipulation necessary to be used when it is required to clean earths or tidal muds being very slight and sufficiently apparent without mentioning them here.

The guano is freely exposed to the action of the air during several days or weeks, according to whether it be rich in moisture and organic matters or otherwise, and also according to the amount of dampness present in the atmosphere; thus, in summer it requires but little exposure to bring the guano to a proper state, whilst, in winter, it will require several weeks. It is thus exposed until it has become perfectly dry, and crumbles to a fine light fawn-coloured powder. It is then washed several times in water that has been carefully filtered through chemists' filtering paper. This filtered, is found to answer all the purposes of distilled, water, which is much more troublesome to procure, and then only by a tediously slow process. Every time it is washed, the water is allowed to stand on it for at least twenty-four hours. It is thus washed until the water takes up no more salts and runs off perfectly clear. The two or three last washings may be, with advantage, made with boiling water.

After every washing, we must make sure that all the guano has settled, that none of the finer forms may be carried over with the water, when it is poured off, and lost. When the washing is complete the guano is introduced into a capacious chemists' beaker-glass, and there is poured on it sufficient chlorohydric acid to cover it to the depth of an inch and a half, when it is boiled for about an hour. It is then well washed with filtered water, and nitric acid made to replace the chlorohydric. The boiling of the nitric acid is now kept up until no more red fumes are given off, and the deposit is again well washed several times. Thus far this process is the same as that recommended in the books, but the undissolved portion is not colourless; we have, therefore, to proceed with the following manipulations.

The deposit which now remains, after the boiling in acid, is well washed until the water comes off perfectly clear and almost free from acid; it is then covered to about the depth of an inch with sulphuric acid, and boiled until all the organic matter contained in it is charred, which is known by its turning black. Sometimes, however, the organic matter is in such small quantity that it hardly shows signs of coloration. When such is the case, it is always better to boil the acid for a short time before proceeding to the next step in the operation. The fumes given off in this and the next stage of the process are extremely unpleasant in odour and effects, so that care should be taken not to inhale any more of them than can possibly be helped, as they are apt to inflame the air-passages and cause severe sore throat. The best method is to conduct this portion of the process in the open air, or under a chimney having a good draught.

Whilst the sulphuric acid is undergoing ebullition, finely pulverized chlorate of potassa in very small quantities is added from time to time, always allowing the violent action resulting from the introduction of one portion to completely subside before another is introduced. During this portion of the process the hand should not be exposed to the vapours given off, as they will act on and corrode the skin; the chlorate may be introduced by means of an ivory spatula—a metal one would be corroded. The heat is kept up all the time until sufficient chlorate is supposed to have been used, which is generally known from the deposit becoming perfectly white. Great care must be taken to add the chlorate only in small quantities and at distant intervals, or a violent explosion will result, shattering the vessel and throwing the boiling acid over the clothes and person of the operator.

A quantity of filtered water in a boiling state is now procured, and the sulphuric acid and deposit poured into it in small portions. If the water were poured into the acid, the heat generated would be so intense that there would be danger of rupturing the vessel. After all the deposit has been introduced into the water, the boiling is kept up for a short time, and then it is allowed to settle. Thus far this process is the same as that proposed by Bailey, but is, as I have before remarked, incomplete, from the formation of sulphate of potassa, which cannot be entirely removed by water alone.

To complete the cleaning, we allow the deposit to settle, and then pour off the supernatant liquid. Sufficient nitric or chlorohydric acid is then introduced to cover the deposit to the depth of about an inch, and it is boiled. This acid decomposes the sulphate, and forms a very soluble salt, which is easily removed by frequent washings with filtered water. The remaining deposit is washed with filtered water until a drop of the liquid does not leave any crystals on evaporation on a plate of glass.

It now consists of sand and Diatomaceæ only, and should be preserved in a mixture of alcohol and water, which prevents the Diatoms matting together, as they are apt to do, and also will not allow of the formation of Confervæ, which form in most quiet water.

What are Marine Diatoms? By G. A. Walker-Arnott, LL.D.

In the Preface to the late Professor Smith's second volume of 'British Diatomaceæ,' at p. 25, we find—"I feel persuaded that a marine species will not flourish under fluviatile influences, nor a fresh-water form long survive when transferred to a marine habitat. Still further, I believe that certain species are far more special in their tastes, some selecting mountain-torrents, and others fixing their habitation in boggy pools or alpine lakes; some being exclusively littoral, and others found only in the deeper parts of the sea." As a mere speculation, this statement is of little consequence, but Smith applies it to the determination of species, when other means fail; thereby employing it, not as a theory, but as an ascertained fact.

In general, the result at which I have arrived corroborates the theory in many particulars, but by no means to the full extent. A truly fresh-water species may be carried down to brackish water, and survive there; but the circulation is more languid, and consequently the amount of silex deposited smaller, so that, although the distance of the striæ may be much the same, they become more faint. If the same species be carried into pools still more of a marine character, it is either killed or grows; but, in the latter case, the circulation is very languid, the silex almost or wholly absent, and the formerly conspicuous striation is now extremely obscure. I have very great doubts if *Fragilaria striatula* be not, on that account, a degenerated form of *F. capucina*. In the same way, truly marine species, when in brackish water, have their silex less in quantity and striæ less visible, and in fresh water are either killed or grow very languidly, and become scarcely siliceous. But there are Diatoms which are peculiar to brackish water, and are not found in a good state either in the open sea or in fresh water. *Epithemia musculus* may be cited as one of these, and unquestionably there are others, as *Navicula amphisbæna* and *Nitzschia dubia*, which flourish as well in brackish water as in fresh water remote from the sea.

As to Diatoms occurring in the deeper parts of the sea, that is no doubt true; but it does not appear to me that any species can increase much without access to more atmospheric air and solar light than can be obtained there; and, consequently, that most of what are found in dredging have been conveyed there by the receding tide from our own, or by ocean currents from a very remote, shore. Even fresh-water species are deposited in that way. I have found, while dredging in fifteen or twenty fathoms, off the coast of Arran, at the mouth of the Clyde, *Eunotia triodon*, *Himantidium pectinale*, and *Navicula rhomboides*; and frustules of the last two have also occurred to me in rocky pools near low-water mark. Dr. Dickie* has given a list of several fresh-water species which he met with in Aberdeen Bay, in the stomachs of Ascidia, in from twenty-five to thirty fathoms, and at five to six miles from land: among these are *Himantidium pectinale*, *Tabellaria flocculosa*, *Cocconeis pediculus*, &c. I have occasionally seen detached valves of *Orthosira arenaria* in dredgings; but, deceived probably by the locality, Dr. Gregory, in his paper on 'Clyde Diatoms,' fig. 44, has reproduced it as a *new species* of *Melosira* (?) or *Coscinodiscus* (?), he is uncertain which.

The mere finding of a species in the sea is therefore no proof of its having grown there; so that other means must be resorted to before asserting that such specimens must form a species distinct from an analogous one occurring in Alpine streams, or elsewhere in fresh water.

Lewes, in Sussex, where Smith principally made his observations, is peculiarly unsuited to solve these difficulties. The influence of the tide is there conspicuous, and when a species is rare, and confined to only one locality, it is quite impossible to deduce whether it is a brackish-water one, or a marine form carried there by the tide, or a fresh-water one swept down from the higher grounds. When, therefore, only one or two localities are indicated by Smith, and these entirely about Lewes, or in a similar place, the peculiarity of the water most congenial to that Diatom must be held to be still in doubt. A few instances of this may be mentioned.

Nitzschia dubia is stated by Smith to occur only in brackish water. I have it from the Queen's Park, Edinburgh, and from several places about Glasgow, South Wales, &c., at a considerable altitude above the level of the sea; so that, although seemingly to grow equally well where the water is partly saline, it certainly affects truly fresh water. *Nitzschia Brebissoni* is stated by Smith to be found in fresh water (he found it only at Lewes); but his slides contain many marine species (as *Nitzschia sigma*, *Navicula minutula*, *Tryblion. scutellum*, *gracilis* and *punctata*, *Bacillaria paradoxa*, &c.) as well as fresh-water ones (as *Nitzschia sigmoidea*, *Navicula cuspidata*, *Nav. ambigua*, &c.) Smith drew his conclusions from a

* 'Annals of Nat. Hist.' for 1848, vol. i, p. 324.

different source: he had obtained from M. De Brébisson *Sigmatella Brébissoni* of Kützing, a truly fresh-water species; and on the supposition that this was the same, he applied the name *Brébissoni* to his species from Lewes, assigning it a fresh-water habitat; but De Brébisson's (and as it was he who discovered it at Falaise, and sent it to Kützing, so his specimens form a correct index to both *Synedra armoricana* and *Sigmatella Brébissoni* of Kützing) proves to be a mere variety of *Nitzschia sigmoidea;* while Smith's *N. Brébissoni* was actually quite unknown to De Brébisson or Kützing. That it is a truly brackish-water species is further proved by its having been found in such situations at Hull by Mr. Norman. I have the same, unquestionably, in a slide got from the drip from the walls at Chester; but it is very scarce there, and may have been carried inland by spray and storms, in the same way as *Navicula pusilla,* and even *N. Jenneri,* are sometimes conveyed to a distance from the sea, and found among mosses on trees with a corky or cracked bark. *Nitzschia Tænia* is said to be from "brackish water:" I have it from several such localities; but I have collected it also from clay-pools in brick-yards, near the Botanic Garden of Glasgow, at an elevation of about 80 feet above the sea. On the other hand, I have found *N. acicularis* sometimes in brackish water; so that both are probably fresh-water species, and carried down by streams.

Cyclotella punctata, Sm., is stated to inhabit fresh water at Wisbeach. In his slide are chiefly fresh-water species, and amongst them *Synedra minutissima,* for which Smith assigns a fresh-water locality only, but which I uniformly find within the influence of the tide. *Surirella ovata* is here copious, but that Diatom is more abundant in brackish than in truly fresh water. The same species has occurred to me, but very rarely, in a preparation from Breydon, Norfolk (collected by the late Mr. Wigham), along with *Cyclotella Kützingiana, Pleurosigma strigilis, Amphora affinis,* and some others not found in fresh water; there are, however, some fresh-water species mixed. This has been more recently and copiously found by Mr. Norman, of Hull, in the Market Weighton Canal, at the end near the sea, and which is occasionally supplied from the sea. Here, although the fresh-water species predominate, there are other forms also, as *Synedra acicularis,* &c., which indicate its brackish tendency. This species appears to me to be a genuine *Coscinodiscus,* very closely allied to *C. subtilis,* and probably with *C. Normani,* Grev., and some others, forming only one species, varying according to the saline nature of the water, and other incidental circumstances. It is the middle of the valve only which is undulated, a character which often disappears after the valves have been separated from the connecting zone by being boiled in acid; the margin and the connecting zone itself is not undulated, as in several genuine species of *Cyclotella*.

Amphiprora paludosa is said by Smith to be found "in fresh or slightly brackish water;" and here I shall suppose his figure to indicate the form intended; this has a peculiar indentation on each half of the valve at the place where the ala or keel meets the body of the valve; but this indentation is not noticed in the text, and does not seem to have been considered of any importance by Smith. I have no slide from him; but I have examined the same form from Woolwich, Hull, the coast of Norfolk, Ayrshire, &c., and invariably accompanied by marine Diatoms. I therefore consider it, like all others of the genus, as peculiar to salt or at most brackish water. I have before me also a form without the indentation, and with striæ (sometimes very obscure) on the body of the valve; which is thus intermediate between the figured *A. paludosa* and *A. alata* on the one hand, and between it and *A. duplex* on the other: so that I cannot avoid drawing the conclusion that these four forms belong to one natural species, recognised by the alate carina, and tendency to twist when the valves are separated and either dried or put into balsam. *A. Ralfsii* has the same tendency to twist, but the keel is not alate. In the same way *A. lepidoptera* represents those that have an ala but do not twist, while *A. vitrea* and *elegans* conjoined form a fourth species, without an ala, and with no tendency to twist. All other species of the genus may, as appears to me, be reduced to one or other of these.

Amphora minutissima is said to be always parasitic and from fresh water; but Mr. Okeden has found, in South Wales, two forms of apparently the same species: one in a salt-water marsh, parasitic on *Nitzschia sigma*; the other in fresh water, and not attached to anything.

Coscinodiscus minor of Smith is stated to be from fresh water; but what he had described he afterwards satisfied himself was only the detached valves of *Melosira nivalis*. Kützing's (and I believe Ehrenberg's) species of the same name is from the sea or brackish water, and is not uncommon at the mouth of the Clyde, and on many parts of the east coast of England: it is figured in Gregory's paper on 'Clyde Diatoms,' as the S.V. of his *Orthosira angulata*; but certainly does not belong to it, for *Orth. angulata* in no respect differs from *Orth. marina*. I have one or two gatherings of *Cosc. minor* from Cumbrae (from Mr. Hennedy), with the valves copious, but no trace of any *Orthosira*.

Eunotia is strictly a fresh-water genus. I may here remark that recent observations on *E. diadema* has convinced me that the character I proposed ('Micr. Journ.,' vi, p. 202) for distinguishing *Eunotia* from *Himantidium* is not tenable: I must have been deceived by examining specimens at the period when the connecting zone was at its minimum, and inconspicuous. I am now quite satisfied that specimens may be found in perfect accordance with Smith's figures.

Epithemia is chiefly a fresh-water genus, although most of the species grow equally well in brackish water. It is also a truly parasitical one. Some species are no doubt found, not on filiform algæ, but among the gelatine of *Hæmatococcus* and others of the *Protococceæ*, to which they seem to attach themselves. *E. musculus* I have never seen, except in salt marshes to which fresh water has access. *E. rupestris* is said to be from fresh, and *E. Westermanni* from brackish, water; but this is liable to doubt, for *E. Westermanni* of Smith can scarcely be distinguished from short forms of *E. rupestris*, and may have been carried down by streams, or be one of those that grow in both places. This is not *E. Westermanni* of Kützing, a species which I have seen parasitic on the leaves of *Zostera* from the Baltic. *E. musculus* of Smith appears to be composed of two species, one which he has described in the text as having "striæ 40 in ·001," and which I have in the same slide with *E. Westermanni*, Kützg., and is the *E. musculus* of Smith's slides from the S. of France (May, 1854); the other, or true *E. musculus*, has distinct moniliform striæ, and is that figured by Smith. The synonyms of the whole species are much confused in the 'Synopsis.' *E. constricta* of Smith is certainly not that of De Brébisson, which is a much smaller species, destitute of the anterior keel to the valves (by which Smith's is distinguished), and more allied to *E. Westermanni* of Smith. *E. alpestris* of Smith's 'Synopsis,' from Katefield, is not the species of that name distributed *in slides* by Smith, which latter wants the large foramina, and is that form of *E. zebra* called *E. librile* by Ehrenberg. *E. argus*, *E. ocellata*, and *E. alpestris* of the 'Synopsis' are three varieties of *E. ocellata* (such is the oldest name), while *E. longicornu* is the sporangial state of the same. *E. Hyndmanni*, Sm., and *Eunotia Luna* of Ehrenberg's 'Mikr.,' tab. XV A, fig. 58, are obviously one species; but Ehr. 'Mikr.,' tab. xxxiii, xii, fig. 15, from Oregon, appears very different. The specific character given of *E. Luna* by Kützing refers to the Oregon species only. In justice to Mr. T. Comber, of Liverpool, I ought to state that the preceding observations on this genus are the combined deductions arrived at by him and myself. I know of no one who has paid more attention to the species of *Epithemia* than Mr. Comber, and much wish that he would give to the public a monograph of them. He is the only one who has studied with care, not merely the F.V. and S.V., but also the vertical view, corresponding to a transverse section of the frustule, which yields characters of some importance.

Tryblionella gracilis is stated to be from fresh and brackish water. It usually occurs in the latter, and these specimens are much larger and finer than the others; but it certainly is found in various localities at a considerable elevation above the sea. Indeed at one time Smith considered this form distinct, and named it *T. minor;* it is more oval than the littoral form, and is scarcely distinguishable from *T. levidensis,* except by the finer striation. Dr. Gregory has published a *T. apiculata,** which he had from Cumbrae, and felt doubtful whether to consider a marine or fresh-water species. This is very common on all the coasts of Scotland and England, and was considered by Smith, when sent to him by me several years ago, a state of *Nitzchia dubia,* var. β. It is alluded to in 'Micr. Journ.,' iii, p. 309. It is certainly a brackish-water or marine species.

Navicula Smithii (*elliptica,* Sm. 'Syn.') and *N. elliptica,* K. (*ovalis,* Sm. 'Syn.') are very closely allied, and would have been probably united, were the one not peculiar to fresh water, the other to the sea; the striation of the former is coarser. Now, taking striation as our guide (and here I regret to differ from Smith, and think striation, or any microscopic difference, unsupported by more natural characters, as a very fallible one), I have been supplied by Dr. Dickie with a series of gatherings made last December in a cave at Skateraw, on the Kincardine coast, which are very puzzling. I understand the cave to be far beyond the reach of the tide, although during great storms the spray may be carried to it. Near the entrance of the cave is *N. Smithii,* accompanied by *Orthosira spinosa* and *Himantidium gracile.* A little further in are *N. Smithii* and *N. elliptica,* much mixed, and *Orthos. spinosa;* further in, a gathering was made composed of *N. elliptica, Epithemia rupestris,* and *E. Westermanni,* Sm., so varied and mixed as to be undistinguishable; *Cocconeis Thwaitesii, Denticula obtusa, Odontidium Tabellaria* and *mutabile* (both small). I believe that the third sample was got on the opposite side of the cave from the second, but am not quite certain; I have not observed in it either *N. Smithii* or *Orth. spinosa.* At the further extremity of the cave *Orth. spinosa* was got quite

* 'Trans. Micr. Soc.,' vol. v, p. 79, tab. i, fig. 43.

pure. Doubts are thus thrown on the distinction of the species, or on the fresh- and salt-water localities assigned.

Nav. amphisbæna occurs in fresh water, brackish water, and in the sea. The first has the extremities capitate, and conspicuously produced; the second much less so (it is β of Smith). The third is smaller, with the ends scarcely at all produced, and is *N. brevis* of Greg.; it was named in March, 1854, by Smith, *N. retusa*, n. sp. (before De Brébisson's other species of that name was published), but I afterwards satisfied him that it was a mere variety of *N. amphisbæna*, and it is therefore not described in the 'Appendix.'

Pinnularia gracilis has a fresh-water habitat given; but a form of it, with a shorter beak, is not uncommon in brackish water. This was at one time considered by Smith a new species, and called by him *P. curta*; it is, however, omitted in the 'Appendix.'

Stauroneis pulchella is beyond doubt marine; but there are two forms so different that some think them different species, and even refer them to different genera. *St. pulchella*, properly so-called, is got in all our rocky pools, and has the stauros (by the way, I wish some more correct name were devised, for stauros is not the transverse beam of a cross, as is here intended, but the whole cross itself) cuneate, or "dilated towards the margin;" and the frustule on a F.V. has the angles rounded. On the other hand the second form occurs in sand-gatherings, has the angles on a front view sharp, the ends of the frustule appearing truncate; and the stauros (?) is a large circular blank spot around the nodule. The striation in both is much the same, and different from what is usually observed in this or the allied genera; but *St. pulchella* is of a tawny colour; the other of a dark bluish green. This latter form De Brébisson wrote me (February 21st, 1858), he proposed to call *Navicula angulata*: he had first found it in 1852, and considered it, with *N. pectinalis* and *retusa*, as a group very distinct from the other species. As this group is in great confusion, the following observations may not be uninteresting. It is not to me quite clear on what De Brébisson originally bestowed the name of *N. pectinalis*; what Smith received from him, and supposed to be so, I have reason to think was *N. retusa*, of which Smith only knew the F.V., and in that state it is almost undistinguishable from *N. pectinalis* of Smith's 'Synopsis.' On February 12th, 1858, De Brébisson was disposed to consider the above *N. angulata* to be his *N. pectinalis*; but a few days after relinquished that view, and formed the opinion that a curious and very distinct species (which he since had called *Amphora? quadrata*) might have been intended; this, which has two striæ at the central nodule, much stronger and more distinct than the others, had certainly not been seen by Smith on the piece of mica he had received, if there at all. When Smith got the specimen from Saltcoats, he found the F.V. to accord with what he was led to think *N. pectinalis*, and as the valve was linear-elliptical, he has so described it in the 2d vol. of the 'Synopsis,' p. 92; but his *N. pectinalis* was unknown to De Brébisson; it is a rare species, and as yet known to me only from the coast of Ayrshire and island of Cumbrae. Unfortunately he has there conjoined with it another form which I first found in Ayrshire (but soon after in Arran, and I have since got it from the west coast of England); this is much smaller, with broadly linear truncate valves, and radiating central striæ. De Brébisson, in 1854, published his *N. retusa*, a species with linear valves, and which I feel certain, as already stated, was the one which was sent to Smith, in 1852, as *N. pectinalis* of De Brébisson; this is very common in the mouth of the Clyde, and has been sent me from several other places considerably distant from each other; it is adopted by Smith in his 'Synopsis.' There results from this, if my views be correct, that *N. pectinalis*, Sm., is not that to which De Brébisson first gave the name; and that the one intended by De Brébisson is probably that which he afterwards published as *N. retusa*. The other two species (viz., the small one confounded with *N. pectinalis* by Smith, and the one at one time called *Amphora ? quadrata* by De Brébisson) are as yet undescribed; the latter was first, in this country, found on the Northumberland coast by Dr. Donkin, and afterwards copiously at Tynemouth by the Rev. R. Taylor; I have since got it from Cumbrae in the Clyde, and I have seen it from Teignmouth in S. Devon, but very sparingly in both these localities. To this group also belongs *Pinnularia rostellata*, Greg. (the F.V. can scarcely be distinguished from that of *Nav. retusa*); I do not see how this differs from *Nav. apiculata*, De Bréb.

Synedra pulchella and *minutissima* are said to grow in fresh water, *S. gracilis* and *acicularis* in brackish. I find no difference in that respect; all when in fresh water are got in the mouth of streams; I never met with any of these at a considerable elevation, nor, indeed, beyond the occasional if not constant rise of the tide; between these four reputed species I find no certain marks of distinction. *S. fasciculata* is said by Smith to grow only in fresh water; while Agardh, Kützing, Greville, and others make it marine; both parties are correct, because they do not mean the same species.

What Smith had in view is *S. parvula*, Kütz. (from which *S. parva*, Kütz., from De Brébisson, scarcely differs; while *S. parva* from the Gulf of Venice appears to be *S. investiens*, Sm.) The *S. fasciculata* of Kützing seems to be a *common variety* of *S. affinis* with blunt valves; Agardh's *Diatoma fasciculatum* is partly *S. affinis* and partly *S. arcus* of Sm. (*not* Kütz., which seems to be a state of *S. Gailloni*); while *Exilaria fasciculata*, var. *a*, of Greville, is *S. radians*, and his var. β a mixture of *S. arcus, S. affinis*, and *S. pulchella*.

Doryphora Boeckii is stated to be marine; but Smith wrote me afterwards that he had doubts on the subject; when I have found it in Arran, it was growing intermingled with *Synedra pulchella, S. minutissima*, and *Eunotia* (also a species of *Synedra*) *arcus*, Sm., all of which were reputed fresh-water species. I have just mentioned that the first two are found at the mouths of rivers or streams, but not beyond high-water mark, and *D. Boeckii* is probably in the same predicament; I have, however, specimens from Norway (from Mr. Norman, of Hull) in which it is mixed only with marine species.

The last to which I shall at present allude is *Homœocladia filiformis:* this is said to be from brackish water, and it is occasionally found there; but it grows abundantly on fresh-water algæ in the Monkland Canal, near Glasgow, a canal which is at the elevation of about 165 feet above the level of the sea, and to which sea-water cannot possibly have access. I cannot call the water there either *sweet* or *fresh*, for it is both dirty and offensive to the nasal organs; but it contains no salt.

It thus appears that although the statement made by Smith, and quoted at the commencement of this paper, may, on the whole, be correct in theory, it is of very little practical value, and may lead incautious observers to very inaccurate conclusions in the distinction of species. At present, and until more facts are collected, it may be held a safe rule that when a whole genus is peculiar to fresh water with the exception of a single species, and that exceptional species is accompanied by some fresh-water forms, it ought to be held also as belonging to fresh water, or at most to brackish water; and that when the genus is marine, with the exception of one species, this, if accompanied by any properly ascertained marine or brackish-water Diatoms, may be regarded also as a marine or brackish-water species: and although a mere gathering may not clear up the point when ditches, canals, and sluggish streams are in question, a slight inquiry as to how these are fed may contribute much towards it.

On some of the Rarer *or* Undescribed Species *of* Diatomaceæ. Part I. By T. Brightwell, F.L.S.

It is my purpose to give in this and some following papers descriptions of some of the many undescribed or unfigured species of Diatomaceæ, chiefly marine, which still are found in our cabinets; illustrated by Mr. Tuffen West's excellent figures, they will, I trust, be acceptable and useful to algologists.

1. *Eunotia eruca.*—Valve slightly arcuate, from three to five or six flexures or undulations above and below; extremities slightly produced, striated. Varies in length from ·0018, with three flexures, to ·004 with five flexures. Striæ 20 in ·001. *Amphicampa eruca* (Ehr., 'Mikr.,' Pl. xxxi, F. vii). Fresh-water lagoon, near Melbourne, New South Wales; Mackie. (Pl. IX, fig. 1, and fig. 1 *a.*)

2. *Cocconeis coronata,* n. sp.—Valve oval, slightly constricted at the extremities, stout marginal band, with from thirty to thirty-two transverse canaliculi; disc striated, moniliform; striæ 15 in ·001. Valves ·002 long by ·0014 broad. Shell cleanings. West Indies. (Pl. IX, fig. 2.)

3. *Cocconeis fimbriatus,* n. sp.—Oval, margin fringed with a band indented internally, disc striated, with lines of dotted striæ. Corsican Algæ. (Pl. IX, fig. 3.)

4. *Campylodiscus striatus,* Ehrenb.—Disc in the middle part smooth, with a double series of parallel canaliculi on each side, eleven in the smaller to twenty in the larger specimens. Kützing, Species 'Alg.' p. 33, No. 11. Vera Cruz. (Pl. IX, fig. 4.)

5. *Surirella limosa,* Bailey.—V. broadly ovate, acuminate, faintly punctato-striate. Canaliculi seventy-five to eighty, short and indistinct, not reaching more than 1-6th across the valve, leaving a large blank centre. Length ·01 by ·045 in breadth. Striæ very indistinct, 22 in ·001.

Professor Bailey, MS.? This species was, Mr. Tuffen West thinks, sent to Professor Smith, with this name.

New Zealand, Mackie. Mud, Hudson River, New York, N.A., Professor Bailey. Mr. T. West has seen a specimen from Thames mud. (Pl. IX, fig. 5.)

6. *Stauroneis fulmen,* n. sp.—F. V. oblong; V. lanceolate acute. Margin with a marked double inflexion on each side. Stauros very slightly, if at all, dilated towards the margin of the valve. Striæ fine and sharp, 22 in ·001. Length from ·008 to ·015.

Fresh water, Melbourne, N. S. W., Mackie. (Plate IX, fig. 6 *a,* V.; 6 *b,* F. V.)

7. *Pleurosigma longina,* P. Smith.—V. lanceolate, flexure moderate, extremities greatly elongated; acute; colour faint straw; striæ transverse, 36 in ·001; length from ·02 to ·025.

Arctic Regions, Dr. Sutherland. (Pl. IX, fig. 7.)

8. *Odontidium speciosum,* n. sp.—Valve subcruciform or rhomboidal, angles rounded, naked, costæ short, distinct, sixteen on each side. (Pl. IX, fig. 8, *a,* side view; *b,* front view.) Shell cleanings.

9. *Odontidium punctatum,* n. sp.—Valve subrhomboidal, angles pointed, cellular, obscurely punctato-striate, without costæ. (Pl. IX, fig. 9.) Shell cleanings.

10. *Odontidium Baldjickii,* n. sp.—Valve ovately rhomboidal. Costæ about twenty on each side the median line, distinct, reaching nearly to, but leaving a linear open space down the centre. (Pl. IX, fig. 10).

From a clay or earthy deposit found on bones imported from Baldjick, near Varna, Mr. Norman.

The species last described are allied to *O. Harrisonii* of Professor Smith, and we refer to his observations ('S. B. D.,' vol. i, p. 18), as to their true position in a systematic arrangement.

11. *Rhabdonema mirificum,* Professor Smith.—"Septa with three to twelve irregular perforations."

See Dr. Walker Arnott's observations, 'Mic. Journal,' vol. vi, p. 92. (Pl. IX, fig. 11.)

12. *Triceratium* (?) *dubium,* n. sp.—Valve clypeate, punctate, with six rounded projections, the lower one elongate.

Mauritius. (Pl. IX, fig. 12, *a,* side view; *b,* front view.)

We place this species (which is not of unfrequent occurrence) provisionally among the Triceratia. It probably forms the type of a new genus.

13. *Amphitetras crux,* n. sp.—Valve cruciform, with the extremities widely rounded, cellular punctate. (Pl. IX, fig. 13, *a,* front view; *b,* side view.)

14. *Amphitetras antediluviana* (?) (Pl. IX, fig. 14.)—Mr. T. West believes this to be a valve of a sporangial frustule, of this species. Its unusually large size, imperfect shape and thinness, the cellular appearance of its punctation, and its occurrence among a large number of valves of the regular form lead to this conclusion.

15. *Biddulphia Balæna.*—V. ovate, elongated at the extremities; F. V. quadrate. Frustule punctato-striate.

Zygoceros Balæna, Ehr.—See Roper, on Biddulphia, 'Trans. Micr. Soc.' vol. vii, p. 20.

Arctic Regions, Cornwall Island, N. Lat. 75°, Dr. Sutherland.

TRANSLATIONS.

Further Observations *on the* Development *of* Pentastomum tænioides. By Rud. Leuckart.

(Henle and Pfeufer's 'Zeitsch. f. rat. Medicin,' 3 ser., Bd. iv, p. 78, 1858.)

The readers of this Journal will remember from my first paper* that I had commenced a series of experiments, in order to decide the question whether the *Pentastomum denticulatum,* which occasionally occurs as a parasite in man, be a fully developed animal, or whether, as might be concluded from certain reasons, it merely represents the larval condition of the well-known *Pentastomum tænioides* which is found infesting the nasal cavity of dogs. To this end I had infected three dogs with *P. denticulatum,* not more than a few millimetres in size, by the introduction directly into their nostrils of several dozen of these parasites, procured from the abdomen of a rabbit.

