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GEORGE BUSK, F.R.C.S.E., F.R.S., Sec. L.S.

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INDEX TO JOURNAL.

VOL. V, NEW SERIES.

A.

B.

M.

[redacted]

[redacted]

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INDEX TO TRANSACTIONS.

VOLUME XIII.

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[redacted]

ORIGINAL COMMUNICATIONS.

On the Genus SYNAPTA, *with some* NEW BRITISH SPECIES. By WILLIAM BIRD HERAPATH, M.D. Lond., F.R.S.L. & E.

(Plate I.)

(Read Section D British Association, Bath, Sept. 16, 1864.)

THE little vermigrade Synaptá has long been an interesting myth to most microscopists, very few of whom have ever had an opportunity of examining any perfect specimen of the animal itself in the preserved condition, and still fewer have ever seen it in its native haunts, or watched it during life.

In fact, until the last few years it has been chiefly from foreign shores that we have obtained our specimens of those curious anchors for which the Synapta has been hitherto principally known to microscopists.

Even our chief standard work on British Echinodermata does not contain any example of Synapta; the figure of Chirodota was probably intended for this animal, but its drawing is singularly inaccurate, and must have been made from a dried specimen or from description; it could never have been seen by Professor Forbes in a living condition. Our best microscopical works dismiss the subject in a very summary manner, and but few papers have been written upon them in the English language. M. Quatrefages has described a Synapta which he had found on the shore of the Chaussey Islands, a point off St. Malo, on the French coast in the Channel, and had called it *S. Duvernæa*. This is a most admirable paper, and enters minutely into the anatomy and physiology of the animal, and is most exhaustive of the subject; it is to be found in 'Annal. des Sciences Nat. Zoolog.,' t. xvii, xviii. There is also an admirable paper by Messrs. Woodward and Barrett on the *S. digitata* and *S. inhærens* in the 'Quarterly Journal of the Zoological Society' for 1858, p. 360. And Professor Wyville Thomson has given, in the 'Microscopical Quarterly Journal,' 1862, an elaborate paper on the structure and reproduction of *S. inhærens*, which he was fortunate in obtaining in considerable quantity buried in mud banks, near low water-mark in Belfast Bay and Strangford Loughs.

When the author was in Guernsey, in the autumn of 1863, M. J. P. Gallienne kindly showed him the locality and mode of finding a Synapta, which he thought to be *inhærens*, and had discovered in Bellegrave Bay, on the coast of Guernsey. Here he had often found it, and naturally felt anxious lest its haunts should be generally known, and thus its habitat be lost. He also informed him that the late Dr. Lukes had found a Synapta in Bordeaux Harbour, on the same island—whether identical with the one about to be described it is impossible to state, as no specimens now exist.

Having visited the spot where M. Gallienne had obtained his specimens, they found several at, and a little above, low water-level at spring tides, in a bed of sand about ten or twelve inches deep, and congregated in a space about twenty yards square, whence they were easily obtained by digging cautiously with a spade, the operator being guided in the task by the appearance of the funnel-shaped opening in the sand, marking the position of their burrows. On inserting the spade and elevating it quickly, the sand generally cracked through the centre of their perpendicular burrows, disclosing the animal in the canal, which appeared destitute of all lining material. The identity of the animal was readily found from its quickly adhering to the fingers by its anchor-shaped hooklets, whilst its appearance, when placed in sea water, was at once indicative; it was of a delicate rosy-pink colour, vermiform in shape, and having five white bands, arranged lengthwise throughout the body, from the oral to the anal apertures. The mouth was surrounded by a ring of twelve tentacles, which were pinnated, and appeared to have six pinnæ on each side, with one terminal digit; thirteen pinnæ in all.

Some of these animals were distended with sand, and appeared darker in colour; but the anal extremity was generally enlarged, more transparent, and of the usual pink colour, from being inflated with sea water; this distension was the means of retaining the animal in its burrow, by giving it a fixed fulcrum for the contraction of the longitudinal muscles.

The sand-bank was dark in colour, and fœtid, from the large quantity of decaying animal matter therein. The Synapta, doubtless, fed upon this refuse material by gorging itself with sand from time to time. In this locality two species of Synapta existed; *S. inhærens* and the new species.

M. Gallienne also informed him that this locality had shifted several yards nearer high water-mark since the Synaptæ were first discovered by him, two or three years ago.

These interesting animals—the Synaptæ—have the property, possessed in common with other echinodermata, of breaking up spontaneously, so that perfect specimens are obtainable only with difficulty. The absence of fresh sea water, and fear, may be the proximate motives prompting them to the act, as they commenced self-division almost immediately upon removal from their dwelling-place, and on being dropped into a bottle of sea water, which gradually filled with the captured prey.

Many were brought home alive and perfect, but in an hour were mutilated extensively, although placed in a larger vessel well supplied with sea water, but, from accident, without sand; it did not depend, therefore, on a question of starvation and loss of nutritive power, as some had imagined, but on mere change of place and the circumstances surrounding it; the principal of which might be the stimulus of light and heat.

That these difficulties might be overcome is evident from the fact that Captain Wethered has contrived to domesticate three or four Synaptæ in a marine aquarium, and has even kept them twelve months therein, and obtained a brood of young in the early part of June, 1861. These have been well described by Professor Wyville Thomson, in the 'Quarterly Journal of the Microscopical Society' for 1862.

Professor Thomson has had the kindness to send the author some specimens of his Belfast Synaptæ, together with another Synapta obtained from a different locality, viz., Carrickfergus, on the Antrim shore of Belfast Lough.

The original species described by him in the journal came from Holywood, and have been identified by this eminent naturalist as *S. inhærens* of Müller, and synonymous with *S. Duvernæa* of Quatrefages, whilst the Antrim or Carrickfergus specimens, he states in his letter to the author, are intermediate between this species and *S. digitata;* he has great doubts whether the species are really distinct. This opinion has, probably, been formed from a consideration of the external zoological character only.

On carefully preparing slides from all these various specimens, and photographing the preparations, great differences are apparent in the forms of the anchors and anchor plates.

Messrs. Woodward and Barrett have laid great stress upon the form and characters of the anchor plates as means of determining the species of Synapta, and from the author's i vestigations into the constant characters of the pedicellariæ of other echinodermata, it is highly probable that full reliance can be placed on these calcareous bodies for specific characters.

In the first place, it may be as well to summarise the position of Synapta in the zoological scale, remarking that, to keep strictly to the method of arrangement adopted by Professor Forbes, Synapta should be removed from the Holothuriadæ and placed in the vermigrade order—as *no* pedal rows of ambulacral cirrhi exist, and there are no appearances of any protusile branchial organs—Echinodermata—order, vi, vermigrada.

Family, Synaptidæ.

Body cylindric, vermiform, without suckers, and destitute of sipuncular prolongation; mouth surrounded with tentacula, elongate, pinnate or digitate; calcareous plates in external skin. (See Plate I.)

Genus, Synapta.

Tentacula more than five, sometimes 12; rarely simple, mostly digitate; calcareous plates perforated, and having anchor-shaped spicula articulated to them.

Genus, Chirodota.

Tentacula 12; digitate at the extremities; peduncle long, calcareous plates "wheel-like," but having no anchors or other spicula; articulated. Whilst the species described may be characterised thus:

Synapta digitata.—Having 12 tentacles and 4 fingers to each tentacle, with a small thumb.

Anchors plain, with 3 or 5 serrations.

Anchor plates oval and leaf-shaped, having a process or stalk at the end to which the anchor is articulated; disk perforated with 4 large simple holes, which are surrounded by smaller perforations sometimes; anchor plate obcordate; articular process has a *slit* like the eye of a needle.

S. inhærens.—Having 12 tentacles with 5 pinnæ on each side, and 1 terminal digit; 8 blow holes or trumpets on each.

Anchor plates pointed ovate, with no process or arch at the articular end; apertures in plates consist of 6 oval fenestra, surrounding a central opening with a scalloped border, as in *S. vittata*. The anchors have serrated flukes, the serrations 3—7, anchors sometimes shorter than plates, sometimes much longer.

S. Galliennii, vel *Saruiensis*.—Having 12 tentacles with 6 pinnæ on each side and 1 terminal digit, therefore 13 in all.

Anchors serrated, occasionally plain; 3—7 serrations, with the flukes reflexed.

Anchor plates ovate, shaped with a process or *arch;* each plate being concavo-convex, like a spoon, having serrated external margins when perfect, and 1 central round aperture with 7 surrounding it, and 2 or 3 oval apertures at the junction of the arch; the lesser end of oval minutely perforated.

Anchors longer than bucklers, to which they are articulated.

The *S. Galliennii*, of Guernsey, has anchor plates which articulate with the anchors by the lesser end of the plate and upon the concave surface of the plate. The anchors are generally elevated at an acute angle with the buckler, and in adult specimens are arranged in 5 longitudinal rows between the muscular bands. They are more numerous at the anterior extremity of the Synapta, and comparatively deficient at the small bulging portion. There appears to be a thin epidermis over both anchors and plates very frequently; these appendages are produced by layers as in any other epidermis, the outer layer wearing away and new ones taking their places; occasionally miniature and imperfect anchors are to be found with incipient plates only.

There are two Synaptæ frequently in the hands of the dealers in microscopical slides, and these are *S. vittata*, from the shores of the Red Sea, and it is the species from which most microscopists have obtained their specimens and with which all are probably familiar; they are obtained near Suez, and the slides are made up in Paris, but re-manufactured in this country. The anchor flukes are plain and simple, and the articular end of the shank deeply subdivided; the plates are furnished with a raised arch at the smaller end, forming a sort of cavity for the reception of the anchor stock. They are exactly like those figured in Müller's article, "Uber der Bau der Echinoderm" ('Berlin Transactions,' 1854), band 6, fig. 17, under the name of *S. serpentina*. There is a woodcut of them in Dr. Carpenter's work on the microscope, and figures are also given in the 'Micrographic Dictionary,' which very summarily dismisses the subject.

Another Synapta, the *S. bi-dentata*, is obtained from China; it has 12 tentacles, with 4-lobed digits surrounded by a sheath.

Anchors short, stout, straight projecting "beams," the flukes smooth and bifid in most instances.

Anchor plates obvate; truncated at articular end; pierced by numerous circular holes, diminishing from the centre to the circumference; margin never completed, edge broken like wire gauze. As far as the author's own preparations are concerned, this description does not bear out the last proposition. The anchor plates are complete, and rounded by a smooth edge. Messrs. Woodward and Barrett's description was probably taken from a young immature specimen.

The Belfast specimens somewhat differ from the description of *S. inhærens*, as the mouth has, in addition to the circle of digitate or pinnate tentacles at the extreme edge of the disk, an inner layer or circle of *simple tentacula* immediately surrounding the oral aperture. These are equal in number to the external circle, and the anchor plate is not quite formed on the model of the engravings which accompany the paper of Professor Wyville Thomson in the 'Mic. Journal,' loc. cit. They are distinctly seven-holed, *six apertures surrounding a central opening*, all of which are more oval in form than round; *the outer margin is smooth*, but the edges of the apertures are crenated; the anchors are longer than the plates; the terminating articulating extremities of the plates are pointed, and pierced by numerous smaller openings. There are no projecting rostra in the convex edges of the anchors, which differ from the *S. Duvernæa* of Quatrefages.

The specimens from Antrim, as Prof. Wyville Thomson states, differ from both *S. inhærens* and *S. digitata* in the fact that the anchors are very short in the shafts; the anterior or convex border is marked by a central depression. The length of the shaft equals the breadth of the flukes from tip to tip. The anchor plates are mostly incomplete, but they agree in those which are perfect in being obcordate, or rather the outer edge is half the section of an oval; the edge nearest the articulating process being rectangular to that projection and straight. This process has parallel sides and rounded end, with *two or three* rounded apertures piercing it in a longitudinal line, *each* of which may be compared to the eye of a needle. The anchor plate has 6 large holes arranged as a pyramid, counting from the straight edge of the buckler; 3 in the first, 2 in the second, and 1 at the apex, which is of course nearer the greater convexity of the shield or anchor plates; the two apertures on the median

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line are the largest on the plate, that at the outer or convex border being the larger. Indications of six other apertures exist, external and towards the convex outline of the shield. The three apertures in the articular end distinguish it from the eye-like slit of *S. digitata.* The shorter form of the anchor and the arrangement of the apertures distinguish this from all the other species of Synapta described.

In conclusion, the author refers to his generalisation in his paper on the pedicellariæ of the Echinodermata, that the anchor plates in the genus Synapta are the analogues of the pentagonal plates of the shell of Echini proper and the anchors arc spicula; but the analogues of the spines of Echinidæ and Prasteridæ organs for locomotion as well as defence, hookless to enable them to crawl out of their burrows. (See Plate I.)

He also presents his kindest thanks to Professor Thomson, of Belfast, and M. J. P. Gallienne, of Guernsey, who have so generously placed these specimens at his disposal, and would propose *S. Thomsonii* for thc Carrickfergus specimen, if not previously described by any other naturalist.

The ANATOMY *of the* EARTHWORM.
By E. RAY LANKESTER.

PART II.

IN the last number of this Journal the tegumentary, muscular, and digestive organs of the earthworm were briefly described, the form and structure of certain œsophageal appendages being more particularly noticed. The following pages will be devoted to the consideration of the Reproductive system, and of such secreting organs as are not of necessity connected either with it or the digestive system.

Segmental organs.—This name was proposed by Dr. Williams,* of Swansea, for certain organs which had long been known and appeared to exist in Annelides disposed in pairs in each segment of the body. These organs in the earthworm and the Oligocheta generally are in the form of tortuous ciliated canals, attached to the diaphragmatic muscles, communicating by one extremity with the exterior, and terminating at the other in a free, open expansion, on to which the cilia of the interior of the tube are continued. In the Limicolæ, the walls of the

* 'Phil. Trans.,' 1858.

canal are somewhat thick, transparent, and show a cellular structure; the cilia are large and vigorous, and the tube is long and frequently closely bent on itself, so as to give the appearance of a double tube. Gegenbaur* has described a more complicated arrangement in the earthworm, which I have not been able fully to confirm, the great difficulty of placing one of these tubes under examination in the microscope, without tearing or twisting it into every variety of form, being one of the chief causes, no doubt, of this discrepancy.

According to Gegenbaur, the segmental organ or ciliated canal of the earthworm is folded and refolded on itself in such a manner as to produce four canals of different dimensions running parallel to one another, the diameter of that which belongs to the end of the canal nearest to its external aperture being much greater than that of the others. The whole of the canal thus bent and complicated is held together by a membrane, on the surface of which ramify very numerous blood-vessels, derived from the abundant capillaries of the diaphragm-muscle. In fig. 4 is drawn a ciliated canal from one of the terminal posterior segments of a large earthworm. The canal appeared to be folded on itself once, and to increase much in size towards its external termination, the walls increasing in thickness rather than the calibre of the canal becoming enlarged, whilst towards its interior termination the tube was very much smaller, and its walls remarkably thin, the interior being freely ciliated. The expanded termination, for which no name is at present in use in this country, possesses a structure of conspicuous hexagonal cells, with distinct nuclei, the surface being densely fringed with cilia, M. D'Udekem has proposed the name "entonnoir vibratile" for the homologue of this expanded portion of the tube, and perhaps the name "ciliated inductor" may be found a convenient though free translation of this term. The network of vessels with which the ciliated canals are connected is described by Gegenbaur, as also by Dr. Williams, who has figured the anastomosing capillaries and their sacculi. If a small portion of one of the ciliated tubes be examined with a power of 200 diameters, the various arrangements of its parts shown in Pl. I, fig. 2, will be seen. The greater part of the wall appears to be composed of the thick, granular tissue (*a*), which is bounded externally by a delicate structureless membrane, and internally by an equally structureless layer produced at intervals into coarse cilia (*b*). On the surface of the tube, the blood-vessel (*c*) is disposed, giving

* 'Köll. and Siebold's Zeitschrift,' 1852.

off few branches and enlarging at intervals into very remarkable sacculi, closely connected with the tissue of the ciliated canal. The fluid contained in the blood-vessels is of a pale red colour, and in the sacculi appears to contain granular matter. The cilia of the canal retain their vibratile movement for a considerable period of time after their removal from the worm, and a careful examination shows that they are urging a liquid containing minute cells, granules, &c., towards the external aperture, which, it should be stated, is so minute as to escape detection on the surface of the worm's body.

It can hardly be doubted that the function of these tubes is excretory, and not respiratory, as sometimes supposed; and, indeed, this appears now to be conceded by many distinguished anatomists. The glandular walls connected with the sacculi of capillary vessels present all the essential parts of a kidney, and it is as such that they must be considered. The "ciliated inductor" undoubtedly removes a certain quantity of the perivisceral fluid from the body, but by so doing it assuredly does not assist the oxygenation of the red fluid, which may be called the blood. For the views which have been entertained on this subject, I must refer the reader elsewhere, to such papers as that of Gegenbaur, of Williams, and the researches of D'Udekem and Claparéde. Drawing a conclusion merely from structural grounds, the ciliated canals of the Oligocheta, and hence of all Annelida, can only be considered as primarily excretory organs or kidneys; the facts which will be hereafter detailed with regard to the differentiation of these canals, adding also a certain amount of weight to the structural argument. The ciliated canals, therefore, of the earthworm, may be considered as *inversions of the integument*, similar in function and essential points of structure to the kidneys of higher animals. In the Lumbricus, a pair of canals of similar structure exists in every segment of the body but the first. In the Naiidæ, the beautiful and elaborate researches of D'Udekem and Claparéde have shown that in the generative segments of the body they are modified so as to form "vasa deferentia" and "Fallopian tubes." Whether this arrangement obtains in any manner in Lumbricus remains to be considered.

Mucous pores.—In the cuticle of the earthworm a system of very minute canals exists, which was briefly referred to in treating of the tegumentary system, and which might either be described in connection with the respiratory mechanism, or here, if we regard these ducts as excretory pores. Fig. 8, Pl. II, shows a vertical section of the integument of *Lumbricus* taken from the posterior part of the body, where the colou matter is deficient. The thin structureless epidermis (*a*) is seen to be underlaid by a somewhat fibrous, but more or less homogeneous tissue, in which are excavated a series of canals of great minuteness, but sufficient to form a most extensive communication between the perivisceral fluid and the exterior. These canals branch much in the same way as the interstitial canals of dentinal tissue, and indeed, present a very marked resemblance in arrangement and form to the tubules of the teeth. Whether the communication of their contents with the surface is direct by orifices in the epidermis, or whether it takes place by a process of osmosis, appears to be uncertain. It is undoubtedly through these minute canals which exist throughout the integument of the earthworm, that water passes to the perivisceral cavity, and a denser fluid passes out, though it appears that the setigerous glands briefly noticed in my last paper, also secrete a fluid of considerable density, which is stated by Dr. Williams to have a remarkable power of absorbing oxygen from the atmosphere. This is no doubt a valuable and convenient property in the mucous secretion, but I have not been able to test it in any way, and cannot, therefore, confirm Dr. Williams's statement. The consideration of the respiratory, vascular, and nervous systems of the earthworm must be deferred for the present, and the much-disputed organs of reproduction noticed.

Organs of Reproduction.—It is impossible here to review the various errors most pardonably made by some of the earlier writers on this subject; Home, Morren, Dugés, and others, were misled by the presence of parasites, and by the absence of any conspicuous true ovary, into all kinds of mistakes. The papers of M. D'Udekem and Dr. Hering, whose truth and accuracy is denied by Dr. Williams, whilst seeking to support an untenable theory, have, however, made the field clear, and the discovery of the true ovaries due to M. D'Udekem, has rendered the appreciation of the rest of the "genitalia" a comparatively easy task.

Testes and Seminal Vesicle.—The testes have been described with considerable accuracy by Dr. Ewald Hering;* but, by some means, that author has been led to regard them as seminal vesicles; whilst he calls certain very minute bodies, which they contain, the true testes. D'Udekem, on the contrary, regarded the seminal vesicles of Hering, as I also am disposed to do, as the male glandular organs. They consist of two pairs (Pl. I, figs. 1, 3), the anterior of which is bilobed, placed in the eleventh and twelfth seg-

* 'Köll. and Siebold's Zeitschrift,' 1857.

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ments. In structure each is a membranous bag of very considerable vascularity, composed of a delicate fibrous tissue, and an internal secreting surface, the whole being distended with its contents, which are zoosperms in all stages of development. The fibrous tunic of each pair of testes, which appears to be slightly elastic, is continued across the median line, forming in each case a sac, which *may* be considered as a "seminal vesicle," the lobulated glandular bodies, in each case, being somewhat apart; the fibrous sheath connecting the two, and forming the delicate sac or bag, envelopes the expanded termination of two efferent tubes. This bag is extremely delicate, and easily ruptured; though no very large accumulation of spermatozoa ever takes place in it, yet, in position, it is a seminal vesicle; the connection between it and the lobulated testicle on either side is considerably constricted. The testes, then, in the earthworm, consist of a double pair in the eleventh segment, connected by their fibrous sheath with one another, and with the expanded termination of the vasa deferentia, and of a single larger pair in the twelfth segment similarly connected.

The contents of the testes are very remarkable, and were the cause of numerous errors as to the true nature of those bodies. Cysts of Gregarinidæ (*Monocystis Lumbrici*), and free individuals of the same parasite, as also of the *Anguillula Lumbrici*, abound. The development of the zoosperms is very apparent; they can be traced from the form of a minute cell, up to the aggregations of ciliated vesicles, which eventually disperse (figs. 7—11, Pl. I). With regard to the testes or appendages of the seminal vesicles, as Dr. Hering considers them, it appears to me that that author has described a more general communication between them and the sac enveloping the termination of the vas deferens than exists, since a constriction shuts off what I believe to be the testicle from the seminal vesicle or sac. M. D'Udekem appears unfortunately to have overlooked the presence of the seminal vesicle altogether.

Vasa deferentia.—These were discovered by M. D'Udekem.* They consist of a pair of ciliated tubes communicating with the exterior in the fifteenth ring, and bifurcating in the twelfth, so that each of them has a pair of anterior terminations. These are expansions of the tube, excessively fragile and delicate, as also are the tubes, thickly ciliated, very vascular, and enveloped in the sacs or seminal vesicles, formed by the fibrous sheath of the testicles, a *pair* in each sac (figs. 1, 3, Pl. I; fig. 1, Pl. II). The expanded

* 'Mem. de l'Acad. Roy. de Bruxelles,' 1856,

termination and the ciliated tube bring forcibly to mind the ciliated tubes devoted to excretory purposes; but as these also exist in the same segments as the vasa deferentia, we are apparently prevented from considering the latter as modifications of the former, though we have no such difficulty in the case of the Limicolæ. The structure of the expanded "ciliated inductors" of the vasa deferentia is merely a pavement of polygonal cells, excessively delicate, and most easily ruptured and destroyed. The continuation of this epithelial membrane into the duct, and the continuity of the fibrous sheath of the seminal vesicle, and the structureless membrane forming the external envelope of the duct, are seen in fig. 12, Pl. II. Their presence, as that of the vasa deferentia themselves, appears to have escaped all observers previous to M. D'Udekem, and also one since, Dr. Williams.

The Ovaries.—The discovery of the ovaries of the earthworm is also due to M. D'Udekem; they have since been described by Hering, and may be found, by a careful examination of the thirteenth segment of the worm, situated on the inner ventral surface, close to the nervous chord (fig. 1, Pl. I, fig. 3, Pl. II). This, however, becomes almost an impossibility without the use of spirits of wine, by which these otherwise transparent and very minute bodies are coagulated, and rendered visible. There is no difficulty, when their nature is considered, in understanding how the presence of these organs has been overlooked, and others mistaken for them. The ovaries of Lumbricus are never more than $\frac{1}{16}$th of an inch in length, and consist of a very fine structureless membrane in the form of a conical tapering sac, provided with minute blood-vessels and enclosing ova in all stages of development, those situated in the narrow part being the most advanced. By one extremity the ovary is attached to the diaphragm between the twelfth and thirteenth compartments, the other is free and tapering, being sometimes terminated by minute papillæ (fig. 3, Pl. II), the function of which is indeterminable. The relative size of the ovaries in *Lumbricus* is a remarkable fact, when we consider the size which these bodies attain in *Tubifex*, *Euaxes*, and other *Limicolæ*. Dr. Williams denies the existence of these bodies, and asserts that both Hering and D'Udekem have described what they did not see. It is hardly necessary for me again most emphatically to confirm those authors' statements, and to deny the truth of Dr. Williams's allegations.

The Oviducts.—These were discovered by Dr. Hering, and form a most valuable addition to our knowledge of the anatomy of the earthworm, inasmuch as they throw great

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light on the homologies of its reproductive organs. They are attached, one on either side of the nervous chord, to the walls of the body, in the fourteenth segment, having each an orifice, in close proximity to the pores of the setæ of the inner series. At their insertion they are fine, delicate tubes, but gradually expand, and terminate in very widely opened ciliated receptacles, attached to the diaphragm-muscle, separating the thirteenth from the fourteenth segment, in which there is an orifice on either side formed by these ducts (fig. 1, Pl. I, fig. 2, Pl. II). They frequently contain ova in an advancing state of development. In the structure of these smaller ducts, about $\frac{1}{8}$th of an inch in length, we are again reminded of the ciliated segment organs, a pair of which, however, with all their normal attributes, exist in the 13th and 14th rings of the body, as in all others. The ova from the ovary drop into the oviduct without any direct communication between the two, the ciliary movements being sufficient to impel the ova, as also the ciliary movements of the ciliated inductors of the spermatic ducts are sufficient to urge the spermatozoa from the sac formed by the extension of the fibrous sheath of the testicle.

Spermatic Reservoirs or Spermathecæ.—Situated on either side in the line of the exterior setigerous glands, in the 10th and also the 11th ring, is a pair of small globular sacs, having a somewhat dense though very vascular wall, and a pedunculated base, the peduncle being a hollow canal communicating with the exterior by very obvious apertures, between the 9th and 10th, and 10th and 11th rings. The contents of the sacs are fully developed spermatozoa, and their function is to retain the seminal fluid received in copulation, and to emit it again, upon the ova when those bodies are deposited in the egg-capsule (Pl. I, fig. 10, Pl. II, fig. 1). In colour they are much brighter and whiter than the testes, which are discoloured by the numerous impurities they contain. Dr. Williams ignores also the existence of these organs, which have been known for many years, and were fully described by both D'Udekem and Hering.*

External Organs.—Having thus reviewed the essential organs of reproduction, the ovary and testis, and their ducts,

* The accuracy of D'Udekem's and Hering's observations is confirmed by Mr. Busk, who, M. Claparède states, informed him, as he also has told me, that he had independently ascertained the same facts as they had. A very interesting and valuable criticism of the papers of MM. D'Udekem, Hering, Carter, and Williams, is to be found in one of the chapters of M. Claparède's 'Recherches sur les Annelides, Turbellaries, &c.' Geneva, 1861.

and the spermatic reservoirs, the apertures of the ducts may be described. An excellent drawing of these is given by Hering, from a specimen of the epidermis of the worm, which he obtained by maceration (Pl. II, fig. 6). The observations may readily be repeated, if spirit be used first to harden the cuticle. Two series of double apertures are then seen on either of the median line belonging to the setæ. Between the 9th and 10th ring, and 10th and 11th, the apertures of the spermatic reservoirs are observed. In the 14th segment between the two series, on either side, is the aperture of the oviduct, and in the fifteenth segment, in connection with a large, well-marked development of the integument on either side, is the aperture of the vas deferens. No apertures to the ciliated canals can be detected, which, however, exist nearer the median line than any of the pores drawn. It will be observed with regard to the apertures of the seminal reservoirs, vasa deferentia, and oviducts, that they all exist in a line between the exterior and interior, or lateral and ventral series of setæ, whilst, as before stated, the apertures of the ciliated canals are between the two ventral series of setæ.