The results of these experiments have been as yet only partially made known. It has been stated that I detected in one of those dogs, killed six weeks after infection (on the 17th February, 1857), three examples of a *Pentastomum,* which, notwithstanding its insignificant size (8—10 mm.) and incomplete development, could be recognised as *Pentastomum tænioides.* As I stated in a supplement to that communication, a far more convincing result was obtained in a second dog. In this case there were found (on the 20th of June, about seventeen weeks after the commencement of the experiment) not less than thirty-nine *Pentastomata,* of whose agreement with the usual *P. tænioides* the smallest doubt could not be entertained. About the half of these examples were males; they were fully developed (15—16 mm. long), and had also to a certain extent accomplished the copulative function, as might be concluded from the circumstance of the seminal pouches of some of the females being filled with semen. The females were larger than the males (up to 26 mm.), though they had neither attained full growth, nor

* 'Jahrg.,' 1857, s. 48—60. "*Pentastomum denticulatum,* der Jugendzustand von *Pent. tænioides.*"

arrived at sexual maturity. Their ovaries only just showed the commencement of the formation of ova, and the vagina (which at the same time serves as a uterus, and fills the entire cavity of the body with its innumerable convolutions in the fully developed female) was as yet not only empty, but quite straight and of inconsiderable length (about 12 mm.)

The question has several times arisen as to the mode in which the two spermatic pouches attached to the upper end of the vagina can, in the fully formed *Pentastomum*, be filled from without. In order to get over the difficulties of the case, and to reconcile the fact with the enormous length and impermeability of the vagina when filled with ova, it has often been suggested that the statements respecting the separation of the sexes in these parasites may be founded in error. The foregoing observation affords the most complete explanation respecting these conditions. It shows us that the vagina of the female is still short and empty at the time of copulation, and not longer than the two protrusile tubes which represent, according to Van Beneden's discovery,* the truth of which is readily proved, the male copulative apparatus, and which are variously twisted together and concealed in a special muscular sac while in a state of rest. It is, indeed, remarkable that the females are not sexually mature at the time of copulation, but this peculiarity is not unfrequent in the lower animals (which have spermatic receptacles), especially among insects.

Of course it cannot at present be my intention to enlarge in detail on the structure of the sexual organs of these animals, —I reserve this, as well as the explanation of the organization of the *Pentastomata*, for a future opportunity,—but I may perhaps be here permitted to say thus much, namely, that the ovaries are situated on the dorsal, while the sexual orifices are on the ventral surface, *i. e.*, at the hinder part of the body, close before the anal aperture in the females; in the male the sexual orifices are placed (and this is the same for both the cirrhus-pouches) much further forward, near the oral opening.

The examination of the third dog, which was undertaken on the 25th of August, *i. e.*, about six months after the infection with *P. denticulatum*, gave the same positive result as had been derived from the two preceding experiments. The nasal cavity and the frontal sinuses also harboured a number of *P. tænioides*, and on this occasion individuals of both kinds fully developed. In respect of

* 'Recherches sur le developpement des Linguatules.' Bruxelles, 1849, p. 16.

size and formation, the males, only two of which were found, showed an entire agreement with the male *Pentastomata* of the second dog; they had evidently gone through their whole development two months before. But this was not the case with the three females found with them, which since that time had grown to more than double their former length (up to 65 mm.), and had also arrived in the mean time at complete sexual maturity. Not only were their ovaries full of ova in various stages of development, but the vagina, which measured nearly one millimetre, was filled with them; and to such an extent was this the case, that, according to a very moderate estimate, their number could be calculated at fully half a million. As might be expected, the ova in the vagina were all mature—nay, more, they were even all fertilised, as might be concluded not only from the circumstance that, before their entrance into the vagina, they must pass the openings of the two seminal pouches above mentioned, but especially from the consideration that they already exhibited unmistakeable signs of a commencing development of the embryo at a small distance from the upper end of the vagina. The lower fifth of the vagina even contained ova with fully mature embryos.

The embryos of these *Pentastomata* were examined and described several years ago, in Utrecht, by the late helminthologist Schubart.* In all essential points they exhibit the same structure which Van Beneden had previously found in the embryos of *Pentastomum proboscideum* parasitic in several species of snakes. They are so strikingly different from the fully formed *Pentastomata*, that, in examining them, we are reminded of certain *Acarina* and allied forms, far rather than of the vermiform parasites now under consideration.

The body of the embryo consists of two distinctly separate parts—a short and broad, egg shaped anterior part (0·07 mm. long, 0·05 mm. broad, and about the same in height), and a rather long, slender tail (measuring 0·056 mm. long and 0·010 broad), which, during its stay in the ovum, is invariably folded on the ventral surface. On the contrary, in the embryo of *Pentastomum proboscideum*—and I observe the same in a second species discovered by Professor Harley in London, from the lung of an African snake, the *P. multicinctum*, Harl., the embryos of which also in other respects agree almost entirely with those of *P. proboscideum*—the tail is much shorter, and separated from the rest of the body in a

* 'Zeits. für wissenschaft. Zool.,' 1852, Band iv, s. 117.

very marked manner, so that the similarity with a Mite above referred to here shows itself still more conspicuously. The anterior extremity of the body exhibits a tolerably large, gaping oral aperture, whose lower margin especially is indicated by a crescent-shaped eversion of the external chitinous coverings, which are elsewhere generally very soft. Close above this opening lies a boring apparatus, which is very much stronger in the embryos of *P. proboscideum* and *P. multicinctum*, and consists of a dagger-like aciculum, placed in the middle and directed straight forwards, and two smaller setæ curved like a hook. The most characteristic feature of this preabdomen consists in the presence of two pair of claw-feet, which project laterally from the body and occupy nearly the whole of the middle third.

Van Beneden and Schubart describe these feet as consisting of two joints, and remark that the two claws form a prehensile apparatus. I must dispute, however, the correctness of these statements, and may do so the more decidedly, as I have subjected this matter to a careful examination.

The embryonal pedal tubercle of *P. tænioides* forms a simple, short, and conical process, which throughout its entire breadth projects from the substance of the body, and exhibits no distinct articulation; it supports two curved claws at its extremity, which are placed, not one behind the other, but *side by side*, and both are curved backwards at their tips. The end of the tubercle supporting these claws is truncate, and provided at the margin with a strong, hard, chitinous ring. I scarcely doubt that the claws are possessed of independent motion.

In addition to the above-mentioned chitinous ring, we may distinguish other solid deposits of rod-shaped bodies in the coverings of the pedal tubercles. In certain positions these appear under the form of a two-pronged fork, the prongs of which, diverging from the place of origin, run downwards, and may be traced up to the extremity of the tubercles. A nearer examination shows that in such an aspect, the anterior surface of the pedal tubercles is always that which is brought into view. I especially recommend the profile aspect, in order fully to comprehend this formation, by the investigation of which one arrives at the conviction that only the two diverging prongs of these rods belong, properly speaking, to the chitinous covering of the foot, while the stem, which is a continuation from them, has no other connexion with the chitinous covering, and projects freely into the contractile parenchyma of the body. Evidently this stem forms a lever, by means of which the motion of the short and stump-like foot is rendered considerably easier. This description applies not only to the embryos of *Pentastomum tænioides*, but also to those of *P. proboscideum* and *P. multicinctum;* nay, in the latter the structural conditions of the foot are still more distinct, because the appendages in question, with their separate parts, are nearly twice as large.

When former investigators regarded the legs of the embryo of *Pentastomum* as made up of two successive segments, they were probably deceived by the inclosed chitinous rods, and, in particular, looked upon the peduncular process of the foot-coverings as the anterior contour of a separate segment. But although such a deception is quite possible in certain positions, the true state of the case will soon be ascertained when the parts are viewed in other and more determinate directions.

Many zoologists appear to entertain the opinion that these pedal tubercles of the Pentastomum-embryo gradually change into the well-known claw-like appendages of the perfect animal in the course of its development. To such an assumption I was myself inclined at first, and the more so as the chitinous fork of the pedal tubercles really bears some resemblance to the subsequently developed organs of support; and the two embryonic claws might be readily compared with the two hooks of *P. denticulatum.* I have, however, by later examinations, ascertained the incorrectness of this hypothesis, and arrived at the conviction that the claw-feet of the embryos, with all their separate parts, represent an apparatus which vanishes entirely during the later metamorphoses. In a physiological point of view, however, one may well compare these structures with the claw-apparatus of the adult animal. The coronets of spines of *Pentastomum denticulatum* are in a similar manner represented in the embryos by some small and delicate setæ, which are found arranged symmetrically, but varying in number, at the posterior extremity of the caudal appendage.

Besides the structures hitherto described, there also exists a roundish sucker-like indentation in the centre of the dorsal surface of the embryo, the bottom of which rises in the shape of a cross. The embryos of *P. proboscideum* and *P. multicinctum* are likewise possessed of these dorsal depressions, but here they are less considerable and without the cross. Internal organs are not perceptible, nor can even any intestine be discovered, although the oral aperture is of considerable size. (I am uncertain whether there be an anus.) The entire parenchyma of the body consists of a tolerably homogeneous granular material, in which, especially at the lower part, are distributed numerous fat-like corpuscles.

The embryos here described are never found free in the sexual passages, but always remain surrounded, even in the lowest portions of the tract, by the coverings of the ovum, which are three in number, as has been quite correctly stated by Schubart and Van Beneden. The most exterior forms a clear, transparent coat, with many folds in *P. tænioides*, which is separated from the two internal tunics by a wide intervening space; and it is possessed of a glutinous character, by means of which the eggs adhere to foreign objects with great facility, a circumstance which in a high degree favours their dispersion and transplantation. In *P. tænioides*, the substance of this exterior covering is converted by the addition of caustic potass into a gelatinous material, which is dissolved under the continued action of the reagent, while the two interior envelopes, which are closely approximated to one another, remain unaltered. These two latter have a very delicate and brittle consistence, so as to be readily ruptured by the application of pressure. This is especially the case with the middle covering, which is also distinguished from the inner by its greater thickness and yellow colour. Schubart says, in regard to the latter, that it is constantly "provided with a little opening or facet." According to our present knowledge of the mode of fertilization of animal ova, we might perhaps interpret this statement to imply that the ova of *Pentastomum* are provided with a micropyle; but the apparent opening is in reality anything but a micropyle. An investigation of the previous stages of development soon shows that the entire innermost coat, together with the structure under consideration, only makes its appearance a long time after the fertilizing act, and in such a peculiar manner, that it might perhaps with perfect justice be regarded as an embryonic membrane. Only the ova contained in the last fourth of the vagina permit us to recognise the three coats above described, while the others present only two of them, which subsequently become the middle and internal coverings. In the first or anterior part of the vagina the coats are moreover only thin and extensible, and lie closely upon one another, the exterior one also presenting a different granular character. All these are circumstances which render the process of fertilization intelligible even without a micropyle.

The first signs of the commencing development of the embryo consist in a segmentation of the yelk, which, however, at an early stage, generally immediately after the first division, becomes irregular and is on the whole not very conspicuous, since the yelk-masses never separate from each other into distinct globular forms. After the segmentation is completed, the yelk resumes pretty much its former fine-granular appearance, only that it is now become more transparent. A distinctly cellular structure is scarcely to be observed in this case, but no doubt, not so much because it is wanting, as on account of the cells having only a very small size and a tolerably homogeneous character.

While the yelk of the *Pentastomum* originally fills the whole internal cavity of the oval egg, it subsequently contracts after the segmentation is completed, so that an intermediate space is formed between it and the contiguous coat. (The character of these coats is now what it will be afterwards, and the external is likewise already transparent and distant.) At the same time the surface of the yelk exhibits a well-defined, almost membranous border. In the middle of the part which subsequently becomes the dorsal surface, there appears a shallow saddle-shaped indentation. Where this depression is deepest, the membranous surface of the yelk thickens into a clear conical process, which projects, comparatively speaking, to a considerable depth into the substance of the granular yelk.

At this stage of development the ovum of the *Pentastomum* remains for a long time, as we may conclude at least from the circumstance that more than two fifths of the vagina are filled with ova in this stage. (In *P. oxycephalum*, from the lung of the Kaiman, investigated by myself, the development of the ova does not appear to make any further progress in the vagina of the parent; at least, no later stages of growth could be observed in a dozen of these animals.) At the commencement of the last third of the vagina, the dorsal process just described assumes an hour-glass form; it is divided by a circular groove into an upper and lower half, the former of which, with its margins, passes directly over into the limiting surface of the yelk, which in the mean time is becoming more and more distinctly membranous. At the same time may be observed opposite the dorsal process, in the middle of the part that afterwards becomes the ventral surface, a transverse groove, by which it is divided into an anterior and posterior zone. The membranous boundary of the yelk-mass does not take part in the formation of this groove, on the contrary it extends across it like an arch, so that in the place in question a little intervening space is formed between the yelk-mass and the previously closely applied membrane. This groove, however, only remains for a short time in its primitive form; it very soon deepens into a cleft, which penetrates into the yelk-mass towards the posterior pole in a diagonal direction. The yelk-segment which is separated by this notch, and coheres with the remaining yelk, only on the dorsal surface of the egg, is the first indication of the tail, of which we have already stated above, that it is constantly folded upon itself forwards underneath the abdomen whilst the embryo remains within the egg-coverings.

After the yelk has thus in general assumed the morphological conditions of the future embryonic body, it likewise commences to retreat at other points from the membranous layer with which it is coated, and to clothe itself, with a new cuticular covering, the future chitinous shield. The former vitelline membrane in this manner becomes a capsular covering of the embryo, in the same way as the two primitive egg-envelopes formed a long time previous; it becomes the innermost coat of the ovum. It is true that, on the dorsal process, this envelope is for a time connected with the embryonic body inclosed within. But this connexion is likewise gradually dissolved, from the circumstance, that the grooving in the centre of the dorsal process above mentioned, deepens more and more, and finally separates the structure in question into two isolated parts. The upper part remains seated on the internal coat of the ovum, forming the "facet" seen by Schubart, while the lower portion becomes the dorsal depression of the embryo, the margins having in the meanwhile become continuous with its chitinous covering. After the separation an alteration often takes place in the relative position of the embryonic body and the internal egg-shell, and on this account, as Schubart has also remarked, we often find the facet placed laterally or even on the ventral surface of the embryo.

Even before the separation of the future dorsal depression is completed from the facet of the interior embryonic covering, the pedal tubercles, with their claws, have also made their appearance. They arise at a time in which the rudiment of the tail has but just been formed and the dermis still appears extremely thin, and in the form of two elevations at the sides of the anterior body. The claws are formed earlier than the chitinous ridges, and in respect of the latter again the prongs of the fork earlier than the stem. At the same time there arises along with the claws, at the anterior extremity of the embryonic body, a roundish depression, constituting the mouth, the chitinous margin of which, however, does not thicken till a later period, when the organs of support become visible on the legs.

Of late it has been the fashion to regard the *Pentastomata* as belonging to the Acarina or Crustacea. But the above observations respecting their embryonic development would scarcely be in favour of this hypothesis, and might perhaps be adduced against it. It has hitherto been considered a general law, that the Arthropoda, to which the Acari and Crustacea belong, are developed by means of a primitive streak, while the *Pentastomata* present us with the instance of a universal development, such as is usually observed in the Annelida. That the formation of the embryonal legs is also by no means to such an extent mite-like or crustacean, as was formerly assumed when an articulation was assigned to them, has been demonstrated above in detail. According to the present state of our knowledge respecting the *Pentastomata,* it would scarcely be at once considered erroneous and unnatural, if some one undertook to defend the old view of the worm-nature of these animals. Although a further and more exact investigation of these relations would be here inappropriate, I have referred to them because many modern helminthologists, well known to the medical public, have probably set too much weight on the presumed crustacean and acarine character of these parasites. Again, on the other hand, notwithstanding the doubts I have here expressed, we must not forget, that in various respects (such as the general form of the embryo, the formation of the chitinous covering, and transverse striation of the muscles, &c.) the *Pentastomata* do really exhibit a greater approximation to the higher articulated animals, than we are elsewhere accustomed to see in a worm.

After these remarks let us return to our proper subject, *i. e.*, to the life-history of the *Pentastomata.*

The three dogs into which I had introduced the *Pentastomum denticulatum* were thus, on examination, without exception found to be infested with *P. tænioides,* and some of them even with very numerous individuals of that rare parasite. It was also apparent that the various states of development of these animals corresponded accurately with the differences and duration of the experiments—that is to say, their development was always the more complete, the longer the interval since the period of introduction.

From these results we are fully justified in concluding that the *Pentastomata* found in the infected dogs were descended from the introduced *P. denticulatum.* In other words, that

that species represents the young condition of *Pentastomum tænioides.*

With the establishment of this fact, our knowledge of the life-history of the parasites in question has certainly been considerably advanced, though by no means brought to a conclusion. Before we can boast of this, the question of the developmental history of *Pent. denticulatum* must be first fully solved.

The embryos of *P. tænioides* exhibited structural conditions which are remarkably different from those of *Pent. denticulatum,* but in what manner and under what conditions these differences are equalised, is as yet completely unknown.

In my first communication respecting *Pentastomum denticulatum,* I have suggested that, according to older observations incidentally made, the ova of *P. tænioides,* which are ejected with the nasal mucus, might be accidentally introduced into the food of rabbits, and then swallowed by these animals. It was further assumed that the egg-shells are dissolved in the cavity of the stomach by the influence of the gastric juice; that the embryos being set free, pierce the intestinal walls, enter the various organs, and are there developed, under favorable circumstances, into the well-known form of *P. denticulatum.* This hypothesis was partly founded on the organization of the embryo and the character of its egg-coverings, partly also upon the analogy with other helminths, especially the Tæniæ, whose eggs and embryos exhibit similar relations. Besides this, I had on a previous occasion tried in vain to make the embryos of these animals escape from the egg by keeping them for some time in water.

The correctness of this hypothesis had now to be tested experimentally. For this purpose, on the very first day of the last investigation (August 25th), I fed eight rabbits with ova containing mature embryos taken from my three female *Pentastomata.*

Two of these rabbits were destroyed within the next few days. I had hoped to surprise the young embryos in the act of migrating in the interior of their host, but my experiments in this direction unfortunately failed; partly, perhaps, because, being still uncertain of a favorable result, I did not devote myself with that perseverance which is necessary in such delicate matters. Nevertheless, I scarcely doubt that a repetition of these researches will repay the trouble, for the discovery of the embryonic *Pentastomata* is certainly less difficult than that of the six-hooked embryos of the tape-worm, which are much smaller. The differences of size between the two kinds of embryo are so marked that they perhaps influence the direction which the wanderers select in the body. This much at least is certain, that if the embryos of the *Pentastomata* follow the circulation of the blood, like those of the Tænioid worms, it can only be when they obtain access to the larger vessels.

[Here follows in the original the detailed account of several observations on the earliest condition of the larval *Pentastomum*, which it seems hardly necessary to give at length; and we shall therefore conclude with the author's summary of the results of his experiments and researches.

These, he says, may be comprehended under some such laws as the following:

1. That the entozoon known under the name of *Pentastomum tænioides* from the nasal cavity of the dog and wolf, passes the early stage of its existence in the interior of the rabbit and other mammals, especially in the lungs and liver (occasionally also in man).

2. The development of *Pentastomum tænioides* takes place under a simple metamorphosis, and presents four successive phases:

(*a*) The condition of the *Pentastomum-embryo,* furnished with a boring apparatus and claw-feet.

(*b*) The condition of the encysted and immotile *Pentastomum* (the pupa state).

(*c*) The condition of the so-termed *Pentastomum denticulatum,* with a crown of spines and double hooks, one of which is moveable (the larval condition).

(*d*) The condition of the sexually mature *Pentastomum tænioides,* with simple moveable hooks and without a crown of spines.

3. The time occupied in the development of *Pentastomum tænioides* is nearly a year—the larger portion of the period being taken up in the formation of the larval form (*Pent. denticulatum*), and the remainder devoted to the transformation into the sexually mature animal (*P. tænioides*). The male reaches maturity earlier than the female.

4. The embryo and larva, possessing special provisional motile organs, are organized for an active migration; and consequently are in a condition either to change their position in the interior of their host, or to pass from one host to another.

5. The first migration of these parasites is passive, inasmuch as the ova containing mature embryos issued into the outer world contaminate the food of other animals in company with which they are conveyed into the stomach.

The observations contained in the foregoing paper, and the conclusions summed up in the five propositions just stated, immediately apply, it should be observed, only to the *Pentastomum tænioides* of the dog; although in all essential points they might be equally applied to the other species of *Pentastomum* as well. This the author believes he will be able to show in a further series of experiments.

In the course of the last year he had an opportunity, besides *P. tænioides*, of examining a large number of other Pentastomata, some in a condition of sexual maturity and some in an immature state. Of the former, he notices *P. proboscideum* from the lungs of *Lachesis* and *Boa constrictor; P. multicinctum*, Harl., from the lungs of the *Cobra di Marocco;* and *P. oxycephalum* from the lungs of the Cayman. All these forms agree with each other and with *Pent. tænioides* in the circumstance that they are without the crown of spines and accessory hooks; and further, that they live free in the interior of certain organs filled with air.

The sexually undeveloped Pentastomata examined by him, on the other hand, presented, without exception, accessory hooks and a crown of spines, although they exhibited considerable diversities in size and form, more especially in the latter. These forms, therefore, associate themselves with *P. denticulatum.* This analogy is the more important, since one of these undeveloped forms in all probability belongs to the *P. oxycephalum* noticed above, which, in the fully developed condition, possesses none of the organs in question.

From these observations, it seems to the author not too bold to conclude that the second species of *Pentastomum* (*P. constrictum,* V. Sieb.), found by Pruner and Bilharz, in Egypt, in man, may also represent an immature young form. He is inclined to adopt this opinion, not only because the form in question occurs encysted in the liver, but more especially because Bilharz ('Zeitsch. f. wissen. Zoolog.,' Bd. iv, p. 68) says respecting it, that the hooks corresponded with those of *P. denticulatum,* and consequently were furnished with accessory hooklets. It is true that V. Siebold (op. cit., vii, p. 331) expressly states a particular, hardly reconcileable with this view, viz., the absence of the circlet of spines; but this perhaps merely proves that the apparatus is exceedingly minute, and discoverable only by microscopic examination. The presence also of the sexual organs in the encysted *Pentastomata,* which has been adduced by some (Van Beneden) as a proof of their independence and perfect development, can now of itself be regarded as proving nothing, since the author's researches have established the fact that these organs, with all their essential parts, are present during the *pupa state.*]

REVIEWS.

Das Mikroskop; Theorie, Gebrauch, Geschichte, und gegenwärtige Zustand desselben. [*The Microscope; its theory, use, history, and present state.*] By Prof. P. Harting.

(Translated from the Dutch in German, by Dr. F. W. Thiele.)

Professor Harting's work on the 'Microscope,' originally written in the Dutch language, and consequently a sealed book to all but a very few, appeared in three distinct portions or volumes, to which a voluminous appendix was added last year. The whole was thus brought up to the present time.

These volumes and the appendix are now brought together, and constitute a goodly tome of nearly 1000 pages, illustrated with about half as many excellent woodcuts, illustrating almost every subject connected with the microscope and its adjuncts.

The present edition, moreover, has been excellently translated, under the author's immediate supervision, by a very competent microscopist, into a language which will render it generally available, and it may therefore be almost regarded in the light of an original work.

It is, undoubtedly, the most complete and satisfactory treatise on the microscope that has yet appeared, containing, in fact, a compendium of all that can be said, or nearly so, on that instrument and its use, and nothing more. For, notwithstanding its considerable size, the book contains very little matter not having immediate reference in some way to the instrument itself or its use. The only exceptions to this are the descriptions and figures of crystals, &c., belonging to the department of micro-chemistry. It does not include, as do most other works on the microscope, copious observations and representations of all kinds of so-termed microscopic objects, which, though interesting and useful in themselves, are scarcely properly placed in the pages of a work professedly upon the instrument by which they are viewed.

Professor Harting's treatise is divided into three parts or books, of which the first relates to the theory and general description of the microscope, including of course its optical arrangements. In the second book, the *use* of the microscope is described, and copious details given respecting the making of microscopical preparations; whilst in the third, we have a lengthened historical account of the instrument in all its forms, and of the state of comparative perfection at which it has now arrived. Every kind of accessory apparatus is also here described, and the utmost pains appear to have been taken to render this part of the work complete, and so far as we can perceive with success.

The subjects of micro-chemical analysis, micrometry, microgoniometry, &c., the estimation of the absolute and specific weights of microscopic objects, their refractive and polarizing properties, &c., are fully and ably treated.

Microscopic drawing and micro-photography also find a place.

In fact, nothing seems to have been omitted to render the present one of the most complete and useful works yet published on the subject of the microscope—and as such we recommend it to our readers.

Half-hours with the Microscope; being a popular guide to the use of the microscope as a means of amusement and instruction. Illustrated from Nature, by Tuffen West. Pp. 83.

This unpretending little book is really one of considerable worth, and will be found interesting to a large class of incipient microscopic observers, who use their instrument more for the purposes of rational amusement than with any actual scientific object. Its great value depends upon the plates, which are filled to repletion with accurate and well-drawn figures of a vast number of objects culled with much discrimination, from almost every department of natural history. To say that the figures have been executed by Tuffen West is to say that they are good and faithful representations of what they profess to delineate—and as we presume the objects were themselves selected by that gentleman, his judgment appears to have been as well exerted in that selection as his skill in the representation of the things selected.

The text is succinct and clear, giving in as few words as possible a description of the various objects represented in the figures, preceded by some brief and judicious remarks as to the mode of using and nature of the instrument.

We give an extract as an illustration of the style in which this little volume is written:

"There is considerable difficulty in at once distinguishing between the lowest forms of animals and plants. Although the animal generally possesses a mouth, and a stomach in which to digest its vegetable food, there are some forms of animal life so simple as not to possess either of these organs. In the sediment from ponds and rivers there will frequently be found small irregular masses of living, moving matter. If these are watched, they will be found to move about and change their form constantly. As they press themselves slowly along, small portions of vegetable matter, or occasionally a diatom, mix apparently with their substance. Cells are produced in their interior, which bud off from the parent, and lead the same life. These creatures are called amæbas; and though they have no mouth or stomach, they are referred to the animal kingdom. They appear to be masses of protein (*sarcode*) without any cell-wall. If we suppose an amæba to assume the form of a disc, and to send forth tentacles, or minute elongated processes from all sides, we should have the sun animalcule (*Actinophrys Sol*). This curious creature has the power, apparently, of suddenly contracting its tentacles, and leaping about in the water. It can also contract its tentacles over particles of starch and animalcules, and press them into the fleshy substance in its centre. This is undoubtedly an animal, but it has no mouth or stomach. A large number of such forms present themselves under the microscope. Some of them are covered with an external envelope, which they make artificially, by attaching small stones and other substances to their external surface, as in the case of the *Difflugiæ;* or they may form a regular case, or carapace, of cellulose, as is seen in *Arcella.* We shall meet again with forms resembling these when we take our microscope to the sea-side.

"One of the most common animalcules met with in fresh water, and whose presence can easily be ensured by steeping a few stalks of hay in a glass of water, is the bell-shaped animalcule. These animalcules, which are called *Vorticella,* are of various sizes. Some are so large that their presence can easily be detected by the naked eye, whilst others require the highest powers of the microscope. They are all distinguished by having a little cup-shaped body, which is placed upon a long stalk. The stalk has the peculiar power of contracting in a spiral manner, which the creature does when anything disturbs it in the slightest manner. In some species these stalks are branched, so that hundreds of these creatures are found on a single stem, forming an exceedingly beautiful object with the microscope. The stalks of these compound Vorticellæ are contracted together, so that a large mass, expanding over the whole field of the microscope, suddenly disappears, and, 'like the baseless fabric of a vision leaves not a wreck behind.' A little patience, however, and the fearful creatures will once more be seen to expand themselves in all their beauty. The mouth of their little cup is surrounded by cilia, which are in constant movement; and when examined minutely, they will be found to possess two apertures, through one of which currents of water pass into the body, and from the other pass out. Not unfrequently the cup breaks off its stalk. It then contracts its mouth, and proceeds to roll about free in the water. Many other curious changes in form and condition have been observed in these wonderful bell-shaped animalcules."

There is also an Appendix, on the Preparation and Mounting of Objects, by Mr. Thomas Ketteringham, which will be found very useful to beginners. The following is the introductory passage to this portion of the work:

"The majority of objects exhibited by the microscope require some kind of preparation before they can be satisfactorily shown, or their form and structure properly made out. To convince the beginner of this, let him take the leg of any insect, and, without previous preparation, place it under his Microscope, and what does he see? A dark opaque body, fringed with hair, and exceedingly indistinct. But let him view the same object prepared and permanently mounted, and he will now regard it with delight. That beautiful limb, rendered transparent by the process it has undergone, now lies before him, rich in colour, wonderful in the delicate articulation of its joints, exquisite in its finish, armed at its extremities with two sharp claws equally serviceable for progression or aggression, and furnished, in many instances, with pads (*pulvilli*), which enable the insect to walk with ease and safety on the smoothest surface. If the beginner has a true love for the study of the microscope, he will be glad of information respecting the method pursued in dissecting and preserving microscopic objects, nor will he rest satisfied until he has acquired some knowledge of the art. We will briefly point out a few of the advantages possessed by those who are able to prepare specimens for themselves.

"Objects well mounted will remain uninjured for years, and will continue to retain their colour and structure in all their original freshness.

"They can be exhibited at all times to one's friends, and may be studied with advantage whenever an opportunity occurs.

"By the practice of dissection such a knowledge is gained of the varied forms and internal organization of minute creatures as can be obtained in no other way.

"There are doubtless many who, possessing a small microscope, are unable by reason of their limited means to expend money in the purchase of ready-prepared specimens. To such a few plain directions, if followed, will be of service, and will enable them to prepare their own.

"The materials necessary for the beginner are few, and not expensive. In fact, the fewer the better; for a multiplicity is apt only to cause confusion. The following will be found sufficient for all ordinary purposes, and may be obtained at any optician's:

"Bottle of new Canada balsam.
"Bottle of gold size.
"Bottle of Brunswick black.
"Spirits of turpentine—small quantity.
"Spirits of wine—small quantity.
"Solution of caustic potash (*liquor potassæ*).
"Ether—a small bottle.
"Empty pomatum-pots, with covers, for holding objects while in pickle.
"Half a dozen needles mounted in handles of camel-hair brushes.
"Pair of brass forceps.
"Two small scalpels.
"Pair of fine-pointed scissors.
"Camel-hair pencils—half a dozen.
"Slips of plate-glass, one inch by three inches—two dozen.
"Thin glass covers, cut into squares and circles—half an ounce.

"We will suppose that the beginner, having purchased the necessary materials, is about to make his first attempt. Let him attend to the following advice, and he will escape many failures.

"He must bring to his work a mind cool and collected; hands clean and free from grease. Let him place everything he may require close at hand, or within his reach. A stock of clean slides and covers must always be ready for use. He must keep his needles, scissors, and scalpels scrupulously clean. An ingenious youth will readily construct for himself a box to contain all his tools. Cleanliness is so essential to success, that too much stress cannot be laid upon it. All fluids should be filtered and kept in well-corked phials. A bell-glass, which may be purchased for a few pence, will be found exceedingly useful in covering an object when any delay takes place in the mounting. For want of it many specimens have been spoilt by the intrusion of particles of dust, soot, and other foreign substances. Let the table on which the operator is at work be steady, and placed in a good light, and, if possible, in a room free from intrusion."

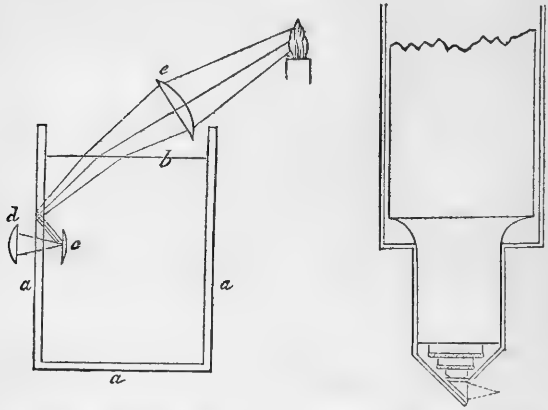
From these extracts and the known excellence of Mr. West as a delineator of microscopic objects, our readers will be able to form a judgment of the merits of this little introduction to the use of the microscope.

NOTES AND CORRESPONDENCE.

Mr. Warington's Portable Aquarium Microscope.—There is, perhaps, no department of microscopic investigation so interesting to most observers as the development, growth, and habits of vital organisms. The aquarium has now become popular, and thrives in the homes of many who do not pretend to cultivate science; but how often do we find that it is unaccompanied with any adjunct for assisting the eye to scrutinise the form and structure of its living tenants. Much of the interest and mental recreation which a study of the details of these remarkable beings will afford is lost, for want of that *indispensable appendage,* a simple form of microscope easy of application. To the ingenuity of Mr. Warington we are indebted for an instrument (described in the present 'Journal') which meets all the requirements of the case, being cheap, simple, and not liable to get out of order.

By reason of the position and other conditions under which the objects to be observed are situated, there will oftentimes be much difficulty in throwing light upon them, particularly when object-glasses of the shortest practicable focus are employed; for most frequently they require to be viewed as opaque objects. I therefore offer some suggestions, which I trust may lead to others of greater value.

If the aquarium, glass tank, or live-box, with its fluid contents, be considered as a square prism, it will be seen that a ray of light incident upon any one of its four plane surfaces, may be thrown back again from the adjoining plane in various directions, within the angle of total reflection. We may sometimes avail ourselves of this fact for the illumination of an object in a peculiar position. Let *a a a* represent the glass sides of an aquarium, *b* the surface of the water. The object to be viewed at *c,* with the object-glass (*d*). If the rays from a lamp be thrown in the direction shown, by means of the condensing-lens (*e*), after passing through the first surface they will be refracted more towards the perpendicular, and on reaching the glass wall of the tank will be reflected back again on the object at *c*. It may be mentioned that the total reflection of the rays takes place from the *outer* surface of the plate glass; therefore, if a small specimen is situated in close contact with the inner surface, it may be found that there is ample space in the thickness of the plate for light to pass over the object and be reflected back again to the point of adhesion with the glass. If the aquarium has glass sides the same rule will apply, which the diagram will illustrate, by considering the tank, condensing lens, &c., to be in plan and placed at the side instead of the top.



c. is not a lens as shown, but a short thick line representing the place of the object.

Of course, at a proper incidence, total internal reflection will also take place from the top surface of the water alone, but I do not see how this can be made available.

Object-glasses of a focus as short as half an inch may be used in the aquarium by the following method: A tube is to be made to slide over the front of the object-glass, and extending back for two or three inches over the body of the microscope. A very small glass prism, either right angled or equilateral, is cemented or otherwise fixed water-tight in the end of the tube, with one of its faces nearly in contact with the front lens. The microscope may be immersed in the water, and used either vertically or inclined, as deep as the "water-boot" will allow. The diagram will explain the arrangement. If the work is neatly put together, considerable focal distance may be obtained in front of the prism, as for a half-inch object-glass it need not be more than one eighth of an inch square, on its faces. The water must not be allowed to get to the *back* of the prism, as it will prevent total reflection therefrom, except at very oblique incidences. For a direct forward view under water, the prism may be replaced by a small disc of thin glass at right angles to the optic axis; this is an old suggestion by Dr. Goring.—F. H. Wenham.

Substitute for the Rack-and-Pinion movement of Microscopes.—I have found the following application of the "frictional gearing" (sometimes used in cotton-spinning machinery) answer perfectly well in lieu of the ordinary rack-and-pinion movement of the body and stage of microscopes. It is quite free from the unpleasant drop consequent upon a worn rack and pinion, and is exceedingly strong, it being impossible to injure or fracture the movement, by any undue violence, in turning the milled head, for beyond a certain amount of strain it will slip.

Fig. 1 is a plan and fig. 2 side view of a microscope body with this movement attached. The same letters of reference apply to both figures; *a* is the body of an ordinary microscope; *b* a strip of brass in the position of the usual rack—this is planed out longitudinally into three or four angular furrows, slightly truncated, as shown; *c* is a turned cylinder of steel with milled heads, in place of the pinion—this has furrows and

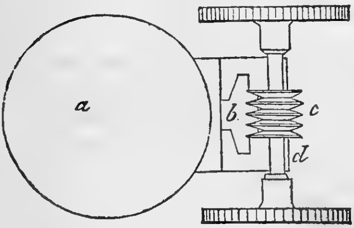


Fig. 1.

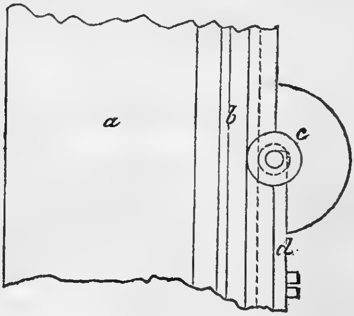


Fig. 2.

grooves of the same angle exactly corresponding with those of the strip.

The pinion or roller is pressed into the strip by means of a hammered brass spring (*d*), which serves to ensure a uniform pressure, needful to obtain sufficient bite between the roller and strip, to overcome the resistance of the work, and also gives accommodation to any irregularities of construction.

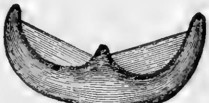
The lifting power or bite depends upon the acuteness of the angle given to the ridges and furrows, which must not be too obtuse, or not exceeding 30°.

I have made a friction rack of this description which works very smoothly, and lifts a weight of 16 lbs. without slipping; this force is amply sufficient for most optical purposes.—F. H. Wenham.

Notes on Tricuspidaria and Pentastoma.—In the preceding number of this 'Journal' (p. 115), a series of clearly defined vascular prolongations are described by me in connexion with the calcareous corpuscles of *Tricuspidaria.* These tubular extensions of membrane, though not previously recorded by any observer, I have there represented to have been known to Professor Van Beneden—an error unintentionally caused by the omission of the monosyllable "no" in my MS. It should have run thus : "In Professor Van Beneden's 'Vers Cestoïdes' *no* mention is made of these tubular extensions in the detailed and accurate description of this Cestode there given."

Since the memorandum referred to was published, I have received Van Beneden's great prize essay, entitled 'Mémoire sur les Vers Intestinaux;' but the structure of the species in question is not there treated at any further length.

As a more fitting opportunity could not occur, I will also mention a peculiarity in respect of the hooks of *Tricuspidaria* which has likewise escaped notice. I allude to the presence of thin chitinous laminæ connecting the two lateral horns of each hook to the central apophysis. The object of this arrangement is probably to afford additional security to the prong-like processes, thereby rendering them capable of



One of the four cephalic hooks of *Tricuspidaria nodulosa.* × 280 diam.

greater resistance; but whatever other signification or use they may possess, their general aspect inevitably reminds one of the aortic semilunar valves in the human subject. Van Beneden appears to think it an error that the cusps of the hooks should have been figured in the 'Règne Animal' as directed forwards, and has himself, consequently, drawn the hooks with the points downwards ('Vers Cestoïdes,' pl. xxii). On referring to the edition of Cuvier's work, edited by his pupils, I find Blanchard's figure ('Intestinaux,' pl. xxxix) to indicate an arrangement of the hooks precisely such as I have myself seen and figured more than once with the aid of a camera; in these cases the cusps were directed forwards. It can scarcely be doubted, therefore, that under different circumstances the same animal may display the hooks in either direction, most probably by inverting and everting the head, the performance of this function having perhaps escaped observation.

In regard to *Pentastoma,* I am greatly indebted to Professor Busk for having placed in my hands a memoir on the development of this genus by Professor R. Leuckart,* the perusal of which has induced me to commence a repetition of that distinguished entozoologist's experiments. The Council of the Zoological Society having liberally accorded me an opportunity of examining the carcases of certain animals dying at the Society's Gardens, Regent's Park, the evisceration of a Bubale (*Antilope Bubalis,* Pallas), on the 10th ultimo (February), fortunately supplied me with fourteen individuals of the so-called *Pentastomum denticulatum. Nine* of these entozoa were the next day introduced into the nostril of a hound ten months old, and *four* into the nasal cavity of an older dog—the *other solitary* parasite being retained for careful microscopic examination.

On the 4th of the present month (March), *i. e.,* three weeks after infection, the first hound was destroyed, but the most rigid inspection of the entire nasal, frontal, and facial cavities failed to detect a single specimen of our young *Pentastomata.* The second dog has not yet been killed.

I have thought it right to place on record this first, although a negative, result. Those only who comprehend the saving value, in respect of checking the superabundance of these and other allied parasites, by obtaining an accurate knowledge of their early wanderings and transformations, will understand the reasonableness of continuing these helminthological inquiries, in spite of the seeming destruction of life which they at present involve.—T. Spencer Cobbold, London.

* See Translation, in another part of the present number of this 'Journal.'

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *December 22d*, 1858.

Dr. Lankester, President, in the chair.

A paper by Lieut. Mitchell, of Madras, "On a new form of Circulating Apparatus observed in a species of Nepadæ" ('Trans.,' p. 36), and also one by Dr. F. Cohn, "On *Nassula elegans*," were read ('Journal,' p. 96).

January 26th, 1859.

Dr. Lankester, President, in the chair.

J. H. Stewart, Esq., Royal College of Surgeons, and J. Pullman, Esq., 17, Greek Street, Soho, were balloted for, and duly elected members of the Society.

The following papers were read:

1. "On Parasitic Fungi of the Human Skin," by Jabez Hogg, Esq. ('Trans.,' p. 39).
2. "On a new Instrument for observing Diatomaceæ," by J. N. Tomkins, Esq. ('Trans.,' p. 57).

Mr. Warington described certain improvements in his Portable Microscope ('Trans.,' p. 58).

February 16th, 1859.

ANNUAL GENERAL MEETING.

Dr. Lankester, President, in the chair.

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

The President delivered an address, giving an account of the proceedings of the Society and of the progress of microscopical science during the past year.

Resolved that the Reports now read be received and adopted, and that they be printed and circulated in the usual manner, with the President's address.

The following donations have been made to the Society:

December 22d, 1858.

	Presented by
Journal of Royal Dublin Society	The Society.
On the Arrangement of Cutaneous Muscles of the Larva of Pygæra	J. Lubbock, Esq.
Journal of Society of Arts, Nos. 314—323	The Society.
Journal of Photographic Society, 3 Nos.	
Pritchard's Animalcules	J. Hogg, Esq.
Bailey on Infusoria	Ditto.
Bailey on *Navicula Spencerii*	Ditto.
Bailey on a New Animalcule	Ditto.
Bailey on Deep-sea Soundings	Ditto.
Rainey on Shells	The Author.

January 26th, 1859.

Dr. Guy on Crystals of Arsenious Acid	Dr. Guy.
Adams on the Microscope	Mr. Williams.
Brewster's Treatise on the Microscope	A. Brady, Esq.

February 16th.

Half Hours with the Microscope	Mr. Hardwick.
The Canadian Journal of Industry, Science, and Art	The Editor.
Zur Kenntniss des Generationswechsels und der Parthenogenesis	Dr. Harley.
Beale on the Microscope in Medicine	Dr. Beale.
Beale on Urine, Urinary Deposits, and Calculi	Ditto.
How to Work with the Microscope	Ditto.
Eight Microscopic Slides of Shell Development	Mr. Rainey.

Hull Microscopical Society.

The members of the Hull Microscopical Society gave an evening dress soirée to about one hundred and fifty ladies and gentlemen, in the Philosophical Rooms and Museum of the Royal Institution.

A brief opening address was delivered in the lecture hall, by Mr. Sollitt, at eight o'clock, explanatory of the great improvements which had of late years been made in the microscope, through the discoveries and researches of the members of the Hull Microscopical Society. He referred also to the great advantages which had been realised by the making of object-glasses of a large angle of aperture, which increase of angle was in a great measure owing to the importance attached by the Hull microscopists to viewing the lines of Diatomaceæ. He also spoke of the indisputable pre-eminence of the microscope in the detection of adulteration of food.

After Mr. Sollitt's address the company adjourned to the side room, where tea and coffee and refreshments were amply provided.

The company then assembled in the museum, where, at different tables, the following class of objects was exhibited by the members of the Microscopical Society, each microscope being accompanied with a card containing the names of the objects exhibited: 1, Spicula and Gemmules of various Sponges, J. D. Sollitt; 2, Sections of Spines from the Echinodermata (Sea Urchins), J. D. Sollitt; 3, Vegetable Structures, Sir Henry Cooper; 4, Sections of Agates, &c., viewed by Polarized Light, B. Jacobs; 5, Vascular Structures of Animal Bodies, J. H. Gibson; 6, Micro-Photographs, Hy. Munroe; 7, Crystallized Salts, viewed by Polarized Light, Hy. Munroe; 8, Anatomical Preparations (Human), Hy. Munroe; 9, Shells of Diatomaceæ, Foraminifera, Polycistineæ, Dr. Bell; 10, Dissections of Insects, R. Harrison; 11, Ciliary Movement in the Mussel—Circulation in Plants (*Valisneria spiralis*), R. Harrison; 12, A variety of Acari (Mites), F. W. Casson; 13, Preparations of Marine Algæ (Sea Weeds), W. Parker; 14, Parasites of various Animals, W. Parker; 15, Scales from the Wings of Butterflies, Moths, &c., Dr. Lunn; 16, Injected Physiological Preparations, Dr. Daly; 17, Sections of Teeth, S. Moseley; 18, Micro-Photographs, J. Malam.

At nine o'clock the company again assembled in the lecture hall, when Mr. Munroe, surgeon, gave a short lecture on the "Revelations of the Microscope." The screen was filled with a great number of large and beautifully executed diagrams illustrative of Acari, Diatomaceæ, blood-discs, Desmidiæ, &c. Mr. Munroe gave a short description of each diagram, and referred the audience to the original slides, which were shown in the museum by the different members of the Society.—*Hull Paper.*

ORIGINAL COMMUNICATIONS.

On Plagiogramma, *a* new Genus *of* Diatomaceæ.

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

The only known species of the new genus of Diatomaceæ, which I propose to establish in this communication, was published by my late friend, Professor Gregory, in 1857, in his paper "On the Marine Diatomaceæ of the Clyde" ('Trans. Roy. Soc. Ed.,' vol. xxi), under the name of *Denticula staurophora*. Soon afterwards, two or three other evidently nearly allied diatoms were observed by Professor Walker-Arnott and myself in Californian guano; and my attention having been thus attracted to these remarkable forms, I lost no subsequent opportunity of searching for them, both in guano preparations and recent gatherings. Some I have detected in a gathering obtained by washing small algæ picked up on the coast of Jamaica; and several very interesting species occurred in the scrapings of conch shells from Nassau, New Providence, kindly sent to me by Mr. Norman, of Hull. The Caribbean Sea appears to be particularly rich in *Diatomaceæ;* and there can be no doubt that this curious little group will be further enlarged when observers shall have been supplied with additional materials from its shores.*

With regard to the affinities of this genus, it seems to be most nearly allied to *Odontidium* and *Denticula;* but the presence of vittæ constitutes an important difference. In the place of costæ, also, the species are furnished in almost every instance with conspicuous moniliform striæ. There is, however, in *P. ornata* an approach towards the costæ of *Odontidium.* The striæ are generally interrupted. The vittæ are composed sometimes of a centrical pair; sometimes with the addition of a solitary one at each extremity of the valve; in one case of a centrical pair, with an indefinite additional number.

* I take the opportunity of recommending that those who are interested in this subject, and have friends in the West Indies, should endeavour to prevail upon them to collect the smaller sea-weeds, especially such as are cast ashore in quiet bays and creeks. It should be explained to them that the object is not the sea-weeds themselves, but the diatoms to be obtained from them, and that those sea-weeds are to be preferred which are covered

Plagiogramma, *Grev.*

Frustules quadrangular, direct, two or more united into a filament; valves linear or elliptical; striæ moniliform; vittæ two or more, pervious, parallel with the striæ.

Section I.—Vittæ 2, centrical.

1. *P. gregorianum,* Grev.—Valve elliptical, obtuse; striæ pervious, 18 in ·001″; frustule in front view somewhat dilated in the middle; length ·0014″ to ·0030.″ (Pl. X, figs. 1, 2.)

Denticula staurophora, Greg., 'Trans. Roy. Soc. Ed.,' vol. xxi, p. 496, pl. x, fig. 37.

Dredged in Loch Fine, by Dr. Gregory. Lamlash Bay, Island of Arran.

This was justly regarded by the late Professor Gregory as a very curious little diatom, nothing similar to it having been previously noticed. As far as I have had an opportunity of examining the side views of the different species, this is the only one which possesses pervious striæ. It is scarcely necessary to remark that, as the centrical vittæ which Dr. Gregory regarded as a stauros, are characteristic of all the species, I have been under the necessity of changing the specific name.

2. *P. jamaicense,* n. sp., Grev.—Valve . . . . . ? frustule in front view with the sides straight; length ·0024″; striæ continued almost quite up to the angle, 16 in ·001″. (Fig. 3.)

Jamaica, in washings of algæ.

As I have not succeeded in obtaining a side view of the frustule, I am unable to give a satisfactory definition of this species. The vittæ, however, are only centrical, and it is certainly distinct from the preceding. The striæ can scarcely be termed strictly moniliform, but rather moniliform costate. I have another form belonging to this section, also from Jamaica, the frustules of which are ·0020″ in length, and the band of striæ considerably narrower; the striæ themselves 21 in ·001″. It may be a different species, but having only seen the front view, I dare not venture to introduce it as such.

3. *P.? tessellatum,* n. sp., Grev.—Valve narrow-elliptical;

with parasites and entangled with zoophytes, forming what the mere collector of algæ would call unsightly tufts. They must on no account be washed, but dried in the rough, just as picked up, and then packed in coarse paper. Small parcels of this kind (a few ounces in weight), from the coasts of the different islands (and from different localities of the same island), could not fail to produce objects of the highest interest to the diatomist.

striæ interrupted, composed of large subquadrate granules, 8 in ·001″; length of frustule ·0040″. (Fig. 7.)

In Californian guano.

A single example of this most remarkable diatom is all that I have seen; and I introduce it with considerable hesitation, for I am by no means satisfied that it belongs to the present genus.

Section II.—Vittæ 2, centrical, and one at each end of the valve.

4. *P. pulchellum*, n. sp., Grev.—Valve linear-elliptical, obtuse; striæ interrupted, robust, conspicuously moniliform, 11 in ·001″; length of frustule ·0025″ to ·0057″. (Figs. 4—6.)

In Californian guano; Jamaica, in washings of algæ; Nassau, New Providence, in scrapings of conch shells.

Of this fine species I have seen as many as five frustules united in a chain, but this is extremely rare; for their coherence in the whole genus seems to be very slight. The terminal vittæ are rather distant from the extremities of the valve, and two or three faint and short striæ are seen on the side of the vitta next the apex. The striæ are very strong, and conspicuously moniliform. It will be perceived how greatly this species varies with regard to size; but I cannot detect any real difference between the large frustule represented at fig. 6 and the smaller ones forming the chain at fig. 5. There is another form, of which I have only seen the front view, which differs in the striæ being shorter and slightly more numerous (13 in ·001″). It occurs in Californian guano and in the West Indies.

5. *P. validum*, n. sp., Grev.—Valve linear, slightly dilated in the middle, rounded at the ends; striæ interrupted, conspicuously moniliform, 12 in ·001″; length of frustule ·0055″, breadth ·0007″. (Fig. 8.)

In Californian guano.

As in the preceding species, I have only seen the side view of this diatom, the character of which is abundantly distinct. The valve maintains its breadth to the extremities.

6. *P. ornatum*, n. sp., Grev.—Valve . . . ? striæ in front view of frustule broad, moniliform-costate, 8 or 9 in ·001″; connecting membrane with longitudinal rows of dots 15 in ·001″; length of frustule ·0052″. (Fig. 9.)

In Californian guano.

An exquisitely beautiful object, first pointed out to me by my friend Professor Walker-Arnott. I have not seen the side view; the specific character must consequently remain for the present imperfect. The front view, however, is amply sufficient to separate it from any of the species described in this paper. The striæ are very peculiar, broad, and appearing almost like flat plates to the eye; indeed, at first sight, they might be taken for costæ, but they are in reality composed of two or three pieces, two only being often visible. Two abbreviated striæ are situated between the terminal vittæ and the angle of the frustule, the last one being a mere spherical granule. What importance may be attached to the beautiful rows of dots, analogous to those which occur in the connecting membrane of some *Biddulphiæ*, I am quite unable to say. As they are not present in any of the other species where I have been able to examine the front view, it is reasonable to conclude that they are characteristic of the present form. It can scarcely be assumed that they have any connexion with the striæ, as they do not correspond numerically. The terminal vittæ in this species are liable to be overlooked in a hasty examination, but they come out quite distinctly with careful adjustment.

7. *P. inæquale*, n. sp., Grev.—Valve . . .? terminal vittæ in front view longer than the centrical ones, and inflected at the apices; length ·0014″ to ·0016″; striæ moniliform, 16 in ·001″. (Fig. 10.)

Jamaica, in washings of algæ; Nassau, New Providence, in scrapings of conch shells.

It is fortunate that although, as in several of the preceding species, the side view is unknown, the front view should possess such well-marked features. At the first glance the eye is struck with the arrangement of the striæ into, as it were, two distinct groups, caused by the centrical and terminal vittæ being somewhat approximated, and the intervals between them being filled up with the striæ. The inflected apices of the terminal vittæ, and the blank space between the centrical vittæ, contribute to produce this effect. Another remarkable peculiarity is caused by the unequal length of the vittæ; the terminal ones are the longest, their points being inflected inwards; so that the ends of the striæ form an oblique line, descending from the points of the terminal to those of the centrical vittæ. Then, again, the boundary line of the connecting membrane follows on each side the direction of the outline formed by the ends of the striæ, and the result is more or less of a rhomboidal figure, of little value in the diagnosis, but adding to the singular aspect of the frustule. It seems to be very rare in both stations.

8. *P. pygmæum*, n. sp., Grev.—Minute; valve narrow-oblong; length ·0012″; striæ moniliform, 21 in ·001″. (Fig. 11.)

Nassau, New Providence, in scrapings of conch shells.

This diatom is distinguished among its congeners for its minute size, its shape, and the small number of striæ; for although they are, in the relative proportion assigned above, there are, in fact, but few in the entire frustule. The valve is not unlike the lower valves of some small *Achnanthes*, but the decided terminal vittæ serve at once to indicate other affinities.

9. *P. obesum*, n. sp., Grev.—Minute; valve broadly dilated in the middle, the ends rounded; length ·0022″, breadth ·0009″; striæ 11 in ·001″. (Figs. 12, 13.)

In scrapings of conch shells, Nassau, New Providence.

The inflated appearance of the valve and the small number of striæ render this a well-marked species.

10. *P. lyratum*, n. sp., Grev.—Valve contracted in the middle, then dilated and narrowly lyriform, linear and rounded at the extremities; length ·0042″; striæ 18 in ·001″. (Fig. 14.)

In scrapings of conch shells, Nassau, New Providence.

The variety of contour exhibited in the valve of this and the preceding species is a striking illustration of the necessity of obtaining a side view of the frustule in order to make up a complete character, although a sufficient *provisional* character may sometimes be furnished by the front view. The present diatom, the most beautiful and remarkable of its genus, seems very rare, as I have only met with one example.

Section III.—Number of vittæ between the two centrical ones and the ends of the valve indefinite.

11. *P. californicum*, n. sp., Grev.—Valve linear, rounded at the ends; vittæ between the centre and apices 3—5; length ·0030″ to ·0038″; striæ 18 in ·001″. (Figs. 15—17.)

In Californian guano.

The only species which has come under my notice belonging to this section.

On the STRUCTURE *and* MODE *of* FORMATION *of the* DENTAL TISSUES, *according to the* PRINCIPLE *of* "MOLECULAR COALESCENCE." By GEORGE RAINEY, M.R.C.S., and Lecturer and Demonstrator of Surgical and Microscopical Anatomy at St. Thomas's Hospital.

IN a paper contained in the 'British and Foreign Medico-Chirurgical Review,' for October, 1857, "On the Elementary Formation of the Skeleton," I have intimated that the globular form of dentine noticed by some of the later writers on the dental-tissues, is the result of the same process of molecular coalescence as that by which bone and shell are formed; and that the so-called "dentinal tubules" are merely spaces bounded directly by the dentine-fibres, and the partially coalesced dentine-globules. As, at that time, I was not aware that a similar view of the nature of these passages had been published by M. Raschkow, any observations of mine, however demonstrative of the fact, can only be regarded as confirmatory of his. This view of the nature of these passages had, to my knowledge, no supporters among those who had written upon the subject in this country, being supposed to have its origin entirely in the fibrous appearance presented by dentine under a low magnifying power, and thus Raschkow's view was passed over as incorrect. I may remark, that as there are few structures which have been so minutely and carefully examined as the dental tissues, it must follow, that so far as microscopical appearances are concerned, it will be impossible to add much to what has, with more or less minuteness and accuracy, been described, and therefore I shall have but little to communicate strictly of an anatomical character which will be new. But originality in this respect is not, in this communication, my object, which is to give the proper interpretation of appearances already described, and to show that they admit of being accounted for, and their mode of formation demonstrated on the same principle of molecular coalescence as has been applied to the formation of shell-tissues. I may further notice, that as this article must be as brief as possible, only such details of the structure of the dental tissues, and the organs concerned in forming them, will be introduced, as are absolutely necessary to render the physiological observations and explanations intelligible.

In discussing the subject, two descriptions of parts will require to be considered; namely, the tooth itself, and the organs concerned in its formation. The latter comprises the dentine-pulp, the enamel-pulp, and the osteo-dentine or bone-pulp. These are all composed of areolar tissue, vessels, and nerves, and are provided each with an epithelium. The former consists of a hard part, made up of dentine and enamel, and a soft part. This latter is limited to the immature organ, and, having the same relation to the calcified portion of a young cusp that the membranous edge of a flat bone has to the ossified part, I shall call it the membranous matrix of the cusp. This being the part where the process of calcification commences, and on which the progressive stages of that process admit of being easily examined, it will require to be described with some degree of minuteness. And to make this perfectly intelligible, a general view must first be taken of all the parts concerned in the formation of a cusp, and of the cusp itself. This will be best done by referring to the following diagram (fig. 1), which is intended to represent all the parts as they are found in the ossifying cusp of a mammal before the tooth has passed through the gum.

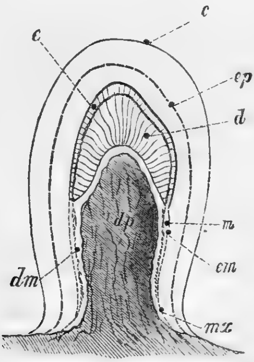


Fig. 1.

c, capsule; *e-p*, enamel-pulp; *d-p*, dentine-pulp; *m*, matrix, undulated, and dividing into *e-m*, enamel-matrix, as the external, and *d-m*, dentine-matrix, as the internal layer; *e*, enamel; *d*, dentine.

A cusp, in which the process of calcification has made but little progress, is best adapted for this examination. In such a cusp, when seen by a low magnifying power, a mere shell of tooth-substance, with a membranous border extending from its lower margin—the membranous matrix—is distinguishable. (Pl. XI, fig. 4). The relative proportions of the hard and soft parts will vary as a cusp approaches the state of a perfect tooth, the latter retaining nearly the same width until the process of calcification is completed. However, I may notice, that in a cusp about one eighth of an inch in length, taken from a fœtal calf, the membranous border constituted at least a tenth part. This structure, when all the parts of an uncut tooth are *in situ*, is situated between the enamel and dentine pulps, its surfaces being respectively in contact with the corpuscles of each and its free margin lodged in the groove formed by their union, to which groove it is united by exceedingly fine connective tissue. The surface of the membranous matrix is not smooth, but pitted, and the lateral borders appear to be undulating, these presenting the same irregularity of form as that presented by the surface of dentine which is in contact with the rods of enamel. Before calcareous particles begin to be deposited on the membranous matrix, it has no appearance of being divisible into layers; but afterwards its division into two layers can be demonstrated, one layer following the lower surface of the layer of enamel in progress of formation, and the other the corresponding surface of the incipient layer of dentine. Its presence in these situations after a time becomes obscured by its intimate connexion with these tissues.

In fact, one layer may be regarded as the membranous matrix of the dentine, and the other as the membranous matrix of the enamel. But this will be better understood when the process of calcification is considered. As respects the structure of this part, it seems to me to be more allied to cartilage than to any other description of tissue, although, in its anatomical characters, it differs materially from it. The membranous matrix appears to be made up of very delicate flattened corpuscles of different shapes and sizes, but generally longer in the vertical than in the transverse direction of the cusp. Near its lower part these corpuscles are imperfectly defined, and in all parts of it they are partially separated by spaces more or less distinct in different cusps, and in different parts of the same matrix. The matrix, when *in situ*, being contiguous to the dentine and enamel organs, has, after its removal, frequently patches of their corpuscles left upon it, which, from their distinctness, and the regularity of their form, cannot be mistaken for those of the matrix itself.

Having now described this part with some degree of minuteness—though not, I conceive, more so than is commensurate with its physiological importance, inasmuch that it not only presents the earliest conditions both of dentine and enamel, but is also the part on which the process of calcification can be examined with the greatest facility—I shall proceed to consider the process of calcification and the mode of formation of the hard parts of a cusp; and shall first speak of the structure of dentine and its mode of formation.