In addition to the pores just mentioned, an exterior organ of generation is found in the cingulum, a glandular mass surrounding the segments from the 29th to the 36th inclusive. Its structure has been before alluded to in connection with the tegumentary system; a portion is figured, highly magnified (Pl. II, fig. 4), showing the papillæ; and the whole organ is shown in Pl. II, fig. 7.

Capsulo-genous Glands.—Besides the regular glands developed on the parietes of the body, the earthworm exhibits numerous glands, destined in all probability to form the egg-capsule, in which both zoosperms from the spermatic reservoirs and ova are deposited. These glands were first detected by M. D'Udekem, who figures them in his beautiful and elaborate paper. They are merely an excessive development of the setigerous glands of the ventral or inner series, occurring in the 9th, 10th, 11th, 12th, and 13th rings of the body. The white colour and thick fleshy look which is sometimes observed about the exterior of these segments is due to the development of the capsulo-genous glands. Whether the capsulo-genous glands have everything or anything to do with the formation of the egg-capsule is very difficult to determine; but the supposition of M. D'Udekem is so plausible, and comes from so good an authority, that it cannot but be received until absolutely disproved. The secretion of the capsulo-genous glands is a thick glairy liquid, containing minute granules. It has been suggested that the crystalline body contained in the anterior œsophageal pouch, described in the last number of this Journal, supplies a certain amount of lime to assist in the formation of the egg-capsule; but this view has not the least foundation in facts—as there does not appear to be any communication between the œsophageal pouches and the exterior, excepting possibly through the intestinal canal. The capsuli-genous glands (*e*), the ciliated tubes (*a*), the efferent male ducts (*c*), the oviduct (*d*), and the spermatic reservoirs (*b*), are seen in Pl. II, fig. 1.

Coition and Parturition.—Almost as little is known, as far as regards the earthworm, of the former of these processes as of the latter. An exchange of zoosperms is effected by the mutual juxtaposition of the pores of the spermatic reservoirs and those of the efferent ducts. How the passage of the seminal fluid takes place is not exactly understood. Portions of the cuticle everted in the form of a temporary copulatory organ have been found attached to the apertures of the vasa deferentia in large worms; but these are by no means persistent. Again, with regard to the manner of the formation of the egg-capsule, we are in total ignorance, though, judging from analogy, we may conceive it to be formed on the exterior surface of the worm, its body serving as a mould. Whilst gradually drawing itself through the so-formed sac, ova and zoosperms are deposited, and the capsule is in some way closed. The subject, however, is one which requires much investigation, attended as it is with so many and almost insurmountable difficulties.

Homologies of the Reproductive Organs.—I wish now briefly to consider the homological relations of the earthworm, representing the *Oligochæta Terricola*, and the *Oligochæta Limicola*, whose structure and anatomy have been so ably and charmingly investigated by Claparéde,* and D'Udekem. In the genera *Tubifex, Euaxes, Stylodrilus, Pachydrilus*, &c., these authors have found that the ciliated canals, of which (as in the earthworm) a pair exists in each segment, are deficient in certain rings of the body apparently, and these segments are those which contain the spermatic reservoirs, the vasa deferentia, and the oviducts, and generally the first five or six anterior segments. The following table, taken from M. Claparéde's 'Récherches Anatomiques sur les Oligochêtes,' p. 62, illustrates this: *s* means ordinary segment organ, *r* sperm reservoirs, *o* oviducts, and *c* efferent canals.

* 'Récherches sur les Oligochetes,' 1862. Geneva.
' " " Annelides, &c.,' 1861. Geneva.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	
Tubifex Bonneti, *Clap.*	...	...	...	...	...	...	S	S	...	R	C	...	S	&c.
Limnodrilus Udekemianus, *Clap.*	...	...	...	...	..	...	S	S	...	R	C	...	S	&c.
„ Hoffmeisteri, *Clap.*	...	...	...	...	...	...	S	S	...	R	C	...	S	&c.
Lumbriculus variegatus, *Grube*...	...	...	...	...	...	...	S	...	R	C	C	O	S	&c.
Stylodrilus Heringianus, *Clap.* ...	...	...	...	...	...	...	S	...	R	C	C	O	S	&c.
Trichodrilus Allobrogum, *Clap*...	...	...	...	...	...	...	S	S	(O?)	C	cR	R	S	
Enchytraus vermiculus, *Hoffm.*	...	...	...	...	R	...	S	S	S	S	S	C(o)	S	&c.

Gegenbaur, describing the ciliated canals of Lumbricus and Sœnuris, stated that M. D'Udekem, in considering that the segment organs were wanting in the generative segments of Tubifex, was wrong, and that the efferent canals which he described were only enlarged segment organs. Dr. Williams, of Swansea, soon after this, made known his views, which are embodied in a paper in the 'Philosophical Transactions' for 1858. He certainly has the credit of having appreciated the fact *that the segment organs in the Limicolæ are in certain segments developed into efferent canals of the reproductive system;* but in attempting to go beyond this that author has been led into many errors and inaccuracies, and his paper has been well-styled by Claparéde "un échafaudage audacieux et peu solid." He attempted to show that not only were the efferent canals modifications of the segment organs, but that the essential glands, the ovary and testis, were developed from them—a proposition which jars against all homologies of the reproductive organs, from the protozoa upwards. To further his view, Dr. Williams published a most remarkable account of the genitalia of the earthworm, and depreciated the accurate observations of Hering and D'Udekem; alternating testes and ovaries of large size were discovered with conspicuous apertures externally, whilst the real ovaries, the oviducts, spermatic reservoirs, and efferent canals, were *entirely* ignored, and their existence denied. I should not have thus emphatically exposed Dr. Williams's inaccuracies had not his statements and views been largely quoted and approved in a book of extensive circulation, viz., 'Rymer Jones' Animal Kingdom,' a work which is much read and consulted by students of comparative anatomy.

Seeing, then, that the segment organs are deficient in the segments containing the oviduct, sperm reservoirs, and efferent canals, amongst the Limicolæ, and considering that in structure they are all very similar in this group, it is concluded that the oviducts, sperm-reservoirs, and efferent canals, are the modifications of the segment organs; the essential organs, of course, having nothing to do with the modification. This is the view advanced by M. Claparède, and universally received, with regard to the *Limiculous oligochetes.* What may be the relations between the segment organs of the Terricolæ and their efferent ducts, is the question which now occurs. M. Claparède, at the conclusion of his 'Recherches,' briefly refers to this question, merely to mention its difficulty, and to promise a future attempt to answer it.

In every segment of the earthworm but the first we have a normal segment organ opening near the median ventral line, and in the 10th, 11th, 14th, and 15th rings we have the apertures placed more laterally (always beyond the first series of setæ) of the sperm reservoirs, the efferent canals, and the oviducts,—organs presenting marked and decisive points of similarity in structure to the normal segment organs, and also to the corresponding modified segment organs in the Limicolæ. Are not, then, the efferent ducts and sperm reservoirs of the earthworm modified segment organs? It is hardly possible to deny the probability of this, in the face of the similarities of structure and general homologies existing between the Limicolæ and Terricolæ, which would be totally upset were we to conceive that the reproductive ducts of each are constructed upon entirely different plans. Assuming, then, that the efferent ducts of Lumbricus and its spermatic reservoirs are modified segment organs, and the actual homologues of the segment organs are ducts of the Limicolæ, we can only account for the presence of two segment organs in a single segment—a normal and a modified one—by conceiving the typical number of segment organs in the oligochetæ generally to be four in each segment, a pair on either side, one or both of which may be suppressed or modified (see Pl. II, fig. 5); as also we have four setigerous glands, of which one pair may be suppressed. In the Limicolæ *both* pairs of segment organs are suppressed in the first six segments, and a *single* pair throughout the rest of the body. In the Terricolæ, on the contrary, *both* pairs are absent *only* in the first anterior segment, whilst *one* pair is suppressed throughout all the other segments excepting those very vascular and well-nourished segments containing the "genitalia," with which the second pair of segment organs here unsuppressed, is connected. This view of the case is further borne out by the presence of a double pair of what may be considered as modified segment organs, in each segment of the leech and perhaps some other Annelids. Seeing that the ovary or the testis, from the protozoon, with its nucleus and nucleolus, up to man himself, are homologous structures in each group o the animal kingdom, being specialised developments, and not modifications of existing structures, the homologies of the reproductive organs of the earthworm may be considered as satisfactorily ascertained, the testes and ovaries being the homologues of testis and ovary in all other animals, and the efferent canals and sperm reservoirs the homologues of the system of ciliated canals or segment organs common to most Annelida, and remarkable in the group of oligochetes as being developed into auxiliary organs of reproduction.*

In Pl. II, fig. 3, an ideal typical segment of an oligochæte is drawn. Suppress the pair of canals attached nearest the ventral surface, and the type of the Limicolous group is obtained. Conceive the exterior pair converted each into a blind sac, and the type of the segment containing the sperm reservoirs in Lumbricus is seen. Imagine three such tubes as the exterior, blended; and the bifurcated ciliated vas deferens of Lumbricus results, whilst both are suppressed altogether, to form the anterior segments of the Limicolæ, or left almost without modification to form the fourteenth segment of the earthworm, with its oviducts and segment organs.

Recapitulation.—The generative organs of the earthworm consist of two pairs of testes, situated in the eleventh and twelfth segments, connected with two seminal vesicles; a pair of bifurcated ciliated vasa deferentia, connected with each testis by means of a ciliated receptacle enveloped in the fibrous sheath of the testis, and opening in the fifteenth segment; a pair of minute transparent ovaries situated in the thirteenth segment, opposite the orifices of two oviducts placed in the fourteenth; a pair of spermatic reservoirs in the tenth and eleventh segments: five pairs of capsulo-genous glands, and the cingulum. The sperm reservoirs, the oviducts, and vasa deferentia, are homologous with the same organs of the Limicolæ (Naiidæ), and are the modifications of a series of segment organs suppressed in other annuli. The normal segment organs exist in all segments but the first two, and form an inner series which is suppressed in the Limicolæ, whose segment organs are the representatives of the exterior series suppressed in all but six segments of the Terricolæ. All the segment organs, however, should be considered as homologous.

(To be continued.)

* In the Limicolæ it appears to be the interior series of segment organs, or those which form the normal ciliated tubes in the Terricolæ, which are suppressed.

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played. By adopting the plan just described all this annoyance and uncertainty will be obviated. If an object happens to be in an awkward or unfavorable position the cover can be raised, and all set right with the greatest ease. Being clean, simple, and easy, this method offers every encouragement to students to mount their own preparations. Nothing so much deters from mounting microscopic preparations as the idea that so much trouble will be incurred in getting all ready before anything can be done. I must not omit to mention that, with proper care, there need be no cleaning off of surplus balsam, for it is so easy to calculate the exact quantity required for a given object, and this can be regulated with such nicety that only as much need be dropped on the preparation as will be just sufficient for the purpose.

A few REMARKS *on the following* EXTRACTS *from* PAPERS *by* CHARLES BROOKE, Esq., *President of the Microscopical Society of London, and by the* EDITOR *of the 'Intellectual Observer.' Also on a* PAPER *by* J. J. PLUMER, Esq., *entitled "A few Words on the Choice of a Microscope," to be found at page* 153 *of the 'Quarterly Journal of Microscopical Science' for July,* 1864. By E. G. LOBB.

EXTRACT I.

From the 'Jurors' Report of the International Exhibition' for 1862. Class 13, page 21.

"No objective yet manufactured for sale at all rivals in its power of development the $\frac{1}{25}$th of Messrs. Powell and Lealand. These able artists have likewise been very successful in the construction of the deepest previously acknowledged powers, namely, those of $\frac{1}{12}$th and $\frac{1}{16}$th inch focus; in these objectives excessive angular aperture has been judiciously sacrificed to more comprehensive and practical utility."

EXTRACT II.

From the President's Address, page 74 of the 'Quarterly Journal of Microscopical Science,' April, 1864.

"I must in conclusion remark, that I have not hitherto succeeded in developing any point of organic structure with

Powell's $\frac{1}{25}$th that is not equally visible with a $\frac{1}{12}$th by Ross; further observation may, however, serve to elucidate points of evident advantage in the deeper power. It must be observed that the $\frac{1}{25}$th does not work well with thicker covering glass than ·0035, and in order to allow for some little distance of the object below the covering glass it is better to use ·003. The $\frac{1}{12}$th employed was originally corrected for covering glass of ordinary thickness, say ·006 to ·007, and could not be adequately corrected by separation of the anterior combination for glass only ·003 inch thick. In order to compare the objective on the same object, it therefore became necessary to construct a new anterior combination for the $\frac{1}{12}$th, specially adapted to very thin covering glasses; and it now works as correctly with these as it does with the original combination, under the conditions which that was designed to fulfil."

Extract III.

From the 'Intellectual Observer,' page 51, *August*, 1864.

"My attention has recently been directed to some remarks contained in page 329 of your June number, alleging a discrepancy between a statement of mine, contained in my 'Report on the Microscopes in the late International Exhibition,' that no objective yet manufactured for sale at all rivals in its power of development the $\frac{1}{25}$th of Messrs. Powell and Lealand; and another statement, contained in my 'Presidential Address,' delivered at the last annual meeting, that I have not hitherto succeeded in developing any point of organic structure with Powell's $\frac{1}{25}$th that is not equally visible with a $\frac{1}{12}$th by Ross. This apparent contradiction has no real existence, inasmuch as the $\frac{1}{12}$th by Ross, to which I alluded (a great improvement on any previously made by him), was not in existence at the time to which the former observation refers; and in corroboration of my own opinion I may further state that, after having successively examined, together with Dr. Beale, with this $\frac{1}{12}$th and with his own $\frac{1}{25}$th (or $\frac{1}{26}$th), several difficult preparations of tissue with which he was well acquainted, he remarked that he did not think he had ever seen some points of structure better shown than they were by my $\frac{1}{12}$th.

"In the following page, 330, the writer asks, 'When an object (other than diatom lines) has been seen with a $\frac{1}{8}$th or $\frac{1}{12}$th, can it not nearly always be shown by the $\frac{1}{4}$th?' To

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this I emphatically answer 'No,' in regard, for example, to the minute structure of nerve-tissue; and in this opinion I am fully borne out by the observations of Dr. Lionel Beale, who has probably done more good work with his $\frac{1}{25}$th than any other observer.

EXTRACT IV.

From the 'Intellectual Observer,' page 129, *September*, 1864.

"Mr. Thomas Ross can desire no higher testimony to his skill than the fact that both Mr. Brooke and Mr. Lionel Beale have seen extremely minute and very delicate objects with the new $\frac{1}{12}$th, in a manner that has not been surpassed by the performance of any other glass. Messrs. Powell and Lealand's $\frac{1}{25}$th is so beautifully corrected as to leave very little possibility for improvement in this respect; but Mr. Ross may still be right in the opinion that minute glasses in the front of any combination tend to introduce certain errors of diffraction, and that, in stopping at his $\frac{1}{12}$th, he is able to keep these errors down. When two great artists such as Ross and Powell both do their best, we cannot expect the balance of merit will be easy to discern; and it would require a prolonged and very elaborate series of experiments to determine whether anything that can be shown with the $\frac{1}{25}$th can also be shown with the $\frac{1}{12}$th, when raised to the same power. It is, however, certain, that if there be cases in which the $\frac{1}{25}$th would surpass its rival, they must be very few. The foremost obstacle to the use of the $\frac{1}{25}$th, and which does not affect the $\frac{1}{12}$th, is the closeness of its approximation to the object; it cannot be worked through glass that will bear handling, and consequently it is better adapted for the display of a carefully prepared object than for research under the usual difficulties which the examination of tissues, &c., entails."

The first extract from the 'Jurors' Report' undoubtedly leads every microscopist to believe that the objectives of Messrs. Powell and Lealand, from the $\frac{1}{16}$th to the $\frac{1}{25}$th, were the best in the Exhibition, more especially the $\frac{1}{25}$th. Nor were the jurors alone in this opinion; many coincided with them, and thought it well earned and well deserved.

The second extract, from the President's Address at the last annual meeting, is rather startling after such a report, and, no doubt, several will disagree with it. Having for a considerable time worked with object-glasses of $\frac{1}{12}$th and of $\frac{1}{16}$th power, and latterly with a $\frac{1}{25}$th (all most excellent objectives, as many can testify), I venture to give my opinion on the point in question; still, differing from so eminent an authority as that of Mr. Brooke may be thought presumption on my part; and I cannot but think, knowing so well the accuracy of Mr. Brooke's observations, that his $\frac{1}{25}$th must have received some injury for a $\frac{1}{12}$th, however good, to resolve difficult points of structure equally well with it. My object-glass of $\frac{1}{25}$th power works through thicker glass covering than my $\frac{1}{16}$th does; the correction for glass ·003 thick is only 8 to 10, it corrects to 36; up to 20 correction, the defining power is perfect; higher correction, that is, from 20 to 36, takes away from the definition, still the objective will focus for covering glass almost as thick as the $\frac{1}{12}$th will focus for.

It resolves *Pleurosigma angulatum* into spherical elevations, as likewise *Navicula rhomboides*; it clearly shows that the wedge-shape markings on the Podura scale are not so many separate wedges, but a continued corrugated structure, giving strength to the extremely delicate scale; also the membranous tissue of the mouse-hair (if it may be so termed) is far more evidently seen with the $\frac{1}{25}$th than with any other power. My $\frac{1}{12}$th of 150-aperture is a most excellent glass, well known to many members of the Microscopical Society, but it certainly does not define so clearly, nor elucidate so plainly, as the $\frac{1}{25}$th; the difference is marked. The $\frac{1}{12}$th in question, of Mr. Thomas Ross, I have certainly not seen through, but a friend of mine, who witnessed its performance on two occasions, told me that, although it was a most excellent glass, he did not consider it better than my $\frac{1}{12}$th, and certainly not to be compared with the $\frac{1}{25}$th.

In Extract III it is stated that the $\frac{1}{12}$th of Mr. Ross was an entire new construction; but in Extract II we are led to suppose that it was an old glass with one of the combinations new, admitting of a different correction; with the $\frac{1}{12}$th as altered Mr. Brooke and Dr. Beale worked; it does not, however, appear that Dr. Beale coincided with Mr. Brooke, he only says that he had never seen *some* points of structure better with his $\frac{1}{25}$th; this is a clear admission that he had seen with the $\frac{1}{25}$th points of structure not to be seen with the $\frac{1}{12}$th; and at the last meeting of our Society, in answer

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to a question that I put to the doctor, he told me that he had traced points of structure in tissues with the $\frac{1}{25}$th that he could not trace with the $\frac{1}{12}$th. Mr. Brooke says emphatically that a $\frac{1}{5}$th will not show what can be elucidated by a $\frac{1}{8}$th or $\frac{1}{12}$th, and I think it may be said also, with equal truth, that a $\frac{1}{12}$th will not show what can be elucidated with a $\frac{1}{25}$th. Mr. Brooke concludes this extract with a remark well deserved by Dr. Beale, for certainly no one has worked at all equal to him with a $\frac{1}{25}$th.

Extract IV is evidently from the pen of Mr. Slack, Editor of the 'Intellectual Observer,' a deservedly popular periodical, having a large circulation. With respect to the impossibility of keeping down errors in object-glasses of deeper power than $\frac{1}{12}$th I can with confidence affirm, that whatever errors can be kept down in a $\frac{1}{12}$th are equally kept down in a $\frac{1}{25}$th; in fact, I have never seen errors so beautifully corrected as they are in this unique objective; certainly, in working with it, care is required, but when accustomed to use it the difficulty soon ceases, and you can almost focus for your object with the rack and pinion motion. As to not focussing through glass but such as will not bear handling, all who have seen the circulation in the Valisneria under it must know that this is not true, as the glass covering has continually to be taken off and wiped; and I should think Dr. Beale could not have worked so constantly and so ably with his $\frac{1}{25}$th if he had not been able to use covering glass that would bear handling. As regards my own $\frac{1}{25}$th, I have no object-glass in which the corrections are so exact as in it; the flatness of the field, the sharpness of definition, the depth of penetration, and its power of working through moderately thick covering glass without injury to its resolving power, all prove the objective to be first-rate, and I feel confident no $\frac{1}{12}$th can equal it. In the paper from which Extract IV is taken there is an allusion to Smith and Beck's $\frac{1}{20}$th. I have seen the performance of this objective, and it certainly would not work through covering glass that my $\frac{1}{12}$th worked through; and I have stated that the $\frac{1}{25}$th works through covering-glass almost as thick as the $\frac{1}{12}$th will work through, and certainly through thicker covering than the $\frac{1}{16}$th will work through, and the sharpness of definition between the $\frac{1}{20}$th and the $\frac{1}{25}$th is most marked. Every one unprejudiced must give the preference to the $\frac{1}{25}$th.

A few words on the paper of J. J. Plumer, Esq., "On the Choice of a Microscope." It evidently supposes that the best instrument can only be obtained of one optician. In answer to this let me observe that my instrument, made by Messrs. Powell and Lealand, in 1860, has been in constant use ever since, few instruments more so; it remains steady at any obliquity *without* a clamping screw, and it bears well the following test:—With a $\frac{1}{25}$th objective and an eye-piece magnifying together 9000 linear, it remains perfectly steady, enabling you to focus almost exactly with the coarse adjustment; in using the fine adjustment there is no tremor, nor is there in using the transverse motions of the stage, or the circular motion of the stage; the object remains steady even with this severe trial. When so much is said in this paper in favour of a certain instrument, I do think it is but fair to set forth a fact like the above.

Since writing the above, Messrs. Powell and Lealand have completed an object-glass of $\frac{1}{50}$th of an inch focus. They exhibited it on the evening of the October meeting of the London Microscopical Society, at King's College. The object shown was a Podura scale, power 4000 linear, perfectly free from chromatic and spherical aberration, the definition and penetration excellent. The glass was made for Dr. Beale, who, no doubt, will make still further discoveries with so excellent an objective. It was thought a wonder when our friends produced a $\frac{1}{16}$th, still greater when their $\frac{1}{25}$th made its appearance; but now they have reached a $\frac{1}{50}$th, the greatest wonder of all. Will not microscopists encourage a firm so untiring in their endeavours to improve the microscope, the object-glasses, and all apparatus that may in any way assist in developing structure?

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TRANSLATIONS.

Die Spermatozoiden *in* Pflanzenreich. (*On the* Spermatozoids *in the* Vegetable Kingdom.) By Dr. H. Schacht. Brunswick, 1864.

The subject of spermatozoids in plants is one of considerable importance and great interest in many points of view, and it has been taken up and considered by Dr. Schacht very fully and ably in this short work.

The plants in which his researches were chiefly carried on were: a species of *Equisetum* (*E. telmateja*), which is common in the neighbourhood of Bonn; various species of ferns (*Gymnogramma, Doodia, Pteris*); *Nitella syncarpa*; Mosses, as *Polytrichum, Haplomitrium, Pellia, Fegatella*; several *Lycopodiaceæ* and *Rhizocarpeæ*; *Algæ*; and Fungi (*Peronospora Alsinæ*.

The general results at which he has arrived are:

1. That the spermatozoids of Cryptogams arise from the solid and liquid contents of their mother-cell in the interior of the antheridium, accompanied with a peculiar division of the nucleus, which in most cases disappears during the process.

2. They consist of a soft and extensible body supporting two or more cilia, and which corresponds with a cell, except that it has no cell-membrane, instead of which it is surrounded with a layer of protoplasm, which encloses the fluid contents intermixed with granules. No nucleus is discernible in the spermatozoid body, except (according to Pringsheim) in certain algæ. The spermatozoid is capable of moving about in the water.

3. The spermatozoid of the mature antheridia becomes free either by the dissolution of the hydrocarbonaceous wall of the parent-cell, or escapes through a rupture of it. Both modes of liberation occasionally occur at the same time.

4. In the algæ the spermatozoid presents the form of

minute, elongated, rounded or pointed cell, which, at a definite spot, supports one, two, or more cilia, often of unequal length. Its movement consists in a rotation on its axis with the cilia in front; and in some species it presents a cell-nucleus.

5. In the Equisetaceæ and Ferns the body of the spermatozoid has the form of a sausage-shaped or half-flat band, which gradually widens from before backwards, and lies rolled up like a watch-spring in the interior of the parent-cell; but when liberated it assumes a closely twisted spiral form. In the Equisetaceæ the body of the spermatozoid is thicker and shorter than in the Ferns. The spermatozoid of Isoetes appears to belong to the same type, and probably that of the Rhizocarpeæ.

6. In the Characeæ, Musci, and Lichens, the spermatozoid has a sausage-shaped very slender body, which, like that of the Equisetaceæ, &c., is rolled up like a watch-spring within the parent-cell, but on its liberation assumes more of a corkscrew figure. The length of the spermatozoid body, and, correspondingly, the number of its spiral turns, varies in different species or genera. In the Characeæ the parent-cells of the spermatozoids are united into long confervoid filaments in the interior of the antheridium; in the mosses and lichens, however, the parent-cells constitute at first a dense tissue in the interior of the antheridium, but afterwards appear as free cells, whose membrane is either ruptured by the spermatozoid, or undergoes solution in the water.

7. Consequently we may distinguish THREE typical forms of spermatozoids, viz :—1, that of the Algæ; 2, that of the Equisetaceæ; and 3, that of the Characeæ. And, moreover, as regards germination and the mode of development of the reproductive organs, an intimate relationship may be observed in the families belonging to each of these types. Thus, in the Algæ we find the *simplest* reproductive organs, and a direct germination; in the Equisetacean type, under which are included the Ferns, on the other hand, we observe the existence of the complex reproductive organs on a prothallium; or, if the Lycopodiaceæ and Rhizocarpeæ are conjoined with these families, we also witness the *appearance of the female organ on the same prothallium.* Lastly, in the Characean type, although similarly constructed, reproductive organs make their appearance on the fully developed plant; no direct germination ensues, but rather the production of a prothallium, from a budding out of which arises the young plant. This type stands midway between those of the Algæ and of the Equisetaceæ.

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8. The cilia of the spermatozoids are delicate elongations or processes of the protoplasmic layer, although of firmer consistence than it. They move only during the life of the spermatozoid body, and are not retracted after death, appearing then more like rigid filaments. They may be best seen in the dried spermatozoid.

9. The thickened part of the spermatozoid body and its cilia behave towards chemical reagents in the same manner as protoplasm.