As the structure of this tissue owes its histological characters to the manner in which it is formed, the account of the mode of its formation will best precede that of its structure; and, therefore, I shall give first the process by which it is formed. The first microscopic indication of the presence of dentine is the appearance of very minute, and more or less scattered, bright particles on the inferior surface of the membranous matrix, a short distance from its lower border. They are far too minute to admit of accurate measurement, appearing merely like very fine particles of dust (fig. 3 *b*). Examined nearer to the hard part of the cusp the dentine-particles are seen to be larger, and of a more or less rounded form, and, in the cusp of the fœtal calf, to be arranged in lines of partially coalesced globules (fig. 3 *c*), but at the free border of a half-ossified fang of human tooth they are collected into globular masses. The component globules of which being, as in the lines, only imperfectly coalesced, spaces, generally considered as tubules, are left between them. Afterwards, a still further coalescence taking place, the lines, which before consisted of strings of globules, are now become long fibres, or rods of dentine. Now this process, in point of principle, is exactly the same as that which takes place in the calcification of the claw of the lobster, of which any one can convince himself who will take the trouble to examine that part in the proper manner. The intervals between the rods, if traced backwards, will be seen to end in, or rather to become continuous with, those between the larger rounded portions of dentine, and these, with the interstices between the smaller granules; and thus these spaces diminish in size, but increase in number, until they are lost among the dusty-looking particles first described. These spaces, severally situated either between the rods of dentine or between the partially coalesced dentine-globules or granules, are the so-called "dentinal tubules," which, by writers upon the dental tissues, are said to have appreciable walls or parietes. As I believe that the intervals in question are merely spaces between the uncoalesced rods of dentine, exactly like those between the rods of enamel, I shall proceed to give my reasons for entertaining this view.

And this being the negative side of the question, I may adduce the following argument. Now, as during the entire progress of formation of all the so-called "dentinal tubules," a portion of dusty-looking material—incipient dentine—always intervenes between the partially formed tubules and the dental pulp, all the fluid which is contained in their interior, must have first passed through mere interstices or spaces. Hence if at this, the most important epoch of a tooth's formation, mere spaces have sufficed for the conveyance and supply of interstitial fluid to its substance, I do not see why parietes should be afterwards added to those spaces; as by such an addition a complex form of structure would be superadded to a simple one, after the tooth-tissues had ceased to perform any obvious organic function, their office being purely mechanical; and thus this substitution of tubes with parietes for mere spaces would come too late to serve any obvious purpose. In other parts where tubes exist, as in the tracheæ of insects, or ducts of glandular organs, a function is performed entirely distinct from that which was required to build up these parts—and one obviously requiring such a system of tubules. But the spaces between the dentine-fibres and between the dentine-globules do not come under this category, but appear to be merely a form of interstice, suited to the character and form of the tissue in which they exist, and so to be strictly analogous to the spaces between the rods of enamel.

As respects the proofs resting upon facts apparent from the examination of dentine by the microscope, I am convinced they are sufficient to satisfy any one who will examine the subject with impartiality. It may not be out of place here to state that the microscopic examination of the dental tissues is far more easy than is generally supposed. For the successful investigation of this subject fœtal teeth, perfectly fresh, are indispensably necessary, and these can be obtained almost at any time. I have especially examined those of the calf as being most easily procurable. It will not be necessary that the investigator should grind and polish sections of all the teeth which he examines; however, it will be advisable that he should possess two perfect sections, which can be easily procured from the opticians. I make these remarks rather to encourage those who are afraid to undertake the subject from the supposed difficulty of making suitable preparations, than to dissuade any one from using his own fingers. Sections of decalcified dentine, examined in glycerine, are very useful, and can be made without any difficulty. It has been stated, that even and regular sections cannot be made of teeth softened by an acid. This does not in the least agree with my experience. A very convenient way of decalcifying teeth in the shortest space of time, and with the feeblest acid, is to suspend them by a thread in a moderately large quantity of the acidified fluid. One part, by measure, of hydrochloric acid, with twelve of water, will serve very well for this purpose; but the solution may be weaker if preferred. Globular dentine of the human tooth, as observed by Mr. Salter, may be easily obtained by introducing the point of a penknife into the hollow of a half-grown fang and scraping its inner surface; or, which is better, by chipping off the free edge of the opening into the fang.

The previous decalcification will not be applicable to enamel, which, containing so little soft material, is lacerated and torn into pieces by the effervescence occasioned by the action of the hydrochloric acid upon the carbonate of lime it contains. However, this tissue is well seen in young cusps, as will be shown hereafter. For the examination of the true nature of the so-called dentinal tubules, the sections of the decalcified dentine must be of different kinds; some being parallel with the pulp-cavity, and others at right angles to it. In such sections, when compared with similar ones of teeth not decalcified, it will be seen that the form and bulk of the decalcified dentine-rods and -globules are not altered, and that they are only distinguishable from those of the perfect dentine by an inferior degree of brightness. This gives an advantage to the decalcified specimens when employed for microscopic purposes. The exact form, extent, and precise situation of the dentinal interspaces are best defined in these, in consequence of the lower refractive power of the material by which they are surrounded interfering less with accurate definition. By such a mode of procedure it will be seen that dentine is made up of solid rods or fibres of a quadrilateral figure (fig. 6) running in different directions from the pulp-cavity towards the external surface, some being parallel with, others at right angles to that cavity, and a third set passing in all the directions intermediate between these extremes. At each of the four angles of all these rods a space, or so-called tubule, exists (fig. 6 *b*), being formed by the meeting of the four adjacent angles of the four contiguous rods (fig. 6 *a*). This interval is more or less limited to the point of conflux of these rods in different parts of a tooth, the difference depending upon the degree of coalescence of contiguous rods. Sometimes it extends some distance between each two adjacent rods, whence the appearance of a dichotomous division of a space is produced. On the contrary, in other parts the coalescence of the adjoining fibres or rods is so complete, that not only the spaces between the apposed surfaces of the rods, but also the intervals at the junction of their angles, are obliterated. In such cases dentinal tubules are said not to be present. Now when a thin section is made through such an assemblage of fibres and passages as above described, and as represented in Pl. XII, fig. 6, the cut rods will present sections of various forms, some will be nearly square, others diamond shaped, and a third set linear; these forms depending upon their several directions — and from what has been before stated concerning the directions of these fibres, it is obvious that the forms will gradually pass one into the other.

The subjoined diagram (fig. 2) representing a vertical section of a tooth at a more advanced stage than the former

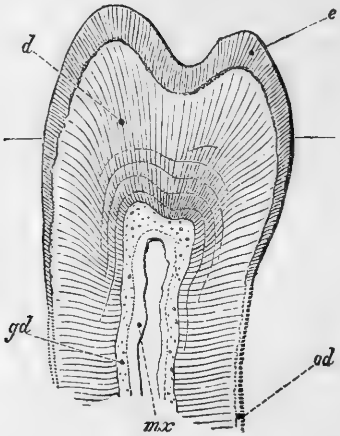


Fig. 2.

e, enamel; *d*, dentine; *o-d*, osteo-dentine; *g-d*, globular dentine; *m*, matrix. The horizontal line represents the part from which the section, a portion of which is figured in Pl. XI, fig. 6, was taken.

one, will illustrate the various points spoken of, as well as the reason for the different forms on section of dentine-rods.

Now if these rods had inclosed tubes of the form represented in plates intended to show them, their sections must have presented first circular areas, and then ovals, becoming gradually more and more excentric until they ended in straight lines. But such is not the case; the sections of these spaces, at first more or less circular, become angular or arrow-shaped, the before-mentioned lines diverging from the angular point losing themselves between the contiguous rods, the depths to which these lines extend depending upon the amount of their coalescence. Where the rods are imperfectly formed, being made up partly of globular portions, then the passages running between them will partake of the same form, and an appearance of anastomosis will result. If the fibres should take a flexuous course, then the contour of the quadrilateral areas will be more or less curvilinear. In fact, it is certain that, if a body were made up of square rods placed side by side, and so inclined towards one another as to assume all directions between a vertical and horizontal axis, and if, at the conflux of every four, there was a minute space, which passed more or less deeply between each adjoining pair, such sections made through this body, as have been directed to be made through the decalcified dentine, would exhibit the same appearances.

The appearance presented in transverse sections of dentine, of rings with a dark point in the centre, has been too exclusively regarded as satisfactory proof of the existence of distinct tubes. It is well known, however, that this appearance is delusive, and not to be depended upon. In proof of this I have only to adduce the structure of the silicious cuticle of the common cane, and the appearance which it presents under the microscope. This is best seen in cuticle which has been boiled in nitric acid. The structure is made up of hexagonal blocks of silica (fig. 1 *a*, *b*), each block having within it a flask-shaped cavity, with the narrow part uppermost (fig. 1 *c*); and at the conflux of every three such blocks there is a space extending from its superficial surface down to the layer of cellular tissue upon which the portions of silica rest. Now these spaces, of the true nature of which no one who has examined them can entertain a doubt, present exactly the same forms and appearances as have been described in the dentine, namely, the annular, arrow-shaped, and linear forms, according to the direction and position in which they are viewed. Also a too great anxiety to account for all appearances on the cell-hypothesis has contributed much to the idea of the tubular nature of dentine, and thus these imaginary tubules have been attributed to "certain filiform prolongations of dentinal cells," or to their elongated nuclei. For between cells and tubes there is considerable analogy, so that an erroneous idea originating in the one is easily propagated to the other. In this manner, probably, the fibres of the crystalline lens have been thought to acquire a tubular form, and hence these also are now described by Professor Kölliker as tubes—an error which will be seen to be corrected in my account of the structure and development of that organ. But the chief cause of fallacy on this point is to be traced to the erroneous notion generally entertained of the supposed physiological importance of the soft material which is left after the action of acids on hard structures; these residua having been regarded as the formative organs and receptacles of the removed earthy matter. Hence has originated the idea of different kinds of dentine, as "well-formed consistent dentine," "secondary dentine," "tubeless and uncalcified dentine," according to the relative quantities of earthy matter thought to exist in combination with the soft tissue.

Now I have no doubt but that the whole of this is erroneous, and that there is only one kind of dentine which, even in its molecular state, is as perfect as it is in the so-called tubular dentine, the latter being formed by the coalescence of the particles of the former, exactly in the same way as the larger globules of earthy matter occurring in the deep layers of the shells of Crustaceans are formed by the coalescence of the smaller ones.

As for "uncalcified dentine," I know no other part of a calcifying tooth which could be taken for such a form of dentine but that which I have designated "matrix"—that upon which the primary particles of dentine are precipitated; but it seems to me that this has no more right to be considered as dentine than the membranous border of the bones of a fœtal cranium has a right to be considered as bone.

Having now described the formation and structure of dentine, I will proceed to the consideration of enamel. The membranous matrix (see fig. 8 *m*) was described as at first single, but soon dividing into two layers—one the dentine, the other the enamel layer. The examination of the mode of formation of the enamel must be commenced from the same point, and followed in the same direction as that of dentine. The enamel is first perceptible as extremely minute bright particles, lying so near to the primary particles of dentine, and so similar in appearance, as not to be distinguishable from them (fig. 7). Soon, however, the particles of these two substances assume their characteristic differences; the dentine particles being known by their coalescing into rows of globules, or congregating in spherical masses, as has been explained—the enamel particles by their parallel linear arrangement. Sometimes the matrix is seen to divide sufficiently near to its lower border to enable the enamel particles to be distinguished from those of dentine prior to their assumption of the linear disposition, as shown in fig. 8.

The particles of enamel, after becoming disposed in dotted lines, lose much of their brightness, having coalesced into oval flat portions, which are at first separated, but which afterwards join to form continuous wavy lines. These lines, after getting more defined and sharper, coalesce into the ordinary forms of enamel, in which all appearance of the antecedent stages becomes more or less completely effaced, or, in some cases, totally obliterated. The verification of these facts can be easily made by a careful examination of the cusps of the fœtal calf in the earliest stages of calcification; and for this purpose the portion of cusp examined should be split longitudinally into two equal pieces, one presenting the enamel and the other the dentine surface to the observer, so that they may be seen together side by side. Several cusps should be split up for this purpose, and the examination will be facilitated by the employment of glycerine.* It is scarcely necessary to say that this examination requires good illumination and great nicety of adjustment. At the commencement it will be made more easily by tracing the film of enamel backwards from the point of the cusp towards the edge of the matrix. The matrix receiving the enamel particles can generally be seen for some distance, but it gradually disappears, becoming blended with and concealed by the contiguous layers of enamel. The films of newly formed enamel soon show a disposition to break up into irregularly quadrilateral forms; but in no instance have I met with regular hexagons, as described by some authors. The laminated character of dentine and enamel will, from the explanation just given of their mode of formation, admit of being easily accounted for; the degree of its distinctness depending upon the completeness or incompleteness of the coalescence of the dentine and enamel particles, will vary in different teeth. Some occasional appearances also, such as very distinct interglobular spaces about the extremities of the laminæ; and the lines called contour lines or markings, will be explicable on the same principle; as well as the homogeneous form of enamel found in some animals, and the absence of any appreciable spaces in some parts of all teeth, the dentine being in these parts said to have no tubules, as before noticed.

The next dental tissue is the osteo-dentine or "crusta petrosa." The mode of formation of this structure can be beautifully seen in the molar teeth of the fœtal calf at the free margin of the pulp-cavity, where a thin scale of this sub-

* I have not had an opportunity of judging whether these would preserve their natural appearance if kept in glycerine for many months. But I may observe that I had a piece of oyster-shell which showed beautifully the coalescing carbonate of lime by polarized light; of which I put one piece into Canada balsam, and the other into thick glycerine—the former remains now as when first put up, but the latter, after some months, began to lose its natural appearance, and now the large globules of carbonate have altogether disappeared.

stance is found partially filling up the opening in the fang. This, which resembles ordinary bone, is formed on a membranous matrix, directly continuous with and similar in structure to that of the dentine; and the primary particles are so like dentine-particles, as only to be distinguished from them by the manner in which they afterwards become arranged. These particles appear to coalesce in the same manner, but in the place of taking a rectilinear arrangement, they have somewhat of an arborescent form, the small spicular branchings of which anastomose, and inclose areolæ of a more or less circular form. These may be regarded either as Haversian canals, lacunæ, or canaliculi, according to their size and shape, and the circumstance of their containing, or not, vessels; in which case they must of course be regarded as Haversian canals. As I have elsewhere described the structure and mode of formation of bone, I do not think it necessary to go further into this subject. The *crusta petrosa* being considered by all anatomists as bone, I have called the vessels and epithelial corpuscles in contact with its matrix "the bone-pulp," and thus the analogy between bone and dentine is preserved; the pulp-cavity of a tooth corresponding to a true Haversian canal, the spaces between the dentine rods to the lacunæ, and the extensions of these spaces between uncoalesced portions of dentine to the canaliculi of common bone. The enamel presents similar analogies, but these are much less obvious and striking.

In this paper I have, so far as I have gone, confined my observations to matters of rational inference, and such facts as can easily be verified by any one who will take the trouble, but my observations would be incomplete if something were not said of the functions of those parts which are indirectly concerned in the formation of the several structures which have been described. These are the dentine-, the enamel-, and the bone-pulps, and the part which has been designated membranous matrix. What I shall advance upon these points must of course be theoretical, and therefore to be valued only according to its degree of probability. These pulps being composed of epithelial corpuscles (I prefer the term corpuscle to cell, as there is nothing hypothetical in its meaning), and abundantly supplied with vessels, as well as containing nerves, are doubtless the organs by which the materials composing the dental tissues are elaborated. It is observed in Kölliker's 'Manual of Histology,' that the reticulated connective tissue of the enamel-pulp contains in its meshes a great quantity of fluid rich in albumen and mucus. This fact I have myself noticed. And I have further found, when the jaw of the fœtal calf with the tooth-sacs entire within it, had been kept until decomposition commenced, that on opening these sacs the cusps were coated in parts with phosphate-crystals sufficiently large to be visible without the aid of the microscope. This circumstance is most probably due to the decomposition of some animal substance required to keep the phosphates in solution, and the subsequent dissipation of its elements in the condition of carbonate of ammonia, &c. Now, if we suppose that this albuminous fluid, holding in solution phosphates and some of the other constituents of enamel, elaborated by the enamel-organ, be applied by the ends of the enamel-corpuscles, to the external surface of the previously formed layer of enamel-matrix; and that this matrix is moistened by a fluid containing in solution a salt or salts capable of decomposing those furnished by the enamel-organ, and so combining with them as to precipitate coalescing particles of enamel such as have been described, we shall have, in principle, exactly what takes place in the formation of shell-tissue. (See this demonstrated in my work 'On the Formation of Shell and other hard structures.') As to the manner in which these organs act in elaborating their respective substances with the albumen necessary to give them their globular coalescing property is not at present known, and a more refined chemistry than has yet been applied to this branch of physiology would be required to throw light upon the subject. What has been stated in reference to enamel and the enamel-pulp will apply equally to dentine and its pulp, as also to bone, as has been shown in the article "Bone," in the volume before alluded to. As in the preceding explanation of the mode of formation of the dental tissues, no mention is made of any influence but what is chemical and mechanical, it is probable that if this paper were thus to conclude, it would be inferred that I had no belief in the participation of vitality in the several processes concerned in the production of these tissues; and thus an opportunity would be afforded of representing all that has been stated as absurd and ridiculous. Consequently a few remarks on the influence of vitality in the processes above explained will be necessary. Now, it is certain, from the foregoing account of the formation of the dental tissues, as observed in tracing their development from the condition in which they are found on first assuming a visible existence up to their completion, that both chemical and physical effects have been produced,—that new compounds have been formed is a proof of the one, and the definite forms which have been taken up by their aggregated molecules are a proof of the other. Hence, the probable questions which will arise are,—whether these effects are entirely due to the direct and sole influence of vitality, or to the exclusive operation of physical forces? In my opinion neither of these views is correct, and one is just as untenable as the other. I am not aware that the latter has any advocates, but I believe that the former is the view generally entertained by physiologists, and that the strictly physiological part of the cytoblast theory is based upon it. To me the truth seems to be between the two extremes, the above-mentioned chemical and mechanical effects being, in my opinion, produced directly by physical and mechanical agency, but under the control of a general vital principle. According to this view, the function performed by the nucleated corpuscles of enamel-, dentine-, and bone-pulp, is chemical, each individual corpuscle being designed to elaborate a material whose elements are brought to it by the blood-vessels. Now, it is no more improbable that there should be in the bodies of animals a strictly chemical apparatus than an electric one, as in the Torpedo, or an optical one, as exemplified by the dioptrical parts of the eye. Indeed, not only animal, but vegetable structures perform an endless variety of chemical operations, and ought, therefore, likewise to abound in chemical apparatus. And it is in no way inconsistent with analogy to suppose that the nucleated particle found in the earlier states of vegetable cells is strictly an organ of this kind, and analogous to a nucleated corpuscle of the enamel-organ, and not a mere transitional form of vegetable tissue, as some suppose. This subject I hope to consider more fully in another communication in a subsequent number of the journal, showing the application of the principle of molecular coalescence to the formation and structure of starch-granules. It may be further observed concerning the influence of vitality, that if the form of a perfectly developed tooth be considered in reference to its adaptation to the place and circumstances under which it is designed and required to act, it will be at once obvious that not only a vital, but an intelligent principle has been concerned in originating and directing the chemical and mechanical forces to which it owes its construction. And further, as the size and shape of an entire tooth depends upon the number, form, and arrangement of the several parts composing it, it is a fair inference that the same design and intelligence which originate and direct the construction of the whole, also originate and direct the physical processes concerned in the formation of the parts; and that, not indirectly, and with the co-operation of deputed and hypothetically endowed material particles, called "nuclei or cell-germs," but by a direct exercise of power and wisdom.

Mycological Notes.

By Frederick Currey, Esq., M.A., F.R.S., F.L.S.

The contents of the following pages are strictly in accordance with the above title, consisting of a number of detached observations which have been entered from time to time in my note-book, and which are here brought together in the hope that they may prove interesting to those botanists whose attention has been directed to the Fungi.

Graphiola Phœnicis, Poit.—By the kindness of Sir William Hooker I have had an opportunity of examining good specimens of this fungus, the history and systematic position of which have hitherto been somewhat obscure. *Graphiola Phœnicis* is a fungus which affects the leaves of Palms, and which at first sight presents the appearance of a small flat disc, of a yellowish colour, surrounded by a black border, strongly resembling a Peziza or Patellaria. From the surface of the disc threads or fibres are frequently seen protruding, but these are by no means always to be found. A vertical section of the fungus, when magnified, shows clearly that the yellow disc is not imbedded in a *cup*, but is only surrounded by a *ring* of black carbonaceous matter. Fig. 2, Pl. XI, shows a vertical section slightly magnified, and fig. 1 a similar section of a much more open disc more highly magnified. In this latter figure, *a* represents the black outer crust, which, as has been stated, is a ring and not a cup. This black ring I suspect to be formed of the disorganized tissue of the leaf, and not to belong to the fungus itself. *b* is a grumous layer, formed either of very minute cells or of granular matter; *c*, elongated cells of the tissue of the leaf; *d*, inner roundish cells of the tissue of the leaf; *e*, delicate, closely packed threads, springing from the granular layer and marked with very faint transverse lines or septa; *f*, a mass of yellowish small spores resting on the threads, and doubtless formed by the breaking off of the terminal cells of the threads. The threads or fibres, which, as I have mentioned, are often seen protruding from the surface of the yellow disc, are, I am satisfied, portions of the tissue of the leaf carried upwards by the growth of the fungus, and have no real connection with the parasite. Fig. 3 represents a specimen of the fungus deprived of its outer black ring, and in which these fibres are very numerous, traversing the vast heap of conglomerated loose spores which form the disc in every direction. This figure is magnified about fifty diameters. If the above view of the structure of the plant be correct there can be little doubt, I think, that its proper place is in the tribe of the Uredineæ; and in this view I am fortified by the opinion of M. Tulasne, who, in speaking of Graphiola, says—"Si eum Uredinei nostrates admiserint, sibi, ut opinor, socium maxime abnormem ac de specie vix consentaneum, licet fortassis revera legitimum adsciscent." At the same time I cannot but feel doubtful as to the systematic position of a plant which by different botanists has been associated with such various genera as Lycogala, Œcidium, Hypoxylon, and Phacidium; and the more so since I know that Dr. Montagne's observations (which I hope will shortly be made public) have led him to different conclusions.

Phragmidium bulbosum.—In the fifth volume of the 'Microscopical Journal' I have recorded some observations upon the structure and germination of the spores of this fungus, and have also noticed a peculiar mode of germination which took place in a closely allied plant, viz., *Triphragmium Ulmariæ.* In the germination of the Phragmidium a filament proceeds from each (so-called) joint of the spore, which filament becomes divided by septa at the extremity into several cells, and from these cells secondary filaments are protruded, which are crowned by small globular vesicles of a brilliant orange colour, as shown in Plate VIII of vol. v, figs. 18, 19; and I have now to notice (what perhaps might have been anticipated) that it is not necessary, in order to produce germination, that the spores of the Phragmidium should be perfect. Fig. 4 represents a spore torn from its stalk, in which the upper joint has thrown out its germ-filament, and the latter, although it has not attained the usual length, has become septate, and produced the orange-coloured vesicles in the regular manner. Fig. 5 represents a fragment of a spore from which two at least, if not three joints, have been separated; but which, nevertheless, has germinated in the usual way, and at the extremity of the germ one of the orange-coloured vesicles is still attached.

These observations, if they do not tend to support my view of the ascoid nature of the spores of Phragmidium, at least show that each individual joint of the spore has a separate vitality, and is physiologically an independent embryo.

Fig. 6 shows a peculiar (perhaps imperfect) mode of germination in *Phragmidium bulbosum,* which is almost exactly similar to that noticed in vol. v, as having occurred in *Triphragmium Ulmariæ.* In this instance, however, the terminal cell, instead of being oblong and rectangular, has assumed an ovoid form, and the last cell but one has thrown out a secondary filament, upon which, however, no vesicle is seen.

Mucor fusiger, Lk.—This mould is parasitic upon the gills of Agarics, and is easily recognised by its large dark-brown or greenish-brown, almond-shaped spores, which are represented in fig. 7. These spores are accompanied by a mass of minute granules, endowed with movements considerably more active than ordinary molecular motion. I did not observe any ciliary appendages which would account for this motile power; indeed, if any such existed, they would probably not be visible without a considerably higher power than I am in the habit of using. It is not impossible that these granules may be of the same nature as the spermatozoa observed in Vaucheria and other fresh-water algæ, but without further observation this can only be suggested as a speculation, and as a point deserving of further inquiry. Mr. Berkeley has noticed similar motions in Endodromia. (See Hooker's 'Journal,' vol. iii, p. 78.)

Patellaria clavispora, B. and Br., 'Annals of Nat. Hist.,' 1854.—I have met with a Patellaria, growing near Tunbridge Wells on a dead oak branch, which is, I think, identical with the above plant, although differing slightly in the colour of the hymenium and in the length of the sporidia. No figure of the fructification of *P. clavispora* is given by Messrs. Berkeley and Broome, and the nature of it is sufficiently peculiar to merit illustration. The peculiarity consists in the fact of the same hymenium producing sporidia contained in asci, and also another kind of fruit which would come under the denomination of stylospores or conidia. It is now well known that such an occurrence is by no means uncommon in fungi, and the existence of the double fruit in this case did not escape the observation of Messrs. Berkeley and Broome. Figures, however, convey much more definite ideas than verbal description, and I have therefore thought it worth while to record these supplementary observations. The hymenium of *Patellaria clavispora* is stated in the 'Annals' to be of a brown colour. My specimens appear quite black to the naked eye, assuming, however, a brown tinge when the hymenium is wetted. A thin vertical section shows that this brown colour is entirely owing to the small brown stylospores or conidia which are attached to the tips of the paraphyses, and which bear some resemblance to the spores of a Cladosporium. These bodies are represented in Pl. XI, fig. 8 *a—e*, all magnified 325 diameters, except *b*, which is magnified 450 diameters. They are, as I have mentioned, of a brown colour, and consist of two, sometimes three, cells; the cells sometimes exhibiting a nucleus, as in *b*, *d*, *e*, sometimes not, as in *a*, *c*. The paraphyses not unfrequently produce two stylospores at the apex, as is seen in fig. 8 *a*, and are occasionally furcate at a distance from the apex. The other kind of fruit consists of asci containing sporidia. The asci are linear, and the sporidia, two of which are drawn in fig. 8 *f*, *g*, are somewhat clavate, exhibiting, when young, a row of nuclei, as shown at *f*; but when more advanced they become three- or four-septate, and have a granular endochrome. The length of these sporidia I found to be 0·0014 to 0·0016 inch, a measurement exceeding that of Messrs. Berkeley and Broome, who state the length of the fruit in their plants to be 0·0010 inch. Mere difference of size in the sporidia is, however, not sufficient for the separation of species which agree in other particulars, and I therefore do not doubt that the Patellaria here figured must be considered the same species as that described in the 'Annals of Nat. History.'

Patellaria atrata, Fr.—I find growing very commonly upon worked wood a species of Patellaria which I believe to be *P. atrata*, of Fries, and which, if I mistake not, exhibits two different sorts of fructification. The ordinary or perfect fruit of the species in question is drawn in fig. 9, and consists of asci containing eight rather long, fusiform, slightly-curved, multi-septate sporidia. The specimens in which I find the other sort of fruit do not differ materially from the ascigerous specimens, except in being of a very much smaller size. The hymenium of these smaller plants produces no asci, but is formed of a mass of cylindrical or clavate, septate spores, such as are shown in fig. 10 *a*, *b*, *c*. If we imagine the asci above mentioned to bear only one sporidium each, the result would be the production of a number of bodies not very dissimilar from the septate spores. I do not mean to say that the identity of the two plants can be considered to be established, but there is at least good ground for the suspicion of a relationship between them, and it is desirable that all such cases should be noticed, with the view of inducing further observations.

Cenangium Cerasi, Pers.—The reproductive organs of this and several other Cenangia have been commented on by M. Tulasne in a paper in the last volume of the 3d series of the 'Ann. des Sciences.' He describes the pycnidia as tubular processes, generally cæspitose, confluent at their base, their cavities communicating with one another. The pycnidia contain large curved stylospores, and sometimes also (according to M. Tulasne) delicate curved spermatia, but the latter I have not seen. In some specimens of *Cenangium Cerasi* which I met with at Eltham, in Kent, I have observed the pycnidia to be somewhat different from those described by M. Tulasne, approximating, in fact, very closely to his description of those organs in *Cenangium fuliginosum*. The pycnidia in my specimens formed irregular tubercles, the substance of which was hollowed out here and there into simple cavities, filled with stylospores growing from short basidia which lined the walls of the cavities. Thin vertical sections of the tubercles are represented in Pl. XI, figs. 11, 12, which show also the cavities and the contained stylospores, the latter being colourless, fusiform, curved, and when ripe (I think) triseptate. There was no appearance of the commencement of the formation of any ostiolum or opening for the exit of the stylospores, which I have little doubt would escape by irregular apertures, as has been observed in *Cenangium fuliginosum*. There is, in fact, hardly any difference between the pycnidia just described and those of *C. fuliginosum*, except that in the latter they are said to be of a dark colour, whereas in *Cenangium Cerasi* they are pale. It may be that the pycnidia of *C. Cerasi*, described by M. Tulasne, were in a more advanced state than those above mentioned, it being quite possible that at a later period than that shown in figs. 11, 12, the cavities might become confluent at the bottom, and tubular by the opening of the apex. As, however, the stylospores in my specimens were perfect, the pycnidia must be considered as fully developed, and I have therefore thought it worth while to notice the form of them, as presenting a marked departure from those hitherto described, and at the same time an approximation to those of a nearly allied species.

Sphæria Zobelii, Tul., 'Fungi Hyp.,' p. 186, tab. xiii, fig. 1. —The Rev. Henry H. Higgins, of Rainhill, near Prescot, lately forwarded to me a specimen of *Peziza sepulta*, calling my attention at the same time to a small parasitic fungus growing on its hymenium. Upon examining it, I found the parasite to be the above-mentioned Sphæria, which forms a very interesting addition to the list of British fungi. *Sphæria Zobelii* was first observed by Corda, growing in the flesh of the white truffle, *Chæromyces meandriformis*, Vittad., and he described it, in the fifth volume of the 'Icones Fungorum,' under the name of *Microthecium Zobelii*. It has since been transferred to Sphæria, there being obviously no sufficient grounds for creating a new genus for it. It was subsequently observed by Tulasne growing over the inner surface of *Hydnocystis arenaria*, a plant which was at one time supposed to be a Peziza, but which is now placed with the Tuberacei. Hydnocystis is, in fact, as has been remarked by Mr. Berkeley, a *mouthless Peziza*, forming a passage from that genus to the genus Tuber.

Peziza sepulta belongs to a small group of *Pezizæ* which grow in sand or on loose earth, in which the cups are more or less buried, and which are hardly distinguishable from Hydnocystis.