10. The granules in the body of the cell-juice of the spermatozoid consist of various substances; some are coloured yellow by iodine; others are indubitable starch-grains, and in some Algæ chlorophyll-granules may be observed.

11. The form of the filament within the limits of the same type may vary to a certain extent, according to the genus and species; and this is true especially with respect to the length of the body and the number of its spiral turns; and, lastly, as regards the thickness, rounding or flattening of the filament, and the number and length of the cilia.

12. The motion of the spermatozoid proceeds from the body itself; it must be regarded as a vital phenomenon of the cell, whose protoplasmic contents are very abundant, and surrounded also with an extensible and mutable condensed wall of protoplasm. The rotation round [its own axis is the principal movement, by means of which the spermatozoid screws its way as it were through the water, invariably with the narrowest spire, which is furnished with cilia in front. A retrograde movement is rarely observed, and it is only momentary when the spermatozoid comes in contact with some solid body.

13. The duration of the motion in water varies according to the species and also according to circumstances; it may be witnessed either for a very short time or for many hours. In general the water appears to exert some action on the spermatic filaments. The body becomes enlarged, softens, and dissolves.

14. All chemical reagents which act upon albuminous compounds are injurious, and even at once destructive to the spermatozoids. Amongst the chief of these reagents may be enumerated ammonia, nitric acid, iodine, corrosive sublimate, alcohol, caustic potass, metallic salts, and tannin. They are also killed by a temperature of 50° Reaumur. Prussic acid and strychnine are less injurious. Very dilute saline solutions produce little effect.

15. The presence of sugar and other soluble hydr

carbons, as well as of fatty matter, cannot be directly proved, although they probably exist.

16. The best preservative media for the spermatozoids of the Equisetaceæ and Ferns are a solution of tannin (10 grains to the ounce), and one of corrosive sublimate (1 grain to the ounce). But for those of the Characeæ, the best medium is diluted glycerine. The cilia are best seen in spermatozoids which have been slowly dried on the object-glass; but, in this case, the body changes its form more or less, or it may be partially or entirely dissolved.

17. As being plant-cells without any cellulose coat, and containing a cell-juice with a granular matter dispersed in it, the spermatozoids correspond with the zoospores of the Algæ and of certain Fungi, from which they differ, however, very essentially in the nature of their function, and their incapability of undergoing any development into a new individual.

18. In their cellular nature and their chemical composition, their richness in albuminous compounds, starch, and other elements, which are also met with, particularly in the pollen-tube, they approach very nearly to the latter or to the pollen-grain, from which it is emitted, and whose cellulose membrane, whose presence, however, is an essential distinction between pollen-tube and spermatozoid, is not directly concerned in the act of impregnation. The same materials of which the contents of the pollen-tube consist appear very manifestly to exist also in the spermatozoid. The potential correspondence between the spermatozoid and the contents of the pollen-tube, lastly, is confirmed by the process of impregnation in *Peronospora Alsinæ*, which takes place without the aid of any spermatic filaments, by the commingling of the contents of the antheridium with those of the female cell, which have become agglomerated into a naked globular mass (Befruchtungskugel.)

19. But if the spermatozoids of the vegetable kingdom are *cells* of a peculiar kind, those of animals, when sufficiently examined with good microscopes, must turn out to be so likewise; because it seems necessary to assume a general correspondence between the two kingdoms in such an important particular.

20. Lastly, the fact of the spermatozoids being of the nature of cells, adds an additional example to the number of cells having *no cellulose coat*, as the motile spores in the Algæ and Fungi, the fertilisable globules in the Crypotogaima and Phænerogamia, &c.; but, like the foregoing membraneless

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cells just mentioned, these are not permanent structures. They enjoy only a very short life. But the swarm-spores and the reproductive globules (Befruchtungskuglen), as soon as they have acquired a cellulose coat, become permanent cells (Daurezellen), from which a new individual is formed. The protoplasmic coat of the cells in question, assumes various degrees of thickness and density.

On the Auditory Organ *in the* Decapod Crustaceans. By Dr. V. Hensen.

*(Abstract.)**

The auditory organ of the Decapod Crustaceans is usually situated in the basal portion of the inner antenna, for it has been satisfactorily shown that the organ at one time termed an "auditory cylinder," and enclosed in the basal joint of the outer antenna, has nothing to do with the function of audition. The true auditory organ was discovered by Rosenthal, in 1811, and in 1843 it formed the subject of careful studies by M. Favre. It has since been studied by several observers, and in particular by M. Kröyer;† but the details of its structure have nevertheless, in great part, remained a subject of dispute. The excellent researches of M. Hensen, which have extended to twenty-eight species of Crustacea, are therefore a welcome contribution on the subject.

The auditory organ of the higher Crustacea is thus constituted:—From the terminal ganglion of a nerve proceeds a delicate nervous filament, which enters a chitinous hair, where it is attached to a part of the wall, presenting a special structure. The connection of this part of the wall with the rest of the chitinous skeleton is such as to allow of vibrations under the influence of sonorous undulations. Besides this, the extremity of the hair often penetrates between the otolites, or even into the interior of one. The different parts of this apparatus must be considered a little more minutely.

To commence with the otolites. MM. Leuckart and Kröyer have very properly described two types of auditory organs in the higher Crustacea, distinguished respectively by the open or closed condition of the orifice of the sac. In the

* 'Zeitsch. f. wissensch. Zool.,' xiii, p. 319. Pl. 19—22.

† 'Mem. de l'Acad. de Copenhague,' 1859, t. iv, p. 287.

former case, which is that of the organ in the crab, lobster, prawns, and shrimps, &c., the otolites are of an irregular form, and resemble grains of sand. Some authors, consequently, have been induced to regard these particles as foreign bodies, whilst others look upon them as integral parts of the animal. M. Hensen has succeeded in settling this question definitely, by examining the Crustaceans in question at the time of moulting. At this period the old otolites are thrown off, together with the chitinous tunic, and replaced by others. Shrimps examined immediately after they have moulted have no otolites, but a few hours afterwards minute, irregular, strongly refractive particles, either siliceous or calcareous, may be observed within the auditory sac. On such an occasion M. Hensen has seen a shrimp scraping the bottom of the glass with its pincers, which it afterwards introduced into the auditory sac, but he was unable to witness the actual introduction of the minute lapilli. In order to remove all doubt about the matter, he placed some shrimps in a vessel containing filtered sea-water, and at the same time covered the bottom with crystals of uric acid. In a short time one of the shrimps moulted, and the auditory sacs of the discarded shell were found to contain the ordinary grains of sand, but no uric acid. Three hours later M. Hensen examined the animal, and found that the sacs contained numerous crystals of uric acid, without a single grain of sand. It is manifest, therefore, that in Crustacea with an *open* auditory sac the otolites are derived from without, as had been previously stated by M. Favre.

In the Crustacea with a closed sac the otolites have no resemblance whatever to grains of sand. They constantly present a peculiar structure, and their surface is never irregular. Nevertheless, even in this case, their duration is only temporary. In fact, the Crustacea in question periodically throw off the auditory sac, together with the otolites, and the whole apparatus is formed anew.

The inorganic constituent of these otolites is a calcareous salt, but it is neither a carbonate, nor a phosphate, nor a silicate, nor a sulphate. Its reactions seem to indicate that it consists of fluoride of calcium.

The cavity of the auditory organ is always lined with a delicate chitinous membrane, which should be regarded as an inversion of the external chitinous coat. This holds good even in the case of the closed sacs, which have no communication whatever with the exterior; and in these it is possible to discern a line or sort of cicatrix, the vestige, as it were, of the point at which the invagination of the sac took place.

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The hairs to which M. Hensen gives the name of "auditory hairs" are of three kinds. 1. Hairs with otolites. 2. Free hairs of the auditory sacs. 3. Auditory hairs of the outer surface of the body.

The hairs belonging to the first class are those which are in contact with the otolites in the auditory sacs. These hairs are generally curved, and their point is inserted between the otolites, as is the case in the crab, lobster, and shrimp, or they may even penetrate into the interior of an otolite, as may be seen in the auditory sacs in the tail of *Mysis*. The otolites are often held in suspension by these hairs. It is impossible, in reading this description, not to recall the setæ described by Max Schultze and Frank-Eilhardt Schultze as existing in the auditory organ of fishes, and which setæ are also said to have their points in contact with the otolites. M. Hensen notices analogous arrangements (vibratilecilia, &c.), which are observed in the auditory sacculi of other animals. He even thinks that he has noticed in some cases (*Pisidium* among the Mollusca, *Cydippe* among the Ciliograda) setæ penetrating into the otolites, as in the Crustacea.

The crabs, and the Brachyura in general, are entirely without otolites; but their auditory sacs are nevertheless furnished with hairs. In *Carcinas mœnas* M. Hensen has counted about 300 hairs immersed in the fluid of the auditory sac. This absence of otolites in the crabs is the less surprising when we find that in the Lobster the auditory sac contains an entire row of hairs, which in their conformation precisely resemble the otolitic hairs, but which never come in contact with those bodies. Some auditory hairs, therefore, may be thrown into vibration without the mediation of otolites. These hairs sometimes existing in a space which is only partially closed (open auditory sacs), it is rendered probable that they may be equally capable of fulfilling their functions if they were placed on the surface of the body. This consideration has led M. Hensen to regard as acoustic organs, certain hairs on the surface of the Crustacea which present the same structure as the hairs connected with otolites.

These external auditory hairs have been studied by M. Hensen in the Carides. They are especially numerous in those species, or in young individuals (larvæ), which have no internal auditory organs. In the Carides, these hairs are situated on the upper surface of the basal portion of the inner antenna, and on the second joint of the outer pair. They are found also on the tail, a circumstance at which we need not be too much surprised when we remember the caudal ears of the Opossum-shrimp.

The physiological interpretation given by M. Hensen of these hairs on the external surface is calculated, at first sight, to excite some mistrust. It should be stated, therefore, that these organs present certain peculiarities of structure which distinguish them from the other hairs of the surface, and cause them to resemble the hairs in the acoustic sacs. The characters common to all the auditory hairs of M. Hensen may be thus summed up:—1. They are always implanted over a hole in the chitinous membrane. 2. The border of this hole is elevated on one side into a sort of tooth. 3. The stem of the hair does not rest directly upon the hole, but is supported by a very delicate membrane, which is often dilated so as to form a sort of *ampulla* at the base of the hair. This arrangement is calculated to isolate the hair from any agitation proceeding from the interior of the body, and, at the same time, perhaps to facilitate its vibrations. 4. Lastly, the stem of each auditory hair presents a sort of appendage (the *languette*), to which the nerve of the hair is attached. Properly speaking, the nerve terminates in a ganglion-cell before it reaches the hair; but from this cell arises a minute and slender nerve-cord (*Chorda*, Hens.), which enters the canal of the hair, and is attached to the "languette." The other hairs of the surface do not exhibit the same complex structure, and, in particular, are wholly devoid of any nervous cord.

The auditory hairs are of course, renewed at each moult. The new hairs, however, are not contained within the old ones, as is commonly said, but are formed beneath the chitinous skeleton. In comparing the new integument of the animal to a glove, the hairs would be placed like the fingers of the glove, if we were to suppose them withdrawn into the inside of the glove in such a way that merely their points were visible at the surface. This observation, however, has not escaped the notice of Mr. Spence Bate and of Leydig. At the moment of throwing off the old shell the cast-off shell drags with it the extremities of the new hairs, and draws out the invaginated portion. The point up to which the extremity of the new hair penetrates into the old hair coincides with the point of attachment of the nervous cord, that is to say, with the border of the languette. It should be stated, also, that shortly before the ecdysis a second nervous cord appears alongside the former one, and that the latter is thrown off at the moment of ecdysis. Moreover, it appears to change its nature, for it becomes, as it were, chitinized at the instant it is thrown off. These auditory hairs, it may be further observed, are so complex in structure that it would be astonishing to find them formed like the scales on a butterfly's wing by the metamorphosis of a single cell (Semper). In reality, a great many cells concur in their formation.

However careful his anatomical researches, M. Hensen's physiological conclusions drawn from them would appear very hazardous, had he not been successful in adding to their value by delicate experiment. It was first requisite to show that the Crustacea possess a delicate sense of hearing. This point M. Hensen has clearly demonstrated. The most conclusive experiment consists in the placing of the prawns or opossum-shrimps in a vessel of sea-water containing some strychnine, an alkaloid which possesses the property of augmenting the reflex power of the nervous centres. Under the influence of this agent, the Crustacean responds, by the most vigorous leaps, to the slightest noises which are heard in the house. Even when the creature has almost succumbed to the effect of the poison to such an extent as to allow itself to be drawn about without resistance in the vessel, by the outer antenna, the slightest sound is sufficient to make it tear itself out of the forceps, and to fall to the bottom, a prey to tonic convulsions.

It is evident, therefore, that the Crustacea are sensible to sounds. The second point was to determine whether the perception took place by means of the auditory hairs. Guided by the beautiful researches of Helmholtz on the perception of sounds, M. Hensen supposed that each auditory hair is capable of being thrown into vibration, exclusively of the rest, by a determinate note. Experiment confirmed this hypothesis. If the attention be closely fixed upon the point of attachment of the *chorda* to the languette of a hair whilst the different notes of the gamut are sounded on an instrument, the point will become indistinct, or the entire hair may be thrown into powerful vibrations by certain notes. At the same time the neighbouring hairs generally remain perfectly still, and can only be made to vibrate by other notes. The conditions by which the vibration of a hair is produced by one note rather than by another are doubtless multiple: amongst them may be enumerated the length and thickness either of the hair or of the languette.

The physiological portion of M. Hensen's memoir is of great interest. It shows us not only that the Crustacea can perceive sounds, but also that sounds affect these animals through organs to which he has given the name of auditory hairs, and it is difficult, seeing the force of his demonstrations, not to accept this term.

REVIEWS.

The Metamorphoses of Man and the Lower Animals. By A. de QUATREFAGES, Membre de l'Institut, Professeur au Muséum d'Histoire Naturelle de Paris. Translated by HENRY LAWSON, M.D.

M. de QUATREFAGES stands unquestionably in the first rank of French naturalists. His researches on the embryology of mollusca, on the anatomy of Annelida and numerous other contributions to zoological science have gained for him a wide reputation. In the small octavo volume before us he has under the title of 'the Metamorphoses of Man and the Lower Animals,' grouped together the latest researches and conclusions of comparative anatomists on the various phenomena of reproduction and development; from these he draws his own deductions and generalisations; the whole being treated in a most pleasant and readable style, and in a manner which, considering the abstruse though interesting nature of the facts dealt with, should ensure the popularity of the work among scientific readers.

It is not, however, as a mere compiler that the author comes before us. The first contribution of this distinguished naturalist to science was a paper on the larval forms of *Anodon*, and his subsequent researches on the development of *Hermella* and *Teredo* are well known, as also other essays on subjects connected with the much vexed questions of parthenogenesis and agamic reproduction. The conclusions, therefore, which the author draws at the end of his book are most worthy of the serious consideration of men of science, and they will doubtless carry the weight with them, to which M. de Quatrefages' name entitles any opinion which he may express.

The title of the work is somewhat inappropriate, as it would lead the reader to suppose that a certain amount of space is devoted to the consideration of the growth of man and the modifications of structure attendant on his progress from infancy to puberty. This is not the case; no particular details of the embryology or subsequent development of the human species being entered upon, the scope of the author has been to lay before his readers the life-history of the animal kingdom in general. Most of the chapters here introduced appeared originally as a series of essays in the 'Revue des Deux Mondes.' These articles are here reprinted together with an account of the progress made since their first appearance. "Its origin," says the author, "will explain the character of the book. In the original articles, I avoided being very technical, merely giving accurate views, supported by the most striking illustrations. In the present volume I am forced to preserve this feature, unless I were to produce a completely new work. Such as it is, I trust that this treatise may be accessible to all who are accustomed to serious reading. At the same time, it will present to naturalists, the principal facts with which they are acquainted, arranged in a manner peculiarly my own and with reference to several works scattered here and there. Perhaps in these different aspects it may prove of service. Such at all events is the object with which I published it." We feel persuaded, from a perusal of the work, that the author has fully accomplished that object.

The first chapter of the volume is devoted to an explanation of the necessity for reproduction, of the waste and renewal of matter continually taking place in animals, resulting finally in death. The next chapter comprises the definition of the term metamorphosis. By *transformation*, the author means the series of changes which take place in the ovum, and those which species born in an imperfectly developed state, present in the course of their external life; the term *metamorphosis* is retained for the modifications undergone after exclusion from the egg, and which alter extensively the general form and mode of life of the individual: *geneagenesis* signifies those changes which relate to generations themselves, including therefore the phenomena known as parthenogenesis, metagenesis, &c. Then follows a description of the changes or transformation of the ovum, the process of yelk division, the development of the blastoderm, the germinal area, and the primitive streak. This part of the subject is treated minutely, with many references to important papers which from their scattered nature might otherwise easily escape the English student. The cell-theory of Schwann, which at one time was so ardently supported in Germany is discussed by the author in connection with the development of the egg. Many serious mistakes arising from the study of the higher animals exclusively have been corrected by an investigation of the anatomy of marine invertebrata, and such an investigation is found to be fatal to the cell-theory. Captivating and beautiful as the doctrine was, exceptional cases presented themselves at its outset which have now gradually increased and assumed proportions, which must compel us to reject it. The comparison of the egg to a single cell does not now receive the unanimous support of physiologists, nor can it be allowed that all the corpuscles of the blood are in any way comparable to modified cells. M. de Quatrefages has shown that the most complete lobes of the vitelline structure in Hermella occasionally coalesce, and others have observed the same occurrences, proving that the supposed cell-wall, the vitelline membrane, is sometimes wanting. The non-cellular character of muscular tissue is considered as beyond doubt, but it is the discovery and appreciation of that primitive, contractile, proteinaceous substance, known as sarcode which seems to have dealt the heaviest blow to the cell-theory. The study of the structure and reproduction of many forms of Protozoa, has shown the existence of vitality apart from cellular structure and vast as may be the import and truth contained in Schwann's theory, yet its universality can no longer be admitted. M. de Quatrefages has clearly stated the history of the cell-theory and whilst successfully combating its doctrines, maintains its partial truth and the benefits that Schwann and Schleiden effected through it for science.

Passing over the highly interesting chapters on the metamorphoses of insects, and the no less interesting description of the author's own researches on the larval forms of mollusca we arrive at that portion of the work devoted to the description of the phenomena entitled by him *geneagenesis*. The history of the whole subject and the gradual progress of discovery bearing upon this department of zoological science, up to the present time, are clearly and elegantly narrated by the author, the references to important original works, being not the least valuable part of these chapters. Previous to the year 1759 the idea generally prevailed among naturalists that species could only be reproduced by the contact of two diverse elements, germ and sperm, each seated in a different individual. The exceptional facts observed in the case of man himself and the fables of the ancients prepared our forefathers for the discovery of certain animals in which the sexes were united, and these were at length discovered in the lower classes of animals, the worms and slugs for example.

Adanson's researches at a later period impressed these facts more fully upon the minds of men of science, and gave rise to this problem: "Can any animal be a male and female parent at once, reproducing its species in the normal manner without intercourse with another individual?" No satisfactory answer could be obtained to this query; reason seemed to reply in the affirmative, but all experiment and observation failed to confirm such a conclusion. The researches of Bonnet, the pupil and co-operator of the illustrious Réaumur, brought about a new phase in the history of this subject. It had been suspected already that among the plant lice (Aphides), each individual possessed the two sexual attributes. To ascertain the truth of this suspicion, Bonnet isolated one of these insects almost immediately after birth, and proceeded to watch it most attentively. In eleven days the virgin aphis produced a young one, and in twenty-one days, no less than ninety-five. Moreover, Bonnet found that this power of reproduction, *sine coitu*, resided also in the individuals already obtained, extending in some cases to the tenth generation. He found, however, that in the fall of the year sexual intercourse did occur, and eggs were deposited as in other insects, the irregular cases of virginal reproduction taking place only in summer. It would have been easy to account for the latter phenomena by the theory of androgynism, had it not been accompanied by the normal process and the existence of distinct males and females. Various explanations were hazarded, the most in vogue, and at the same time that which was most accredited until of late years, being that the force of one impregnation by the male extends over several generations and that the ova in the exceptional cases, are hatched within the mother's uterus, as in the ovo-vivipara. Trembley's observations on Hydra followed these, and were the cause of much excitement and speculation in the scientific world. Everywhere the reproduction of lost parts, and the propagation of species by fissuration and gemmation were investigated and established as facts. Finally, three quarters of a century after Trembley's discovery, the true ova of the *compound ascidians* (animals which have been classed with the polyps, and whose powers of gemmation were known), were discovered by Milne-Edwards and Audouin. The ova were found to produce a larva, which eventually settled down and gave rise to a colony. As in the aphides, the ascidian sprung from an egg, was found to give rise, without sexual intercourse, to a number of new beings, and, finally, coming under the ordinary law, deposited true ova. In 1819 Chamisso detected the mode of reproduction of the biphoræ, and coined the expression "alternation of generations." He found that the isolated

Salpæ could only produce chain-salpæ, and only by gemmation, whilst the chain-salpæ produced isolated Salpæ, and only by ova. The discovery of the now well-known life-history of the Medusæ marks the next era. Saars and Siebold showed that the *Medusa aurita* deposits an egg, which, when fructified, gives rise to a polyp, which grows by gemmation, and by fissuration produces from a single individual numerous small Medusæ, who, again, in their turn, produce ova. Other phenomena were soon collated with these, the fissiparous generation of Annelida, and the various processes exhibited by certain Hydrozoa, Infusoria, and Spongidæ. The remarkable larvæ of the Echinodermata, from whose viscera the future perfect being is given off by a process of gemmation, were described by T. Müller in 1845, and the researches of Kuchenmeister and Van Beneden, afterwards illustrated the remarkable migrations and metamorphoses of the Helminthes. A great portion of M. de Quatrefages' volume is devoted to the details of these researches; the history of the gradual establishment of the facts at present known with regard to what he calls geneagenetic phenomena, being ably treated. And now it may be asked, what are our author's general views with regard to these phenomena? After passing in review the various theories brought forward in explanation, from the time of Chamisso, criticising more particularly those of Steenstrup and Owen, he states that the opinions which he himself had formed on this matter, agree almost entirely with the views expressed by our eminent countryman Dr. Carpenter, in the 'Medico-Chirurgical Review,' 1848, views which we believe are held by most of the advanced school of English biologists. Oviparity must not be considered as a process homologous with genuine parity; the one is the result of sexual union, and is of a nature peculiar to itself; the other is simply part of the process of *growth*, comparable only to the growth of a mutilated limb. The gemmation of the Hydra, the medusification of the Strobila, the virginal parturition of the *Aphis*, the segmentation of the *Nais*, the gradual development of the Echinoderm, within its Plutean larva, and, similar instances, are all mere phenomena of *growth*, whilst sexual reproduction is a distinct process, destined only to occur when the former fails. Hence we consider, as do M. de Quatrefages and Dr. Carpenter, that the term *parthenogenesis* is inapplicable to any of the phenomena mentioned, inasmuch as it is likely to mislead, and appears to imply some connection between these phenomena and the female organs of generation.

Moreover, a series of facts have been of late years observed and described, to which the term "parthenogenesis" can really be applied; and hence Owen's discarded term may be turned to good account. In the three penultimate chapters of M. de Quatrefages' work, these facts are collated. In the *Liparis dispar*, in *Psyche*, in the silkworm and other nocturnal Lepidoptera, it was stated, that females which have had no connection with the males can deposit *eggs*, which become developed. These observations were scattered in various works by Bernonilli, Tréviranus, Luckow, Burmeister, and others. In 1845, M. Tiezou, curate of Carlsmark, discovered that the queen bee can deposit ova, which are fertile, without intercourse with the male, the eggs, however, on hatching, producing only males. Siebold took the matter up, and with Leuckart investigated these phenomena. He found by careful experiment and observation, that Tiezou's observations were perfectly correct; and, moreover, that this *true* parthenogenesis took place in the silkworm, and in many other groups of insects, crustacea, and mollusca. His observations have been since confirmed and extended by many naturalists. Messrs. Huxley and Lubbock have lately endeavoured to show that the viviparous individuals of Aphis produce their progeny primarily from a body which is the same in constitution as an ovum; and, if so, we have here an instance of true parthenogenesis; if, on the other hand, as M. de Quatrefages believes, and appears also from his own researches, these reproductive bodies are not comparable to ova, but are, as also the pseudova of the orange kermes described by Lubbock, buds, *gemmæ*, enclosed, it may be, in a shell—then the case belongs to the series of geneagenitic phenomena, and is not parthenogenesis at all. We are inclined to think that this will, after all, turn out to be the true view that should be taken of the matter. There are forms of reproductive bodies intermediate between ova and buds, as shown by Lubbock, 'Phil. Trans.,' 1861; and, although it appears that *true* parthenogenesis does take place in the examples before cited—the queen bee, the silkworm, and perhaps others: it remains for science to determine to which group of phenomena many doubtful cases belong. The author accounts for the phenomena of parthenogenesis which has thus been shown to occur, in the following manner:—The ovum has always a certain power of growth of its own, as he has shown in Hermella and Teredo, but it is usually very limited; the production of buds is also confined to certain groups and classes; so also it is possible, and probable, theoretically and apart from what has been observed, that the power of growth in the ovum should be extended in certain groups and classes; although deficient in others, in the absence of the male element. Neither, however, in budding nor parthenogenesis is this power of growth unlimited; these processes stop after a certain number of generations. Hence the importance of the male sex. The male element regulates and imparts peculiar vitality to the ovum, probably by some chemical action; but how we are ignorant. The prominent distinction between geneagenetic and parthenogenetic phenomena is, that fecundation in the former is at fixed intervals, whilst in the latter its absence is merely fortuitous.

We particularly recommend the latter portion of the volume to the student, as we believe that here, for the first time, the various observations relating to *true* parthenogenesis have been placed in a collected and readable form. The last two chapters of the book are devoted to to general considerations, and a comparison of the geneagenetic phenomena of the animal and vegetable kingdoms. Our space will not permit us to do more than mention these, although we agree entirely with the views expressed, and admire the clear and readable style which the author uses.

The following note, taken from p. 180 of this volume, cannot fail to interest microscopists:—"Notwithstanding the many improvements which the microscope has undergone for the last thirty years, it is still far from supplying the wants of histologists. In order to become accurately acquainted with many details, it would be necessary to have a magnifying power of from ten to twelve hundred diameters, with the same clearness and definition as one of three or four hundred diameters."

Much credit is due to Dr. Lawson for the discretion which he has shown in choosing such a book as this for translation, and also for the manner in which he has executed his task. It is, of course, impossible to render a scientific work from the French with the same grace and charm which characterise the original; but Dr. Lawson has done more than would have been deemed possible. He might, however, with advantage both to himself and his readers, have converted the French measures of length quoted in the volume, into corresponding English terms; a translation can hardly be considered complete without this, and the omission moreover might be regarded as arguing either ignorance on the translator's part, or disregard for the comfort and enlightenment of a certain class of his readers. We cannot agree with the somewhat puerile strictures on the author made by the translator in his preface. The intimate association of metamorphosis and geneagenesis, is undoubted, both being part of a series of changes undergone by a living being in the cycle of its existence; and Dr. Lawson's objection to the statement, that "vital operations are not to be explained by a reference to the known laws of force," is certainly trivial and unnecessary. Can Dr. Lawson explain vital phenomena by any of the *known* laws of force? We think not; those laws, whose existence is undoubted, which come into play, in the fecundation of the ovum, in the appropriation of nutriment resulting in growth, and such phenomena, are at present, though possibly not for many years, unknown. At any rate, these phenomena never have been explained by any known laws; and the high branch of organic chemistry which their study constitutes forms one of the most important fields of labour for the physiological chemist.

ENTOZOA.—*An Introduction to the Study of Helminthology, with reference more particularly to the Internal Parasites of Man.* By T. SPENCER COBBOLD, M.D., F.R.S.

OF all possible subjects, perhaps the last that one would expect to see treated in a book having the appearance of being "got up" more to lie on the table in the drawing-room than in the study, is that of Helminthology. However unjust its claims, it cannot be denied that the study of the life-history of internal parasitic animals is by no means one which offers attractions to the popular mind, which is always so prone to content itself with the contemplation of the outsides of things, and, moreover, so apt to be disgusted with any reference to what may be taking place in the interior of the animal body.

Within the outer and visible animal world, however, there is another for the most part concealed from view, and in some cases almost invisible to the unaided sight even when sought for, but whose existence is rendered but too manifest by its noxious or even fatal effects. But it is a world equally worthy of study with the exterior, and which in fact affords peculiar phenomena amongst the most remarkable in the whole organized creation. Scarcely any animal, from the lowest protozoan to the highest mammal, is exempt from the liability of becoming the involuntary Amphitogon to unbidden parasitic guests, which are in many cases destructive to the life of their host, and in nearly all are at any rate productive of more or less discomfort and disease.

The number, therefore, of these parasitic creatures throughout the entire animal kingdom is enormous, and their study, consequently, to be effectually carried out, must be pursued by those in a measure specially devoted to it. Amongst these, in this country at least, none ranks higher than Dr. Cobbold, who has for many years been so favorably known for the unwearied zeal and assiduity with which he has followed the study of helminthology by observation and experiment.

The pages of this journal have so often been the vehicle for observations having reference to this subject, which is one, in fact, from the minuteness in many cases of the objects themselves, and in others from the peculiarity of their structure, especially demanding microscopic research, that we do not hesitate to call the attention of our readers to the present work, which may be regarded as the first important original systematic treatise on helminthology in the English language; as it is also one which, from the copiousness and value of its contents, the ease of its style, and, it may be added, the luxurious elegance with which it has been published, reflects the highest credit upon its author and his enterprising publisher.

We have termed it a work on helminthology, though more strictly speaking it is confined more particularly to human parasites. But as it is impossible to treat so fully of these as Dr. Cobbold has done, without entering at the same time very largely into the history of these creatures generally, his work may be regarded as conveying a tolerably complete view of the present state of helminthological knowledge in its whole extent. In fact, it may be said, that among the thirty or forty entozoa infesting man, are to be found nearly all of the types under which they exist throughout the animal kingdom.

We are unable to enter into many particulars of the matter contained in the volume, but are desirous of saying a few words on the subject of the classification of entozoa adopted by the author. Dr. Cobbold is "satisfied that the method of retaining the entozoa as a distinct group is fraught with advantages more than counterbalancing the apparent orthodoxy which a rather more exact and systematic treatment of the subject might involve." And that the "happiest and perhaps after all the most truly philosophic way of studying them is to regard them as a peculiar fauna destined to occupy an equally peculiar territory," &c.

The latter is an ingenious though fanciful conceit, and in a monograph of this kind there may perhaps be some present convenience in regarding the entozoa as a distinct group in the animal kingdom; but, in a scientific point of view, we conceive that such an arrangement is open to grave objections, having a tendency to lead some to suppose that such a group really represents a zoological division, whilst the fact is that all the entozoa, notwithstanding the extraordinary and diverse anomalies they present in the organization adapted to their peculiar habits, are nevertheless easily referable to a class which also embraces infinitely more numerous non-parasitic forms, and even to an order from which it is impossible to exclude some. With one or two very doubtful exceptions referable to the protozoa, all the entozoa may in fact be ranged in the annulose sub-kingdom, in the annuloid province of which they, together with the non-parasitic turbellaria, constitute the entire class *Scolecida.*

We are aware that Dr. Cobbold is supported by some authority in constituting the entozoa into a distinct group, but we cannot but regret that in a scientific work of this importance, and which is calculated to influence the opinions of so many, a truer zoological classification has not been adopted. And we think that the actual relations of these animals would thus have been kept more distinctly in view than can be when they are habitually regarded as a group apart from the rest of the Annulosa. Nor can we perceive how "endless confusion" can arise from the "attempt to distribute" them "amongst the different invertebrate groups," in which as we have shown they in reality constitute one already formed almost by themselves. For other considerations also it seems to us that the scheme of classification proposed by Dr. Cobbold, however convenient it may be for his special object, is by far too artificial and unnatural to be admissible in a scientific point of view.

All this, however, is apart from the intrinsic and practical merits of the work, which may be regarded as a compendious and well-digested repertorium of all that is known respecting human internal parasites, and as one in which the subject, though treated in a thoroughly scientific manner, is yet handled in such a way as will, it is to be hoped, tend to popularise a very useful and highly interesting line of inquiry, which until the last few years had remained in a very unsatisfactory state.

Kryptogamen Flora von Sachsen, der ober Laüsitz, Thuringen, und Nordböhmen. Dr. L. Rabenhorst. 1863.
Beitrage zur näheren Kenntniss und verbreitung der Algen. Dr. L. Rabenhorst. 1863.
Flora Europæa, Algarum Aquæ dulcis et submarinæ. Sectio 1. *Algas Diatomaceas complectens.* Dr. L. Rabenhorst. 1864.
Ueber neue oder ungenügend gekannte Algen. A. Grunow, *Verh. der Akad. Wien*, 1860.
Die Österreichischen Diatomaceen. A. Grunow, *Verh. der Akad. Wien*, 1862.
Ueber einige neue und ungenügend bekannte Arten und Gattungen von Diatomaceen. A. Grunow, *Verh. der Akad. Wien*, 1862.

The advance that has been made in the pursuit of microscopical science during the last few years, stimulated by improved and cheaper instruments and the advantages observers have over their predecessors in good introductions to the various branches of study, has, in no field, been greater than in the investigation of the microscopic forms of Algæ. Of these the special favorites have been that class whose siliceous skeletons afford, in many cases, such beautiful objects for mere admirers of the wonders of nature, whilst the elucidation of their modes of structure, propagation, and growth, are equally attractive to the scientific observer, and afford some of the most difficult problems of microscopical study.

This tribe or class of Algæ, known as the Diatomaceæ, has for many years occupied the attention of observers, both in Europe and America. Their indestructible siliceous skeletons are found in abundance in every quarter of the globe, every pool contains its species. Rivers, seas, and lakes, are rich in characteristic forms. The Polar seas abound with them to such an extent that cases are recorded of soundings being almost wholly composed of their remains. We find them at the lowest depths of the Atlantic, and on the edges of the newest-formed coral reef in the Tropics. We meet with them in abundance in the Himalayas and the Alps, and in Germany, America, and many other localities, whole strata beneath the surface of the earth consist almost entirely of the indestructible remains of these minute organisms.

It is no matter of surprise, therefore, at the present day, when microscopes of good working capabilities are easily obtainable at a moderate cost, that such universally distributed objects should be one of the most attractive studies both for the microscopist, who merely seeks for slides to gratify himself and his friends by the beauty and interest of their contents, and for the naturalist, who not only admires their structure, but endeavours to give a satisfactory reason for the various markings brought out by the higher powers of the microscope, to work out their habits and distribution, and to reduce to some kind of systematic order, the various species which abound in different parts of the globe.

With the Diatomaceæ, as with most other of the lowly organized forms of animal and vegetable life, it is a matter of extreme difficulty to arrive at any solution that will meet the approval of even the majority of observers, of the difficult question—What is a species? Some, in fact, we may say many, regard every minute variation of form or marking as sufficient ground for the formation of a new species. Those, however, who have most carefully and extensively studied these organisms, by a critical comparison of large suites of specimens, by observing the variation arising from the localities in which they grow, and by studying the differences arising from the depth, temperature, and nature, of the water in which they are found, or from their living on sandy, muddy, or rocky shores, are led to the conclusion that a large number of these so-called species are mere varieties of some typical forms, whose growth has been stimulated or partially arrested by the favorable or unfavorable nature of the locality to the development of their siliceous skeleton.

The majority of our English writers on this branch of natural history, since the time of Professor Smith, have been more engaged in the examination of gatherings, recent and fossil, and the descriptions of hitherto unrecognised forms, than in any attempt at systematising or working out the structure of the valves of the various species. The works at the head of this notice show, however, that in Germany the description of new species, though also largely indulged in, is combined with, and secondary to, more important objects. The local floras of Rabenhorst and Grunow giving very full and detailed description (in the latter case accompanied, generally, with very fairly executed figures) of the various species that occur in Saxony, Lusatia, Bohemia, and Austria, are very useful to students, for the sake of comparison with the species that occur in our own country, whilst, in the latest work of Dr. Rabenhorst, the 'Flora Europæa Algarum,' the first section is devoted to a description of all the known European fresh and brackish water species of Diatomaceæ, for which he proposes a new systematic arrangement, that differs materially from those of his prede-

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cessors; and as the work of one who has long and attentively studied the subject, ought to be in the hands of every one devoted to this branch of algology. In some cases improvements are made in the classification proposed by Professor Smith in the Synopsis, but we doubt that, as a whole, the species are divided into more natural groups, or that the work would prove as useful an introduction to the student seeking for a knowledge of the forms in any particular gathering as that of our fellow-countryman.

The 9 sub-tribes of Professor Smith are divided into 15 families, and the 59 genera he describes are extended to 71, though the whole number of genera included in the work amounts to 126, including such as Dictyocha, Chœtoceros, &c., which are considered doubtful members of the group by many; there are also included some foreign forms whose position in the arrangement is merely indicated. The work is only illustrated by figures to mark the genera which appear to be similar to those in the Saxon 'Flora;' but they are inferior in execution to most of those of M. Grunow. We can, however, recommend both Dr. Rabenhorst's and Grunow's works to the careful consideration of the English student.

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QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

Observations on Raphides and other Crystals. By GEORGE GULLIVER, F.R.S. ('Ann. and Mag. of Nat. Hist.,' Oct., 1864.)—Prof. Gulliver describes in this paper raphides from the *Quillaja saponaria*, the peculiar form of which, he considers, may be used as a very satisfactory test of the genuineness of the article sold under this name. In shape the raphides of Quillaja closely resemble the prismatic crystals of the Iridaceæ and some other Monocotyledones. In a species of Melastoma, the same persevering observer has found an abundance of sphæraphides in the endophlœum and mesophlœum, but none in the bark or leaves. In the Mesembryaceæ he has always met with a profusion of raphides, but, curiously enough, none are observed in the Crassulaceæ or Cactaceæ. In three plants examined of the order Nyctaginaceæ, a large number of raphides were observed; the result, however, of an investigation of the Plantaginaceæ and Amaranthaceæ was negative. In Chenopodiaceæ, Phytolaccaceæ, and Polygonaceæ, the presence or absence of raphides seems a matter of great uncertainty and variability.

On the Anatomy of the Balanophoreæ, as regards the Characters which it furnishes for the Classification of these Plants. By M. A. CHATIN. ('Comptes Rendus,' July 11th, 1864.)—The valuable investigations of Messrs. Weddell, I. D. Hooker, Griffith, and Hoffmeister, on the seed of these plants, show that its embryo is formed only by a homogeneous cellular mass, like the spores of Cryptogamic plants—a simplicity of organization which has led to the Rhizanths being regarded as degraded plants, forming a peculiar group, between Cryptogamia and Phanerogamia. The observations of M. Chatin do not favour this opinion; he would rather assign the Rhizanths a place between the Monocotyledones and Dicotyledones, more closely approaching the former by their peculiar structure, and the latter by their affinity to certain orders. It is more particularly by the structure of the stamen, and also by that of the ovule, that the Rhizanths are elevated in the vegetable scale. The following anatomical diagnosis of the Balanophoreæ, furnished by a microscopic study of their structure, is given by M. Chatin:—Spiral vessels rare, and never capable of being unrolled; true cortical fibres wanting; cells of the parenchyma generally with numerous nuclei; sclerous tissues frequent; epidermis (of the parts above ground) with its cells granuliferous, and never exhibiting sinuous outlines; stomata wanting; rhizome with scattered vascular bundles; scale-like leaves, with several vascular bundles, which are replaced sometimes by little columns of sclerous cells; pericarp divisible into several concentric zones, of which, at least one is of a sclerous nature; anthers having the second membrane (endotheca of authors) of a fibrous nature (except in Balanophora), with one or two layers of filamentous cells arranged *en griffe;* the connective and the septa usually not fibrous, and destitute of placentoids. The author then characterises the genera of the Balanophoreæ anatomically, and concludes by promising an investigation of the allied order Rafflesiaceæ, the results of which are to be communicated to the Academy.

Researches on the Vibriones. By M. C. DAVAINE. ('Comptes Rendus,' October, 1864.)—The author of this paper accepts the division of the Vibriones into the genera Bacterium, Vibrio, and Spirillium, but is inclined to remove them entirely from the Protozoa, considering them all as plants. In structure, he affirms that they are homogeneous, and present analogies to the filamentous Confervæ. By exposing various solutions to the atmosphere, he obtained various forms of Vibriones, and found that forms occurring in salt water or fresh water singly were destroyed by an admixture of the two.

New British Epiphytal Fungi. By MORDECAI COOKE. ('Journal of Botany,' Nov., 1864.)—Mr. Cooke describes three new forms of microscopic vegetable organisms, parasitic on Hydrocotyle, Parnassia, and Rhamnus respectively, which he assigns to the genus Trichobasis.

On the Fecundation and Development of Marsilea. By Dr. HANSTEIN. ('Monatsbericht der Akademie der Wissenschaften zu Berlin,' August, 1864.)—The following important observations on this subject are recorded by Dr. Hanstein. A few hours after the microspores and myaspores have escaped into the surrounding water, in the manner formerly described by the author, and issued from their sporangia, the following changes take place. The small androspores become homogeneous and plastic, and contract all round the margin; the mass then is divided by three planes of segmentation into eight parts, and eventually into thirty-two, the process resembling the segmentation of the animal ovum, and on the completion of the segmentation a cell-membrane is formed round each mass. In each of these thirty-two cells a spermatozoid is developed, and, in the course of from eighteen to twenty-two hours, the developed daughter-cells are set free. Each spermatozoid consists of a corkscrew-like filament, which possesses a rapid whirling motion, and is beset by long cilia. The impregnation of the archegonium, which has in the mean time been developing, then takes place.

The process of the development and subsequent impregnation of the archegonium are minutely described by Dr. Hanstein. The entrance of the spermatozoid into the archegonium by a rapid drilling process was witnessed; in one case two were observed to enter in this manner simultaneously. The number of spermatozoids which collect in the mucous envelope of a gynospore often amounts to several hundreds, the necks of the fertilised archegonia being quite brown with them. For further details we must refer the reader to the author's paper, or to an excellent translation of it, in the 'Ann. and Mag. of Nat. Hist.' for December.

On the Source of Living Organisms. By JAMES SAMUELSON, Editor of the 'Quart. Journ. of Science,' iv.—The author of this article gives a brief but very complete account of the history of the discussion on spontaneous generation, noticing the researches of Redi, Spallanzani, Pouchet, Jolly, Musset, Wyman, Schaaffhausen, Mantegazza, and Schultze, Schwann, Schroeder, Pasteur, and Quatrefages, referring also to the recent experiments of Dr. Gilbert Child ('Proc. Royal Soc.,' vol. xiii, 65). He then proceeds to detail some researches of his own, carried on in connection with Dr. Balbiani of Paris, the eminent microscopist. Various infusions were prepared by Mr. Samuelson, of which he sent part to Dr. Balbiani, and retained part for his own examination. The infusions were dissolved through distilled water and exposed to the atmosphere. In the specimens examined by Dr. Balbiani, great numbers of a *Cercomonas* (*C. fusiformis*) were found, both in the animal and vegetable infusions, as also the *Amœba Gleicheni* and *Cyclidium glaucoma.* These animalculæ were also detected in window-dust and exposed distilled water, from the same locality as that in which the infusions were placed. Mr. Samuelson detected similar forms to those noted by his coadjutor, and proposes to make the Amœba a new species, under the name *A. Balbianii.* These and Vorticella, Enchetis, Kerona, and an Entomostracan, were found in distilled water; and the author asks whether it is possible that these forms should be repeatedly produced by heterogenesis, considering that the presence of ova and zoospores in the air is the true explanation of the phenomena. A very pleasingly executed plate illustrates Mr. Samuelson's paper.

Observations on the Structure of Amœba and Actinophrys.—Recently, at a meeting of the Boston Society of Natural History, Dr. Wyman gave an account of some Amœbæ which he had obtained in a rather remarkable manner. They appeared first as minute points, and gradually developed, in some fibrine placed with water, between two plates of glass, for the purpose of observing its decomposition. They appeared to consist of a simple sarcodic mass, in which granules were numerously imbedded; these passed out of the Amœbæ with great freedom, and Dr. Wyman was inclined to consider these animals as deprived of any proper integument. Dr. Henry James Clark was inclined to disagree with Kölliker as regards the homogeneous nature of Actinophrys, considering the vacuoles displayed in that animal as true cells. Dr. Clark had observed these cells with an objective of 150 degrees angular aperture, made for him last June, by Tolles, of Canastole, New York, with which he had no difficulty in working, through a sufficient depth of water to cover the Actinophrys, and he states that he could readily detect the walls, not only of the superficial but also of the innermost cells.

Professor Clark, who communicates an account of this discussion to the 'Ann. and Mag. Nat. Hist.,' November, 1864, draws particular attention to the angular aperture and working distance ($\frac{1}{30}$th of an inch) of this objective. He also briefly states his views on the production of vibratile cilia, which he considers to be produced in the amorphous intercellular substance, as also the "cuidæ" of Cœlenterata.

On the Formation of Coral. By M. Lacaze Duthiers. ('Quart. Journal Science,' iv, 1864.)—A series of investigations were recently undertaken by M. Duthiers on this subject, for the purpose of prosecuting which he has been spending some time on the coast of the Mediterranean. In the present paper he speaks first of the observations of Peyconnel rejected by the French Academy, and complains bitterly that so notable a discovery as the true nature and affinities of corals with the animal kingdom should thus have been transferred from the archives of France to those of England. In tracing the development of the red coral M. Duthiers had considerable difficulty, in consequence of the apparent impossibility of retaining the ova of the polyp in a state of vitality. He, however, at length succeeded, and watched their development from a spherical, naked vesicle, to the perfect coral. The first change observed was a lengthening in the ova, a cavity forming (subsequently developed into the mouth) in the interior—a worm-like creature provided with minute porapodia being produced, the length being scarcely $\frac{1}{16}$th of an inch. These worm-like larvæ had a tendency to aggregate and flattening to apply their extremities to the sides of the glass vessel in which they were placed. This they all eventually did. They then gradually enlarged in breadth and diminished in length, becoming lens-shaped discs, in the midst of which was the oral aperture: around this the tentacles were developed. The characteristic red colour of the ectoderm was then developed, whilst the tentacles retained their want of colour, appearing in the perfect coral-like white stars. The development of the coral is then, as M. Lacaze Duthiers shows, a simple one, and not attended with any of those remarkable phenomena incident to the growth of other cœlenterates.

Observations on the Mode of Fecundation of the Amphileptus Fasciola. By M. DESGOULTES ('Comptes Rendus,' October, 1864.)—Whilst observing some confervæ in the month of December, the author observed very numerous individuals of Amphileptus. One he fóund performing rotatory movements, revolving round a point. This he watched for some time, till, at length, it performed sundry convulsive movements, its caudal extremity became truncated, and gave passage to a round gray body. At this moment another individual arrived, leisurely swimming over the field of observation; suddenly, on coming near to the protruded vesicle appended to the revolving Amphileptus, it threw itself against it, and by the movements of its body aided the disengagement of the vesicle from the first specimen. The Amphileptus, liberated from its burden, retired into a confervoid mass, whilst the "accoucheur" attached himself to the vesicle, passing himself over it and rubbing his body against it. These movements were continued for four minutes, when the "accoucheur" departed, and the other Amphileptus came from its retirement and began to advance towards the vesicle, which appeared then to be seized and rubbed till it was broken and its contents liberated in the form of little bodies considered by M. Desgoultes as eggs. The fecundation was several times observed by the author, but the subsequent disintegration of the vesicle was only noticed in this single instance.

A Contribution to the Anatomy of Bothriocephalus latus. By Dr. LUDWIG STIEDA. ('Riechert und Du Bois Raymond's Archiv' (Müller), July, 1864.)—A very careful and well-illustrated paper appears on this subject. The author has chiefly studied the disposition of the generative organs, and his results are thus summed up at the conclusion of his paper:

1. The body-substance of the *B. latus* is a simple cellular matrix.

2. The outermost covering of the surface of the body is composed of a structureless cuticle.

3. The elements of the muscles are spindled-shaped, like the type of the so-called smooth muscles of vertebrata composed of cells. They are disposed in three bundles, and form, *a*, a series of circular or ring-muscles; *b*, a series of long muscles; *c*, isolated oblique muscles.

4. The *B. latus* has a genital-pore.

5. The male organs consist of, *a*, the testes situated at the side of the rings; *b*, of the united excretory tube of all the testes, the seminal duct, which passes into, *c*, a muscular sac, of which the anterior end bent upon itself exposes, *d*, the penis, which discharges the function of a genital-pore.

6. The female organs are, *a*, a tough vaginal canal discharging into the genital-pore below the muscular sac; *b*, a tough, H-shaped ovary, placed under the muscles on the central surface; *c*, yelk-sacs and yelk-ducts are disposed over much of the integument of the side of each ring, and joining with one another, take the form of a corn sheaf—from these a system of canals arises in the middle of the ring; *d*, the excretory duct of the ovary receives the yelk-duct, which meets it in the middle, besides a canal coming from the end of the vagina; *e*, the uterus, or egg-holder, is a canal folded up in many loops, which possesses an independent opening beneath the genital-pore; *f*, the junction between the beginning of the uterine canal (Knäuel rohre) and the end of the ovarian duct takes place at an enlargement of the latter (Knäuel drüse.)

Note on the Termination of Motor Nerves among the Crustacea and Insects. By M. Ch. Rouget.—In his last note on the termination of motor nerves, Kuhne, the author states, seeks to establish a similarity between the mode of termination of the nerves among the Articulata (long since described by Doyere) and that which he (M. Rouget) discovered in the superior Vertebrata; an assimilation which is by no means in accordance with the facts. *Cancer mænas, articus,* larvæ of the *Diptera,* and *Coleoptera,* were the subjects of M. Rouget's examination. He finds that the cone described by Doyere and Quatrefages really exists, but is not the *termination* of the nerve. The form and appearance of the cone and its fibrils depends on the amount of tension. The termination of the nerve in beetles is similar to that in the Batrachians, but there is no general similarity between the Articulata and Vertebrata in this respect. The axis cylinder presents no modification of structure or appearance in the three higher classes of Vertebrata, but spreads out in the form of a finely granular plexus, accompanied by an aggregation of minute globules. Whether these researches are confirmatory of Dr. Beale's, M. Rouget does not say. His results seem certainly to agree better with those of our own countryman than with those of Kuhne or Kölliker. ('Comptes Rendus,' Nov. 21st, 1864.)

A paper on the same subject as this will be found in the last number of 'Kölliker und Siebold's Zeitschrift' for this year, by Dr. Lehman, of Copenhagen, detailing the results of some important original investigations.

The Embryology of Insects. By Dr. August Wiesemann.—Two very valuable papers on this subject have lately been published, one in the October number of Reichert's 'Archiv,' and the other occupying the whole of the July number of Kölliker's and Siebold's 'Zeitschrift.' We have not space to notice the various details of microscopic and minute anatomy which are given by the author, but would just draw attention to the subject as one of great interest. Dr. Weismann's papers are profusely illustrated.

On some peculiar Structures in the Seminal Fluid of Janthina. By Fritz Müller. ('Wiegman's Archiv,' 1863, p. 179.)—During some observations made on the shores of the Mediterranean the author detected numerous little bodies, apparently possessed of head and tail, freely swimming in the seminal fluid of Janthina. He at first considered them as parasites, but on a subsequent examination found that their filamentous appearance and movement was due to the aggregation of zoosperms; and hence he concludes that they are spermatophora. The question, however, is one admitting of further investigation, likely to be attended with interesting results. (See 'Ann. and Mag. Nat. Hist.,' Dec., 1864.)

On the Muscular Submucous Layer of the Intestine of Mammifers. By M. Louis Fasce. ('Robin's Journal.')—The disposition of the muscular layers of the intestines, as shown by M. Fasce, is as follows:—1. Muscular fibres placed beneath Lieberkuhn's tubes, surrounding them partly, always disposes in the same direction. 2. Connective tissue separating the above from, 3, circular muscular fibres. 4. Longitudinal fibres. This layer is three times as thick as any other. 5. Submucous tissue. 6 and 7. Sub-serous muscular layers, longitudinal and annular. 8. Serous membrane.

The Gray Substance of the Medulla Oblongata and Trapezium.—Dr. Dean, in his recent researches published at Washington, gives some important observations on the decussation of the hypoglossal roots, &c. In the *medulla oblongata* he considers that we have three classes of nerve-fibres:

1. Vagus (spinal accessory) and hypoglossal roots, which arise from or terminate in cells in their respective nuclei.

2. Vagus (spinal accessory) and hypoglossal roots meeting in cells.

3. Vagus (spinal accessory) and hypoglossal roots directly continuous.

He also gives some observations on the olivary bodies, and is disposed to agree entirely with Mr. Lockhart Clarke, considering that the groups of very large cells from which the upper olivary bodies originate, are developed from the remains of the antero-lateral nuclei. ('Amer. Journal Medical Science.')

On the Conditions of Osteo-genesis with or without pre-existing Cartilage. By M. Robin. ('Robin's Journal,' September and December, 1864.)—M. Robin is publishing an important series of observations on this subject, which he has made during very laborious researches. The papers are illustrated by drawings from nature.

Researches on the Mucous Membrane of the "col-uterim." By M. Cornil. ('Robin's Journal,' September, 1864.)

On the Epithelium of the Urinary Canal. By Dr. H. Linck, (Reichert and Du Bois Raymond's 'Archiv,' July, 1864.)

A Contribution to the Histology of the Pacinian Corpuscle. By Professor Hoyer. (Reich. and Du Bois Raymond's 'Archiv,' July, 1864.)