The occurrence of *Sphæria Zobelii* upon the hymenium of the above Peziza might seem to indicate a further affinity between the latter plant and Hydnocystis, in addition to that derived from similarity (almost identity) of structure; but as the Sphæria grows also upon Chæromyces, it is not improbable that any fungus of subterranean habit might afford an equally fitting nidus.

In fig. 13 I have drawn the sporidia of the Sphæria under a magnifying power of 325 diameters. The sporidia are biseriate, elliptical, slightly drawn out and truncate at the extremities, very dark brown, margined, 0·001 inch long. Beautiful and elaborate figures of the plant and of its microscopical structure are contained in the 'Fungi Hypogæi' of M. Tulasne, tab. xiii.

I am informed by Mr. Higgins that *Peziza sepulta* with the Sphæria occurred abundantly on the sand-hills at Crosby, near Liverpool, in November, 1857, in low and moist places, about 300 yards from high-water mark. The Peziza was growing in company with *Agaricus maritimus*, a species not hitherto recorded as British. Mr. Higgins adds that, although *Peziza sepulta* was also abundant in 1858, he did not then see the Sphæria.

Sphæria Tiliaginea, Currey.—Under this name I have described, in the 'Philosophical Transactions' for 1857 (p. 545), a Sphæria which occurs in the neighbourhood of Blackheath upon Lime. I stated it to belong to the division Circinatæ, but observed that the perithecia were more deeply immersed in the inner bark than is usual in that division. In the specimens there described the sporidia, although fully formed, appeared to be hardly quite ripe; in fact, the plants had not attained their full age. I have since found, also upon Lime, a Sphæria not distinguishable in its perithecia or sporidia from *S. Tiliaginea*, and which, I do not doubt, is the same species in a more advanced stage of growth. This latter Sphæria belongs, however, to the Circumscriptæ, the perithecia being imbedded in a white woody stroma, and the stroma itself surrounded by a manifest conceptaculum. The existence of the conceptaculum would afford no ground for separating the species from *S. Tiliaginea*, for it may well be that the conceptaculum does not appear until the plants have attained some age; and besides this, I suspect that other species of Sphæria occur, in which the conceptaculum is sometimes present, and sometimes not. I have referred to this circumstance in my Synopsis of the Kew Sphæriæ, in the last part of the 'Transactions of the Linnean Society,' under *S. taleola*, and need not dwell upon it here.

Within the conceptaculum above alluded to were contained a number of perithecia, and the interest of the plants consisted in the fact that some of the perithecia were ascigerous and others stylosporous. The ascigerous perithecia produced asci and sporidia exactly resembling those of *Sphæria Tiliaginea*, as figured in the volume of the 'Phil. Trans.' above-mentioned, pl. xxv, fig. 12. The stylosporous perithecia, or pycnidia, as they ought, perhaps, to be called, produced oblong or elliptic stylospores, sometimes slightly incurved on each side in the middle, with a granular endochrome, of a greenish colour, and with usually a very distinct double outline. These stylospores are drawn highly magnified; in fig. 14 their length varies from 0·0005 to 0·0007 inch. My former observations showed that this Sphæria produced spermatia and naked stylospores, besides the normal sporidia, and it now appears (if the species in discussion be identical with *S. Tiliaginea*, of which I have no doubt) that there is also a fourth kind of fruit, viz., stylospores contained within perithecia.

Sphæria ciliaris, n. sp.—This Sphæria occurred on branches of ash at Weybridge, in October, 1857, and is particularly interesting, from its intimate connexion with a species of Helminthosporium, which latter, it is probable, may be a second form of fruit of the Sphæria. In a paper in the fifth volume of the fourth series of the 'Annales des Sciences,' Tulasne states in effect that Helminthosporium is not a true genus, but only a state of Sphæria, and if this be correct, there would, I think, be no doubt of the relationship between *Sphæria ciliaris* and the Helminthosporium to be presently mentioned. Some botanists, however, are not disposed to admit so general a view, and are inclined to look upon cases like the present as instances of parasitism. The question is one not yet ripe for decision, the evidence being at present insufficient. Every case bearing upon it, however, is worth recording, if only with the view of bringing it to the notice of other observers.

The ash-branches above mentioned were covered with perithecia, concealed (with the exception of the ostiola) by the cuticle, and many parts of them also were rough with the erect hairs or threads of a species of Helminthosporium. By removing the cuticle with great care, I found that the threads of the Helminthosporium proceeded from the apices of the perithecia, breaking out through the cuticle in little tufts. Under an inch glass the spores of the Helminthosporium were easily seen attached to the tips and sides of the threads. These spores are drawn in fig. 15 *b*, and are not, I think, distinguishable from those of *Helminthosporium macrocarpum*, Grev. The perithecia of the Sphæria are small and subglobose; and it is a fact worthy of notice that the perithecia diminish in size in proportion as the hairs of the Helminthosporium are more developed, becoming in places almost obsolete. The sporidia are biseriate, colourless, narrow, pointed at the extremities, sometimes almost almond-shaped, sometimes strongly constricted in the middle, always (or almost always) with four nuclei, varying in size from 0·0005 to 0·0009 inch in length. They are drawn in the ascus, in fig. 15 *a*, × 315 diameters. I have called the Sphæria, *Sphæria ciliaris*, the name applied by Sowerby to Greville's *Helminthosporium macrocarpum*. If the above observations are sufficient, as I think they are, to show that the sporiferous threads and the perithecia are the produce of one plant, the Helminthosporium will merge in the Sphæria, and Sowerby's name should, I think, be adopted.

Sphæria obtecta, n. sp.—I have in my herbarium a Sphæria (for which I am indebted to Mr. Broome) which is closely associated with a species of Helminthosporium, the spores of which, although too far advanced for very accurate observation, did not appear to differ from those of *Helminthosporium macrocarpum*. In fig. 16 *b, c,* I have drawn the spores of the Helminthosporium in question, and in fig. 16 *a,* the fruit of the Sphæria, which is very handsome. The following is the description of the Sphæria, which, as far as I know, is new:

Sphæria obtecta, n. sp. (Obtectæ).—Perithecia round, with a short, somewhat flat, sometimes rather gaping ostiolum, solitary, or in small groups, mostly quite concealed by the bark. Sporidia biseriate, dark rich brown, oblong, usually slightly constricted in the middle, 0·0012 to 0·0015 inch long. On Wych elm.

Sphæria macrospora, Desm.—Mr. Broome has called my attention to the frequent association of this Sphæria with *Coryneum macrosporium,* Berk. I do not know whether the fruit of this Sphæria has ever been figured. In fig. 19 *a,* I have drawn the sporidia, which are colourless at first, and eventually become of an olive-green tinge. They are 3-partite or 3-septate, and surrounded by a narrow gelatinous envelope. The Sphæria itself is described in the 'Annales des Sciences,' series 3, vol. x, p. 390; it belongs to the Cæspitosæ. The spores of the Coryneum are drawn in fig. 19 *b.* It seems to me not at all improbable that the Sphæria and the Coryneum may be the produce of the same mycelium.

Sphæria stercoraria, Sow.—In this species I have observed a curious process of germination, which seems worthy of notice. It consists in the protrusion from one end of the sporidia of an oblong or fan-shaped expansion, forming a sort of crown at the apex of the sporidium, whilst from the other extremity the usual elongated germ-filament proceeded. In fig. 17 I have drawn two of the sporidia, which are still attached to the fragment of an ascus, and both of which have thrown out the crown from one extremity, and the filament from the other, the former of which appears to consist of four short colourless threads or cells compacted together. The sporidia of *S. stercoraria* are at first colourless, then of a sort of olive-green, and eventually almost black. They germinate as actively in the hyaline state as they do after having attained the black colour of their full age. Their length is very variable, sometimes reaching to 0·0010 of an inch. In the figure the remains of the inner membrane of the ascus are seen collapsed upon the tips of the sporidia.

Sphæria Spartii, Nees, 'Fr. Syst. Myc.,' ii, p. 124.—The mention of the inner membrane of the ascus leads me to notice an instance of extreme elasticity in this membrane, which I have seen in *Sph. Spartii*, Nees. This species (which, by the way, is identical with *S. elongata*, Fr.) has oblong or elliptical multicellular sporidia, of a dark yellowish-brown colour. Fig. 18 *a* represents the ordinary state of an ascus, with the eight contained sporidia. Fig. 18 *b* shows an ascus of the same species in which the outer membrane has been ruptured at the point (*x*), and an exit has thus been afforded for the inner membrane, which has not, as I think is usually the case, itself burst in the act of egress. It will be seen, by referring to the figure, that the length of the expanded inner membrane is at least twice that of the outer one, whilst the breadth of each is the same. One of the sporidia remains imprisoned at the base of the ascus, the rest having been carried upwards by the escape of the inner membrane. An account of the elasticity of the inner membrane of the ascus in *Sphæria Scirpi* is given by Pringsheim, in the first volume of the 'Jahrbücher für wissenschaftliche Botanik,' but I cannot help thinking that his observations require confirmation.

Phlebia mesenterica, Dicks.—M. Tulasne, in his paper on the 'Tremellini,' published in the 'Ann. des Sciences' for 1853, mentions that he has observed the parenchyma of *Næmatelia nucleata* to contain a number of calcareous concretions of a round, ovoid, flattened, or irregular shape. These concretions were very large, being about the size of a cabbage-seed. He noticed, moreover, in *Tremella recisa*, Dittm., both on its surface and in its substance, a vast quantity of very short linear crystals. I do not know whether these bodies have been observed in other fungi, but I am able to state that raphides occur also in *Phlebia mesenterica*, Dicks. I have found the hymenium of the latter plant covered with a mass of crystalline bodies intermixed with the spores of the fungus. The crystals were quite microscopic, requiring a power of 200 diameters to exhibit them with any clearness. Some appeared to be in the form of octahedrons, and others of dodecahedrons. M. Tulasne speaks of the raphides of *Næmatelia nucleata* being brought to the surface and exposed by the gradual decay of the tissue, but I do not understand him to mean that their number increased with the decomposition of the plant. I have seen, however, an instance in a phænogamic plant (a species of Myriophyllum), where the raphides increased in number prodigiously as the tissue decayed. These raphides were of the stellate kind, and occurred in the intercellular passages of the stem of the Myriophyllum. It has been alleged,* that raphides are always contained in cells, in contradiction to the opinion of Raspail, who stated that they were also met with in the intercellular passages, a statement which I am enabled to confirm from my observations on the above Myriophyllum. An account of these raphides, with a figure, will be found in the 'Phytologist' for April, 1859.

Blackheath Park, S.E.;
June, 1859.

Description *of a* Museum Microscope.

By Edwin Lankester, M.D., F.R.S.

In the annual address to the Microscopical Society I drew attention to the importance of familiarising the public with the use of the microscope, in order that they may become acquainted with its applications. One great barrier to its use in museums has been that, as usually constructed, it has been easily displaced, put out of order when adjusted, or its parts could be removed fraudulently. These evils could only be remedied by the constant presence of a skilful and watchful attendant. In order to obviate these difficulties I have had a microscope constructed, of which the accompanying figures will give a good idea. The first object to be secured was that of the *fixity* of the whole instrument. This has been effected by attaching the stand, *e* (figs. 1 and 2), to a block of wood. Fig. 1 is intended for viewing transparent objects, and the stand is fixed at an angle of about 59°. Fig. 2 is intended for viewing opaque objects, and the stand is made upright. The block, *h*, to which the stand is affixed, may be screwed to a table, shelf, or other fixed object, where there is a good light, by a couple of screws from the bottom. This arrangement secures the instrument from being knocked over. The eye-piece, *a*, is placed in the tube in the ordinary way, but by means of a slit at the back of the tube, which admits of the movement up and down of a screw attached to the eye-piece, it is fixed at any point which may be thought desirable. This screw, *b*, is only

* See Quekett's 'Lectures on Histology,' p. 43.

moved by the aid of a screw-driver. This secures the immovability of the eye-piece. As a matter of experience, I may state that the screw needs to be very strong, as persons having a little knowledge of the microscope, and wishing to display it, have made violent efforts to remove the eye-piece, which of course is intended to be fixed. The object-glass, *d*, is attached to the tube, and is also secured by the aid of a screw. Thus the only movement permitted to the

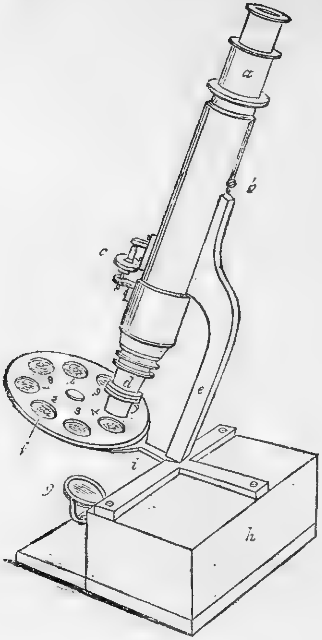


Fig. 1.

tube of the instrument is performed by a screw, *e*, which moves the tube in the way of the fine-adjustment of the ordinary microscope. As moveable slides would be liable to accident or to be purloined, two forms of slide which are not removeable from the microscope have been supplied. These are fixed in the position usually occupied by the stage, *f*. The slide for transparent objects is circular, and is made of wood, and has holes bored for the reception of eight pieces of glass on which the object is placed. A piece of thin glass is then put over this, and the whole kept in position by an elastic metallic ring. The slide revolves on a metal screw, which is attached to the holder, *i*, and which occupies the place of the stage. By this means eight, ten, or more objects may be mounted at the same time, and brought under the object-glass by merely moving the circular slide. The compound slide for viewing opaque objects (fig. 2 *f*) is constructed on a somewhat different plan. It is a frame into which the common glass slides, three inches by one, can be pushed, and when it is filled up they are secured by means of the screws, *k*. The slides in their frame are then made to move backwards and forwards in a frame attached to the arm, *i*, which is situated in the place of the ordinary stage.

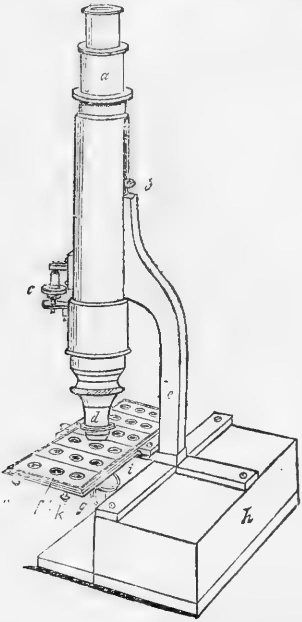


Fig. 2.

Although this slide was made for mounting opaque objects upon the upright stand, it can be equally applied to transparent objects and the oblique stand.

Two of these microscopes, constructed by Mr. Ladd, of Chancery Lane, have been at work for some weeks in the Food collection of the South Kensington Museum, and have excited great interest amongst those who have visited the Museum. A list of the objects exhibited, as numbered on the slides, is placed on the table, and every one seeing the object can thus obtain some knowledge of its nature. It has also been found necessary to write out a short label, giving directions how to adjust the focus of the microscope by the aid of the screw on the tube. Strangers to the instrument do not generally understand the way of throwing light on the object from the mirror below, and this should be done occasionally by an attendant. When it is known, however, exactly where the microscope is to be placed, the mirror might be fixed so as to require no further adjustment. With these precautions the instrument seems to have worked as well as I anticipated, and I hope that they may be erected in other museums; as there are, undoubtedly, a large range of objects equally interesting to the general public, as those seen by the naked eye, which can only be viewed by the aid of the microscope.

The instrument described above is far from being as complete and convenient as it might be; but I have been encouraged to draw attention to it, in the hope that the directors of museums and instrument-makers may take up the subject, and thus render the microscope more available for popular teaching in science than it has hitherto been. I ought also to add that I understand instruments have been constructed to carry out the above objects, and that I hope this notice will serve to draw attention more generally to their construction and use.

TRANSLATIONS.

NOTICE *of the* OCCURRENCE *of a* NEMATOID PARASITE *in the* OVUM *of* LIMAX GRISEUS. By M. A. BARTHÉLEMY.

(From the 'Comptes rendus,' Jan. 24th, 1859.)

IN studying the development of *Limax griseus*, I was not a little surprised to discover in the first ovum submitted to microscopic examination a minute Nematoid worm, in which might still be observed some vitelline granules. In other ova, more advanced in development, I have noticed similar vermicules, often to the number of three or four, and which had apparently undergone a development corresponding to that of the creature whose domicile they had invaded. At this stage they were large enough to be readily seen with a simple lens, performing tolerably active movements. In most cases they remain at some distance from the embryo, though occasionally I have noticed one of them attached to the vesicle which surmounts the head of the future mollusc. Lastly, in some ova still further advanced, the parasite had destroyed its host, the walls of the ovum were collapsed, and the Nematoid worms might be observed in the interior arrived at their full development—that is to say, furnished with the reproductive organs.

The transparency of the worm renders a precise knowledge of its anatomical constitution easily attainable by simple microscopic examination. Its conformation appears to me to remove this worm so far from all known types, as to authorise the establishment for its reception of a new genus, for which I propose the name *Ascaroides*. The species I propose to term *A. limacis*.

In the first place, I had to investigate the mode of origin of the worm. The presence of this animalcule within an ovum, to all appearance so efficiently protected against such invasions, was an embarrassing fact. Having ascertained, by direct experiments, that the worm is present in the ovum at the time of oviposition, I subjected to anatomical inspection under the microscope those *slugs* whose ova were thus infested. In several of these, I found in the alimentary canal and in the ovaries the parasitic vermicule still distended with vitelline granules, and always accompanied by a very minute monadiform Infusorium. I have seen and drawn two of these vermicules already installed in the ova in process of formation, and have thus discovered the complete vital cycle of the new parasite.

On the Measurement *of the* Vertical Thickness *of* Microscopic Objects; *and on the* Determination *of the* Chemical Properties *from their* Refractive Power. By Dr. H. Welcker, of Giessen.

In the 'Zeitschrift f. Rat. Medicin,' N. F., vi, p. 172, and viii, p. 241, the author endeavoured to show, that when by a methodical raising or depression of the tube of the microscope the *relief* of microscopic objects has been ascertained,—the question, especially as respects the more difficult class of objects, may be decided, as to whether they are hollow or solid, depressed or convex. If a microscopic object be of such a size as to allow of its near and distant surfaces being each distinctly and separately brought into view by the proper adjustment of the tube of the instrument, the determination of this question is usually unattended with any difficulty; the proceeding, in fact, being one commonly practised. The author, however, has endeavoured to show, that in the smaller or even in the most minute microscopic formations—so small even that they appear only as simple dark points—a bright flash or gleam ensues upon the *elevation* of the tube, in those cases that is to say in which the bodies in question are convex; and a similar flash on the depression of the tube, when they are concave. "I have shown," he says, "that in the former case the convex corpuscles act like minute *convex lenses,* and in the latter like *concave lenses.* Oil-drops contained in water or air, albuminous and many other sorts of particles,—in short, all such as in regard to their optical property are referable to the perfectly spheroidal form, show the brilliant appearance on the *elevation* of the tube; whilst minute air-bubbles, the cavities in bone, teeth, &c., containing air or fluid, &c., present the same phenomenon when the tube is *lowered.*

Since in by far the greater number of cases the fluids of the animal or vegetable organism have less refractive power than the solid constituents suspended in them, or which, on the other hand, may lodge the fluids in question in internal cavities, it is apparent as a rule that when an object exhibits its utmost brilliancy on the *elevation* of the tube, a convexity must exist; and again, that it must be concave when the brilliancy is witnessed on the *depression* of the tube. But I have lastly remarked, that for the determination of the *relief* of a microscopic object it is of essential importance also to regard the refractive property of the *surrounding medium.* For under certain circumstances, even perfectly spheroidal bodies or convex solid corpuscles—as, for instance, a particle of glass—may exhibit the brilliancy on the depression of the tube when such bodies are contained in a medium possessing stronger refractive power than themselves. Thus particles of glass contained in oil of aniseed, appear brilliant on the *depression* of the tube, exhibiting, in fact, precisely the same optical conditions as a cavity in glass or an air-bubble in water.

The following observations are intended to point out the further applicability of a methodical *elevation* or *depression* of the object-glass.

1. Measurement of the vertical diameter of microscopic objects.

The idea readily suggests itself, that the *height* of microscopic objects may be estimated under the microscope by the determination of the distance passed through by the object-glass, when focussed on the apex and base of the object. When the value of a turn of the screw of the fine-adjustment is known, and can be estimated by proper graduation of the head of the screw, it is very easy to determine how much the tube has been raised or depressed in this operation. This mode of determining the altitudinal diameter is given by Harting,* and several authors have stated the values of vertical diameters obtained in this way. But the vertical diameter of microscopic objects cannot be thus *immediately* determined by the amount of movement of the tube, which movement gives us the *vertical diameter of the object, as affected by the difference between the refractive power of the air and that of the object under view.*

The correctness of this statement is obvious, from the simple consideration, as first pointed out by V. Mohl,† that the rays of light proceeding from an object covered with glass enter the objective in a different direction, and consequently require a different (more elevated) position of the tube, than do those of an uncovered object. When layers of equal thickness of various highly refracting substances are examined, it will be found that the distance traversed by the tube when adjusted to the upper and lower surfaces respectively, is less in proportion to the greater refractibility of the substance examined. The length of movement of the tube, therefore, employed immediately as a measure of the vertical thickness, would lead to an under-

* 'Das Mikroskop.'—*Germ. Transl.*

† 'Mikrographie,' p. 159.

estimation of it in proportion to the degree in which the refractive power of the substance exceeded that of the air.*

I give, in the first place, a very generally applicable method of determining the refractive power, or of the "*apparent height*" of microscopic objects, together with some numbers by which, from the "apparent height" thus determined, the "true height" of the object may be calculated.

If the microscope, like the instruments of Kellner, Belthle, Oberhäuser, &c., is furnished with a fine-adjustment screw, having a horizontal head, this will be readily made into a micrometer, by marking off each fifth or tenth groove on its edge by a fine line, to be numbered accordingly. The index may be formed by a small point suspended from any fixed part of the microscope immediately above the screw-head, and just touching it. Lastly, the value of a turn of the screw is ascertained, as well as of parts of a turn.†

In my microscope, made by Kellner, whose screw-head is accurately divided at the edge into 205 parts, I obtained the following figures:

30 turns of the screw depress the tube about 11·0mm.
1 turn consequently = 0·3667mm.
1 notch at the edge ($=\frac{1}{205}$ turn) = 0·0018mm.

By means of the screw of this microscope I then estimated the refractive power of numerous substances, selecting in fact, for the purpose, the most important fluids and transparent tissues of the animal body, as well as some of the substances used in the examination and preservation of microscopic objects.

Two narrow strips of glass, not quite 1mm. thick, were glued upon the object-bearer, a few millimètres apart, and upon these was laid thin covering glass. The two glass slips inclosed between them a stratum of air, whose thickness, by accurate measurement, was found to be 0·9873mm. On the under surface of the covering glass, as well as on the upper surface of the object-bearer, very fine lines were scratched with a diamond; the upper ones in a vertical, and the under in a horizontal direction. The accurate microscopic definition of these two sets of lines required a movement of the tube corresponding to two turns of the screw and 142 notches, in all 552 notches.‡ When the stratum

* This *under-value*, according to the author's investigations, amounts, in substances possessing slight refractive power, to about one third, and in those of very considerable power to nearly one half of the true value.

† It is scarcely necessary, perhaps, to remark that a properly divided screw-head accompanies the fine-adjustment of most English microscopes.

‡ In all cases the upper set of lines were first viewed, and then, by a

of air was replaced by a fluid,—for instance, by *glycerine* introduced between the two plates of glass—the accurate definition of the two surfaces now required a movement of the tube corresponding to 372 notches. The real thickness, therefore, of the layer of glycerine, was to the apparent thickness as 552 to 372, or as 148 to 100. To ensure correctness, I prepared a second glass cell, within which the stratum of air measured 1002 notches, and that of glycerine 678,—*i. e.*, in the same proportion to each other of 148 to 100. The fluids enumerated in the following collection were all proved in this double way. The refractive power of solid substances was estimated in a similar manner,—that is to say, by measuring the apparent thickness of a section compared with the thickness of a stratum of air of the same actual thickness.

TABLE,

Showing the *true* thickness of various substances whose *apparent* thickness = 100.

Air	100
Distilled water	138
Spring water	138
Human blood-serum	139
Albumen of Hen's egg (fresh)	139
Blood-serum of *Lacerta muralis*	140
Human corpus vitreum (eighteen hours after death)	140
Sulphuric ether	141
Alcohol, 87°	142
Recent muscle of frog	142·6
Water-glass of Batka (fluid)	145
Mucilage of gum (1 centigram. water; 0·5 gramm. gum-arabic)	147
Glycerine	148
Thicker mucilage of gum (1 centigram. water; 1 gramm. gum-arabic)	149
Water-glass of Batka (dry)	150
Marrow (knochenfett) bleached in the sun	151
Oil of turpentine	151
Oil of lemons	151·5
Human fat	152
Rape oil	152·5
Canada balsam (fresh)	154·5
Common crown glass	155, 156
Copal varnish (fresh)	156
Oil of aniseed	158
Dry albumen	165
Gelatine (dry)	170
Bone	172
Ivory	175
Enamel of Horse's tooth	179

downward movement of the screw, the under ones; because if the contrary direction had been followed, the spiral elevating spring might possibly not be exerted uniformly, and a dead turn of the screw-head be made.

From these figures the true thickness of numerous objects may be readily estimated from the apparent thickness as shown by the focussing of the tube.

The conditions of bodies having even horizontal surfaces present the problem in its simplest form, and bodies of this kind may in the first place be considered. For instance, an albuminous investing layer of a microscopic object requires for the definition of its upper and under surfaces a movement equal to 12 notches. For albumen the above table gives the number 139. Consequently we have $100 : 139 = 12 : x$, and obtain the value of 16·6 notches, that is to say (according to the value of the division of the screw-head given above), 0·0297 mm. as the thickness of the investing layer, whose *apparent* thickness (12 notches) would be 0·0215 mm.

In this way I have several times estimated the thickness of horizontal layers in cases where the preparation of vertical sections and the common mode of measurement were inapplicable.

If it be asked what is the *certainty* of the above method, and to what extent it is applicable, it should be remarked that the certainty of the optical focussing is far greater than it would at first sight appear to be. The movement of the tube, in defining the upper and under surfaces of a very thin lamella may amount to less than a notch; but it will be pretty nearly the same in repetitions of the experiment. In the hands of any one practised in the precise definition of microscopic objects, the results do not readily vary more than a half per cent. The uncertainty of the method, however, diminishes in proportion to the minuteness of the objects. In the case of a stratum of albumen of the same density as the saliva, the depression of the tube amounts to 1·5 to 2·5 notches, as may be ascertained with sufficient certainty, and for which apparent thicknesses, instead of 0·0027—0·0045 mm. may be properly substituted 0·0037—0·0062 mm. If the thickness to be measured be less than that of a human blood-corpuscle (0·0020 mm.), the movement is so little, and the numbers denoting the *apparent* and the *true* thickness so nearly the same, that the method (at any rate with the common magnifying powers and the simple apparatus here described) appears to be no longer applicable.

If the refractive power of a body, whose thickness it is sought to determine, is not contained in our Table, an approximate estimate of it is always possible.

This arises from the circumstance, that from the optical relation which the body in question exhibits with respect to the medium surrounding it, and whose refractive power is known, it may be deduced whether the apparent thickness of the body under examination should be corrected to the refractive power of aqueous media (100—142), fluid fat (100—150), or the most strongly refractive substances (100—160—180). If a substance (*e. g.* glass) lying in Canada balsam exhibit the bright spot when the tube is elevated, and in oil of aniseed when it is depressed, it may at once be concluded that the refractive power of the body lies between 154 and 158.*

In the case of a *spherical* or cylindrical body, it is obvious that the determination of the horizontal diameter by common linear measurement will be preferred to the estimation of the vertical thickness. But the question is different when it is doubtful whether the figure be really spherical or cylindrical, or not rather of some other rounded form.† In the determination of the vertical diameter, which (if the object does not admit of rotation) may in cases of this kind be desirable, it is assumed that the refractive power of the surrounding medium is known.

In the experiments above detailed, in which the object was a horizontal plate, the objective, when focussed upon the two surfaces, travelled in one and the same direction, dependent upon the thickness and refractive power of the particular object, and communicated one and the same thickness, whether the object were placed in air and exhibited a great degree of brilliancy, or in oil and wholly without any. If the object, however, be a sphere (and precisely analogous phenomena are exhibited in other bodies having rounded surfaces) the microscope will afford a view of the upper *and* of the lower surfaces only when the refractive power of the object and that of the surrounding medium are equal or nearly so. When the object possesses a considerably greater refractive power than the surrounding medium, the focussing of the objective will afford, not the "optical transverse dia-

* Conclusions of this kind are inadmissible when the surrounding fluid exerts any kind of chemical or physical influence upon the object of such a kind as may alter its refractive power. Thus, in glycerine the striped muscular fibre shows brightness on the elevation of the tube, because its refractive power is increased (probably by imbibition of water), and it thus appears to possess a *stronger* refractive power than glycerine. But the refractive power of unaltered muscular fibre is by no means higher than that of glycerine, but far less, being little greater than that of blood-serum.

† With respect to this, it is well known that our vision may be deceived in very many ways by refraction. Thus, in the case of perfectly cylindrical objects, the appearance of *flattening* is always produced when the refractive power of the surrounding medium is but little less than that of the inclosed object. Thus a cylindrical thread of glass in Canada balsam appears as a flattened band-like streak of little brilliancy.

meter," as it is said, more particularly in such instances, by the majority of authors, to do, but only of that part of the spherical surface which lies above the equator; the under hemisphere exhibiting only very faint images. If the object possess less refractive power, or be a hollow sphere, the optical focussing reaches only the lower half of the hollow sphere. If the distance traversed in the focussing of the objective between the apex (or base) and the equator be now measured, we obtain a *reciprocal value* according to the quality of the surrounding medium. We measure, in fact, the apparent depth of a layer of the surrounding medium, which, corrected for its true depth, is nearly equivalent to the semi-diameter of the sphere. In exactly the same way, in the case of rounded objects not of a spherical figure, the focussing of the objective embraces that part of the surface of the object which rises *above* the greatest horizontal section, when that portion of the object refracts the light like a convex lens, and the *under* portion when it acts like a concave lens. In this case the movement of the tube bearing the objective corresponds to the apparent thickness of a stratum of the surrounding substance, whose true thickness is nearly equal to the height of the rotundity to be measured.