On the Pathology of Tetanus. By J. Lockhart Clarke. ('Lancet,' Sept. 3, 1864.)—Of all the diseases to which the human frame is subject, while in none more than in tetanus the pathology has perplexed inquiries, in none, perhaps, have the skill and ingenuity of the practitioner been more variously but vainly expended. It is lamentably true that in many disorders a complete knowledge of their pathology has been but of little avail in pointing to the method of cure; but in tetanus we have not hitherto enjoyed even the possible advantage of this kind of knowledge, however unavailable it may prove; so that the different plans of treatment, which are numerous, have been wholly tentative or empirical.

In this frightful malady it may be said that scarcely anything has been ascertained of the changes which ensue in the condition of the nervous centres. Some of the sympathetic ganglia have been found inflamed, or more or less hyperæmic; but these conditions are far from being constant. Swan tells us that in one case of tetanus he discovered well-marked inflammation of the semilunar ganglia; in another the vascularity of these ganglia was much increased; while in a third there was enlargement with increased vascularity, not only of the semilunar ganglia, but also of those in the chest. Some of the ganglia of the abdomen, however, remained unaffected. In other cases of tetanus in which the sympathetic ganglia have been examined, they have been found perfectly healthy.

Of the peripheral nerves in tetanus, many cases of well-marked disease have been recorded by different authors. Mr. Curling mentions two cases in which the nerves at particular spots appeared inflamed. Instances of the same kind have been recorded by Pelletier, who believes that in every case of traumatic tetanus the disease is due to inflammation, extending from the injured nerves to the membranes and substance of the spinal cord;* and Froriep has published seven cases of traumatic tetanus, in which there were swelling and redness of particular portions of the nerves between the wound and the spinal cord.† Of the spinal cord itself, the principal abnormal appearances that have been hitherto observed consist only of hyperæmia of its membranes and substance, with occasional effusion of fluid around its surface.

Having given this brief summary of what is at present chiefly known of the pathology of tetanus, I proceed to the results of some observations which I lately made on the spinal cord in the two following cases which occurred in St. George's Hospital.

On the 30th of April, 1863, a man fell a distance of twelve feet to the ground, by which the skin of the right leg was said to be severely bruised. On the 11th of May he complained of stiff-neck, and some difficulty of deglutition. In the night his mouth became quite closed, and he had several fits of severe dyspnœa, accompanied by contraction of the muscles of the back. On the following day the surface of the body became cold and clammy, with large drops of sweat on his forehead. When lying supine on the bed, his back was so curved that the hand and forearm could be passed between it and the bed. He had the risus sardonicus ex-

* 'Revue Méd.,' 1827, vol. iv.

† 'Neue Not. aus dem Gebiete der Natur und Heil Kunde,' 1837, vol. i, No. i.

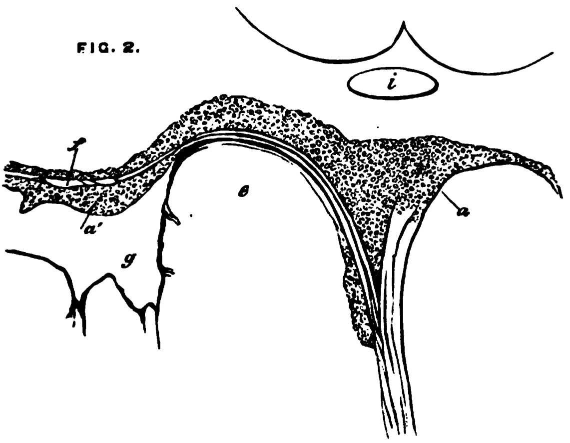
pression of face. The pulse was weak, but regular—100. Every ten or fifteen minutes there was momentary contraction of the facial and spinal muscles. Attempts at deglutition, or taking a deep inspiration, brought on these spasms immediately. The breathing was nearly all abdominal, the thorax moving very slightly. The right leg was inflamed about its middle, and there was a deep slough four inches long and two inches wide. The actual cautery was applied from the occiput to the middle of the dorsal region, the patient being under the influence of chloroform. The spasmodic attacks gradually increased in frequency as well as intensity, and the man died in one of them on the morning of the 13th. He could move his jaw freely during the last four hours.

The post-mortem examination was conducted by my friend Dr. Dickinson, of St. George's Hospital, who gave the following account of the external aspect of the spinal cord :— "The sheath of the cord was natural in appearance. It had a reddish hue, owing to the fulness of the vessels on the surface of the cord. Over its whole extent the cord was covered with large injected vessels, which were nearly as thick as whipcord. They were near together, and ran more or less parallel to the length of the cord. The white and gray matter were both congested, and the puncta were very conspicous everywhere."

A portion of this cord—the principal part of the cervical enlargement—was given to me by Dr. Dickinson. It was

already hardened by long maceration in chromic acid. In sections I found the gray substance in particular very much congested; and not only were the vessels unnaturally dilated, but each was more or less surrounded by a granular and originally fluid exudation, in which the natural tissue of the part became broken down and ultimately dissolved. In fig. 1, a large triangular mass of this exudation is represented at *a*, where it occupies the bottom of the anterior median fissure (*b*), and has destroyed a part of the anterior commissure by extending to the right as far as *c*. The same parts, of the gray substance of other sections, more highly magnified, are represented in Figs. 2 and 3. In Fig. 2, a large

FIG. 2.



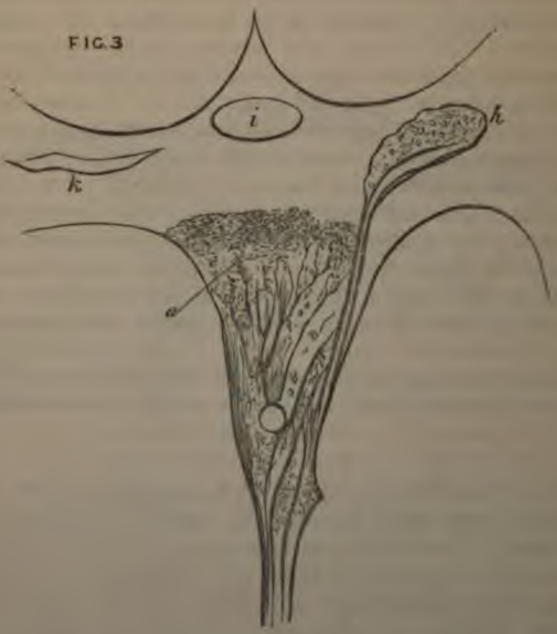
quantity of granular exudation (*a*) has enveloped and partially destroyed some blood-vessels, and the pia mater which supports them. The exudation extends to the left, around the bottom of the anterior column (*e*), destroying a portion of the anterior commissure, and following the course of an evidently diseased blood-vessel (*f*) into the middle of the anterior cornu (*g*), where it has destroyed a part of the gray substance. In Fig. 3, we find at *a* the same kind of granular exudation enveloping the pia mater and blood-vessels which enter at the anterior median fissure; and at *h*, in the same figure, is a separate and oval mass of the same kind of exudation, surrounding the cut end of one of the blood-vessels as it bends round on the right side of the canal. On the left side of the canal, at *k*, is another elongated, finely granular, and almost pellucid area of degeneration. On tur
ing to Fig. 1, we find that small areas or patches (*d, d, d,*

which under a high power are seen to be of this description, are scattered over different parts of the gray substance. Most of them may be seen to lie, as they probably all do, at the side of or around blood-vessels. In some places they are exceedingly minute, and much more numerous than they are represented in the figure.

Of the second case of traumatic tetanus the history is as follows :

On December 26th, 1863, a girl, aged seven years, trod on an iron meat-stand, and received a small wound on the

FIG. 3



ball of the toe of the right foot. Some pain and inflammation followed, and the part was kept poulticed. On January 7th, 1864, the mother noticed a peculiar expression about the face, and forty-eight hours later the girl complained of pain about the lower jaw. On the morning of the 10th she had lost all power of opening the mouth. On the evening of the same day her head began to be drawn backward, and her spine to be somewhat curved. The following day she had opisthotonos and sardonic grin; the pulse was small and quick. The wound in the foot had healed, and the cicatrix was not painful. The posterior tibial nerve was divided by Mr. Henry Lee. On the 12th the risus sardonicus was less marked; she could open her mouth about half an inch, and protrude her tongue easily; deglutition was perfect. Any sudden movement of the bed-clothes, however, threw her into a state of spasm, in which the back became bent, and the corners of her mouth much drawn down. The abdomen was hard; respiration 38 per minute; pulse 160 and regular; she answered questions readily. Two doses (each three grains) of calomel, followed by an enema, brought away copious motions. There was great thirst, and a constant cry of "Drink, drink!" On the 14th the attacks of spasm were less frequent and severe; she passed a much quieter night. On the following day she was very much purged, but this action was arrested by a six-grain dose of Dover's powder. On the 16th she had a very severe attack of spasm, in which her face became blue; she was quite insensible to all external objects, and opisthotonos ensued. After this she slept for two hours. On the 18th there was some pleurosthotonos towards the right side. On the 19th she was much weaker. On the 20th, in the morning, she had two severe spasmodic attacks, with only an interval of a few minutes. In the afternoon of the same day she had three others, and died at twenty minutes past two.

On examination of the body by Dr. Dickinson, the pia mater of the brain was found to be slightly blood-stained in the neighbourhood of vessels, but otherwise healthy. The dura mater of the spinal cord contained about half an ounce of blood-stained fluid. The vessels of the surface of the cord itself were greatly injected, especially in the lumbar enlargement. Its gray matter was congested. The remainder of the cord was more than usually vascular, both on the surface and in the interior, but less so than in the lumbar region.

Nearly the whole of the spinal cord was sent to me by Dr. Dickinson for examination. To the unassisted eye nothing unusual was observable in its interior. But when the microscope was employed on sections properly prepared, lesions were discovered of the same general nature as those which I described in the first case. Every region—the cervical, dorsal, and lumbar—was more or less affected; but in each the morbid appearances seemed rather to recur at intervals, and not uniformly throughout its length. In some sections the injury was limited to the gray substance; in others it involved the white columns, particularly the posterior and lateral. Sometimes the lesion was in the form of a granular deposit around blood-vessels; sometimes in the form of globular masses or rings, arising from injury and displacement of the white substance of the adjacent nerve-fibres. The latter appearance was more frequent in the white columns and along the sides of fissures containing blood-vessels, where the tissue had occasionally the aspect of a moth-eaten cloth. In some places the lesional spots were exceedingly small, and might easily have been mistaken by an unpractised eye for the natural appearance of the part.

Although I shall abstain from giving any decided opinion on the exact nature of the morbid action in tetanus until I have examined more cases, the plan of treatment which I should try would be the following:—Division of the wounded nerve as early and as high up as possible; cupping along the course of the spine; frequent doses of calomel combined with opium; and potassio-tartrate of antimony, repeated, during the severer paroxysms, at short intervals and in sufficient quantity to produce nausea, or perhaps vomiting. The chief object of the tartrate of antimony is to subdue the spasms, but it might also assist in arresting the morbid action of the blood-vessels. Some years back, in the columns of this journal, I recommended the use of tartrate of antimony in those violent and prolonged paroxysms of hysteria which are so intractable and distressing, and I have never known it fail. As soon as nausea supervenes, the spasms, however violent, begin to relax; and if the paroxysm be excited or prolonged by the presence of undigested food in the stomach, the vomiting will prevent its recurrence. In tetanus, any depression that might be caused by the antimony would be much less than the exhaustion of the nervous system resulting from the violence of the spasms.

I shall be glad to receive the spinal cords and medullæ oblongatæ of any patients that may die of tetanus. If they cannot reach me immediately, they may be cleanly cut with a sharp knife into pieces about an inch long, and preserved in a solution of chromic acid, in the proportion of 1 part to 300 parts of water. I shall also be glad to receive cords belonging to cases of muscular atrophy or "wasting palsy."

[We have given the above cases from the 'Lancet,' to show our medical readers what may yet be expected from microscopic research with regard to nervous diseases. It is not because, by a rude inspection with the naked eye, no changes can be observed in nervous structures where nervous disease has been present, that such diseases has not been attended with structural derangement. It is because nervous pathologists have not yet made themselves masters of nervous structure that so little has yet been made out. Observers have but to follow in the footsteps of Lockhart Clarke, to reap a rich harvest of explanatory facts.—Ed.]

NOTES AND CORRESPONDENCE.

Diagrams of Microscopic Objects.—In looking over Mr. Beale's new edition of his work, "How to Work the Microscope," I have been struck with his observations relative to drawing objects in pp. 26—28. There is no doubt as to the general correctness of his remarks, but, at the same time, it is certain that there are many amateurs in microscopy who can never attain any proficiency in the cunning of the pencil. I do not, however, write to bewail my own inability in this matter, but for another purpose. The teachings of the microscope have now become so popular that I, for one, am constantly being asked to give lectures on the subject at parish rooms, young men's associations, &c.; and as it is impossible on such occasions to illustrate one's observations to large audiences under the microscope itself, recourse must be had to diagrams, which I have found great difficulty in obtaining. At the *soirée* given by the Bath and Bristol microscopical societies in connection with the late meeting of the British Association, the walls of the various rooms were profusely covered with well-executed enlarged drawings of the principal microscopic objects in the vegetable, animal, and mineral kingdoms, and the same is generally the case at the annual *soirées* of the London Society. Now, it appears to me that it would answer the purpose of any enterprising publisher to bring out a well-selected series of diagrams illustrating, say, for instance, the structure of insects and plants. For these would find a ready sale amongst schools, families, young men's associations, &c., and such a proceeding would, surely, do much towards popularising the microscope. There may possibly be such a series already published, and if so I should be obliged to any correspondent who would inform me where they can be procured.

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Value of Habitat as a Distinctive Species.—At the time my short account of Homœocladia in fresh water, contained in the July number of this Journal, was written, I was not aware that the subject I wished to draw attention to, viz., the occurrence of so-called marine diatoms in fresh water, and *vice versâ*, had before been treated in that publication, or, in fact, anywhere else. Shortly after I read a very able and valuable memoir by Professor Walker Arnott, on "What are marine Diatoms," which fully sustains my own views, and brings a large amount of evidence, well and forcibly displayed, to bear on the subject, the author arriving at the conclusion that, although Mr. Smith's statements, ascribing a limited sphere of *habitat* to each species, may on the whole be correct, they are of very little practical value, and may even tend to mislead when applied to the distinction of species. Now, a theory disproved by the facts from which it is said to be deduced, should certainly be altogether dismissed, and those species which, directly or indirectly, derive their existence from the supposition of its correctness should be submitted to a thorough revision. It is not impossible tha[illegible]
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I am glad to be able to close these lines with an account of what I believe to be an encouraging new fact. Through the kindness of Dr. Abercrombie, of Cheltenham, I have just received a living gathering of *Bacillaria paradoxa* from the Avon, above Tewkesbury, associated with such freshwater forms as are common in every roadside ditch, *Pleurosigma attenuatum*, *Nitzschia sigmoidea*, *Navicula gracilis* (*E.*), &c., and *Encyonema prostratum*. The unique *Bacillaria* is very plentiful, indeed, in this beautiful gathering, and continues, placed in common well water, in most energetic activity. *Nitzschia dubia* is also stated by the same gentleman, on the authority of Dr. Greville, to be frequent all around Cheltenham, though it had no business there." Lastly, our *Homœocladia filiformis*, or a very similar species, is reported to be very abundant in the Severn, above Tewkesbury, thus affording new evidence with respect to the great range of adaptability enjoyed in by these marvellous fairy gems; and which, when properly followed up, will certainly not fail to throw a gleam of light on the obscure paths of physiological inquiry. —TH. EULENSTEIN, Stutgard.

N.B.—The following errata should be corrected in M. Eulenstein's former communication (Vol. IV, p. 172):

Page 172, in line	8	from top,	substitute a comma for the full stop.	
" "	11	"	for *Berkeleyia*,	read *Berkeleya*.
" "	9	"	" *Drokreia*	" *Dickieia*.
" "	29	"	" *Mastigloia*	" *Mastogloia*.
" "	30	"	" *Homœcladia*	" *Homœocladia*.
" "	31	"	" *Raphdoglœa*	" *Rhabdogloia*.
" "	34	"	" *Homœcladia*	" *Homœocladia*.
Page 173 "	6	"	" *fifililiformis*	" *filiformis*.

In the title of the paper, *for* HOMŒCLADIA, *read* HOMŒOCLADIA; and the author's initials are Th., and *not* F. L.

Mr. Goddard's Mounting Table.—In the last number of the Journal, p. 296, Mr. Stokes, writing respecting my table, states that the balsam in which specimens are mounted is very liable to boil. I think, if the flame of the spirit lamp be carefully regulated snch mishaps will be almost impossible. I have left my table covered with slides for two hours at a time, and on no occasion have I found the accidents complained of.

By changing the position of the lamp and regulating the flame, any degree of heat required may be obtained.—D. EVERETT GODDARD, Bank of England.

PROCEEDINGS OF SOCIETIES.

MICROSCOPICAL SOCIETY, *October* 12*th*, 1864.

CHARLES BROOKE, Esq., President, in the Chair.

J. W. Fairey, Esq., D. E. Goddard, Esq., and B. W. Smith, Esq., were balloted for and duly elected members.

A short paper by M. Neyt, of Ghent, "On a New Species of Thrips," was read.

Mr. J. Beck gave a verbal "Account of the Hatching of the Eggs, and the Progress of the Larvæ of the Flea of the Cat."

November 9*th*, 1864.

CHARLES BROOKE, Esq., President, in the Chair.

G. E. Cox, Esq., was balloted for and duly elected a member.

Dr. Beale gave a verbal communication "On the Method of preparing Delicate Tissues for Examination with High Powers."

A paper by Dr. Greville, "On some New Forms of Diatomaceæ," was read ('Trans.' p. 1).

December 14*th*, 1864.

CHARLES BROOKE, Esq., President, in the Chair.

J. Heseltine, Esq., W. W. Reeves, Esq., William Hudson, Esq., and William Cotterell, Esq., were balloted for and duly elected members.

Pursuant to notice, a discussion took place "On the most Advantageous means of Illuminating Objects under the High Powers of the Microscope."

Mr. Tomkins exhibited an apparatus for greatly increasing the illuminating power of the ordinary gas.

Dr. L. Beale gave notice that, at the next Annual Meeting, he should move that ladies be eligible for admission as members of the Society.

[redacted]

PRESENTATIONS TO THE MICROSCOPICAL SOCIETY.

October 12th, 1864.

	Presented by
Reptiles of British India, by Dr. Günther. Ray Society, 1864	Subscribed for.
Dr. Bowerbank on British Sponges	Ditto.
Quarterly Journal of Geological Society, No. 79	The Society.
Journal of the Linnean Society, No. 29	Ditto.
Transactions of the Tyneside Naturalists' Field Club, Vol. I, Part II.	Ditto.
Canadian Journal of Industry, Science, and Art, Nos. 51 and 52	Ditto.
Memorias da Academia real das Sciencias de Lisboa, Tom. 3, Part I.	Ditto.
Historia de memorias da Academia real das Sciencias de Lisboa, Tom. 3, Part I	Ditto.
Catalogue of Minerals, by T. Egleston	Smithsonian Institution.
Report on Patents, 2 vols.	
Smithsonian Report of the Trustees of Comparative Zoology	
Miscellaneous Collections, Vol. 5, 1864	
Contributions to Knowledge, Vol. 13	
Boston Journal of Natural History, Vol. 7, No. 4	
Gray Substance of the Medulla Oblongata and Trapezium, by John Dean	
9 Photographs of Ditto, by John Dean	
15 Photographs of Thrips, by Monsr. Neyt	
Popular Science Review, Nos. 10 to 13	The Editor.
Intellectual Observer, Nos. 30 to 33	Ditto.
Die österreichischen Diatomaceen, by A. Grunow	The Author.
How to work with the Microscope, by Dr. Lionel S. Beale, 1864	Ditto.
The Annals and Magazine of Natural History, Nos. 79 to 82	Purchased.

November 9th.

The Intellectual Observer, No. 34	The Editor.
The Photographic Journal, No. 150	Ditto.
Quarterly Journal of Geological Society, No. 80	The Society.
List of the Geological Society, 1864	Ditto.
The Canadian Journal, No. 53	Ditto.
The Annals and Magazine of Natural History, No. 83	Ditto.

December 14th.

The Intellectual Observer, No. 35	The Editor.
A Mahogany Rotating Table for Microscopes	W. K. Bridgman.
On some new and singular intermediate forms of Diatomaceæ, by F. W. Lewis, M.D., Philadelphia	The Author.
Notes on new and rarer species of Diatomaceæ, by F. W. Lewis, M.D., Philadelphia	Ditto.
Twenty Slides, illustrating the above Papers of Dr. Lewis	Ditto.
Two Slides—*Homœocladia filiformis*, freshwater, near Stuttgart; " *Pinnularia nobilis*, Professor Eulenstein, Stuttgart	Ditto.

W. G. Searson, *Curator*.

ADDITIONAL SUBSCRIBERS TO THE QUEKETT MEMORIAL FUND.

G. Busk, Esq., F.R.S.	1	1	0
H. Coles, Esq.	1	1	0
— Chambert, Esq.	1	1	0
— Cowan, Esq.	1	1	0
Dr. Guy	1	1	0
— Hewitt, Esq.	0	10	6
H. Lee, Esq.	1	1	0
R. Mesteyer, Esq.	1	1	0
M. Marshall, Esq.	2	2	0
M. Pillischer, Esq.	2	2	0
Powell and Lealand	1	1	0
J. Stainton, Esq.	1	0	0
J. Suffolk, Esq.	0	10	6
W. Wright, Esq.	1	1	0
J. Van Voorst, Esq., F.L.S.	1	1	0

The Hull Natural History and Microscopical Society.

The Hull Natural History and Microscopical Society, formerly designated the Hull Micro-Philosophical Society, has thus changed its title, with the object of the admission of members interested in field pursuits as well as at the microscopical table. The title embraces a wide latitude of inquiry, and it is hoped that the change may prove an effective stimulus to increased exertion amongst its various members.

At the General Meeting held on the 7th October, 1864, George Norman, Esq., was unanimously re-elected President, and William Lawton, Esq., was elected Vice-President, the latter office being an additional appointment, as also that of Librarian in the person of Mr. B. Cooke. Treasurer in that of Mr. W. H. Rust, and the Secretary as before, Mr. William Hendry.

The Sixth Sessional Course for 1864-65 commenced its Meetings on Friday, October 21st, to be continued bi-monthly up to the 17th March, 1865.

During the past summer the Society had their Annual Field-day on June 11th, and as the weather was fine throughout, the day was spent in a most enjoyable manner. A special conveyance took the members *viâ* Cottingham and Little Weighton to Newbald. From Newbald the various gentlemen constituting the Society, with several invited guests, walked over the beautiful country to Cliffe, the botanists filling their collecting boxes with many interesting plants, found by the way, while those whose studies were restricted to minute objects for the microscope filled their bottles with gatherings of diatoms, desmids, &c. The entomologists also were busy with their nets, and frequent were the excited chases after their insect prey.

From Cliffe, the excursionists wended their way to the Catholic Reformatory near Market-Weighton, where they had an invitation to view the establishment of that locality. Here they were most hospitably received by the Rev. Father Caccia and Professor Gagliardi, who had thoughtfully prepared a sumptuous repast for the hungry visitors. It is perhaps unnecessary to say that full justice was done to the feast. After enjoying the repast, the health of the reverend gentlemen at the head of the establishment was drunk, and a cordial vote of thanks passed for the kind and hospitable reception the members had received. The visitors were now conducted over the Reformatory, and were much gratified with the admirable arrangements in connection with the juvenile criminals, and the kind and fatherly manner in which the head of the establishment apparently keeps watch over his charge. The farming operations were now inspected, and the judicious system of marling noticed. Formerly the whole country hereabouts had evidently been a waste of sandy peat. Marl of a dark-red colour was found on the estate, and this, applied with judgment, has worked wonders, and now the land produces excellent crops of corn, hay, and turnips. All the manual labour is done by the boys belonging to the Reformatory.

After taking leave of the gentlemen connected with the Reformatory, the members commenced their homeward walk towards Newbald, the botanists finding, *en route*, a locality for the beautiful and rare fern *Osmunda regalis*.

On arriving at Newbald tea was discussed, and soon afterwards the conveyance started homewards. Thus was brought to a conclusion a day that will be long remembered by the members as the most pleasant excursion made since the commencement of the Society.

NOTE.—On the subject of diatoms it might be, perhaps, well to make note by the several Societies the period of various gatherings by their respective members, as, for instance, *P. attenuatum*, *Amphipleura pellucida*, &c., in such a month, after rains, or dry weather, in ponds, ditches, &c. *P. angulatum*, *P. fasciola*, *P. Makrum*, or others, relating to salt or brackish waters, lagoons, stagnant or running waters, thus tending to confirm or advance opinions and knowledge already existing on the subject.—W. H.

OXFORD MICROSCOPICAL SOCIETY.

THIS Society was founded in April, 1864. The Rules, of which a copy is annexed, were adopted.

I.—That a Microscopical Society be formed for the study of subjects directly connected with the use and structure of the Microscope, and for the collection of Microscopic objects.

II.—That the Meetings of the Society be held at least twice in each Term.

III.—That the business of the Meetings consist, First, of communications on subjects connected with the study of the Microscope; Secondly, of the display of objects of general Microscopical interest.

IV.—That any Member be at liberty to bring with him to the Meetings one or more friends, provided that the same person is not introduced more than once during the term.

V.—That the Officers of the Society be a President, a Secretary, and five other Members, who, with the President and Secretary, shall constitute a Council.

VI.—That the Officers of the Society be elected, and other general business transacted, at a special Meeting to be held annually at the beginning of Lent Term:—that the President shall continue in Office for not more than two consecutive years, that the Secretary shall be re-eligible, and that at each election two of the other Members of the Council shall retire.

VII.—That the name of any person desiring to become a Member shall be submitted to any Meeting, with the names of his Proposer and Seconder; and that his election shall take place at the following Meeting.

VIII.—That an Annual Subscription, at the rate of 2*s*. 6*d*. a Term, together with an entrance fee of 2*s*. 6*d*., be paid by each Member.

IX.—That at the beginning of each Term, Members intending to oblige the Society with scientific communications, shall, if possible, send their name to the Secretary, with the subjects which they propose to illustrate.

X.—That it shall be the duty of the Council to determine early in each Term the days on which the Meetings of the Society shall be held; and, as far as practicable, the subjects to be discussed thereat; and that the Secretary shall send notice of the same to each Member three days before such Meeting.

XI.—That books be kept by the Secretary, in which the names of Members, an abstract of the transactions, and the financial accounts of the Society, be duly entered.

XII.—That every Member possessing a Microscope be requested to attend at the place of meeting, bringing with him his Microscope and Lamp, a short time before the business of the evening is to commence; and that the Secretary shall see that at least two Microscopes are on the table at every Meeting of the Society.

XIII.—That these rules shall not be altered without at least one Term's notice, and the consent of two thirds of the Members present.

The following gentlemen were elected to serve upon the Council: Dr. Acland, *President*, Professor Phillips, Professor Rolleston, Professor Westwood, H. G. Madan, Esq., C. Robertson, Esq., *Council*, Rev. W. Tuckwell, *Secretary*.

Two Meetings were held in the Museum during the following Term. An Address was delivered by the President, which he has undertaken, at the unanimous request of the Society, to print; and the following objects were exhibited, with comments and explanations.

By Professor WESTWOOD—The scales of certain butterflies, affording criteria for the discrimination of species.

By Mr. ROBERTSON—Young fish, in the ova or newly hatched, displaying the circulation of the blood.

By Professor PHILLIPS—Sections of wood, charred for greater distinctness, and mounted in balsam.

By Professor ROLLESTON—Sections of the molar teeth of a Sumatran and American Tapir.

By Mr. THOMAS—A scarce Rotifer, not known to have been anywhere described.

By Dr. TUCKWELL—A portion of human Epidermis, containing the burrow of *Sarcoptes scabiei*, with the acarus, its ova and excrement, *in situ*.

By the SECRETARY—Diatoms embedded in the tissues of a caterpillar.

At the first Meeting nine microscopes, at the second, eighteen microscopes were displayed.

The Society, starting with thirteen members, has risen in three months to forty-six. A room in the Museum has been placed at its disposal by the President, and a first-class microscope, due to the munificence of the Radcliffe Trustees, ordered for its use. Its surplus funds will be devoted to the collection of books, drawings, photographs; and the formation of a cabinet of slides. Gifts of various kinds are beginning to flow in, and the President has offered a handsome sum of money towards the establishment of periodical prizes on subjects connected with the microscope.

BRITISH ASSOCIATION, BATH.

MICROSCOPICAL SOIRÉE BY THE BATH AND BRISTOL SOCIETIES, ASSEMBLY ROOMS, BATH.—*September* 20, 1864.

Two hundred years ago, August 13th, 1664, Mr. Samuel Pepys wrote in his memorable diary, "Comes Mr. Reeve, with a microscope and scotoscope. For the first I did give him £5 10*s*., a great price, but a most curious bauble it is, and he says, as good, nay, the best he knows in England."

Whether we regard the greatness of the price, or the curiousness of the bauble, the contrast between 1664 and 1864 is striking enough. At the soirée we are about to describe, the microscopes were insured for £6000, and saloons of noble proportions, thronged with the members and associates of the body specially devoted to the "Advancement of Science," bore witness to the progress of this "curious bauble."

The conception and entire arrangement of this soirée were of a somewhat novel character, and demand a special explanation. The Bath Society is one of the youngest in the country (founded December, 1858), and its enterprise in undertaking an affair of this magnitude and responsibility, and carrying it through with such a marked success, must be proportionately estimated. As soon as the British Association accepted the invitation to visit Bath, the Society resolved to invite the assistance of the British Society, and conjointly with them to attempt, no mere exhibition of "curious baubles," but a scientifically arranged and classified illustration of the results of microscopical investigation in every natural kingdom. This plan (suggested by the Secretary of the Bath Society, Mr. J. W. Morris) being at once accepted, and the cordial co-operation of the British Society being secured, the arrangements, which must have involved a vast amount of labour to all concerned, was carried forward to a completeness which was the theme of unqualified admiration to all who were present.

The plan embraced the following features, which were most faithfully carried out:—On entering the large Ball Room, the visitor found himself in the "Vegetable Kingdom." Large green placards directed him from THALLOGENS to EXOGENS, smaller ones from ALGÆ to FUNGI.

Coloured diagrams, illustrative of the objects exhibited, afforded those who could not approach the besieged instruments a means of rapidly surveying the gradations of vegetable life in structure or in form. To the illustration of the vegetable kingdom twenty-nine microscopes were devoted.

Red inscriptions now announced the "Animal Kingdom," and at once it was apparent that the recent classification of Professor Huxley had been adopted; and thirty-nine microscopes enabled the observers to follow, by a most interesting development, the ascending scale from the Amœbiform Rhizopods of the PROTOZOA to the high degree of structure illustrated by the beautiful preparation of the organs of the INSECTÆ.

Here, however, the large room had to be exchanged for another, and passing the sergeant of militia, who strictly guarded the exits and the entrances, the studious "member" or "associate" found himself or herself, as might be, in another department, where the "Histology and General Anatomy" of the VERTEBRATA were displayed by seventeen microscopes; and yellow labels invited the inspection of Geological, Chemical, and Mineralogical collections, to which twenty more microscopes were allotted. An observable feature in the arrangements, which the unavoidable haste of such an occasion did not, however, permit of being fully appreciated, was the supplying to almost all the microscopes a "series" of slides illustrating the entire subject under exhibition, the printed synopsis informing the visitor that "any object might be selected from such series for examination."

A third room—a capacious octagon—was devoted to the exhibition of microscopes and other philosophical instruments. Here

Messrs. Smith and Beck, Ladd, Baker, &c., of London, and Husbands and Clarke, of Bristol, were in full force. And herein was illustrated the distinctive idea of the Bath Soirée. The microscope, as an optical instrument—a triumph of optical science—was kept to itself. The microscope, as an aid to scientific investigation in well nigh every branch of natural science, claimed its rank, and kept it. There has been quite enough of the "curious bauble" style of soirée, and the resolute endeavour to assert the real relation of the instrument to general science, could not have received more fitting illustration than when two microscopical societies united to play the host to the British Association. Every microscopical society is, indeed, such an association in miniature, so long as it regards the instrument, as an *instrument*, a means to an end, and, in a generous and comprehensive spirit, surveys the entire field of inquiry which it is called upon to illustrate by the special power at its disposal.

In conclusion, we may observe that each of the microscopes enumerated above was manipulated by a member of one or other of the societies, or by one of their friends; but lest we may appear to be actuated by a microscopic partiality for what must be regarded as a microscopical triumph, the words of the "Authorised Reprint of the Report of the British Association" may here be quoted:

"The arrangements, which were under the able direction of Dr. Wilbraham Falconer, President of the Bath Microscopical Society; Mr. J. W. Morris, its secretary; and Mr. Leipner Acting Secretary of the British Microscopical Society, were admirable in the extreme. So brilliant was the assemblage that it appears almost invidious to enumerate the names of any of the company who were present. Science, learning, wit, and beauty were equally well represented, and the result was a scene which will never fade from the memory of those who witnessed it, and of which it may be said in the words of a celebrated Irish poem, as translated by Dean Swift, that, like

"'O'Rourke! noble feast, it will ne'er be forgot
By those who were there, and by those who were not.'"

The following is the programme of the arrangement of specimens at the meeting:—

VEGETABLE KINGDOM.

VEGETABLE CELL AND CELL CONTENTS.

1. Forms of Cells. Hairs of Plants. &c.
2. Spiral Cell and its modifications. SERIES.
3. Yeast Plant.
4. Cell contents. *Circulation of Endochrome.*

5, 6. Starch. Raphides. Cystoliths. &c. SERIES.

THALLOGENS.

ALGÆ.

PROTOPHYTES :—

7. Volvocineæ. *Volvox globator.*
Desmidiaceæ.
8, 9. Diatomaceæ. SERIES.
10. Palmellaceæ.
Ulvaceæ.
Oscillatoriaceæ. (*living.*)
Nostocaceæ (*living.*)
11. Siphonaceæ. *Vaucheria, &c.*
Confervaceæ.
Conjugateæ. *Zygnema, &c.*
Chætophoraceæ.
12. Batrachospermeæ. (*living.*)
Characeæ. *Chara, Nitella, &c.*
13. Melanospermeæ. SERIES.
14. Rhodospermeæ. SERIES.

FUNGI AND LICHENS.

15. Spores. Gonidia. &c.
Sections of Fungi. Moulds. &c.

ACROGENS.

HEPATICÆ.

16. Jungermanniæ of Bristol District. SERIES.
17. Spores and Elaters of Jungermannia.
Fructification of Marchantia.

MUSCI.

18, 19. Development of Mosses: Antheridia, Archegonia, Capsules, Leaves, &c. SERIES.

LYCOPODIACEÆ.

20. Fruit of Selaginella, &c.

EQUISETACEÆ.

Siliceous cuticle.
Fructification.

FILICES.

21. Development of Ferns. Prothallus.
22, 23. Sections, Fructification, &c. SERIES.

ENDOGENS.

24. Sections of Canes, Palms, Lilies, &c.
25. Fructification of Orchids.
26. Grasses. Siliceous Cuticles.
Pollen.

EXOGENS.

27. Epidermal Structure.
28. Stem Structure. *Wood.* SERIES.
29. Pollen. Seeds, &c.

[redacted]

ANIMAL KINGDOM.

PROTOZOA.

RHIZOPODA.

1. Amœba. (*living.*)
2. Foraminifera. SERIES.
3. Soundings: Atlantic, Red Sea, &c.

SPONGIDÆ.

4. Sponges. Spicules, Gemmules, &c. SERIES.

INFUSORIA.

5. Vorticella. Stentor. &c.
6. Noctiluca.
Vibriones in Vegetable and Animal Infusions.

CÆLENTERATA.

HYDROZOA.

7. Hydra viridis, &c. (*living.*)
8. Myriothela. Coryne. Tubularia. Laomedæa. Sertularia. &c. SERIES.
9. Polypidoms of Plumulariadæ, Sertulariadæ, &c. SERIES.
10. Auditory Organ of Medusa.

ACTINOZOA.

Spicules of Alcyonium.
11. Gorgoniæ. Spicules of Gorgoniæ. SERIES.

MOLLUSCA.

POLYZOA.

12. Polyzoaries. SERIES.
13. Polypes. Marine. SERIES.
Pedicellinida. Cyclostomata.
Ctenostomata. Cheilostomata.
14. Polypes. Freshwater. (*living.*)

BRACHIOPODA.

15. Sections of Shells.

CONCHIFERA.

Sections of Shells.
16. Cilia on Gills of Oyster, Anodon, &c.
17. Embryo of Oyster. Viviparous ova of Anodon.
Parasite of Anodon.

GASTEROPODA.

[G. Pulmonata. G. Diœcia. G. Monœcia.]
18, 19. Lingual Ribbons. SERIES.
20. Internal Shell of Limax and Arion.
21. Otoliths. Dissections. SERIES.

CEPHALAPODA.

22. Shell of Cuttle Fish. Suckers. Lingual Ribbon, &c.

ANNULOSA.

ECHINODERMATA.

23. Crinoidea. *Comatula.* SERIES.
Development and Histology of Comatula. SERIES.
Parasite of Comatula.
24. Asteridia.
Ophiuridea.
25, 26. Pedicellariæ of Asteridia and Echinidea. SERIES.
27. Spines, and Sections of Spine, of *Echinus* and *Cidaris.* SERIES.
Holothuridea. Calcerous plates of *Synapta, &c.*

SCOLECIDA.

28. Rotifera:—*Rotifer, Brachionus, &c.*
Turbellaria:—*Planaria.*
29. Nematoidea:—*Trichina spiralis, &c.*
30. Tæniada:—Head of *T. elliptica.* *T. Crassicollis, &c.* Ovaries, &c. *Cysticercus* from Human Brain partially developed into Tape Worm.
Trematoda. Fluke, &c.

ANNELIDA.

Discophora. Original preparations by JOHNSON, illustrating his work on the *Leech.* SERIES.

CRUSTACEA.

31. Cirrhipedia. Histology of *Lepas Hillii, Conchoderma virgata, &c.*
32. Ostracoda. *Cypris, &c.*
Copepoda. *Cyclops. Suctorial Crustaceæ, &c.*
Branchiopoda. *Daphnea, &c.*
33. Edriopthalmia. *Caprella.*
Podopthalmia. Sections of Shell. *Megalopa* and *Zoëa.*

ARACHNIDA.

34. Acari. Parasitic Acari. Eggs of Acari. SERIES.
35. Spiders.
Chelifer.

MYRIAPODA.

Julus. Exuvia of Myriapod.

INSECTA.

36. Parasitic Insects. SERIES.
37. Whole mounted Insects. SERIES.
38. Parts of Insects. Scales. Hairs. Eyes. &c.
39. Anatomical preparations:—Spiracles. Tracheæ. Tongues. Gizzard. &c. SERIES.

HISTOLOGY and 'GENERAL ANATOMY' of the VERTEBRATA.

BONE SYSTEM—

1, 2. Fish.
Amphibian.

Reptilian.
Bird.
Mammalian.

MUSCULAR AND FIBROUS SYSTEM—

3. Muscle, voluntary and involuntary.
Fibrous tissue.
Elastic tissue.
Cartilage.

NERVOUS SYSTEM AND ORGANS OF SENSE—

4. Nerve. *Pacinian bodies.*
Otoliths of Fish. SERIES.
Structure of Crystalline Lens of Fish.
Papillæ and Nerves of Tongue.

INTEGUMENTARY SYSTEM—

5. Sections of Skin, &c.
6. Scales:—Cycloid. Ctenoid. Placoid. Ganoid. SERIES.
7. Feather. SERIES.
8. Hair. Rhinoceros Horn. Baleen. &c. SERIES.
9. Hoof.
Nail.
Horn.
10. Teeth. Development of Teeth. SERIES.

NUTRITIVE SYSTEM—

11. Blood-corpuscles. Capillaries. SERIES.
12. Circulation.
13. Gland Tissues.
14. Transparent Injections. SERIES.
15. Opaque Injections. SERIES.

MISCELLANEA:—

16. Sections of Egg Shells of Birds.
17. Histology of Saw of the Saw Fish.

GEOLOGY.

Microzoal Deposits.

1. Crag Polyzoa. SERIES.
2. Fossils from the Pleiocene. SERIES.
Foraminifera. Polyzoa. Entomostraca. Bone Sections.
3. Fossils from the Eocene. SERIES.
Seeds. Foraminifera. Entomostraca. Mollusca.
4. Fossils from the Chalk and Green Sand. SERIES.
Sponges. Foraminifera, &c.
5. Fossils from the Upper and Inferior Oolite. SERIES.
Polyzoa. Entomostraca. Teeth, &c.
6. Fossils from the Lias, Treas, Carboniferous, Devonian, Silurian. SERIES.
Foraminifera. Corals. Polyzoa, Entomostraca. Sections of Teeth and Bone.
7. Sections of Oolitic Limestone, Clifton. SERIES.
Fossil Otoliths. SERIES.
8. Sections of Fossil Teeth and Bone. SERIES.
9. Fossil Diatomaceæ. Polycystina. SERIES.
10. Sections of Fossil Wood, Coal, &c. SERIES.

CHEMISTRY.

11. Goniometrical analysis for determination of the chemical nature of crystals. Illustrated by Dr. Leeson's and Ross's Microgoniometers.
12. Crystallization.
13, 14. Chemical Crystalline preparations: *Vegetable Alkaloids. Salts.* Sublimations of *Arsenic. Mercury. Antimony, &c.*

ADULTERATIONS.

15. Adulteration of Quinine.
 " Honey.
16. " Coffee.
 " Chocolate.

MINERALOGY.

17, 18. Sections of Minerals:—*Agate. Hyperstine. Avanturine, &c.*
19. Crystalline Minerals:—*Oxides of Copper. Phosphate of Lead. Pyrrhite, &c*
20. Native Metals:—*Gold. Silver. Copper. Antimony.*

Birmingham Natural History and Microscopical Society.

During the past quarter several interesting exhibitions have taken place at the microscopical meetings of the above-named Society. Amongst the specimens shown were:—*Acronycta Alni*, and *Eunomidea apicuria*; a pair of *Rumphomicron vulcani*; specimens of lower mountain limestone strata from below the Suspension Bridge at Clifton; of volcanic rock from near the cave of Alexander Selkirk at Juan Fernandez; *Favosites Portlandica* from Beachy Island, Wellington Sound, and others. Of the Favosites some beautiful sections were shown under the microscopes.

A graphic and extremely interesting account of a week's sojourn in Cornwall, illustrated by means of a map. Specimens, both botanical, mineral, and zoological, &c., were given by Mr. Henry Webb, at one of the meetings. A paper on the "Common House Fly," by Mr. Thomas Fiddian, was also read. The anatomical portion of the subject was very carefully handled, and all points of difficulty explained. The means by which flies walk upon the ceiling or on any surface, with their backs downwards, was particularly pointed out; the old idea of the sucker on the feet being disproved, and the true instruments which enable the fly to accomplish this apparently difficult task were admirably explained. The paper was illustrated by a very splendid lithographed diagram showing all the principal organs and structures in the body of the fly.

At the Adjourned Annual Meeting of the Society, held on the 13th ult., a new code of laws was adopted; and the Secretary's report on the proceedings of the past year read. The Treasurer's account showed a balance of upwards of £7 in favour of the Society. A short address by the retiring President was read. Two points in particular deserve notice. Referring to the new element which had been incorporated with the Society during the year, the President congratulated the members on the accession of strength which the addition of the microscopic section had brought to the parent Society. He also pointed out the utility of microscopical studies, and the advances which had been made in every department of science since the more general use of the microscope had obtained. The meeting of the British Association for the Advancement of Science, to be held in Birmingham in September next, was then commented on, and the members of the Society were urged to use their best endeavours to forward the cause of science. Votes of thanks to the various retiring officers were then passed. The retiring President, W. R. Hughes, Esq., F.L.S., was re-elected, and Mr. James Hinds was elected Secretary.

British Pharmaceutical Conference.

Bath Meeting.—September, 1864.

On Microscopical Research *in* Relation *to* Pharmacy. By Henry Deane, F.L.S., and Henry B. Brady, F.L.S.

We have chosen for the particular subject of the present communication, the various preparations of opium. Whether regarded in respect to their importance in the practice of medicine, their variability in strength and character, or the peculiar conditions in which the active matter exists in the crude drug, no better subject could be found for the purpose in view.

Opium, as is well known, is an extremely composite substance, being a pasty mass formed of resinous, gummy, extractive and albuminous matters, containing a larger or smaller per-centage of certain active principles diffused through it. These principles are morphine, narcotine (with its two homologues), codeine, narceine, meconine, thebaine, and papaverine, either existing free or in combination with meconic, sulphuric, or other acids, the sum of the crystalline constituents, exclusive of inorganic salts, contained in good samples of the drug being from twenty to thirty per cent. of its entire weight. Any preparation, exactly to represent opium, must contain the whole of these principles, as indeed the tincture may be said fairly to do.

It has, however, been shown that some of the principles are inert, and others even deleterious in their action, and we have consequently had a class of preparations introduced which are understood to be of superior efficacy, not from their containing any active matter which the tincture does not contain, but because they are free from certain substances which are retained by it. Narceine, meconine, and meconic acid are believed to be inert, whilst narcotine possesses properties widely different from those for which opium is usually employed. Of the bulkier constituents, the resin appears to be worse than useless, whereas the bitter extractive, though opinions differ with regard to its precise properties, seems at any rate to increase the narcotic power of the more active constituents. A typical preparation of opium should, therefore, at least contain the whole of the morphine and codeine, with meconic or some other acid to keep them in solution, and the bitter extractive. Codeine itself, and the salts of both codeine and morphine, are readily soluble in either water or alcohol, the remaining principles are fully dissolved by alcohol, but scarcely soluble in water; hence, in the preparations alluded to, water rather than alcohol is used as the solvent.

The process we adopt in examining the constituents of a fluid preparation of this sort under the microscope is a very simple one.

Having, as a preliminary step, taken the specific gravity, and ascertained the percentage of carefully dried extract contained in it, we evaporate a small quantity, usually from four to six drachms, on a sand-bath in a watch-glass, to about the consistence of treacle. It is then poured upon a slip of glass and covered with a piece of thin glass, and after standing a few days, it is sealed in with gold-size. Crystallization sometimes commences before the preparation is removed from the watch-glass, sometimes immediately after transferring to the glass slip, but in many cases for several days. The time taken is dependent upon one of two influences, viz., the quality of the opium, and the exact degree of inspissation.

In determining the value of a preparation from the appearance of this extractive under the microscope, we do not rely entirely upon the amount of crystallization, it is requisite to go one step further to obtain the full value of our labour, and by investigating the form and physical characters of morphine and its compounds, of codeine, narcotine, meconic acid, &c., place ourselves in position to see the significance of the appearance the slide presents, and to identify any crystalline principles which may be present. Nevertheless, even in the absence of very accurate knowledge, any one who will make a few experiments for the sake of practice, will soon be able, by observing the presence or absence, the abundance or scarcity, of certain forms of crystals easily seen in typical specimens, to pronounce with little hesitation on the quality or genuineness of samples of any of the ordinary preparations of opium.

Before proceeding to speak of the opiates which have come under our examination, it may seem necessary to say a few words on the forms assumed by the various opium principles and the physical characters their crystals present.

In the first place—

Morphine.—The pure alkaloid crystallizes in right-rhombic prisms often running into needles. The single crystals have but little effect upon the polarized ray, but where the solution has been concentrated (as from alcohol), and the acicular crystals are much overlaid, they present a good deal of colour.

It is exceedingly difficult to say in what condition morphine exists in opium; we are well aware that it has been set down as meconate, with a smaller per-centage of sulphate, but we have reason to suspect that sulphate is present to a larger extent than is generally supposed. The messing and manipulation which all kinds of opium appear to undergo before they reach this country, renders the belief which is suggested by other circumstances, that a portion of the meconic acid is decomposed, extremely probable. It is scarcely likely that a substance which even boiling water decomposes, evolving carbonic acid, should remain unchanged through the various treatments to which the drug is subjected.

Meconate of Morphine is set down in chemical works as being uncrystallizable, a statement to be accepted with reservation; for by careful manipulation peculiar conical crystals may be obtained either from the solution of the commercial salt in dilute alcohol, or by the evaporation of mixed solutions of morphia and meconic acid. These crystals do not resemble any which are found on evaporating opium solutions; but, as we have said, the subject requires more investigation than we have as yet been able to give to it.

Sulphate of Morphine takes the form of small flat-ended prisms; with a strong tendency to collect in radiating tufts; the larger flat crystals only polarized.

Codeine crystallizes in octahedra running into four-sided prisms. In the octahedral condition it is not easily mistaken for any other of the opium alkaloids, but the prisms strongly resemble those of narcotine.

They may be distinguished by their not presenting the fluted or striated surface which crystals of narcotine have, and by their much less striking effect on the ray of polarized light.

Narcotine occurs in the form of prisms, with oblique one or two-faced ends. As above stated, the surface of the crystals is fluted or striated, and on pressure they break up into tolerably regular smaller crystals. Owing to a sort of composite structure, they have very marked effect on the polarized ray, more striking indeed than any other of the opium principles. Were it not for this property, they would be distinguished with great difficulty from many other crystalline substances which they resemble in form. There is a tendency, as in other cases, to cluster together in more or less radiating tufts, but the individual crystals still keep their shape and do not degenerate into mere radiating plumose needles, like those of narceine.

Narceine.—As narceine exists in opium in about the same per-centage, on the average, as morphia and narcotine, it is of greater consequence in these investigations than it is in a medical point of view, being probably an inert substance. It is readily soluble in alcohol, and slightly so in water, and therefore must exist to considerable extent in most of our preparations. The absolute form of the individual crystals it is impossible to determine, but the masses of delicate, somewhat opaque, silky needles, either radiating from a centre or taking an irregular feathery shape are very characteristic, and the absence of any effect on a ray of polarized light is a negative property of importance.

Meconine occurs in six-sided prisms with dihedral summits, and has little, if any, polarizing power.

Thebaine is readily soluble in alcohol, slightly so in water. From solutions in weak alcohol it crystallizes in beautiful rectangular plates, often associated in tufts more or less radiating from a centre. It is a most beautiful polarizing object.

Papaverine is present to so trifling an extent that it scarcely requires notice. The little which is dissolved by boiling water crystallizes out again on cooling in minute needles often aggregated in rounded balls, so closely packed as to be quite opaque. The large crystals obtained from the alcoholic solution possess slight polarizing properties.

Meconic Acid.—Although the meconate of morphine in opium is an acid salt, it seems probable that part of the meconic acid is also there in a free state; at any rate, we frequently find it in preparations. As it is soluble in both alcohol and water, preparations are pretty sure to contain whatever quantity does exist in the crude drug, unless it has been removed by chemical means. The form of the crystals is primarily a square prism, but we have only seen this in minute examples, and it is very difficult to trace the relationship to this type in the flat, pointed lozenges, somewhat resembling the attenuated forms of uric acid, which generally occur. Even these frequently run into still more strange varietal shapes, whose only resemblance to the lozenge-form exists in their broad centres and two pointed ends. They all have some effect on the polarized ray. Boiling water decomposes meconic acid; carbonic acid is given off, and komenic acid, a substance we have not yet studied, is formed.

We may now proceed to the practical application of the facts enumerated, and detail the results of the examination of the many preparations which have come under our notice.

Of *Turkey Opium* we have investigated—firstly, the tincture, prepared by ourselves from different samples of opium, as well as specimens procured from certain well-known operative chemists; secondly, the extract; thirdly, the wine; fourthly, the more or less aqueous solutions sold as Liquor Opii Sedativus, Battley's, one or two samples prepared by ourselves, and specimens procured from four well-known firms; and fifthly, certain proprietary opiates, viz. "Black Drop," "Jeremie's Sedative," "Nepenthe," and that sold as "Solution of Bimeconate of Morphia."

We must be excused giving the names of the makers from whom specimens have been obtained, in most cases, as it is not our object to sit as inquisitors on our pharmaceutical brethren, though in one or two instances, where we have nothing but good to say, we may, without offence, break this rule.

Tincture yields, on evaporation, crystals of almost the whole of the opium principles, and we find that, as the spirit volatilizes, the resin is also precipitated in an insoluble form. Our own preparation, from different samples of good opium, is tolerably constant, and agrees in appearance with a specimen procured from a manufacturing house of some standing; but neither are quite so rich in crystalline principles as a sample furnished to us by our friend Mr. Morson, which seems to have been prepared from peculiarly fine opium.

Extract shows a much smaller proportion of narcotine crystals, with abundance of morphia salts and tufts of narceine. Turkey opium is not rich in codeine, and we suppose that in extract prepared from it this principle is retained diffused through the bitter matter. A specimen of *commercial* extract of opium which we have seen, recently imported from the East, is a very different substance, showing fewer morphine crystals, but a large proportion of codeine.

Wine.—The mucilaginous matter of wine very much retards, if it does not entirely prevent, the formation of crystals upon evaporation, and consequently we can say but little respecting the appearance presented by the extract obtained from vinous solutions.

Liquor Opii Sedativus.—The striking appearance resulting from the evaporation of Battley's Sedative first drew our attention to the mode of investigation now described. We have examined it frequently, and always have met with the same characters. The slides present an almost opaque mass of crystals of morphine salts and codeine, with a very small proportion of narcotine (and meconine acid ?), and, so far as we have observed, complete absence of resinous matter and narceine. Any one who has studied the microscopic characters of this preparation will readily understand how it has kept its place with the profession in spite of the cheap imitations which have been so largely puffed as substitutes for it. We have necessarily thought much as to its probable mode of preparation, and cannot see any reason to doubt the statement made by Dr. Pereira, on the authority of the late Mr. Battley himself, that spirit and water were the only materials used in its preparation from Turkey opium. Dr. Christison discredits the statement, on the ground of the comparative absence of meconic acid; but, as we have before said, boiling water is sufficient to decompose that acid, and therefore the argument is not a valid one. Though we have experimented much with a view to preparing a similar liquor, we have not yet arrived at an identical result. It is perhaps only justice to say that the preparation which gives results most nearly like Battley's of any which we have had opportunity of testing, is that made by Mr. Morson, of London. Of three other makes which we have examined, one is largely charged with resinous matter, and the proportion of crystalline constituents is so minute that we are satisfied its activity must be very small; another gives a few morphine crystals, a good deal of narcotine, and more narceine; a third is chiefly remarkable for its lack of everything crystalline.