2. The determination of the chemical quality of microscopic objects from their refractive power.

The optical relations of objects have hitherto been employed only to a very limited extent as a means of diagnosis in microscopic researches. Leaving out of account the application of the polarizing apparatus, observers have hitherto confined themselves almost entirely to speaking of the *greater* or *less* refractive powers of objects according to the greater or less brilliancy of the light proceeding from them. But not only is this mode of description in itself vague, but in addition, so long as the refractive power is estimated simply from the impression made upon our eyes by the object—that is to say, from its greater or less brilliancy—our judgment is exposed to great deceptions. For, as has been shown above, it depends wholly and solely upon the refractive power of the medium surrounding the body under investigation, whether the refractive power of the body can be estimated from the phenomenon of its brilliancy or not. Thus in the case of microscopic fatty particles, the strong brilliancy of the fat affords one of the most useful means of recognition; but it must be remembered, that fat injected into the canaliculi of a bone, owing to the greater refractive power of the bone, does not exhibit its usual brilliancy.

It occasionally happens in microscopic investigations, that minute morphological elements of unknown chemical nature occur within a tissue, but which are too minute or too difficult of isolation to be subjected to chemical analysis. May it not, in such a case, when the "true" and the "apparent" thickness of the corpuscles are known, perhaps be possible to arrive at some conclusion as to their chemical constitution? Let us, by way of example, take a case in which it is doubtful whether an inclosed corpuscle be albuminous or fatty. Let the apparent thickness of the corpuscle = 0·0030 mm., and the true thickness (ascertained by common measurement of it in profile) = 0·0042mm. The object in this case *cannot be fat,*—for in fat the true diameter stands to the apparent in the proportion of 0·0045 to 0·0030. But this ascertained refractive power would correspond with that of albumen (0·0030 : 0·0042 = 100 : 140).

But, although considerations of this kind may lead to the prospect of a new, and not altogether useless method of diagnosis, its application will be found to be much limited by the following conditions. In the first place, the method would become more and more uncertain, and ultimately wholly useless, in proportion to the greater minuteness of the objects. And, also, when the object has rounded surfaces, it is not, for the reasons already adduced, at all adapted to determine the refractive power or the apparent thickness of the object.

From the above exposition, I am by no means of opinion the mode of measuring by the vertical movement of the tube of the microscope, for either of the purposes proposed, is capable of any extensive application. My object has rather been to test the applicability of such a mode of measurement in the general method, and to establish it in some particular, may be rare instances.

REVIEWS.

Evenings at the Microscope; or, Researches among the Minuter Organs and Forms of Animal Life. By PHILIP HENRY GOSSE, F.R.S. London: Society for Promoting Christian Knowledge.

IT is always a pleasant thing to meet Mr. Gosse in print, whether he ushers himself into the world from the Red Lion press in Paternoster Row, or obtains the sanction of "the Committee of General Literature and Education appointed by the Society for Promoting Christian Knowledge." Why Mr. Gosse publishes his books under the direction of a Society for promoting Christian knowledge at all we are at a loss to perceive, for we find nothing in this book that might not have been published by Mr. Van Voorst, or the most sceptical publisher in the Row. We are, in fact, a little jealous of religious societies publishing books of this sort, both on the grounds that such books are not strictly Christian, and that funds are appropriated to their production to the injury of the regular publisher which were not intended for this object. It is true that this does not in any way interfere with the quality of the work, and this is with what we have more particularly to do. As its name would imply, Mr. Gosse's book is a popular introduction to working with the microscope. It differs, however, from other introductions to the microscope, that it contains no account of the structure of the microscope at all. This is really a feature, albeit a negative one, in the book. As reviewers bound to read every word of every book we notice, we are glad for once to deal with one on the microscope without anything about the microscope at all.

Turning to Mr. Gosse's work, and conscientious reviewers as we are, we miss a chapter of contents which would be particularly useful to us just now; we find that he treats of the usual objects examined under the microscope. He begins with human hairs, and this naturally enough brings him to hogs' bristles and cats' hairs. From hairs we proceed in morphological order to the feathers of birds and the scales of fishes. Here we are arrested, not in any scientific or consecutive order, by a chapter on the blood. Then come the shells of mollusca, with descriptions of the tongues, teeth, and eyes of the same animals. From these we are taken to a general survey of the structure of insects, with interesting dissertations on the functions of their microscopical organs. All this time we feel the author is doing himself violence. He longs to get to the sea-shore. There he has used his microscope with most success, and on the microscopic objects of the sea he dwells with more than usual wonder and eloquence. Crabs, the structure and transformation of Crabs, Sea-acorns and Barnacles, the hooks of Serpula, the movements of Pedicellariæ, the spines of Echini, the anchors of Synapta, and the transparent wonders of *Sarsia, Thaumantias, Cydippe,* and *Turris,* all pass before us. Polypes and sponges finish the history of sea-animals, and the volume closes with accounts of infusory animalcules. Such is a brief outline of Mr. Gosse's book. To say there is nothing new in it would be wrong, for Mr. Gosse always looks at things for himself, and the Gossean view is frequently a new one.

But it is for no scientific novelty that this work will be valued. Mr. Gosse is a writer, and a very agreeable one too, and in all this work he succeeds in throwing a charm over his subject which can but lead his reader on, whether they ever looked into a microscope or not. We shall not, therefore, transfer to our pages any of his more technical descriptions of microscopic objects, but give one or two passages to illustrate the style of the book. His chapters are more like lecturettes or demonstrations than anything else. We may fancy him sitting at a table with his microscope before him, and discoursing quite at his ease to a few friends invited expressly to hear what he has to say. The party being seated, he thus begins:

"Not many years ago an eminent microscopist received a communication inquiring whether, if a minute portion of dried skin were submitted to him, he could determine it to be *human* skin or not. He replied that he thought he could. Accordingly a very minute fragment was forwarded to him, somewhat resembling what might be torn from the surface of an old trunk, with all the hair rubbed off.

"The professor brought his microscope to bear upon it, and presently found some fine hairs scattered over the surface; after carefully examining which, he pronounced with confidence that they were *human* hairs, and such as grew on the naked parts of the body; and still further, that the person who had owned them was of a fair complexion.

"This was a very interesting decision, because the fragment of skin was taken from the door of an old church in Yorkshire;* in the vicinity of which

* "I am writing from memory, having no means of referring to the original record, which will be found in the first (or second) volume of the 'Transactions of the Microscopical Society of London.' The general facts, however, may be depended on."

a tradition is preserved, that about a thousand years ago a Danish robber had violated this church, and having been taken, was condemned to be flayed, and his skin nailed to the church door, as a terror to evil-doers. The action of the weather and other causes had long ago removed all traces of the stretched and dried skin, except that from under the edges of the broad-headed nails, with which the door was studded, fragments still peeped out. It was one of these atoms, obtained by drawing one of the old nails, that was subjected to microscopical scrutiny; and it was interesting to find that the wonder-showing tube could confirm the tradition with the utmost certainty; not only in the general fact, that it was really the skin of man, but in the special one of the race to which that man belonged, viz., one with fair complexion and light hair, such as the Danes are well known to possess.

"It is evident from this anecdote that the human hair presents characters so indelible that centuries of exposure have not availed to obliterate them, and which readily distinguish it from the hair of any other creature. Let us then begin our evening's entertainment by an examination of a human hair, and a comparison of it with that which belongs to various animals."

Thus pleasantly does the author lead us on to the structure of a hair from his own head—we are afraid it is getting grey,—and from this to all other hairs. At his next sitting he takes up the blood, and thus prepares us for an interest in this important fluid:

"The microscope is daily becoming a more and more important aid to legal investigation. An illustration of this occurred not long ago, in which a murder was brought home to the criminal by means of this instrument. Much circumstantial evidence had been adduced against him, among which was the fact, that a knife in his possession was smeared with blood, which had dried both on the blade and on the handle. The prisoner strove to turn aside the force of this circumstance by asserting that he had cut some raw beef with the knife and had omitted to wipe it.

"The knife was submitted to an eminent professor of microscopy, who immediately discovered the following facts:—1. The stain was certainly blood. 2. It was not the blood of a piece of dead flesh, but that of a living body; for it had coagulated where it was found. 3. It was not the blood of an ox, sheep, or hog. 4. It was human blood. Besides these facts, however, other important ones were revealed by the same mode of investigation. 5. Among the blood were found some vegetable fibres. 6. These were proved to be *cotton* fibres,—agreeing with those of the murdered man's shirt and neck-kerchief. 7. There were present also numerous tesselated epithelial cells. In order to understand the meaning and the bearing of this last fact, I must explain that the whole of the internal surface of the body is lined with a delicate membrane (a continuation of the external skin), which discharges mucus, and is hence termed mucous membrane. Now this is composed of loose cells, which very easily separate, called epithelial cells; they are in fact constantly in process of being detached (in which state they constitute the mucus), and of being replaced from the tissues beneath. Now microscopical anatomists have learned that these epithelial scales or cells, which are so minute as to be undiscernible by the unaided eye, differ in appearance and arrangement in different parts of the body. Thus, those which line the gullet and the lower part of the throat are *tesselated*, or resemble the stones of a pavement; those that cover the root of the tongue are arranged in cylinders or tall cones, and are known as *columnar*; while those that line some of the viscera of the abdomen carry little waving hairs (*cilia*) at their tips, and are known as ciliated epithelium.

"The result of the investigation left no doubt remaining that with that knife the *throat* of a *living human* being, which throat had been protected by some *cotton* fabric, had been cut. The accumulation of evidence was fatal to the prisoner, who without the microscopic testimony might have escaped.

"But what was there in the dried brown stain that determined it to be blood? And, particularly, how was it proved not to be the blood of an ox, as the prisoner averred? To these points we will now give a moment's attention."

We might add a large number of extracts such as these, but enough has been given to show the way in which Mr. Gosse treats his subject. The work is copiously illustrated with woodcuts, the majority of which are from Mr. Gosse's own drawings. The woodcuts are perhaps a little coarse, but they appear to be faithful representations of the objects described. We can recommend Mr. Gosse's book as a very pleasant companion to the microscope.

Tobacco and its Adulterations. With illustrations, drawn and etched by Henry P. Prescott, of the Inland Revenue Department. London: Van Voorst.

Many substances used for the adulteration of articles of commerce, which formerly defied all kinds of investigation, are now easily discovered by the aid of the microscope. The medical man was the first to apply this instrument in the detection of fraudulent adulterations of food and medicine. The Government has been slow to appreciate its use in the cases where it might have been employed to detect fraud on taxed articles of consumption. We are, however, glad to be able to congratulate the Inland Revenue department on the possession of an officer who is so capable of appreciating the value of microscopic aid in the detection of adulterations as Mr. Prescott appears to be. It has been long known that chemistry is of little service in detecting the adulteration of tobacco. In fact, for many years, it seems, that instead of chemistry detecting frauds in the adulteration of tobacco, it was the unintentional source of fraud by the Government, who fined tobacconists for having tobacco in their possession which contained sugar, when it afterwards turned out that all tobacco naturally contains a certain quantity of sugar.

Dr. Hassall, in his report on the adulterations of tobacco, says that he could not discover, in forty specimens of tobacco he had examined, the admixture of any foreign leaf. Mr. Prescott, however, states, that from time to time there have been discovered with the leaf of the genuine "weed," the leaves of rhubarb, dock, burdock, coltsfoot, beech, plantain, oak, and elm. Also peat, earth, bran, saw-dust, malt-worts, barley-meal, oatmeal, bean-meal, pea-meal, potato-starch, and chicory leaves steeped in tar-oil. Now this is a list that would surely arrest the most inveterate smoker in his course, provided he was not assured that, by the aid of the microscope, all these substances may be detected. This is the object of Mr. Prescott's book; not to enable smokers to detect adulterated tobacco, but to enable Government officers to prevent the sale of adulterated tobaccos to smokers at all. In order to do this, Mr. Prescott thinks that two things are necessary; first, that Government officers should know what leaves are; and second, that they should know what a microscope is. So that his book is not so much an account of tobacco, as it is of the things with which it is adulterated, and the instrument by means of which they are detected. It is somewhat humiliating to find that people who have been to school within the last twenty-five years should have to be taught what leaves are, and what a microscope is; but such is the fact, and very thankful such people ought to be to those who write for their instruction and benefit. But Mr. Prescott has not only written on these elementary subjects, but he has given in this work a series of original researches upon the structure of the tobacco leaf, and the leaves of several other plants, very useful for the Inland department, and highly interesting to all engaged in botanical pursuits. He has very modestly put his observations into the form of illustrations of the objects investigated, with descriptions of the plates. He first describes, minutely, the structure of the tobacco leaf, giving its tissues, vascular and cellular, their distribution in the petiole, the ribs, and the blade. The epidermis and its appendages are especially described, and it is on this point that Mr. Prescott dwells as affording the greatest amount of evidence in judging of the purity of specimens of tobacco.

Of course, all our microscopic friends who smoke know that the hair of the tobacco leaf is a knobbed hair. Three or four long cells grow up straight from the epidermis, and at the end of these is a compound cell, composed of five or six cellules. Such a hair does not seem to occur in any other plant. Now, if in the examination of a particular specimen, any other kind of hair occurs than this identical mace-like hair, then it may be at once concluded that the tobacco has been adulterated. But adulterated with what? That is the next question to which Mr. Prescott addresses himself. A large series of the leaves of plants are examined for the purpose of showing the forms and nature of their hairs. Not only are those plants described which are used for the adulteration of tobacco, but many others. Mr. Prescott feels that he has struck upon a vein that will reward the working, and with perhaps more love for science than regard for the revenue, he gives us a series of descriptions of the hairs of other plants than are used by fraudulent tobacconists. In this work will be found beautiful and truthful delineations of the epidermis and hairs of the thorn-apple, the potato, the dandelion, the sunflower, the elecampane, the comfrey, the foxglove, the mullein, the hellebore, and the plantain, besides those employed for adulterating tobacco. He has also given representations of the starches contained in these plants, so that should the hairs fail, the form of the starch itself may in some cases lead to the detection of adulteration.

Whilst going over Mr. Prescott's book, we have been struck with the fact that a closer attention than has yet been generally given, to what might be termed the special microscopic characters of plants, would be advisable, and likely to prove advantageous in diagnosis. Mr. Prescott's observations, for instance, on the "Hairs of Plants," will suffice to show what may readily be done in this direction. The subject, at any rate, is one deserving of notice by younger microscopical observers who may be in want of a subject, and to them we cordially recommend the present volume.

NOTES AND CORRESPONDENCE.

Bermuda Tripoli.—This material is in great request among students of Diatomaceæ, but its history requires to be cleared up. The general belief is that it was obtained from the Bermudas, and Ehrenberg states this in express terms; his sample, however, was received from the late Dr. Bailey, who himself speaks more cautiously. He mentions, in his account of this deposit, in 'Silliman's Journal,' vol. xlviii, that he had received it from Mr. Tuomey; and that Mr. Tuomey had obtained it from a mineral collector, as tripoli, from Bermuda; but Dr. Bailey states that this tripoli is not calcareous, whereas other fossil remains occurring in Bermuda Islands contain abundance of calcareous Polythalamia. He, therefore, when he distributed portions of the sample, added "locality doubtful." Although some of the diatoms in this deposit are peculiar to it, there are others which occur also in the Virginian and Maryland earths, a circumstance which indicates that it was more probably collected in the United States. The Richmond deposit, including that from Schuckoe Hill (on which part of the city of Richmond is built), is well known to be very extensive. Petersburgh, about twenty-six miles to the south, also yields diatomaceous earth scarcely differing from that of Richmond. Both these are elevated several feet above the level of the sea, although the earth be full of marine productions.

On the north bank of the James River, where it begins to widen into an estuary or bay, is the plantation or "hundred" called Bermuda, about twenty miles below Richmond. It seems perfectly clear that, although unknown to Dr. Bailey, this is the place from whence the mineral collector had received the tripoli. The deposit may be more recent than those of Richmond and Petersburgh; and, if so, all the species of *Heliopelta*, for which it is celebrated, may yet be found recent along the shores of the estuary. The Bermuda in Virginia appears, then, to be the Bermuda of Diatomists, and is situated nearly in N. Lat. 37° 18′, and W. Long. 76° 26′. The confusion seems to have arisen from Long Island, one of the Bermudas or Somer's Islands, being also sometimes called Bermuda.—G. A. WALKER-ARNOTT, Glasgow.

The Diagonal Scale.—Among the greatly increased and continually increasing number of microscopists, there may be some to whom remarks even of a somewhat elementary character may be acceptable. To such I would offer some suggestions on what, from my own experience, I conceive to be a very great desideratum. This is a more extended knowledge of and practical agreement in microscopical mensuration.

The various quantities used in defining the magnifying powers of lenses, as well as in speaking of the magnitude of images of objects, are to the uninitiated somewhat perplexing; but when the mind is trained to a just appreciation of standard measures, a moment's consideration clears up what otherwise presents an apparently mystical and indeterminate aspect.

On this account I would suggest to microscopists the general use of the diagonal scale, that is, of a scale of 12 inches, with the terminal inch divided both ways (ends and sides), the vertical lines being diagonal—a common Gunter's scale at once provides the requirement. Why I suggest one of 12 inches is because it is portable and supplies a measure also for the determination of a 10-inch or other elevation in using the camera, &c.

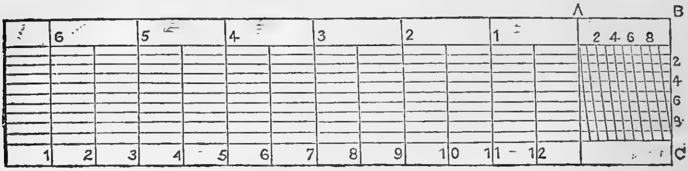
The inch being usually divided into 100th or 1000ths, I shall refer to these as the 100th or 1000th scales.

If, therefore, the 100th scale is implied, the numbers on the line A B will indicate the parts of a hundred in tens for each line, and the numbers on the line B C will indicate units. Thus, supposing I wished to know the exact measure of a magnifying power of 95, by placing one leg of the compass on the point A, and extending the other to the figure 9 on line A B, the space equals 90; then, by following down the lines diagonally towards C, until opposite the figure 5 on the unit line, I have a standard measure corresponding to a power of 95. Every deviation from this must be accounted erroneous.

If, again, I wished to know the measure of space on the 1000th scale of a magnifying power of 450; then, what were before considered tens and units are now regarded 100ths and tens; thus, from the point A, to figure 4 on the line A B, equals 400, and as in the former example, the distance on the diagonal to opposite the figure 5 on line B C, equals 50, or 450, the measure required.

It will also frequently occur, that ten times this quantity may be needed, or ten spaces of 1000 inch scale, magnified in the same ratio; then, taking as above 450, add a cipher making 4500,—the 4 will then indicate clear inches; the 5 on line A B will equal hundreds; and, if tens are wanted, they will correspond to some figure on line B C, being now tens of the 1000 scale, as they were units of the 100 scale.

Thus have we a ready means of fulfilling several important requirements; first, of measuring the elevation for the camera; secondly, of accommodating or adjusting one power with another; thirdly, of proving the reputed powers of different



lenses; fourthly, of proving the precision of micrometers; fifthly, of drawing the images of objects in exact numerical terms; and lastly, of detecting errors of observation.

The accompanying scale is only half the size of that required. Gunter's scale represents a full inch.—WM. HENDRY, Surgeon, Hull.

Angular Aperture.—I beg to submit an account of a simple method by which any one may easily measure the angular aperture of his object-glasses. I can hardly suppose it is original; but as I have met with no account of it, and as it dispenses with the use of the protractor, and of the apparatus described in the books for the purpose (without which some, I know, are not aware that the object in view can be effected), I venture to send it, in the hope that it may be of use.

Place the microscope horizontally, with the eye-piece removed, and the object-glass attached whose aperture is to be measured. On a line (which may be conveniently indicated by a piece of string stretched across the table on which the microscope stands) at any moderate distance from the object-glass, and at right angles to the axis of the instrument produced, place two candles, having their flames, as nearly as may be (which may be easily managed by the aid of a few books), on a level with the axis of the instrument. Now, with the eye applied to the ocular end of the microscope, make an assistant slowly move first one candle and then the other along the line on which they are placed, till the images of the two flames are *just seen* at opposite edges of the object-glass. Measure carefully, with a bit of string, first the distance between the two flames, and secondly the distance from the object-glass of the line joining them. The former of these distances divided by twice the latter will give the tangent of half the angle of aperture. The angle corresponding to this tangent, therefore, being found by the aid of the ordinary trigonometrical tables, the double of it will be the angle required.

Thus, with an excellent quarter by Ross, I find the distances between the flames $21\frac{1}{2}$ inches, and the distance of the line joining them from the object-glass $12\frac{1}{4}$ inches. Hence, dividing 21·5 by 24·5, I obtain ·8775, which I find to be the natural tangent of 41° 16′; consequently the angular aperture is $82\frac{1}{2}$ degrees.—P. GRAY, 7, St. Paul's Villas, Camden Town.

Glycerine Jelly.—In most of the works on the microscope, gelatine is mentioned as a medium for the mounting of certain objects, and several mixtures of gelatine with other substances have been suggested, but none of these have succeeded so well in my hands as the following, which I am induced to publish, because all my friends to whom I have communicated it have tried and approved it.

It is the only medium which will preserve the natural colour of vegetable substances.

The beautiful green of some mosses, I mounted two years ago, is still as fresh as on the day they were gathered.

My formula is as follows:

Take any quantity of Nelson's gelatine, and let it soak for two or three hours in cold water—pour off the superfluous water, and heat the soaked gelatine until melted. To each fluid ounce of the gelatine add one drachm of alcohol, and mix well; then add a fluid drachm of the white of an egg. Mix well (*whilst the gelatine is fluid, but cool*). Now boil, until the albumen coagulates, and the gelatine is quite clear.

Filter, through fine flannel, and, to each fluid ounce of the clarified gelatine, add six fluid drachms of Price's pure glycerine, and mix well.

The objects intended to be mounted in this medium are best prepared by being immersed, for some time, in a mixture of glycerine, one part, and dilute alcohol (six of water to one of alcohol), one part. The bottle of glycerine jelly is put into a cup of hot water, until liquefied, where it is used in the same way as Canada balsam, excepting that it does not require, and must not be subjected to, the same amount of heat. A ring of asphaltum varnish round the cover completes the mounting.

As I have found lately, that in mounting *Confervæ* and other delicate fresh-water Algæ in my glycerine jelly, that the glycerine, although it preserves the beautiful green colour, contracts and alters the position of the endochrome,—to remedy this evil I propose, *instead* of six fluid drachms of pure glycerine, to add to each fluid ounce of the clarified gelatine six fluid drachms *of a mixture* composed of one part of gelatine to two parts of camphor water, as recommended by Dr. Carpenter, at p. 245 of 'The Microscope' (1856).—JOHN WILLIAM LAWRANCE, Peterborough.

On a Method of Preparing and Mounting Hard Tissues for the Microscope.*—Having for several years occupied my leisure moments with what are usually denominated "microscopical studies," I beg leave to offer, as the result of successful experience, a simple and certain method of preparing and mounting *hard tissues,* such as bone, teeth, shells, fossilized wood, &c.

I am aware that treatises upon the microscope give a few indications for the making of sections and embalming them in Canada balsam; but they are unsatisfactory either by reason of their brevity or their want of precision. Specimens may be procured ready-made from the hands of Topping, Bourgogne, and others, but while they are expensive, persons in remote situations are obliged to purchase by catalogue without the opportunity of selection. Besides, it is oftentimes difficult or else impossible to obtain series of particular objects, so that the student must either limit his researches or "prepare" for himself; in the latter case he may increase his number of objects indefinitely, and supply himself with many such as are not attainable from abroad, and divided in any direction he may require.

A microscopic section should be as thin as the structure of the object will allow, of uniform thickness, and polished on both sides, whether it be mounted in the dry way or in balsam. To meet these requirements, I proceed as follows:

Being provided with—

1. A coarse and fine 'Kansas hone, kept dressed *flat* with fine emery;
2. A long fine Stub's dentist's file;
3. A thin dividing file and fine saw;
4. Some Russian isinglass boiled, strained, and mixed with alcohol sufficient to form a *tolerably* thick jelly when cold;
5. A small quantity of Canada balsam;
6. Slides;
7. Cover glass;

* From 'Silliman's Journal.'

8. One ounce of chloroform;
9. One of F.F. aqua ammoniæ;
10. Some fragments of thick plate (mirror) glass 1 inch square, or 1 by 2 inches; and finally,
11. An ounce of "dentist's silex," and—
12. Thin French letter paper, of which 500 or more leaves are required to fill up the space of an inch: I examine the object and decide upon the plane of the proposed section.

Coarse approximative sections may be obtained with the saw or dividing file (excepting silicified substances), but these instruments are not applicable to longitudinal sections of small human or other teeth, small bones, &c. Take now the object in the fingers if sufficiently large, and grind it upon the coarse hone with water, to which add "silex" if necessary, until the surface coincides with the intended plane. Wash carefully: finish upon the finer hone; and polish upon soft linen stretched upon a smooth block.

If the object be too small to admit of immediate manipulation it should be fastened upon a piece of glass with isinglass—or what is better, upon thin paper well glued with the same substance upon glass; and a piece of thick paper or visiting card, perforated with a free aperture for the object, must be attached to the first paper. This is the *guard*, down to which the specimen must be ground with oil; and its thickness and the disposal of the object require the exercise of good judgment. Hot water will release everything; and chloroform remove the grease from the specimen; which, like that ground with water, is ready for the second part of the process.

2d. Carefully cover the surface of a piece of the plate glass with thin French letter paper; next apply a paper *guard*, as before stated, but not thicker, for teeth and bone, than $\frac{1}{300}$th inch; then trace a few lines with a lead pencil upon the first paper in the little space left in the *guard* so that the increasing transparency of a specimen being prepared may be appreciated; and finally moisten the "space" with isinglass to the extent of the object, which must be delicately brushed over on the ground surface and at the *edges* with tolerably thin isinglass before it is cemented in its place. Gentle pressure should now be employed, and maintained with a wire spring, or thread wound round about.

In two or three hours the second side may be ground in oil; silex may be employed at first, or even a file; but these means must not be persevered in, and the operation must be completed upon the bare hone. When the second side shall have been wiped with chloroform it may be polished with a bit of silk upon the finger; and after *spontaneous* separation from the paper in hot water the specimen ought to be well washed on both sides with a camel's-hair pencil and soap water, dropped into cold water, and thence extracted to dry. After immersion in chloroform for a moment, and examination for the removal of possibly adherent particles, the *section* may be declared suitable for mounting.

Before proceeding to this step, a few precautions are necessary about particular sections. Transverse sections of teeth or bone should be dried, after the preliminary washing, between glass, in order to avoid the disadvantage of warping. Very porous parts, such as cancellated bone, or fragile bodies, such as the poison fang of serpents, require that the whole structure, or the canals, be saturated with glue and dried. Sections may now be cut with a saw, ground in oil, and cemented to the holding-glass subsequent to immersion in chloroform.

Mounting.—Spread a sufficient quantity of old Canada balsam, or of that thickened by heat (not boiling), upon a slide, and, when cold, place the section upon it. Have ready a spatula bearing a quantity of equally inspissated balsam warmed until it flows, with which cover the specimen, and then immediately warm the slide, being careful to employ the least possible heat. Now carefully depress the section, and withdraw every air bubble with a stout needle set in a handle towards the ends of the slide: put on the cover glass, slightly warmed, not flat, but allowing one edge to touch the balsam first, press out superfluous balsam, and the specimen is safe. The slide may now be cleaned with a warm knife, spirits of wine, and ammonia.

This communication would be incomplete without some very important hints concerning "cover glass." It is easy to clean small covers, but very thin glasses or large ones, one or two inches in length, are not so safely handled. All danger of breaking is, however, avoided by placing a cover upon a large clean slide, and wiping one side only with a bit of linen damp with aqua ammoniæ, and then with a dry piece. The other side may be cleaned after the mounting.

In the next place, all preparers are aware of the difficulty attending the use and application of large covers. I beg leave to assure the inexpert that the following method will ensure success. Having prepared the cover glass, and superimposed it, let it first be gently pressed downwards at many points, with the flat end of a lead pencil; it will be found, however, almost impossible to flatten it without breaking, consequently too much balsam will overlie and underlie the section. Let now a piece of thin paper be laid over the cover, and upon this a thick slide; if a moderate heat be applied to both the slides, over and beneath the specimen, direct pressure, evenly exerted with the finger (or spring clothes-pins), will force out all unnecessary balsam, and leave the section and the protecting cover perfectly flat and unbroken.

The reader will not deem me too prolix when he attempts his first preparation, or when, after having followed the plans so scantily given in the books, he feels the need of something precisely definite. It is certain that neither Canada balsam nor gum mastic will retain the first ground side of a specimen upon a slide long enough to enable the preparer to reduce it to the requisite thinness, and with both these substances *heat* must be employed, which is objectionable, because most objects are thereby warped or cracked; and, furthermore, the paper *guard*, which I hold to be indispensable for limiting and equalizing the thinness of a section, is not mentioned in treatises, in which, if known to the author, such a measure should be noticed. But it is possible to fasten agate, fossil wood, &c., with hot gum shellac, so that they may be ground upon both sides with a water stone; but even in these instances invidious cracks may endanger or destroy the beauty of a choice preparation.

I am confident that my specimens are second to none in any respect; and the highly creditable performances of friends, to whom I have given the method, forming the subject of this communication, lead me to believe, that with the facilities it affords, the observers of our country will need no Topping for objects within their reach, and I beg leave to add that the profitable pleasure I have enjoyed induces me, through the 'American Journal of Science,' to invite participation.—Christopher Johnston, M.D.

On Actinocyclus and Eupodiscus.—Mr. Edwards, in a paper "On American Diatomaceæ," read on the 3d March, states that he considers the *Actinocyclus triradiatus*, described by me in the 'Micr. Journ.,' vol. vi, p. 23, to belong to the genus *Coscinodiscus*. I have, however, good evidence that this is not the case; and that, in fact, it is merely an internal plate, or perhaps an imperfectly formed valve, of the common *Actinocylus radiatus* of Smith. In some gatherings kindly forwarded to me by Colonel Baddeley, this species is very abundant, and the peculiar valves, which I had found previously always in a detached state, occur on many of the perfect frustules, and I imagine are the newly formed valves, not fully silicified, of frustules undergoing self-division. *Actinocyclus triradiatus* must therefore be cancelled entirely. Mr. Edwards afterwards refers to some remarks on *Eupodiscus*, in the 'Micr. Transactions,' vol. vii, p. 19, in a way I do not exactly understand; but my intention there was to show that the form called *Eupodiscus radiatus* by Professor Smith, was distinct from Professor Bailey's species of the same name, and in fact a *Biddulphia*. At that time I had not seen Professor Bailey's species, but having since received authentic specimens, my opinion is fully confirmed; Bailey's species is a true Eupodiscus, with projecting processes or "feet," all similar in form, as in *E. argus*, and quite distinct in structure from the form which occurs in the Thames, and elsewhere on our coasts. The processes are merely hyaline projections, without any markings, and there are no spines. I consider, therefore, that *Eupodiscus radiatus*, Smith, should be cancelled, and *Biddulphia radiata* be substituted for our English species; whilst *Eupodiscus radiatus* of Bailey may be considered as a good species, known, however, at present, only in America.—F. C. S. Roper.