There are certain preparations, to which we must next allude, which give little or no evidence as to the active matters they hold in solution by crystallization on evaporation. As examples, we may instance vinum opii, amongst officinal, and Braithwaite's black drop, nepenthe, and a fluid sold as "solution of bimeconate of morphia," amongst proprietary formulæ. That there should be exceptional cases in which the reaction to a certain peculiar set of tests is doubtful, is only what might have been expected, and it can scarcely be regarded as a weak point in their application. Scarcely any *chemical* test we use but is open to some contingency of the same sort, but as long as we know the conditions of uncertainty, it is no drawback to its employment; it only becomes necessary that these conditions should be investigated, and comparison becomes easy.

We have found that when opium is exhausted, the liquor evaporated to an extract, and this extract redissolved in alcohol, that the tendency to crystallize is very much lessened or entirely destroyed. The cause of this we are not yet able to explain with certainty, but may state the fact as one which we have noticed in relation to every sort of opium we have worked upon. It will account for the very sparing indications of crystalline principles from all preparations made by redissolving in alcohol a once-formed extract. The residue not taken up by alcohol in the experiment is readily soluble in water, and contains certain crystalline matters which we have not yet examined sufficiently to report upon. Again, the subacid viscid matter left on evaporating wine prevents crystallization, consequently vinum opii gives a clear non-crystalline extract; we believe this also to be the reason why one of the proprietary preparations named yields the same result, as it seems to us to be a mere solution of morphine or one of its salts in wine, and not to be made direct from opium. The well-known "black drop" gives no crystals upon evaporation, but in their place a peculiar deposit, consisting of an amorphous, almost opaque fæculence. This is probably owing, in great measure, to viscid matter held in solution, which on evaporation becomes insoluble through some change and is precipitated, carrying down with it the active matter. We know too little of the solvent employed to speak very positively, but if the commonly received theory be true—that it is made by a fermentation process, in which impure mallic acid is concerned—we can readily understand how viscid organic matter may be present in sufficient quantity to produce the result alluded to.

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In addition to the preparation of Turkey opium, we have also had the opportunity of experimenting on small quantities of the Patna, Malwa, and Persian varieties, and all of them present peculiarities of interest. An aqueous extract and a tincture have been made from each, and from the Patna sort sufficient has re-remained to make a specimen of liquor.

The most striking fact in connection with the whole of them is the existence of large quantities of codeine. In the extract of Patna opium it is the chief crystalline constituent, and though the liquor shows abundance of the other opium principles, it evidently owes its narcotic effect much more to codeine than Turkey opium does. We have the experience of an opium eater on this point; he states that the quantity required to produce the effect is larger, but there is less discomfort in the after effects than with other sorts. Malwa opium shows more narcine and narcotine; but in the tincture we have, in addition to a mass of minute crystals, certain larger prisms, which are probably codeine. Persian opium also evidently contains a large proportion of narcotine and codeine.

We stated at the commencement that this must be looked upon only as a preliminary research, there remaining many points on which our information is far from complete. In continuing the inquiry we intend to devote ourselves chiefly to the elucidation of certain particulars. *Firstly*, the condition or form of combination in which morphine exists in crude opium; *secondly*, the relation of extract of poppy to opium in respect to crystalline principles; and *thirdly*, the influence which the extractive matters may have in altering the crystals obtained in opium solutions, and the variations of the normal forms induced by this cause.

The general conclusions we have arrived at in addition to a knowledge of the appearances presented by typical and special preparations of Turkey, Patna, Malwa, and Persian opiums, are mainly these:—

> That tincture, most nearly of any of the preparations, represents the properties, good and bad, of the crude drug.
>
> That when crude opium is taken up with proof spirit as in tincture, the resin separates on evaporation.
>
> That the preparations which have held their ground with the public and the medical profession, in spite of price, differ from the tincture in comparative freedom from resin and narcotine, and in containing only a diminished quantity of meconic acid.
>
> That in the preparation of extract of opium it is important to use a large quantity of distilled water to ensure the separation of narcotine and resin.
>
> That when extract of opium is dissolved in water, filtered and evaporated again to an extract a second or third time, the crystals frequently differ considerably from those seen in the normal or first-formed extract.

That when extract of opium is taken up with rectified spirit 56° O.P., and evaporated again to an extract, crystallization does not take place, or only to a very trifling extent.

That morphine and its salts, and perhaps other opium principles, do not crystallize readily from their solution in wine.

Finally, it remains for us to express our obligation to our friends Mr. Morson, of London, and Messrs. T. and H. Smith, of London and Edinburgh, for the courteous way in which they have assisted us with specimens, when working upon those of the alkaloids which exist only in minute quantities in opium; without this assistance we could scarcely have procured them in a state of reliable purity.—*Pharmaceutical Journal*, 1864.

ROYAL SOCIETY, *May*, 18, 1864.

NEW OBSERVATIONS *upon the* MINUTE ANATOMY *of the* PAPILLÆ *of the* FROG'S TONGUE. BY LIONEL S. BEALE, M.B., F.R.S., &c., Fellow of the Royal College of Physicians, Professor of Physiology and of General and Morbid Anatomy in King's College, Physician to King's College Hospital, and Honorary Fellow of King's College, London.

(*Abstract.*)

AFTER alluding to the observations of Axel Key, whose results accord with his own more closely than those of any other observer, the author refers particularly to the drawings of Hartmann, the latest writer upon the structure of the papillæ. According to the author, Dr. Hartmann, owing to the defective method of preparation he employed, has failed to observe points which had been seen by others who had written before him, and which may now be most positively demonstrated. Hartmann's process consisted in soaking the tissue for three days in solution of bichromate of potash, and afterwards adding solution of caustic soda. It can be shown by experiment that many structures which can be most clearly demonstrated by other modes of investigation, are rendered quite invisible by this process. Hartmann's observations, like those of the author, have been made upon the papillæ of the tongue of the little green tree-frog (*Hyla arborea*).

With reference to the termination of the nerves in the fungiform papillæ of the tongue of the Hyla, the author describes a plexus of very fine nerve-fibres, with nuclei, which has not been demonstrated before. Fibres resulting from the division of the dark-bordered fibres in the axis of the papillæ can be traced directly into this plexus. From its upper part fine fibres, which interlace with one another in the most intricate manner, forming a layer which appears perfectly granular, except under a power of 1000 or higher, may be traced into the hemispheroidal mass of epithelium-like cells which surmounts the summit of the papilla. This hemispheroidal mass belongs not to epithelial, but to the nervous tissues. It adheres to the papilla after every epithelial cell has been removed; the so-called cells of which the entire mass consists cannot be separated from one another like epithelial cells; fibres exactly resembling nerve-fibres can often be seen between them; and very fine nerve-fibres may be traced into the mass from the bundle of nerves in the papilla.

The fine nerve-fibres which are distributed to the simple papillæ of the tongue, around the capillary vessels, and to the muscular fibres of these fungiform papillæ, come off *from the very same trunk as that from which the bundle of purely sensitive fibres which terminate in the papillæ are derived.* The fine nucleated nerve-fibres of the capillaries which the author has demonstrated have been traced into undoubted nerve-trunks in many instances, so that it is quite certain that many of the nuclei which have been considered to belong to the connective tissue (connective-tissue-corpuscles) are really the nuclei of fine nerve-fibres not to be demonstrated by the processes of investigation usually followed.* These nerve-fibres in the connective tissue around the capillaries are considered by the author to be the afferent fibres of the nerve-centres of which the efferent branches are those distributed to the muscular coat of the small arteries.

The author's observations upon the tissues of the frog convince him that the nervous tissue is distinct in every part of the body from other special tissues. For example, he holds that nerve-fibres never pass by continuity of tissue into the "nuclei" (germinal matter) of muscular fibres, or into those of tendon, of the cornea, or of epithelium. He advances arguments to show that the epithelium-like tissue upon the summit of the papilla is not epithelium at all, but belongs to the nervous tissues. Hence it follows that nerves do not influence any tissues by reason of continuity of tissue, but solely by the nerve-currents which pass along them.†

* See "On the Structure and Formation of the so-called Apolar, Unipolar and Bipolar Nerve-cells of the Frog," Phil. Trans. 1863, pl. xl, fig. 44.

† The author feels sure that the conclusions of Kühne, who maintains that the axis cylinder of a nerve-fibre is actually continuous with the "protoplasm" (germinal matter) of the corneal corpuscle, result from errors of observation. The prolongations of the corneal corpuscles, on the contrary, pass over or under the finest nerve-fibres, but are *never* continuous with them, as may be distinctly proved by examining properly prepared specimens under very high magnifying powers (1000 to 5000 linear). The corneal tissue results from changes occurring in one kind of germinal matter—the nerve-fibres distributed to the corneal tissue from changes occurring in another kind of germinal matter. If the connection is as Kühne has described, a "nucleus" or mass of germinal matter would be producing nervous tissue in one part and corneal tissue in another part; and since it has been shown that the "nuclei" of the corneal tissue are continuous with the corneal tissue itself, the nerve-fibres must be continuous, through the nuclei, with the corneal tissue itself; and if with corneal tissue, probably with every

The author states that the so-called 'nuclei' (germinal matter) of the fine muscular fibres, of the papillæ are continuous with the contractile material, as may be demonstrated by a magnifying power of 1800 linear; and he holds the opinion that the contractile matter is formed from the nuclei. He adduces observations which lead him to the conclusion that these nuclei alter their position during life, and that, as they move in one or other direction, a narrow line of new muscular tissue (fibrilla) is as it were left behind.* This is added to the muscular tissue already formed, and thus the muscle increases.

ROYAL SOCIETY, *June* 16*th*, 1864.

INDICATIONS *of the* PATHS TAKEN *by the* NERVE-CURRENTS, *as they* TRAVERSE *the* CAUDATE NERVE-CELLS *of the* SPINAL CORD *and* ENCEPHALON. BY LIONEL S. BEALE, M.B., F.R.S.

ALTHOUGH the caudate nerve-vesicles, or cells existing in the spinal cord, medulla oblongata, and in many parts of the brain, have been described by the most distinguished modern anatomists, there yet remains much to be ascertained with reference to their internal structure, connections, and mode of development. In this paper I propose to describe some points of interest in connection with their structure. In the first place, however, I would remark that there are neither "*cells*" nor "*vesicles*" in the ordinary acceptation of these words, for there is no proper investing membrane, neither are there "*cell-contents*" as distinguished from the *membrane* or *capsule;* in fact, the so-called cell consists of soft solid matter throughout. The nerve-fibres are not prolonged from the nucleus or from the outer part of the cell, but they are continuous with the very material of which the substance of the "cell" itself is composed, and they are, chemically speaking, of the same nature. So that in these caudate cells we have but to recognise the so-called "*nucleus*" (*germinal matter*) and *matter around this* (*formed material*) *which passes into the* "*fibres*," which diverge in various directions from the cell (see Plate VIII, Vol. IV, N. S., fig. 1.)

At the outer part of many of these "cells," usually collected together in one mass, are a number of granules. These are not usually seen in the young cells, and they probably result from

other tissue of the body. But such a view is opposed to many broad facts, and not supported by minute observation. The nuclei of the nerve-fibres are one thing, the nuclei of the corneal tissue another; and the tissues resulting from these nuclei, nerve-tissue, and corneal tissue are distinct in chemical composition, microscopical characters, and properties and actions.

* "New Observations upon the Movements of the Living or Germinal Matter of the Tissues of Man and the higher Animals," 'Archives,' No. XIV, p. 150.

changes taking place in the matter of which the substance of the cell is composed. But it is not proposed to discuss this question in the present paper.

My special object in this communication is to direct attention to a peculiar appearance I have observed in these cells, which enables me to draw some very important inferences with reference to the connections and action of these very elaborate and most important elements of the nervous mechanism.

In some very thin sections of the cord and medulla oblongata of a young dog, which had been very slowly acted upon by dilute acetic acid, the appearances represented (fig. 1) were observed. Subsequently, similar appearances, though not so distinct, have been demonstrated in the caudate nerve-vesicles of the gray matter of the brain of the dog and cat, as well as of the human subject. I have no doubt that the arrangement is constant, and examination of my specimens will probably satisfy observers that the appearance is not accidental. Each fibre (*a*, *a*, *a*) passing from the cell exhibits in its substance several lines of granules. The appearance is as if the fibre were composed of several very fine fibres embedded in a soft transparent matrix, which fibres, by being stretched, had been broken transversely at very short intervals. At the point where each large fibre spreads out to form the body of the cell, these lines diverge from one another and pursue different courses through the very substance of the cell, in front of, and behind, in fact, around the nucleus. Lines can be traced from each fibre across the cell into every other fibre which passes away from it. The actual appearance is represented in Plate VIII, Vol. IV, N. S.; and in the diagram, fig. 2, a plan

Fig. 2.

A diagram of such a cell as that represented in fig. 1, showing the principal lines diverging from the fibres at the point where they become continuous with the substance of the cell. These lines may be traced from one fibre across the cell, and may be followed into *every other fibre* which proceeds from the cell.

of a "cell," showing the course of a few of the most important of these lines which traverse its substance, is given.

I do not conceive that these lines represent fibres structurally distinct from one another, but I consider the appearance is due to some difference in composition of the material forming the substance of the cell in these particular lines; and it seems to me that the course which the lines take permits of but one explanation of the appearance. Supposing nerve-currents to be passing along the fibres through the substance of the cell, they would follow the exact lines here represented; and it must be noticed that these lines are more distinct and more numerous in fully-formed than in young cells. They are, I think, lines which result from the frequent passage of nerve-currents in these definite directions.

Now I have already advanced arguments in favour of the existence of complete nervous circuits, based upon new facts resulting from observations upon *a*, the peripheral arrangements of the nerves in various tissues;* *b*, the course of individual fibres in compound trunks, and the mode of branching and division of nerve-fibres; † and *c*, the structure of ganglion-cells.‡ I venture

Fig. 3.

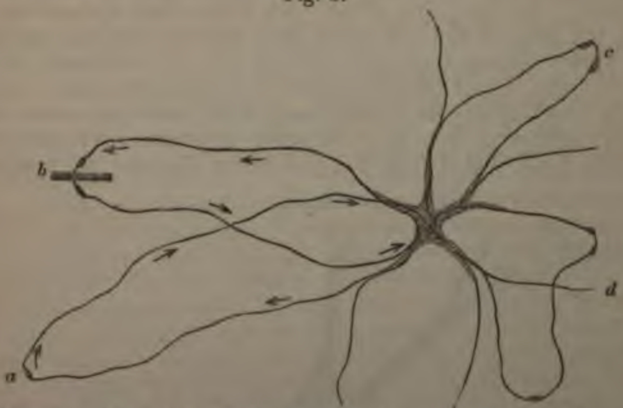


Diagram to show the possible relation to one another of the various circuits traversing a single caudate nerve-cell. *a* may be a circuit connecting a peripheral sensitive surface with the cell; *b* may be the path of a motor impulse; *c* and *d* other circuits passing to other cells or other peripheral parts. A current passing along the fibre *a* might induce currents in the other three fibres, *b*, *c*, *d*, which traverse the same cell.

* Papers in the 'Phil. Trans.' for 1860 and 1862. "Lectures on the Structure of the Tissues, at the College of Physicians, 1860."

† "On very fine Nerve-fibres, and on Trunks composed of very fine Fibres alone," 'Archives of Medicine,' vol. iv, p. 19. "On the Branching of Nerve-trunks, and of the subdivision of the individual fibres composing them," 'Archives,' vol. iv, p. 127.

‡ 'Lectures at the College of Physicians.' Papers in 'Phil. Trans.' for 1862 and 1863.

to consider these lines across the substance of the caudate nerve-cells as another remarkable fact in favour of the existence of such circuits; for while the appearance would receive a full and satisfactory explanation upon such an hypothesis, I doubt if it be possible to suggest another explanation which would seem even plausible.

Nor would it, I think, be possible to adduce any arguments which would so completely upset the view that nerve-force passes centrifugally from one cell, as from a centre, towards its peripheral destination, as this fact. So far from the fibres *radiating from one cell*, or from the nucleus as some suppose, in different directions, *all the fibres which reach the cell* are complex, and contain lines which *pass* uninterruptedly *through it into other fibres*. Instead of the cell being the point from which nerve-currents *radiate* in different directions along single fibres, it is the common point where a number of circuits having the most different distribution intersect, cross, or decussate. The so-called *cell is a part of a circuit*, or rather *of a great number of different circuits*.

I conclude that at first the formed material of the cell is quite soft and almost homogeneous, but that as currents traverse it in certain definite lines, difference in texture and composition is produced in these lines, and perhaps after a time they become more or less separated from one another, and insulated by the intervening material.

It may perhaps be carrying speculation upon the meaning of minute anatomical facts too far to suggest that a nerve-current traversing one of these numerous paths or channels through the cell may influence all the lines running more or less parallel to it (fig. 3).

I have ascertained that fibres emanating from different caudate nerve-cells situated at a distance from one another (fig. 4, *a*, *a*) at length meet and run on together as a compound fibre (*b*, *b*, *b*), so that I am compelled to conclude (and the inference is in harmony with facts derived from observations of a different kind), that every single nerve-fibre entering into the formation of the trunk of a spinal nerve, or single fibre passing from a ganglion, really consists of several fibres coming from different and probably very distant parts. In other words, I am led to suppose that a single dark-bordered fibre, or rather its axis-cylinder, is the common channel for the passage of many different nerve-currents having different destinations. It is common to a portion of a great many different circuits. The fibres which result from the subdivision of the large fibre which leaves the cell become exceedingly fine (the $\frac{1}{100,000}$th of an inch in diameter or less), and pursue a very long course before they run parallel with other fibres. As the fibres which have the same destination increase in number, the compound trunk becomes gradually thicker and more distinct. The several individual fibres coalesce and form one trunk, or axis-cylinder, around which the protective white substance of Schwann collects.

At the periphery the subdivision of the dark-bordered fibre again occurs, until peripheral fibres as fine as the central component fibres result.*

Although it may be premature to devise diagrams of the actual arrangement, if I permit myself to attempt this, I shall be able to express the inferences to which I have been led up to the present time in a far more intelligible manner than I could by description. But I only offer these schemes as rough suggestions, and feel sure

Fig. 4.

Diagram to show the course of the fibres which leave the caudate nerve-cells. *a*, *a* are parts of two nerve-cells, and two entire cells are also represented. Fibres from several different cells unite to form single nerve-fibres, *b*, *b*, *b*. In passing towards the periphery these fibres divide and subdivide; the resulting subdivisions pass to different destinations. The fine fibres resulting from the subdivision of one of the caudate processes of a nerve-cell may help to form a vast number of dark-bordered nerves, but it is most certain that *no single process ever forms one entire axis-cylinder.*

that further observation will enable me to modify them and render them more exact. The fibres would in nature be infinitely longer than represented in the diagrams. The cell below *c* (fig. 5) may be one of the caudate nerve-cells in the anterior root of a spinal nerve, that above *b*, one of the cells of the ganglion upon the posterior root, and *a*, the periphery. I will not attempt to describe the course of these fibres until many different observations upon which I am now engaged are further advanced, but I have already demonstrated the passage of the fibres from the ganglion-cell into the dark-bordered fibres as represented in the diagram.

The peculiar appearance I have demonstrated in the large caudate cells, taken in connexion with the fact urged by me in

* "General Observations upon the Peripheral Distribution of Nerves," my 'Archives,' iii, p. 234. "Distribution of Nerves to the Bladder of the Frog," p. 243. "Distribution of Nerves to the Mucous Membrane of the Epiglottis of the Human subject," p. 249.

[redacted]

several papers, that no true termination or commencement has yet been demonstrated in the case of any nerve, seems to me to favour the conclusion that the action of a nervous apparatus results from varying intensities of continuous currents which are constantly passing along the nerves during life, rather than from the sudden interruption or completion of nerve-currents. So far from any arrangement having been demonstrated in connection with any nervous structure which would permit the sudden interruption and completion of a current, anatomical observation demonstrates the structural continuity of all nerve-fibres with nerve-cells, and, indirectly through these cells, with one another.

Fig. 5.

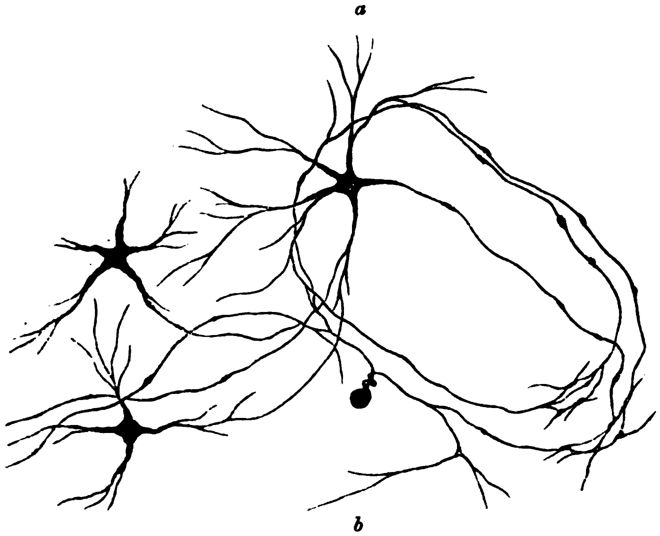


Diagram to show possible relation of fibres from caudate nerve-cells, and fibres from cells in ganglia, as, for example, the ganglia on the posterior roots. *a* is supposed to be the periphery; the cell above *b* one of those in the ganglion. The three caudate cells resemble those in the grey matter of the cord, medula oblongata, and brain.

I venture to conclude that the typical anatomical arrangement of a nervous mechanism is not a *cord with two ends—a point of origin and a terminal extremity*, but a cord *without an end—a continuous circuit.*

The peculiar structure of the caudate nerve-cells, which I have described, renders it, I think, very improbable that these cells are *sources* of nervous power, while, on the other hand, the structure, mode of growth, and indeed the whole life-history of the rounded ganglion-cells, render it very probable that they perform such an office. These two distinct classes of nerve-cells, in connexion with the nervous system, which are very closely related, and probably, through nerve-fibres, structurally continuous, seem to perform very different functions,—the one *originating* currents, while the other is concerned more particularly with the distribution of these, and of secondary currents induced by them, in very many different directions. A current originating in a *ganglion-cell* would probably give rise to many induced currents as it traversed a *caudate nerve-cell*. It seems probable that nerve-currents emanating from the rounded ganglion-cells may be constantly traversing the innumerable circuits in every part of the nervous system, and that nervous actions are due to a disturbance, perhaps a variation in the intensity of the currents, which must immediately result from the slightest change occurring in any part of the nerve-fibre, as well as from any physical or chemical alteration taking place in the nerve-centres, or in peripheral nervous organs.

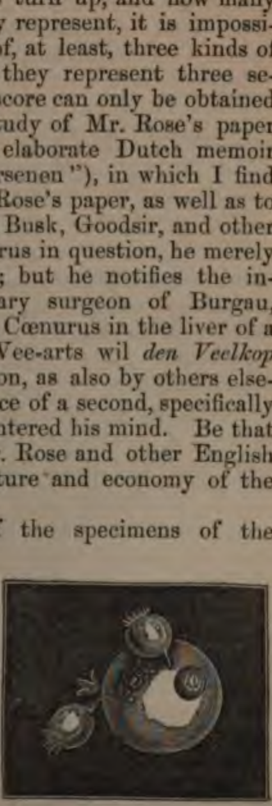
Linnean Society, *May* 5, 1864.

Note *on* Cœnurus. By T. Spencer Cobbold, M.D., F.R.S., F.L.S., Lecturer on Comparative Anatomy at the Middlesex Hospital.

I beg to call the attention of the Society to a specimen of Cœnurus obtained from the viscera of an American Squirrel which died at the Zoological Gardens, Regent's Park, several years back. In doing so, my object is partly to correct the opinion, still very generally held, that there is only one kind of Cœnurus, and partly, also, to point out the time when the existence of a second kind of Cœnurus was first demonstrated, and by whom, likewise, the discovery was made. When, in January 1859, I described to the Society a large Cœnurus obtained from the viscera of a Madagascar Lemur, I carefully abstained from theorizing on the subject, but I never entertained any doubt as to its distinctness from the ordinary *Cœnurus cerebralis* of the Sheep. I refrained also from giving it any specific title, on the ground that it was only a larval parasite. Shortly afterwards, Leuckart, in one of his able, 'Reports' in Wiegmann's Archiv (for 1860, S. 140), made special allusion to the description and figure as given in the Society's 'Transactions,' and at the same time referred to a case by Baillet who had recently discovered a Cœnurus in the pectoral muscle of a rabbit; he also quotes a similar example by Eichler, who had found a Cœnurus in the subdermal cellular tissue of a sheep. Until recently, I must confess that I was not aware that the discovery of a second kind of Cœnurus dated even much earlier than the period here mentioned, and I doubt if even Leuckart is yet aware of the earliest record on the subject. A few weeks ago, Mr. Caleb B. Rose, now of Great Yarmouth, but formerly of Swaffham, Norfolk, called my attention to the circumstance that he had described

Cœnuri from the rabbit so far back as the year 1833. He had, indeed, mentioned the fact to me at the Cambridge meeting of the British Association, two years ago, but I could not, at that time, look fully into the matter. I further understood that Prof. Owen had doubted the correctness of Mr. Rose's interpretation of the facts observed. On comparing the facts as described in the original paper (published in the 'London Medical Gazette' for November 9, 1833) with those observed by myself in the Cœnurus of the Lemur, and with those observable in the specimens now before the Society, I have no hesitation in saying that not only does a third kind of Cœnurus exist, but the priority of the discovery of the second kind of Cœnurus is due to Mr. Rose. How many kinds of Cœnuri may yet turn up, and how many specific tapeworm-forms they collectively represent, it is impossible to say; but my own examinations of, at least, three kinds of Cœnuri have led me to believe that they represent three separate species of *Tænia*. Proof on this score can only be obtained by future breeding-experiments. The study of Mr. Rose's paper further led me to look into Numan's elaborate Dutch memoir ("Over den Veelkop-blaasworm der Hersenen"), in which I find he has made frequent reference to Mr. Rose's paper, as well as to the earlier writings of Owen, Gulliver, Busk, Goodsir, and other English authors. As regards the Cœnurus in question, he merely gives the facts recorded by Mr. Rose; but he notifies the interesting circumstance that a veterinary surgeon of Burgau, Engelmeyer by name, has also found a Cœnurus in the liver of a cat. Numan says *the* Cœnurus ("De Vee-arts wil *den Veelkop* gevonden hebben"), by which expression, as also by others elsewhere given, I conclude that the existence of a second, specifically distinct form of Cœnurus never once entered his mind. Be that as it may, he has done full justice to Mr. Rose and other English writers who have investigated the structure and economy of the hydatids and their allies.