PROCEEDINGS OF SOCIETIES.

Microscopical Society, *March* 30*th*, 1859.

Dr. Lankester, President, in the chair.

F. E. Webb, Esq., J. O. Dix, Esq., and Joseph Beck, Esq., were balloted for, and duly elected members of the Society.

Dr. Bowerbank read a paper on *Grantia ciliata* ('Trans., p. 79).

A paper by Mr. Edwards, 'On Diatomaceæ,' was read by Mr. Roper ('Trans.,' p. 84).

It was resolved, "That the microscope-makers who adopt the standard screw be requested to ascertain that one of the gauge-taps, recommended by the Society, May 19th, 1858, will enter the bodies of their microscopes to the extent of three tenths of an inch."

"For this purpose it will be necessary to omit the cylindrical fitting beyond the *inside* screw recommended by the sub-committee ('Trans.,' Jan., 1858, p. 39); retaining, however, the plain collar on the object-glass to facilitate its attachment."

"N.B.—A supply of taps and screw-tools is now in the hands of Mr. Williams, the Assistant-Secretary of the Society."

The President announced that in consequence of the soirée on May 5th, the ordinary meeting of April 27th would not be held.

May 5*th*, 1859.

The annual soirée was held this evening at the South Kensington Museum. Although somewhat removed from the centre of the metropolis, the rooms of the South Kensington Museum offer so many advantages for a large gathering, that from the time the Council had obtained the permission of the Committee of Council on Education to hold their annual soirée in this magnificent suite of apartments, they lost no time in making arrangements for a display of microscopes such as had not been seen in the metropolis before. The Council divided itself into committees, each of which took up certain departments of preparation. One section of the members saw to the lighting by oil and gas lamps. Another collected together diagrams illustrative of microscopic objects. The invitations to country members, correspondence with exhibitors of microscopes and objects, were also thus carried on. It was soon found that the large preparations necessary for the exhibition of the number of microscopes which were promised would be so expensive that the funds of the Society would not bear it without bankruptcy. One of two plans offered, either to collect subscriptions from members, or to charge a sum on extra tickets required by members for their friends. The latter seemed the preferable plan, and, accordingly, each member was allowed, as on previous occasions, two tickets, and as many others as he wished for by paying for them. In this way the Council hoped to defray the expenses of the soirée without making a demand upon the funds of the Society, which ought to be devoted to strictly scientific purposes. It is gratifying to know that this arrangement so far succeeded, that the Society's funds have suffered less by it than at any previous soirée. The fact of the members having become liable for the tickets they presented to their friends has been misunderstood, and has led to the report that the tickets were sold by the Council. This is only true in the sense that membership is paid for, as the distribution of tickets was entirely confined to the members of the Society.

In the arrangement of the tables for the exhibition of the microscopes the committee received the greatest possible assistance and attention from the officers of the South Kensington Museum, who contributed all the help that lay in their power to the preparations necessary for the reception of the large party expected.

Although nearly 5000 invitations were issued, it was not anticipated, till the evening of the soirée, that so large a number of persons would assemble. Long before the hour of eight o'clock, at which time the company was invited, they began to assemble, and from this time till eleven o'clock a continuous stream of visitors passed through the doors. The next morning it was found that 2847 tickets had been taken at the doors, so that there can be little doubt that considerably above 3000 persons were present.

The display of microscopes—the great object of the evening's assemblage—took place in the new galleries erected for the reception of the Turner and Vernon pictures. Along the whole length of these splendid galleries 1000 feet of tables were erected for the reception of the microscopes. As these galleries are not supplied with gas the whole of the microscopes were lighted with oil lamps, spirit not being allowed to be burned in the building.

The following is an imperfect list of those who exhibited microscopes, but as those mentioned were known to have exhibited, it was thought better to publish their names:

Beale, Dr.	1	Lankester, Dr.	2
Lobb, Henry	1	Blenkins	2
Legg	2	Roberts	3
Carpenter, Dr.	2	Hogg	2
Du Pasquier	1	Knight	2
Furze	1	Farmer	1
Tomkins	2	Williams	1
Pavy, Dr.	1	Hislop	1
Varley	4	Walford	1
Peel	2	Mestayer	1
Hopgood	1	Garnham	1
Millar, Dr.	1	Shuter	1
Deane	1	Smith	1
Ladd, Dr.	3	Burr	1
Roper	1	Penkit	1
Mummery	2	Hicks, Dr.	1
Hassall, Dr.	1	Knipe	1

MAKERS AND OTHERS.

Ross	16	Topping	2
Powell and Lealand	12	Darker	4
Smith and Beck	20	Society	4
Ladd	13	Pitchford	2
Pillischer		Protheroe	2
Baker	20	Rainey	2
Salmon	16	College of Surgeons and Mr. Quekett	14
Horne and Thornthwaite	6	Brodie	1
Amadio	4	Prendergast	1
Field	12		

The number of microscopes really exhibited amounted to about 300.

It would be impossible here to enumerate either the forms of microscopes exhibited, or of the objects by which their powers were tested. It must suffice to say, that every form of instrument was present, from the cheap and efficient instruments of Messrs. Field and Son, of Birmingham; Baker, Salmon, and Ladd, of London; to the magnificently equipped instruments which are turned out from the establishments of Messrs. Powell and Lealand, Ross and Son, and Smith and Beck. Not only were there lenses of great power and accurate definition exhibited, but almost every possible variety of accessory apparatus. To those who looked upon the exhibition with an instructed eye, it was a perfect museum of microscopical apparatus.

As for objects, it would be much easier to indicate things which were not exhibited than those that were. The Council had hoped to have arranged the objects in a classified form, but it was found quite impossible to do this for so short a space as the evening's exhibition. It might, however, be a subject of thought for the Council of the Microscopical Society, as to whether, at some future period, they could not organize an exhibition of microscopes, which, instead of extending over a few hours, should extend to a few days, and thus present a more permanent means of studying the instruments and their improvements.

May 26th, 1859.

Dr. Lankester, President, in the chair.

Dr. Eve, James Murray, Esq., and E. J. Meeres, Esq., were balloted for, and duly elected members of the Society.

Mr. Beck read a paper "On the Uniform Screw for Microscopes." ('Trans.,' p. 92.)

Mr. Smith exhibited and described a model of a new form of microscope, remarkable for the smallness of the space in which the whole of the necessary apparatus was contained.

West Kent Microscopical Society.

Under this title a society has been formed in the neighbourhood of Blackheath, Lee, and Lewisham, having for its object the encouragement and promotion of microscopical science, and, although the officers were only elected on the 2d of June, it already numbers nearly forty members, many of whom are practical microscopists. Its officers for the ensuing year are—

President.—John Penn, Esq.

Vice-President.—John F. South, Esq.

Treasurer.—Dr. Noyes.

Secretary.—Mr. Clift.

Members of Council.—W. Brown, Esq., W. Groves, Esq., R. Hicks, jun., Esq., Rev. G. F. Lacey, Rev. R. H. Marten.

INDEX TO JOURNAL.

VOLUME VII.

JOURNAL.

Erratum in Vol. VII.

Page 27, for "P. G. Rylands," read "T. G. Rylands."

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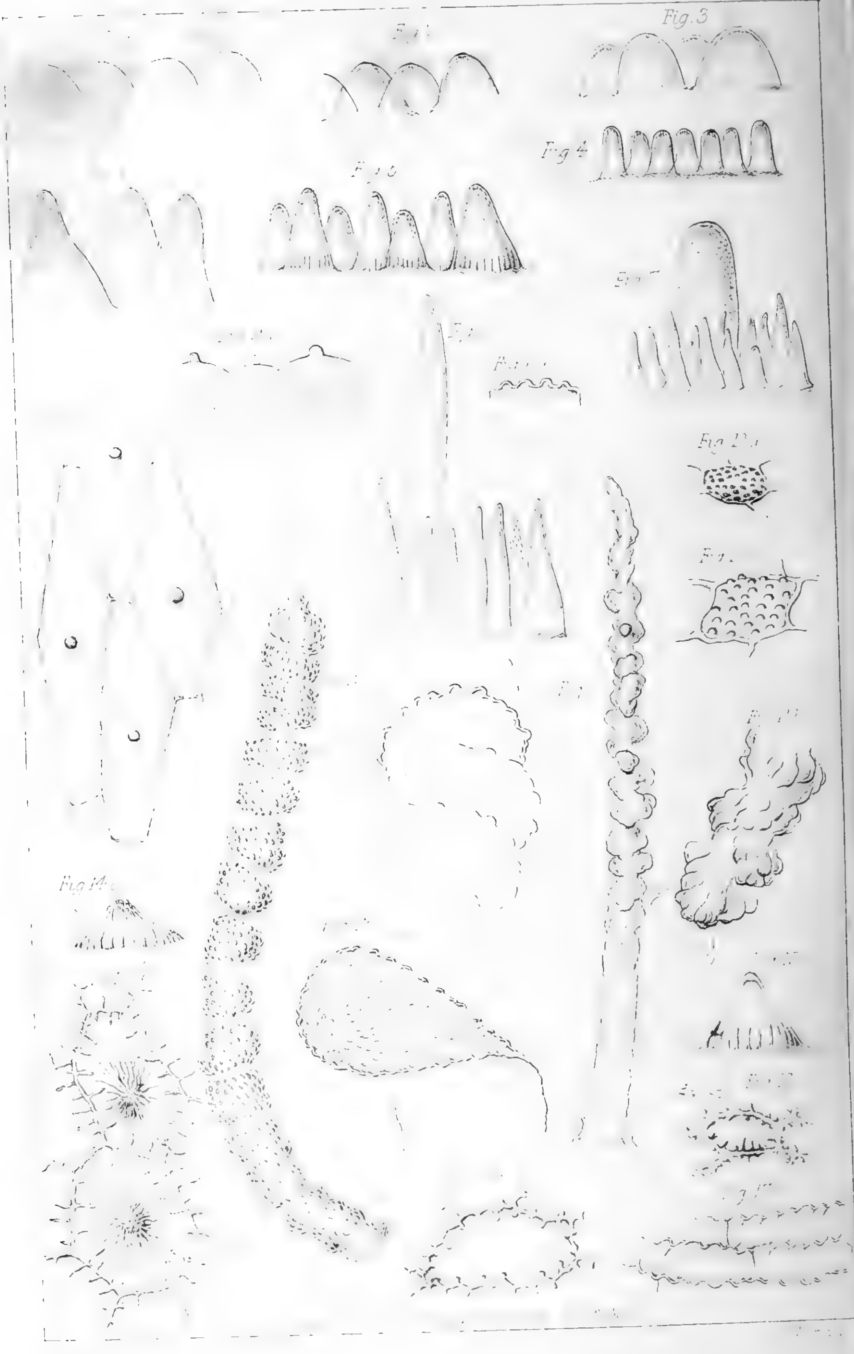


Fig. 3
Fig. 4

JOURNAL OF MICROSCOPICAL SCIENCE.

DESCRIPTION OF PLATE I,

Illustrating Mr. West's paper on the Structure of Flowers, &c.

Fig.

1.—*Ranunculus aquatilis*, profile view, inner surface of petal.		
2.—Iris,	ditto,	ditto.
3.—Ten weeks' Stock,	ditto,	ditto.
4.—*Pyrethrum parthenium*,	ditto,	ditto.
5.—Scarlet Geranium,	ditto,	ditto.
6.—*Orchis pyramidalis*,	ditto,	ditto.
7.—Sweet William,	ditto,	ditto.
8.—Comfrey,	ditto,	ditto.

9.—Gladiolus; *a*, profile, inner surface; *b*, cells of same, as seen from above.

10.—*Galium verum; a* and *b*, as seen from above; *c*, sectional view of same.

11.—Pansy, knotted hair from the throat: *b*, portion of same more highly magnified.

12.—Verbena; *a*, hair from the throat of; *b*, portion of same more highly magnified, showing section; *c*, one cell of petal, from above, showing angular sinuosities, with small pats of secondary deposit at the projecting angles.

13.—Musk-plant, large hair from the petal, accidentally bent over near the tip. × 400 diameters.

14.—Pelargonium; *a*, profile view of inner surface of petal; *b*, two cells of same from above, showing the folds radiating from the centre, and the little teeth-like patches of secondary deposit.

15.—Periwinkle, one cell of petal of, in profile.

16.—Clove-pink, small portion of petal in profile.

17.—White poppy, ditto.

DESCRIPTION OF PLATE II,

Illustrating Prof. Max. Schultze's paper on the Phenomena of Internal Movements in Diatomaceæ of the North Sea.

Fig.

1—4.—*Rhizosolenia styliformis*, Brightwell.

1. A perfect living specimen. × 72 diam.

2, 3. The ends of two specimens still adhering to one another after the division in different positions. × 180 diam.

4. The end of a specimen which had been made red-hot, showing the characteristic surface marking. At *a, a,* are places which possibly are apertures in the shell. × 180 diam.

5—10.—*Rhizosolenia calcar avis*, mihi.

5. A living example. × 72.

6. A similar one in the act of division. × 72.

7. The two ends of a specimen. × 330.

8. The inferior ends of two examples adhering to each other, in the interior of which newly developed points lie. × 180.

9 *a.* One of the newly developed points shown in fig. 8, at *a, a.* × 330.

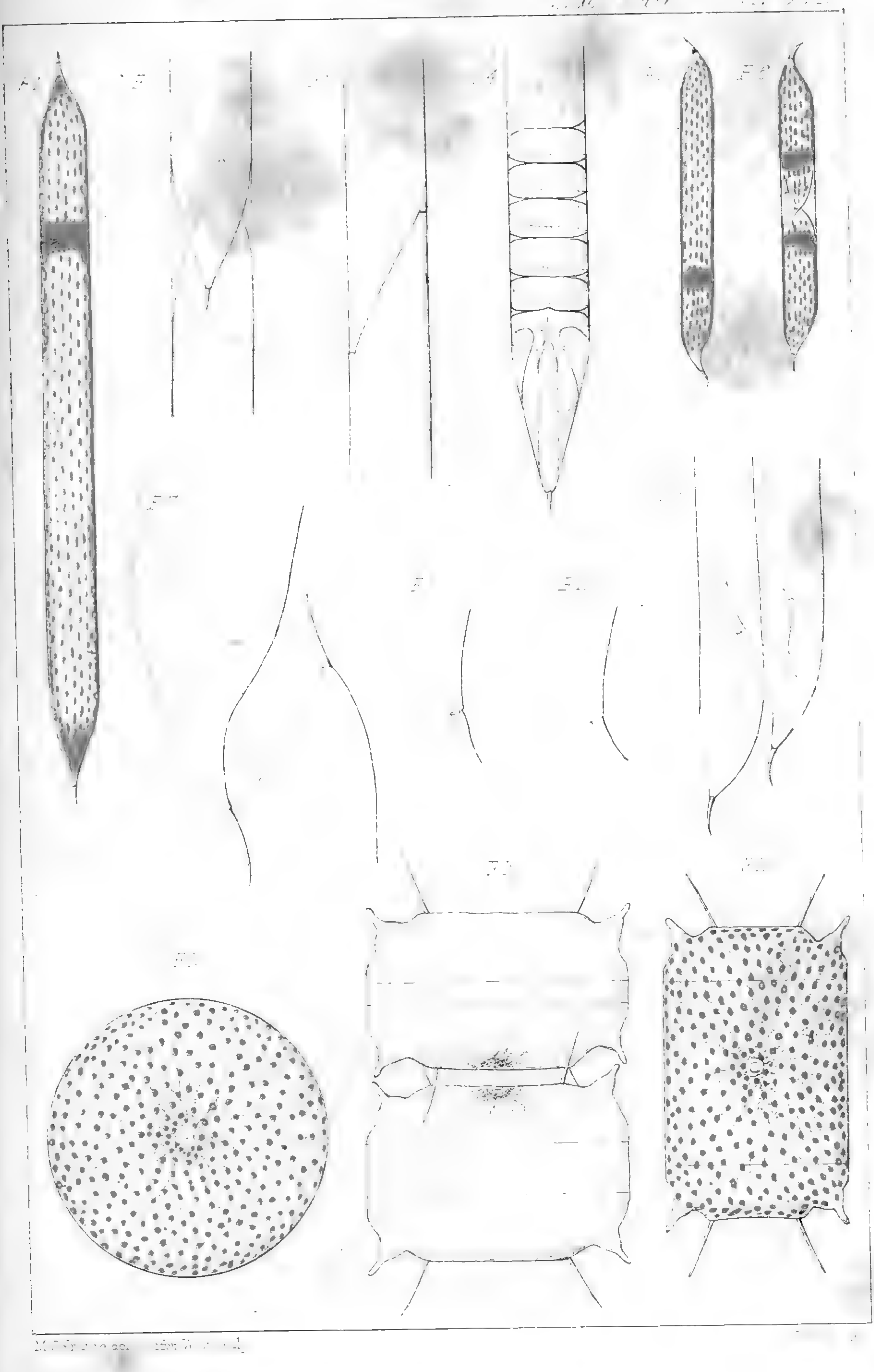
10 *a.* One of the points shown at *b, b,* in fig. 8. × 330.

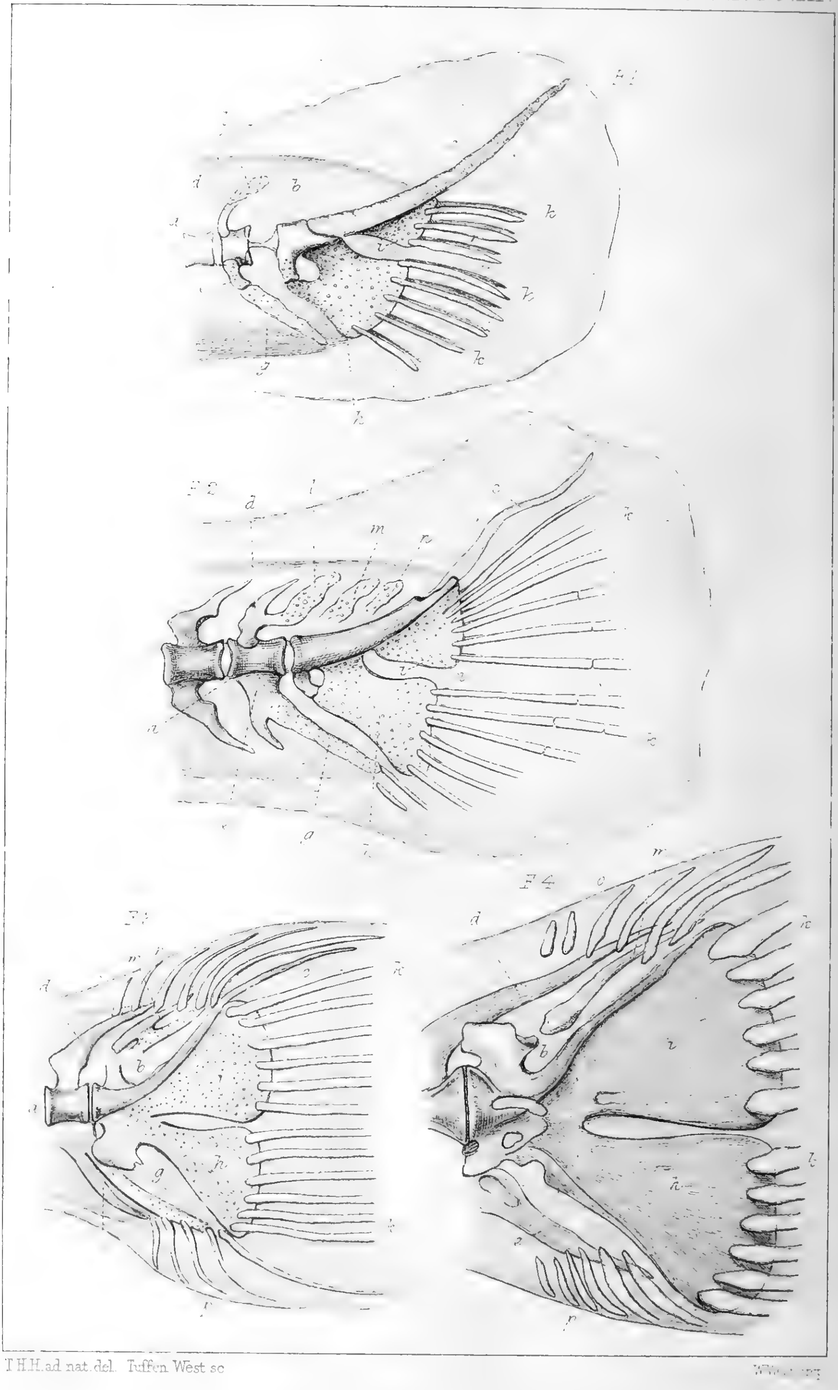
11, 12.—*Denticella regia,* mihi.

The former is shown alive, the latter without its organized contents, and caught whilst dividing. The position of the nucleus is only indicated by the dark granular masses extending themselves in a radiate manner. Both × 180 diam.

13.—*Coscinodiscus centralis*, Ehrenberg. Alive. × 180 diam. The sculpture of the shell is so fine that it is not visible with so low a power. It is adapted also in its organized contents to the other *Coscinodisci* occurring at Heligoland.

These figures are all drawn with Nobert's camera lucida.





T.H.H. ad nat. del. Tuffen West sc

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DESCRIPTION OF PLATE III,

Illustrating Mr. Huxley's paper on the Development of the Caudal Skeleton in the Stickleback (Gasterosteus Ciurus.)

Fig.

1.—The tail of a young fish, 5-16th of an inch long.

2.—The tail of a young fish, 7-16th of an inch long.

3.—The tail of a half-grown specimen.

4.—The tail of a full-grown *Gasterosteus.*

The two last figures are drawn in their proper relative proportions, while figs. 1 and 2 are on a much larger scale than figs. 3 and 4.

The letters have the same signification throughout.

a. Centrum of the last distinct vertebra.
b. Urostyle.
c. Notochord.
d. Neural arch of the last distinct vertebra.
e. Interior arch of the same vertebra.
g. Inter-hæmal cartilage or bone of the last ordinary vertebra.
h. Anterior hypural apophysis.
i. Posterior hypural apophysis.
k. Principal caudal fin-rays.
l. Interneural cartilage or bone of last ordinary vertebra.
m. Anterior epiural apophysis.
n. Posterior epiural apophysis.
o. Superior accessory fin-rays.
p. Inferior accessory fin-rays.

DESCRIPTION OF PLATE VI,

Illustrating Dr. Greville's paper on New British Diatomaceæ.

Fig.
1.—*Cocconeis pinnata,* Greg.
2.— „ *Arraniensis,* Grev.
3.—*Coscinodiscus Normanni,* Greg.
4—7.—*Nitzschia arcuata,* Greg.
8, 9.— „ *macilenta,* Greg.
10, 11.—*Navicula forcipata,* Grev.
12.—*Pinnularia semiplena,* Grev.
13, 14.—*Achnanthes Gregoriana,* Grev.
15—17.—*Podosira lævis,* Greg.

All the figures are × 400 diameters, except that of *Coscinodiscus Normanni,* which is × 800.

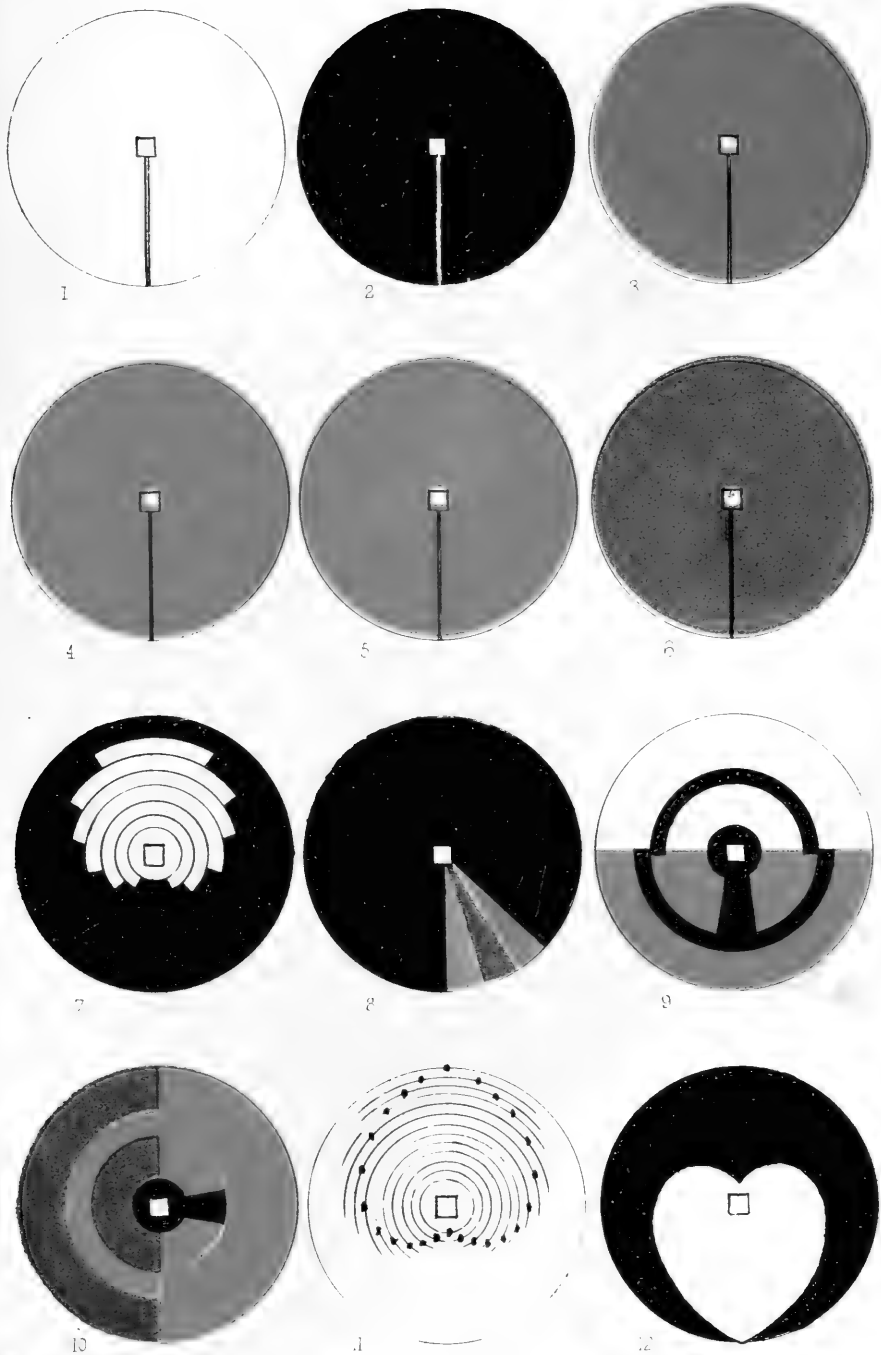
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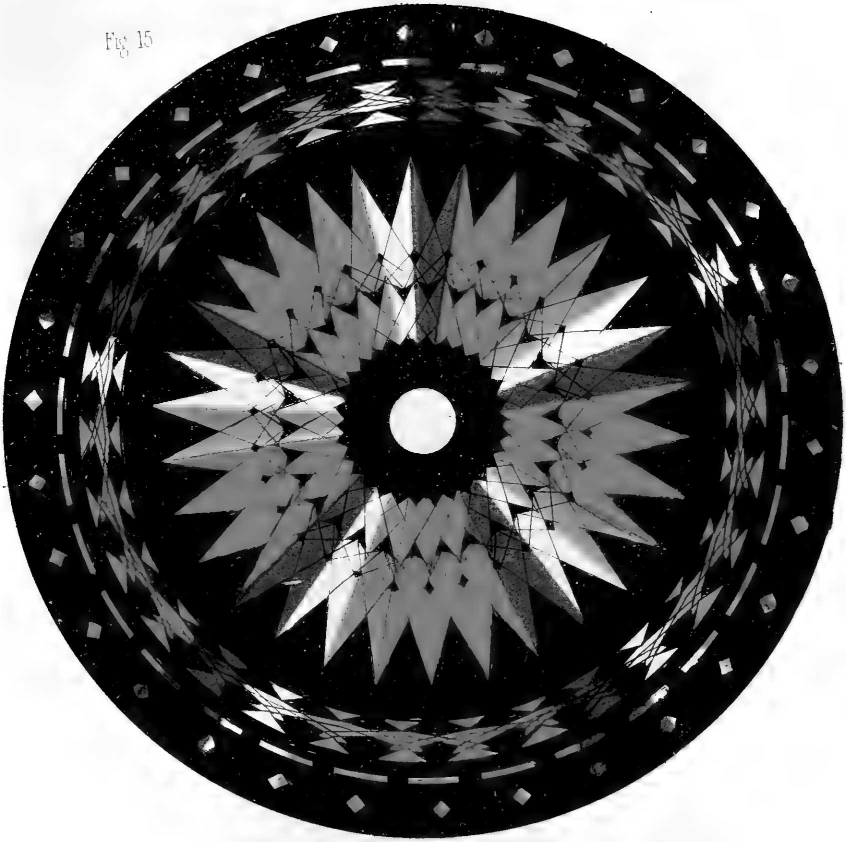
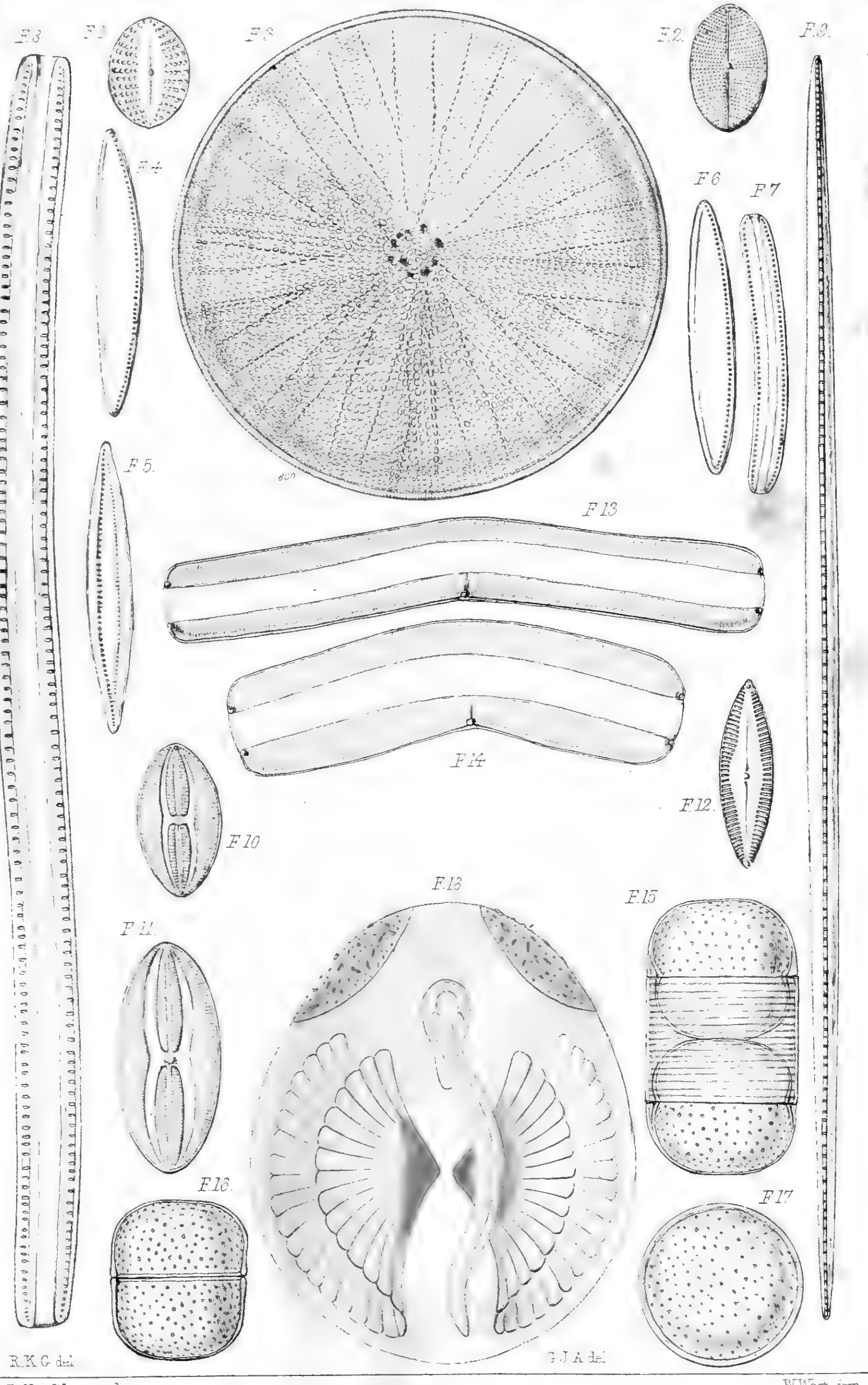
Fig 15



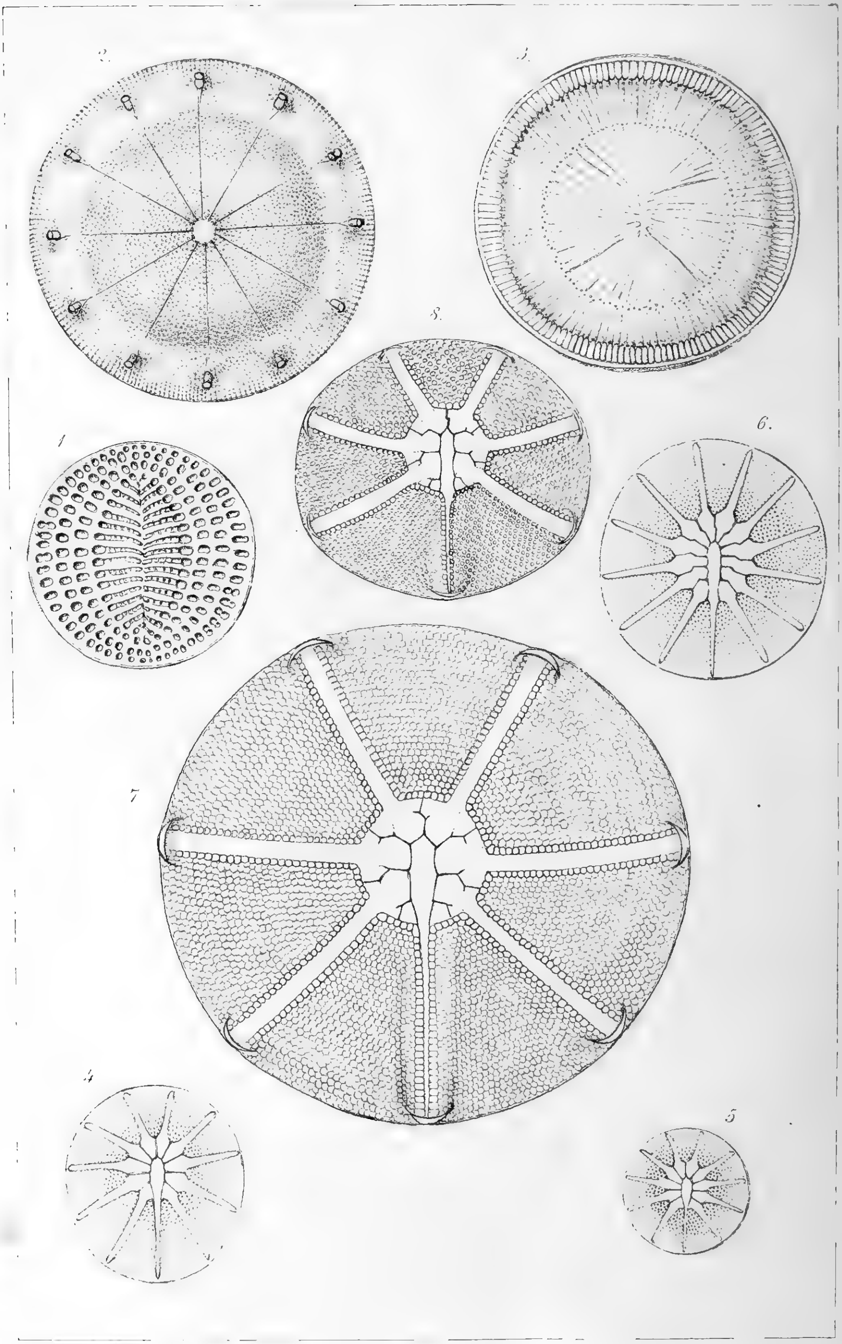
J. Gorham del. Tuffen West lith.

W. West & Co. imp.



Tuffen West sculp.

W. West imp.



R.K. Greville del. Tuffen West sc.

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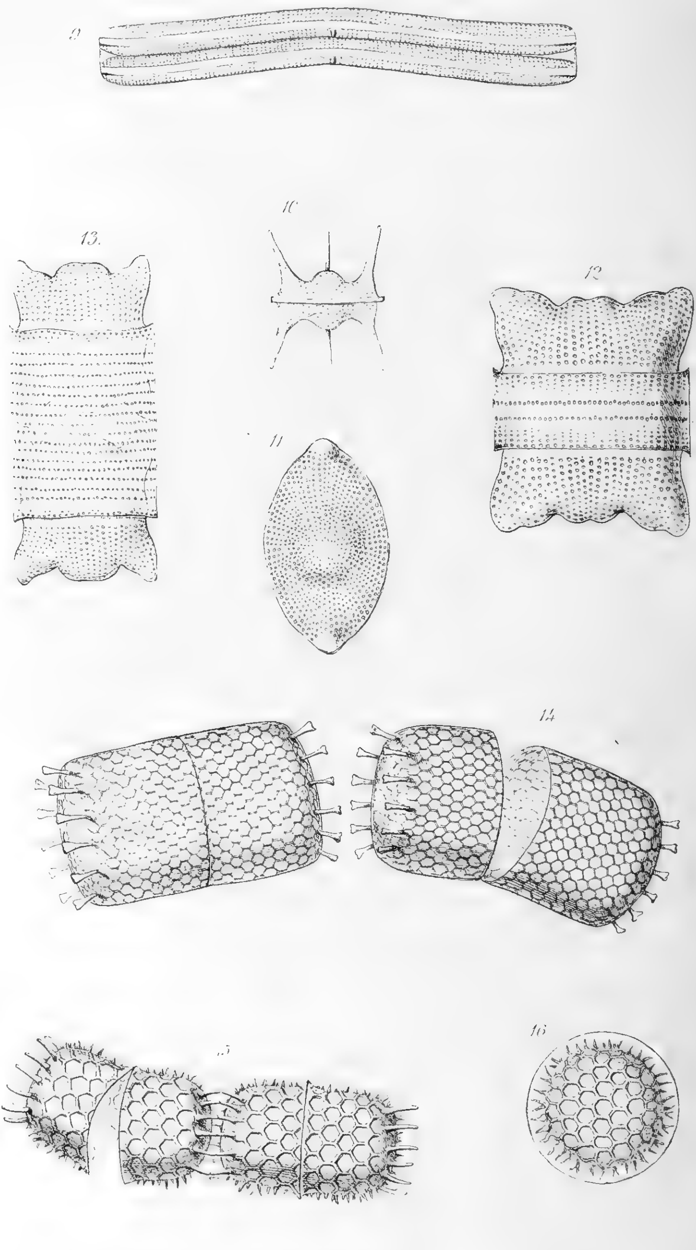

R. K. Greville del. Tuffen West sc

W West imp.

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DESCRIPTION OF PLATES VII, VIII,

Illustrating Dr. Greville's paper on Diatomaceæ in Californian Guano.

PLATE VII.

Fig.
1.—*Cocconeis regalis.**
2.—*Aulacodiscus Oreganus.*
3.—*Campylodiscus stellatus.*
4.—*Asteromphalus flabellatus?* with straight rays.
5.—The same? with the hyaline area nearly central and the rays straight.
6.—*Asteromphalus elegans.*
7.—*Spatangidium Ralfsianum*, very large; the hyaline area nearly central, and the rays nearly straight.
8.—The same; typical in its characters.

PLATE VIII.

9.—*Achnanthes angustata.*
10.—*Biddulphia longicruris.*
11.— „ *Roperiana;* side view.
12.—The same; front view.
13.—The same; front view, approaching self-division.
14.—*Cresswellia turgida.*
15.—*Cresswellia* (?) *ferox;* frustules in union.
16.—The same; a valve seen vertically.

The figures are × 400 diameters.

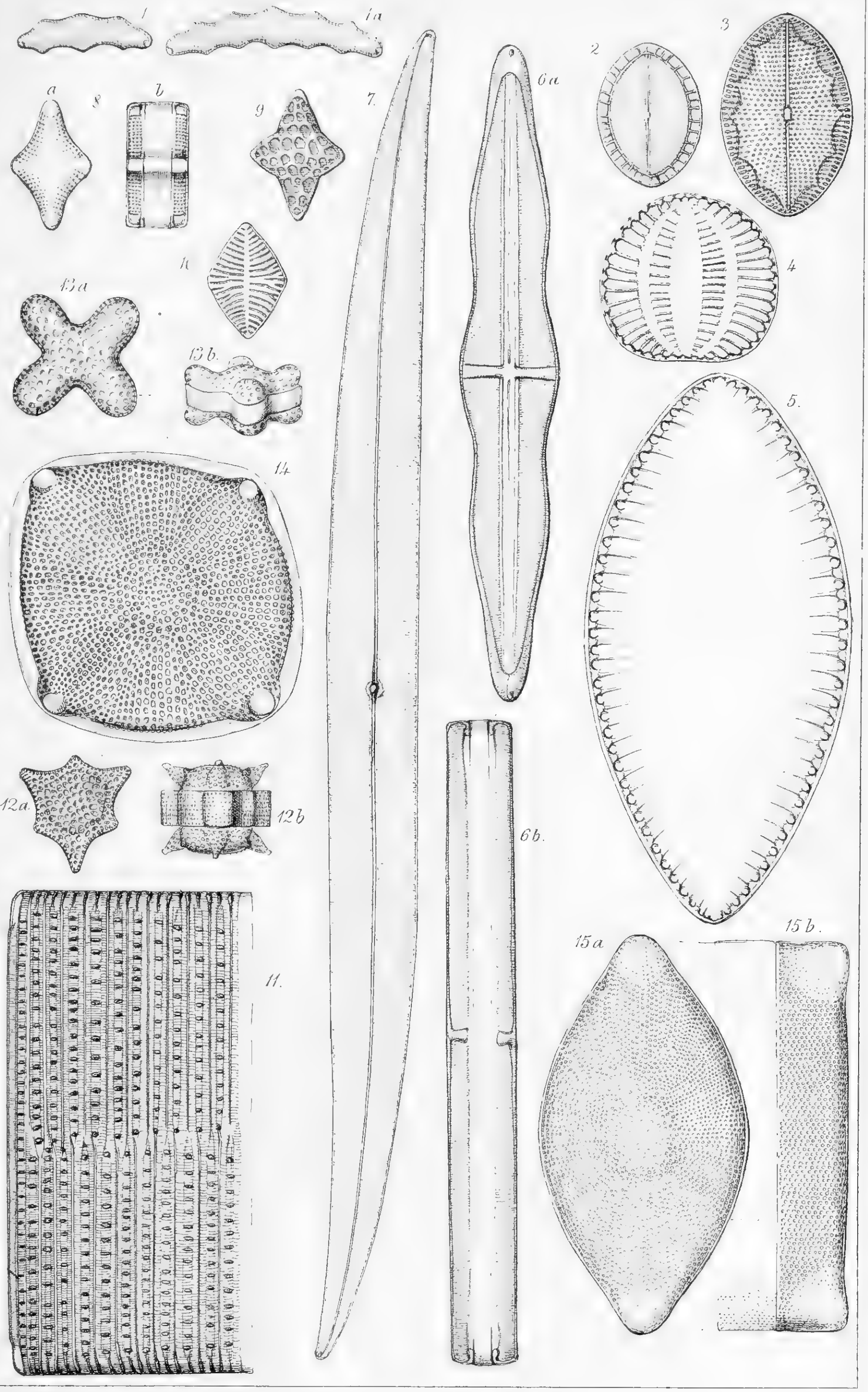
* Since this paper was written I have seen a species much resembling this, in guano from Algoa Bay, in which I find it had also been previously detected by several friends. It has been suggested that it may be only the sporangial state of *Cocconeis Grevillii.* It remains to be seen, however, whether it be really identical with the one I have figured. The view of the upper valve from within has not occurred to me in Californian guano; nor the view represented in the plate, in Algoa Bay guano.

DESCRIPTION OF PLATE IX,

Illustrating Mr. Brightwell's paper on various Diatomaceæ.

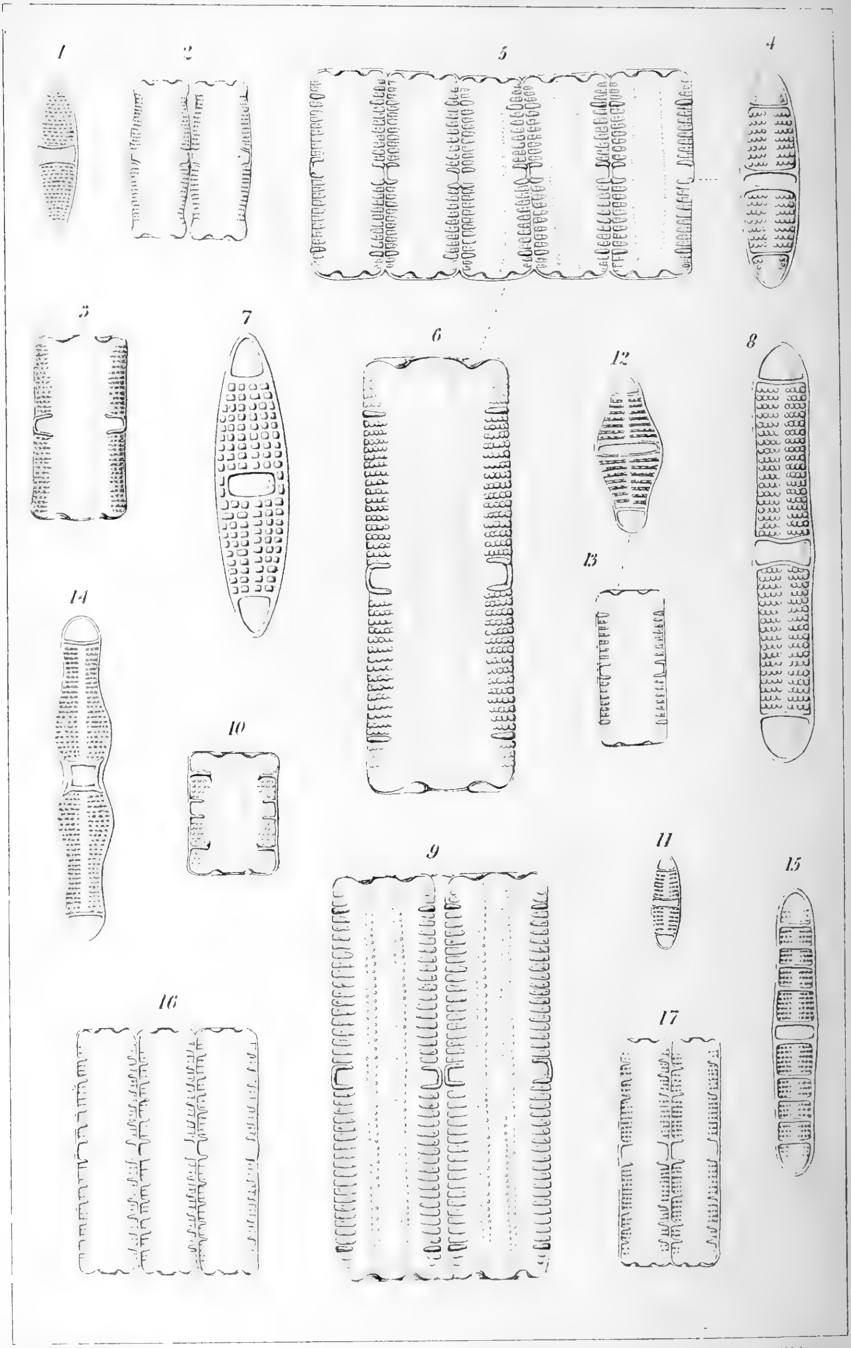
Fig.
1.—*Eunotia eruca,* Ehr.
2.—*Cocconeis corōnata*, n. sp.
3.— „ *fimbriata*, n. sp.
4.—*Campylodiscus striatus*, Ehr.
5.—*Surirella limosa,* Bail.
6.—*Stauroneis Fulmen*, n. sp.
7.—*Pleurosigma longina*, W. Sm.
8.—*Odontidium speciosum,* n. sp.
9.— „ *punctatum,* n. sp.
10.— „ *Baldjickii*, n. sp.
11.—*Rhabdonema mirificum,* W. Sm.
12.—*Triceratium* (?) *dubium,* n. sp.
13.—*Amphitetras crux*, n. sp.
14.— „ *antediluviana* (?), probably a valve from a sporangial frustule.
15. *Biddulphia Balæna*, Ehr.

Figures 5, 6, 7, 11, 14, 15 × 300 diameters; the remainder 400.



Tuffen West sc. ad nat.

W. West imp.



R.K.G. del. Tuffen West.

W. West imp.

DESCRIPTION OF PLATE X,

Illustrating Dr. Greville's paper on Plagiogramma, a new genus of Diatomaceæ.

Fig.
1.—*Plagiogramma Gregorianum;* side view.
2.—The same; front view.
3.—*P. Jamaicense;* front view.
4.—*P. pulchellum;* side view.
5.—The same; front view; chain of five frustules.
6.—The same; a large example; front view.
7.—*P. tessellatum;* side view.
8.—*P. validum;* side view.
9.—*P. ornatum;* front view.
10.—*P. inæquale;* front view.
11.—*P. pygmæum;* side view.
12.—*P. obesum;* side view.
13.—The same; front view.
14.—*P. lyratum;* side view.
15.—*P. Californicum;* side view.
16.—The same; front view.
17.—The same; front view, with fewer *vittæ*.

All the figures are × 400 diameters.

DESCRIPTION OF PLATE XI,

Illustrating Mr. Currey's Mycological Notes.

Fig.

1, 2, and 3.—*Graphiola Phœnicis,* Poit.

1.—A vertical section of the fungus highly magnified.

a. The black outer crust (which is a ring, *not a cup*), apparently formed of the disorganized tissue of the leaf.

b. A layer, formed either of very minute cells or of granular matter.

c. Elongated cells of the tissue of the leaf.

d. Inner roundish cells of the tissue of the leaf.

e. Delicate, closely packed threads, springing from the granular layer, and marked with very faint transverse lines on septa.

f. A mass of yellowish, small spores, resting on the threads, and probably formed from the breaking off of the terminal cells of the threads.

2.—Vertical section of another specimen, less highly magnified.

3.—Vertical section of the fungus deprived of its outer carbonaceous coat, and showing the threads or fibres (? formed from the tissue of the leaf) traversing the mass of spores. × about 50 diameters.

4.—Fruit of *Phragmidium bulbosum,* deprived of its stalk, and germinating from one of its joints.

5.—Two joints of a broken fruit of *Phragmidium bulbosum* germinating from the upper joint.

6.—A germ-filament of *Phragmidium bulbosum* differing from the usual form, as pointed out in the text.

7.—Spores of *Mucor fusiger,* Lk. × 220.

8.—Fruit of *Patellaria clavispora,* B. and Br.; *a—e,* stylospores; *f* and *g,* sporidia. × 325, except *b,* which is × 450.

9.—*Patellaria atrata,* Fr.; *a,* ascus, with unripe sporidia; *b, c, d,* ripe sporidia.

10.—Stylospores of *Patellaria atrata,* Fr.

11, 12.—Vertical sections of pycnidia of *Cenangium Cerosi.* × highly.

13.—Sporidia of *Sphæria Zobelii,* Tul.

14.—Stylospores of *Sphæria Tiliaginea,* Currey. × highly.

15.—Fruit of *Sphæria ciliaris,* Sow.; *a,* ascus, with sporidia; *b,* secondary fruit.

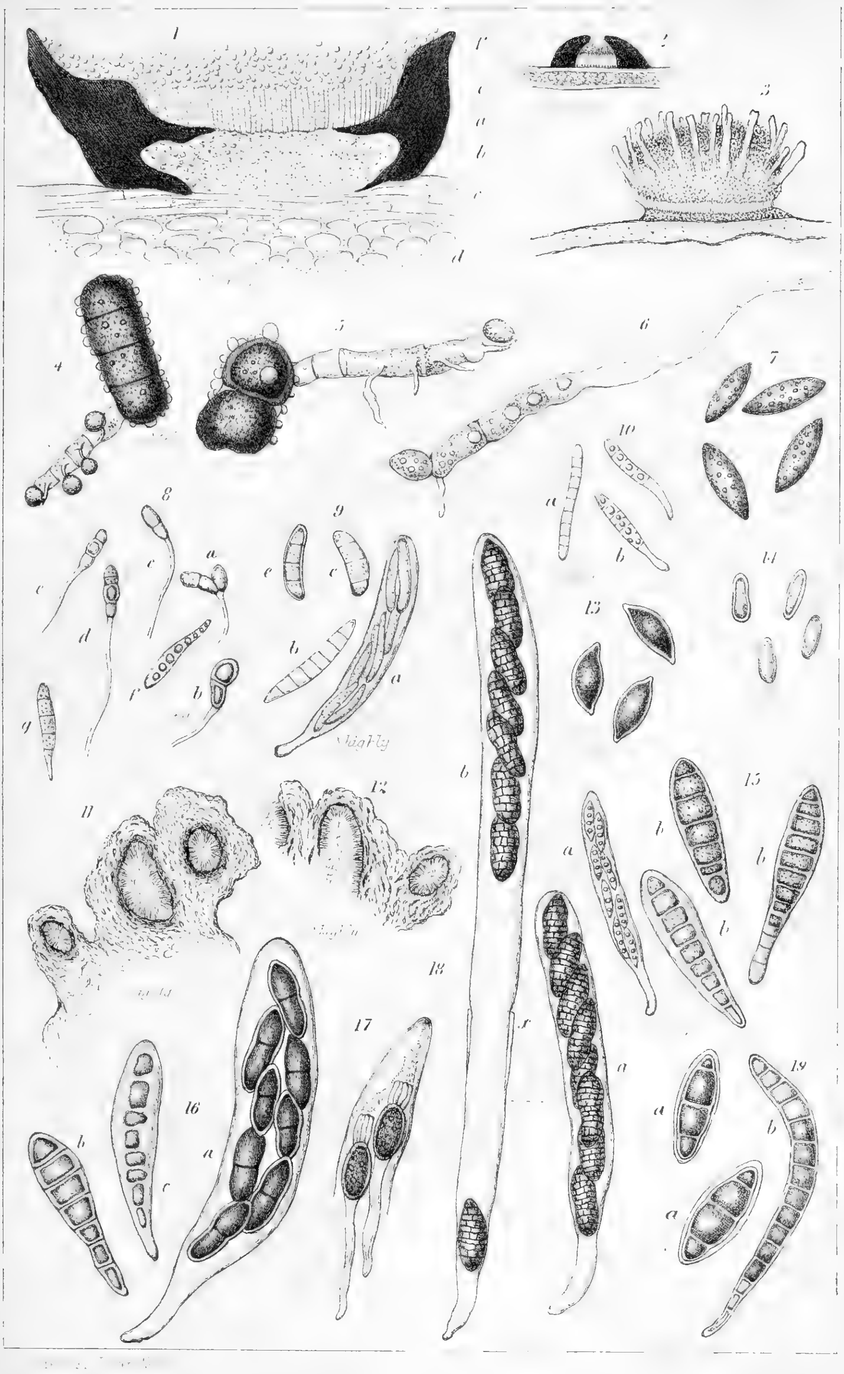
16.—*Sphæria obtecta,* n. sp.; *a,* ascus, with sporidia; *b, c,* secondary fruit?

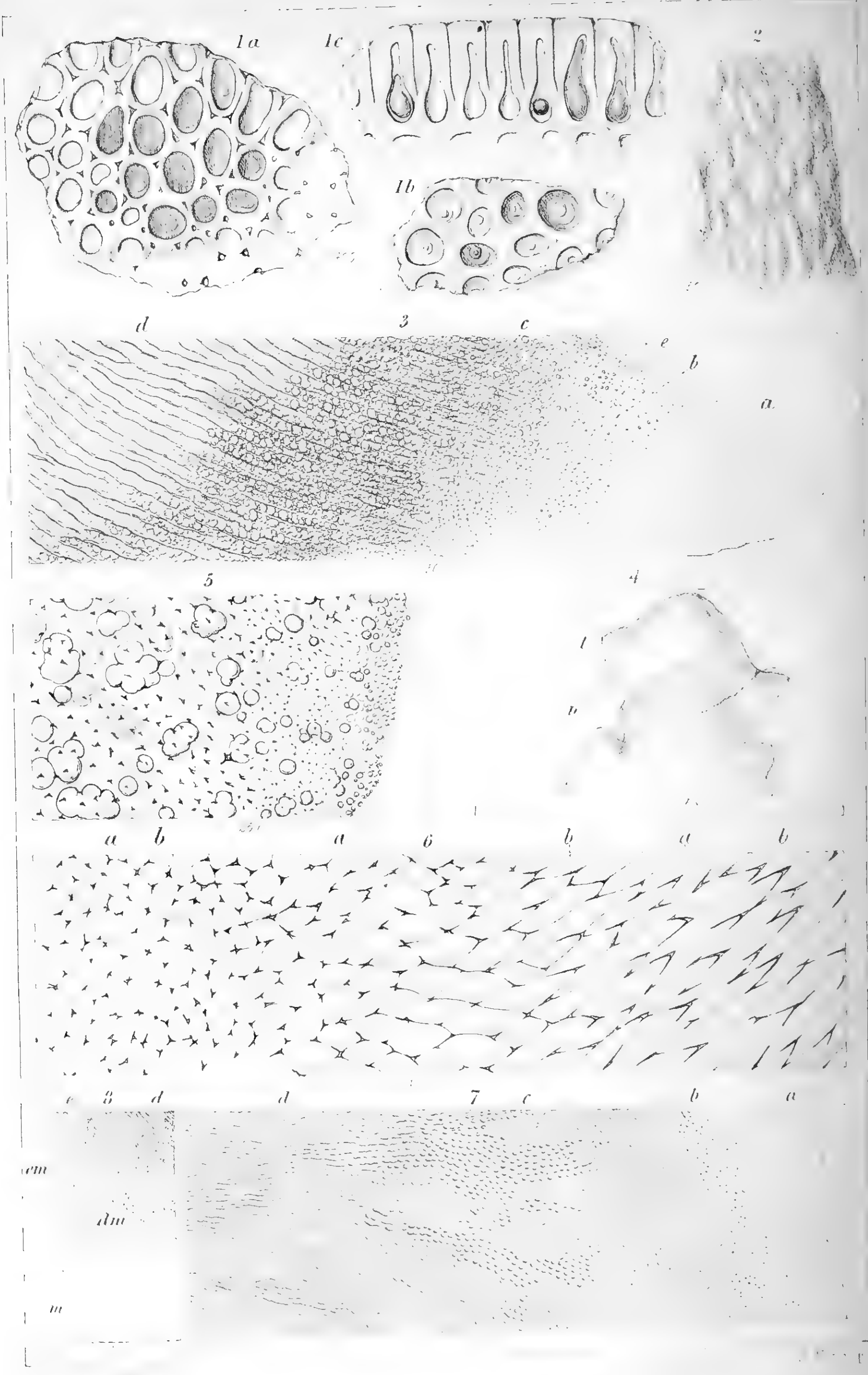
17.—Germinating sporidia of *Sphæria stercoraria,* Sow.

18.—*Sphæria Spartii,* Nees; *a,* ascus of the usual form; *b,* ascus ruptured at the apex (*x*), and with the inner membrane protruding.

19.—*a,* sporidia of *Sphæria macrospora,* Desm.; *b,* fruit of *Coryneum macrosporium,* Berk.

All the figures are × 325 diameters, except where otherwise stated.

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dm
m

DESCRIPTION OF PLATE XII,

Illustrating Mr. Rainey's paper on the Formation of Dental Tissues.

Fig.

1.—*a.* Portion of silicious cuticle from sugar-cane, as seen from above.

b. The same, from below.

c. Vertical section.

2.—Undulated margin of entirely uncalcified dentine-matrix, fom the specimen given in outline at fig. 4.

3.—Dentine in different stages of development; from fœtal calf. The lines in the engraving necessary to indicate the spaces between the dentine fibres and globules, do not exist in the specimen from which the drawing was taken.

4.—Tooth from fœtal calf in very early stage, gently removed from the subjacent pulp; *t*, tooth; *p*, dental pulp.

5.—Globular dentine; from human tooth.

6.—Horizontal section of dentine; from human tooth decalcified.

7.—Enamel in different stages of development; from fœtal calf.

8.—Matrix dividing into two layers; *m*, matrix before dividing; *e, m*, enamel matrix, with particles of enamel; *d, m*, dentine matrix.