From a microscopic examination of the specimens of the Cœnuri from the Squirrel, it would seem that these last undescribed polycephalous bladder-worms represent a kind of intermediate type between the ordinary brain-Cœnurus and Echinococcus properly so called. At all events, in place of separate heads (scoleces) in groups irregularly massed together as in *Cœnurus*, I find bundles of heads, so to speak, forming small nodules, which are often arranged in a linear manner. There is, on the other hand, no evidence of a true brood-capsule, such as we find in *Echinococcus*; but the formation of daughter-vesicles, by the exogenous method of budding, reminds one of the ordinary



A moderate-sized *Cœnurus cuniculi*, with daughter-vesicles proliferating externally.—Rose.

mode of development seen in the hydatids derived from *Tænia Echinococcus*. There are some other minute points, on which I am not at present prepared to dwell; these may reasonably stand over for future investigation. The little drawing, of which the woodcut is a copy, lent by Mr. Rose, and representing his Cœnurus (called *C. Cuniculi* in his MS., but not so named in his published papers), is not unlike some of the Cœnuri from the American Squirrel, and it is not improbable that it may represent the larval condition of one and the same Tænia. What species of Tænia this may happen to be I do not care to conjecture, but I think it may be safely affirmed that it is not the *Tænia Cœnurus* of authors.

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ORIGINAL COMMUNICATIONS.

The ANATOMY *of the* EARTHWORM.
By E. RAY LANKESTER.

PART III.

IN the present number of the Journal the hæmal and nervous systems of the earthworm remain to be described. No special respiratory organs can be indicated. The processes, therefore, of the oxygenation of the blood and tissues will be considered in connection with the hæmal system.

HÆMAL SYSTEM.—In the earthworm, as in other Annelidæ, there are two fluids, each of which has claims to rank as "blood." One of these fluids is red and free from corpuscles, and contained in a very extensive series of vessels; the other is colourless and transparent, abounding in nucleated cells and corpuscles, and occupies the general or perivisceral cavity —the space intervening between the digestive tube and the muscular parietes of the body or integument. It is obvious that the latter corresponds to the fluid contained in and circulated by the heart of the Insecta and Crustacea, as has been shown by the researches of De Quatrefages. It is no less evident, as Professor Huxley has suggested, that the red vascular fluid is homologous with the water-vascular system of the Turbellaria, Trematode worms, and other Scolecida, which again appears in the Echinodermata as the ambulacral system, communicating with the exterior in the Echinidea and Asteridea, but definitely closed in the Ophiuridea, Crinoidea, and Holothuridea. The two fluids of the Annelid are represented still lower down in the scale of creation by one, as that contained in the somatic cavity and canals of the Clenophorous Actinozoa, which gives evidence of its homologies with the ambulacral system of Echinoderms by its relation to the tentacular processes, and with a nutrient system, such as that of the Asteropods by its intimate connection with the contents of the stomach. Thus, then, we gain a very definite view of the probable homologies of the two fluids in the earthworm, but it is not yet apparent which of the two should be called "blood," and recognised as the homologue of that fluid in the vertebrata—whether that which represents the sanguineous system of Insects, or the red fluid, homologous with the water-vascular system of Scolecida.

The following view, which tends to explain the matter and place it in a clear light, is put forward by my friend Professor Busk. In vertebrata the blood can be separated into two parts—the red corpuscles and the clear white plasma with the white corpuscles. The function of the red corpuscles, it is generally admitted, is to carry oxygen—in fact, is respiratory. The function of the plasma, on the other hand, with its white corpuscles, is simply nutrient. Assuming that this is a correct view of the case, since it is supported by many and conclusive facts, and, indeed, is very generally conceded, let us turn to the Annelida. We find a red fluid, undoubtedly devoted to respiratory purposes in many genera, and a colourless plasma with white corpuscles, bathing all the organs of the body. The conclusion is, obviously enough, that the red vascular fluid represents simply the corpuscles, whilst the colourless corpusculated fluid is homologous with the white plasma of vertebrate animals. It would be unsafe to draw any conclusions as to the respective functions of the fluids from this comparison. The functions of the two fluids in the Annelida have yet to be much studied, all that zoologists at present appear to be agreed upon being that the red vascular fluid is the chief medium through which respiration is effected; how far this function is shared by the corpusculated fluid, or how far nutrition is also a part function of the red fluid, are questions to which no decisive reply has yet been offered, though the considerations above adduced would tend (perhaps erroneously) to the conclusion that respiration belongs to the one and nutrition to the other exclusively.* In speaking, then, of these two fluids, I prefer

* M. Milne Edwards, in the remarkably exhaustive and valuable work, which he is now completing, commenced in 1857, and entitled 'Leçons sur la Physiologie,' adopts, to a great extent, the view advanced first by De Quatrefages, and used aftewards, more or less, by Dr. Williams, that in the Annelida, as a rule, the perivisceral fluid becomes oxygenated and transfers its oxygen to the vascular fluid, which, however, in other cases may become directly oxygenated by the direct contact of its containing vessels with external fluids. He also considers the vascular fluid as having a nutrient function (vol. ii, p. 95; vol. iii, p. 239).

Professor Huxley, on the other hand, is inclined to regard the system of vessels in which this usually red fluid is contained as an extreme modification of the water-vascular system of Trematoda and Cestoidea, which is by M. Milne Edwards considered as an excretory apparatus, by others as

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adopting such names as "red" and "colourless," or "vascular" and "perivisceral," fluids, to using the terms "pseudo-hæmal" or "chylaqueous system."

Colourless or Perigastric Fluid.—On opening an earthworm by a longitudinal incision the various chambers of the body formed by the interseptal muscles will be found to contain a certain amount of a free fluid, having a more or less milky appearance, but generally very nearly clear. This is the "colourless" or "perigastric fluid;" it varies very considerably in amount in different specimens, but is always most abundant towards the posterior end of the body. Though the interseptal muscles or diaphragms divide the perivisceral cavity of the earthworm into various chambers, it must not be supposed that each of these is hermetically sealed. In addition to the general osmosis by which the fluids of two contingent chambers can be exchanged, there are openings in the diaphragms, imperfect attachments to the intestinal wall and ganglionic cord, by means of which a communication is established freely from one end of the body to the other. Thus it is that in the last segments of the body we find by far the largest amount of perigastric fluid, containing also a variety of conspicuous foreign bodies, in the form of small white cysts, detached setæ, &c; the fluid itself also has a decidedly milky appearance. It was this congregation of foreign bodies at the posterior portion of the worm which led Sir Everard Home to regard the earthworm as self-impregnating and viviparous; it is, no doubt, owing to the continual pressure in an antero-posterior direction, to which the movements of the worm subject its body, that this accumulation takes place; but it of course depends also on the fact that there is a free communication between the various cavities, and that the fluid has no definite course of circulation to follow. In most cases, when a worm is opened, the anterior segments of the body will be simply moist, whilst the fluid increases in quantity as the posterior annuli are approached.

Communications with the exterior.—The perigastric fluid has two direct and apparently special series of communications with the exterior, by means of which it can escape from the worm's body; and another equally special series of communications, by which it appears that fluids can pass *from* the exterior, and become part of its substance. The most important of the two series of exits is that furnished by the "segmental organs," described in my last paper, which, by

respiratory, and by others as nutrient; the truth being, probably, that its function combines, more or less, the offices of all three, or of the first two at least.

means of their ciliated inductors and interiors, establish a continuous current, setting from their internal to their external apertures, which, of course, carries off daily a certain amount of the perivisceral fluid, since the trumpet-like inductors of the ciliated canals float freely in this liquid. Placed along the dorsal aspect of the worm's body, my friend Professor Busk has pointed out to me a series of openings or pores of considerable size, which form a second means of exit for the perivisceral fluid. They are situated nearly in the median line, and number three or four in each segment. All do not seem directly to perforate the integument and subcutaneous muscular layers; but they vary in this respect, as also in their relative position, which is not subject to any regularity. One of these orifices, situated in the median dorsal line of the segment, appears always to be larger than the others, and penetrates directly to the perivisceral cavity (fig. 9). That these openings form a very ready and frequent means of escape to the "colourless fluid" may be ascertained by handling a large earthworm, when some considerable quantity of colourless fluid is nearly invariably found to escape from its dorsal surface.*

FIG. 1.

* The following are Prof. Busk's notes on the subject, which, with Fig. 1, he has kindly given me to make use of.

LUMBRICUS TERRESTRIS.

Large specimen, with clitellus, &c., apparently well developed. Killed with chloroform, and the cuticle stripped off.

Surface presented pores as shown in figure No. 1.

The range of median dorsal pores commenced in the interspace between the 8th

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The means whereby the aqueous constituent of the perivisceral fluid appears to me to be chiefly replenished is to be found in the remarkable minute tegumentary canals, described and figured in my last paper, and resembling somewhat in their appearance "dentinal tubules." These minute canals

and 9th rings, and was thence continued, apparently without interruption, to the caudal extremity.

The fluid expressed from these pores was of a dirty grayish colour, thin and opaque. Examined under the microscope it contained numerous spherical particles and pyriform granular bodies, besides irregular organic particles. The only other openings observable on the dorsal aspect, as far as to the 32nd ring, where the clitellus commenced, were minute rounded pores of smaller size than the median dorsal, and situated, not in the intervals between the rings, but on the sides of the rings themselves, at a greater or less distance from the dorsal median line; they occurred in the following rings, viz. (see Fig. 1, p. 102).

There being none on the 1st, 2nd, 3rd, 8th, 12th, 16th, 25th, 30th.

From these puncta could be expressed a clear fluid, containing only minute nucleolar particles, and it was probably derived from the subcutaneous *glandular* tissue, constituting the lubricating fluid of the surface.

In a second specimen, prepared in the same way, and at the same time, and apparently in the same condition as to development, the arrangement of the pores and puncta was as follows.

No. 2.—Median dorsal pores commenced between 8th and 9th rings, and they afforded a fluid precisely like that of the former case. The puncta were situated in the following rings:

There being none perceptible on the 1st, 2nd, 3rd, 4th, 16th, and they were not looked for beyond the 22nd. The fluid expressed from them was the same as in the former case.

In other cases, again, the median dorsal pore did not exist anterior to the 11th segment, and the lateral puncta appeared very variable.

Besides these pores and puncta, in a worm which had been immersed in water, a general sweating or oozing from very minute pores, was observable all over the surface, especially on the dorsal aspect.

No other kinds of permanent openings exist in any part of the body except the mouth and anus. The sexual openings in the 16th segment appear to be formed only at the time they are wanted, and of these, as well as of the smaller lobes on either side, no vestige whatever is perceptible, even in very large worms, when not sexually mature. The same may be said of the clitellus, of which no indication whatever is often perceptible; one, also, of the two adherent discs (?) in the 27th segment, which appear to be formed solely for the purpose of sexual congress. They are developed on the situation, and, in fact, by a thickening of the integument immediately around the inner pair of setæ in that segment. This swelling is very porous, and a mucous fluid can be freely expressed from the pores. Another change in the external aspect of the worm, connected with the period of sexual activity, consists in the thickening and opacity of the subcutaneous tissue, in the ventral halves of the segments, extending from 8th or 9th to 14th or 15th (?), and which is more observable in the inside. And in the 11th segment, at this time, an elevation and porosity of the skin is set up around the inner pair of setæ, which, in some cases, are themselves altered in shape from the rest, and when pulled out they draw out with them a long stringy appendage, not apparently of cætera descent.

undoubtedly have the power of absorbing liquid by capillary attraction from the external surface, as may be demonstrated by immersing the caudal extremity of a worm in a solution of carmine and ammonia, when the capillary tubes will be found containing carmine if viewed under the miscroscope. *Composition.*—The composition of the perivisceral fluid which is thus situated in the worm's body now remains to be considered. Chemically, it appears to resemble dilute serum, and to have much the same constitution as the blood of higher animals, being, however, poorer, or containing a larger amount of water. Portions of it coagulate, and it becomes turbid when submitted to the action of strong spirits of wine; it has, moreover, a slightly saline taste, and an alkaline reaction with turmeric paper. When examined with the microscope it is seen to consist of a plasma and corpuscles, the latter varying in number, size and form. The general form of the corpuscles is a flattened transparent cell, containing granules and a nucleus, and about the $\frac{1}{1000}$th of an inch in diameter; sometimes they exhibit amœboid movements, but generally are inert. A great variety of particles of other forms are to be found in this perivisceral fluid, particularly at the posterior portion of the body. Among these are young forms of the *Monocystis Lumbrici*, one of the Gregarinidæ,* encysted individuals of this species, its pseudo-navicula, parasitic nematodes, and their eggs (fig 6). The colourless fluid presents, therefore, a marked contrast to the vascular fluid with regard to its intimate structure; its function may be briefly considered when the disposition and nature of the vascular fluid has been described.

Vascular, Non-corpusculated, or Coloured Fluid.—The vascular fluid of the earthworm is contained in a very extensive series of vessels, which have three principal trunks and various ramifications. The vascular system in Annelida is divided, by M. Milne Edwards,† into two parts—the cutaneous and the visceral. In the ideal representative, Annelida, the *cutaneous system* is considered as being composed of two longitudinal lateral trunks, which communicate with one another by their cutaneous and terminal capillaries, and also (as in the higher forms of Annelida) by direct transverse vessels, called by M. Milne Edwards the "inferior commissural vessels." This forms the cutaneous system; the two lateral trunks may be united into one and form a single *ventral* vessel, when, of course, there are no inferior commis-

* See the author's paper in this Journal, April, 1863.
† Loc. cit., vol. iii, p. 252.

sural vessels. In order to understand well the *visceral system* it is necessary to consider it as being composed again of two dorsal and two sub-intestinal trunks, each pair having a tendency, in the various modifications met with in the class, to coalesce and form a single vessel. The two dorsal vessels, when they are developed, are connected by transverse vessels, called "superior commissural vessels;" the two sub-intestinal vessels, or the one which they form, also communicate with the dorsal vessel by lateral branches, called "deep commissural vessels;" and, again, the capillaries of the cutaneous system communicate with the dorsal vessel, or it with them, by the "latero-dorsal" vessels, thus establishing a general communication.

Having thus seen what is the general arrangement in the Annelida, let us turn to the earthworm. If killed with chloroform, the worm presents on the dorsal surface of its alimentary canal, when opened, a rhythmically moving dark-coloured vessel, generally containing a considerable amount of the red fluid. This is the dorsal vessel of the visceral system, and extends from the eighth segment throughout the body (Part I, Pl. VII, fig. 5, and Pl. II, figs. 1, 2, 3, *a*). Beneath the intestine, but not closely attached to it as is the dorsal trunk, is the single sub-intestinal vessel (Pl. VI, figs. 1, 2, 3, *b*), also with highly contractile walls, but generally not to be observed in movement, inasmuch as the dissection required before it is reached destroys the lingering vitality of the worm. The sub-intestinal vessel extends throughout the whole length of the body excepting the first four or five anterior segments, where it is broken up into capillaries. The dorsal and sub-intestinal vessels are connected by the lateral "deep commissural vessels" (Pl. VI, figs. 1, 2, 3, *l*), thus completing the visceral system of M. Milne Edwards. Of the deep commissural vessels there are two in each segment posterior to the sixteenth, embracing the alimentary canal; those from the sixteenth to the nineteenth, in connection with the stomach and gizzard, dividing into a wonderfully fine capillary plexus, the vessels of which in the fibrous gizzard have a horizontal parallel disposition. From the nineteenth ring backwards the deep commissural vessels consist merely of a pair in each segment, closely attached to the wall of the intestine, and imbedded in or covered up by the yellow granular substance which is spread over its surface and is supposed to have a biliary function. Anteriorly to the sixteenth ring the deep commissural vessels are single; in fact, the two are fused into one, and, until the seventh segment is reached (when they cease to exist or become as the dorsal vessel itself, broken up into a capillary network investing the pharynx), they assume a more or less doubly conical form, and have been called by authors on the subject "hearts" (see Part I, Pl. VII, fig. 1).*

When the nervous cord extending along the ventral interior surface is dissected away from its attaching branches, and its inferior surface is examined, a delicate vessel, capable, however, of much expansion, is seen closely attached to it, sending out branches with the nerve-branches, and, in fact, following the ganglionic cord and its branches throughout the worm (figs. 1, 2, 3, *b*). It forms a capillary plexus at the cephalic and at the caudal extremities, thereby communicating with the dorsal and sub-intestinal trunks; this is, then, the main trunk of the *cutaneous system*, the single ventral vessel representing the two longitudinal lateral vessels met with in some other Annelida. The rest of the cutaneous system (figs. 1, 2, 3, *e*) of vessels is seen in the innumerable ramifications and delicate networks visible on the inner surface of the perivisceral cavity, which form one of the main objects of beauty attracting the eye when an earthworm is opened for dissection. There is no special superficial cutaneous circulation, that is to say, disposed near the external surface; a few vessels penetrate the muscular layers of the integument and give off numerous delicate branches, which are occasionally seen in the pigmentary layer; but there is no great cutaneous plexus, as, in fact, may be partly seen by the completely colourless aspect of the posterior three fourths of any worm's body; in fact, the integument of the earthworm has a *remarkably small* true cutaneous circulation, being, such as it is, merely adapted to perform the general offices of a vascular fluid. It is upon the interior superficies of the integuments that a plexus exists, belonging to the *cutaneous system* of M. Milne Edwards, which, perhaps, it were better to call *peripheral*. This plexus is supplied in each segment by a branch on either side from the ventral or sub-ganglionic vessel; it is also connected in each segment (the seven cephalic segments are exceptional) with the sub-intestinal vessel by a special branch on either side, and with the dorsal vessel by large vessels, given off on either side, closely connected with the diaphragmatic muscle, and sending branches elsewhere also. These latter vessels, or their representatives in other Annelids, are what M. Milne Edwards calls the *latero-dorsal* vessels. Thus, then, we see a general connection

* A somewhat serious error has been unaccountably made in the figure referred to. There should, of course, be but *one* pair of "hearts" in each segment.

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established between the three longitudinal trunks—between the great dorsal and the sub-intestinal by the deep commissural vessels, between the ventral and the dorsal and sub-intestinal by the internal superficial tegumentary plexus, and, again, between all three by the capillaries into which they break up at either extremity of the worm.

There is, however, another distribution of the branches of the great trunks by which they become connected, and it is in the diaphragmatic muscles and the segment-organs. A branch is given off on either side in each segment from the sub-intestinal vessel near the anterior septum, from the ventral vessel near the posterior, and these on either side entering the diaphragmatic muscle are distributed to the segmental organs in the manner described in my last paper, forming small lacunæ and networks most intricately and intimately ramified; and thus we have in connection with each segment-organ a special *afferent* and *efferent* branch. The latero-dorsal vessels send ramifications through the diaphragmatic muscles with which they are closely connected, as also do the branches from the ventral vessel, which, though not so constant and regular in their disposition as the pair of vessels in each segment given off from the dorsal trunk, may nevertheless be conveniently spoken of as the *latero-ventral* branches. Neither the latero-dorsal nor the latero-ventral vessels send any branches whatever to the segmental organs, which are supplied solely by the special branches from the sub-intestinal and ventral vessels; these branches may therefore be called the afferent and efferent excretorial vessels.

A modification of the visceral circulation takes place in the seven segments posterior to the seventh. It is in these segments that the organs of generation are situated, as also the three pairs of œsophageal glands, organs which are all most profusely supplied with the vascular fluid, and for the purpose of feeding which it would be supposed that the arrangements of an ordinary segment would be found inadequate. Accordingly, parallel to the sub-intestinal vessel are found two others, one on either side, with which the enlarged, deep, commissural vessels, or hearts, communicate (fig. 2, *p*). Branches are given off from all three of these longitudinal vessels to the various organs; the central sub-intestinal vessel supplying, especially, the testes and ciliated inductors of the vasa deferentia, whilst the parallel additional vessels seem more closely connected with the œsophageal glands.

We have, then, in the various segments of the worm's body four principal modifications of the circulation, the simplest of which is that extending from the 19th segment to the penultimate one, and represented diagrammatically in figs. 1 and 3. The seven cephalic segments, and the one caudal, in which the circulation is merely capillary, all the great trunks being broken up, form a second modification, whilst the third is that described above in the generative segments, and represented diagrammatically in fig. 2; whilst a fourth modification occurs in the 15th, 16th, 17th, 18th and 19th segments, where the deep commissural vessels are large and *single*, but there are no additional parallel vessels.

Structure of the Vessels.—The vessels, thus disposed for the purpose of circulating the red fluid, may be considered as possessing an internal structureless amorphous tunic, without epithelium, and an external tunic of more or less modified connective tissue; between these two are longitudinal and transverse muscular fibres in some of the smaller as well as in the large vessels.* In most of the vessels the transverse fibres are radiated from a point and placed in bundles at intervals (fig. 7). The result is that when the transverse fibres contract they produce an uneven moniliform appearance in the blood-vessels, but are the more effective in propelling the fluid. The alternating points of contraction and expansion in the dorsal vessel and so-called hearts are well seen when a worm is freshly opened.

Structure of the Vascular Fluid.—The vascular fluid is completely devoid of corpuscles, and is entirely structureless. It is more easily coagulated than the perivisceral fluid, but otherwise appears to have the same composition. The nature of its colouring matter is not known.

Functions and homologies of the Vascular and Perivisceral Fluids.—It has been already pointed out that De Quatrefages has established the existence of undeniable homological relations between the perivisceral fluid of the Annelida and the fluid occupying sinuses and lacunæ among the Crustacea, Arachnida, and Insects,† and circulated by a heart with valves, and considered as true blood. The researches of Professor Huxley‡ tend to establish the conclusion that in the vascular system we have a closed representative of the water-vascular system of Scolecida. The function of the two fluids does not in any way necessarily affect the question of their homologies, and in considering the part which they play in the animal economy we must not be hampered by the

* See Leydig's 'Lehrbuch der Histologie.'
† 'Annales des Sciences Nat.,' 1843—1854.
‡ 'Brit. Ass. Reports,' 1854.

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hypothesis sometimes hazarded as to the function of the water-vascular system of Scolecida or the blood-sinuses of Arthropods. There can be no doubt that the vascular system of the earthworm, as in other Annelids, is adapted for exposing its fluid to the action of oxygen. How does it do this, and has it any other functions? In no Annelid can it be satisfactorily shown that the vascular fluid has a definite circulation; the fluid is made to move, to oscillate, and pass more or less from one series of vessels to another by the contractions of the vessels, but, as M. Milne Edwards observes, there is no definite circle of movement. In certain Annelids M. De Quatrefages has shown that the perivisceral fluid absorbs oxygen; this he has demonstrated chemically, and it appears that, as a rule, the perivisceral fluid absorbs oxygen, to which the vessels of the vascular system afterwards become submitted. In the earthworm, then, it is probable that the perivisceral fluid absorbs oxygen or water containing oxygen through the capillary canals forming a characteristic structure of the integuments. To the action of this the fluid contained by the vascular plexuses and the great vessels is everywhere more or less exposed by osmotic action. It would appear also that this process takes place to a very large extent in the vessels distributed to the numerous diaphragmatic muscles, which are necessarily very largely subject to the action of the perivisceral fluid.

Another vastly important function of the vascular fluid, and one for which it seems specially adapted, is *excretion*. This takes place through the segment-organs, and is also shared in a minor degree by the perivisceral fluid which is continually passing through them.

Absorption of alimentary matters may equally be the function of both fluids; certain matters passing by osmose through the very delicate walls of the intestine into the perivisceral cavity, and others possibly, though not very probably, being absorbed by the delicate networks formed by the visceral branches of the vascular system. It has been hinted by Claparède* that the greenish-yellow mass of granules enveloping the intestine and the dorsal vessel and its branches, even at its anterior extension, may have some connection with the formation of the corpuscles of the perivisceral fluid, and assist materially in other respects in the functions of that liquid. It appears very certain that in the earthworm the perivisceral fluid absorbs aliment through the intestinal walls, and nourishes all the organs which it bathes, and also it brings oxygen to the vascular

* 'Recherches sur les Oligochetes.'

fluid, whilst this latter removes waste matters from and oxidizes the tissues, and performs all the offices of excretion and secretion.

NERVOUS SYSTEM.—The nervous system of the earthworm consists of a sub-intestinal and supra-intestinal chain of ganglia, with their branches. I have little or nothing here to add to the very elaborate, accurate, and detailed description given by Mr. Lockhart Clarke, in his paper published in the 'Proceedings of the Royal Society' for 1857, but will give a brief description of the subject of his researches, in which I shall make extensive use of his essay.

In the centre of the third ring of the worm, overlying the pharynx, are two closely united pyriform ganglia, or a single bilobed ganglion, of which the lobes are united by their broad ends in the mesial line. This is the *supra-œsophageal ganglion.* The small end of each of its lobes divides into two nerve-trunks, of which one forms the root of its cephalic nerves (fig. 6), and the other the *pharyngeal crus,* which curves round the sides of the pharynx, to join the first sub-ventral ganglion.

From each crus, or from either side of the collar thus formed (see fig. 6), there spring eight or nine nervous branches. The first four or five arise from the under part of its anterior half, and immediately enter the upper surface of a minute and delicate cord-like chain of ganglia, the chain which was above designated the *supra-intestinal portion* of the nervous system. This very interesting structure was, to all intents and purposes, discovered by Mr. Clarke, since Brandt and others had only spoken of it as a simple dorsal twig, given off from the bilobed cephalic ganglion. The chain lies on the side of the pharynx, concealed by the crus. The breadth of its first ganglionic enlargement is the $\frac{1}{250}$th of an inch in a good-sized worm. Each border of the chain gives off several trunks of considerable size, which unite to form a continuous plexus, supplying with its inner part the muscular and mucous coats of the pharynx, with its outer the muscular bands and salivary tubules. From the pharynx the plexus descends along the side of the œsophagus, lying on the abdominal vessels, and communicates with minute filaments from the nerves of the subventral ganglia.

The four or five nerves which are given off on either side from the posterior part of the crus communicate with each other by loops before they leave it. The first and largest sends some filaments to the muscular bands of the mouth, upon which they communicate by evident but slight dilatations with the plexus of the pharyngeal chain, and, after supplying the muscles of the anterior segments, are lost in the integument of the lower lip. The rest take nearly the same course. But what is extremely interesting is that the roots of the nerves of this the posterior set are continuous across the crüs with those of the anterior set belonging to the supra-intestinal chain.

The *subventral chain* of ganglia forms with its nerves the sub-intestinal portion of the nervous system. It is a double cord, gangliated at short intervals by the addition of vesicular substance and extending from the third ring throughout the body. Anteriorly the cords are divergent and form the two pharyngeal crura, posteriorly they become closely cemented along the middle line. The ganglionic enlargements vary in shape, size, and approximation, at different parts. Each gives off from its sides two pairs of nerves, which, after sending some filaments to the diaphragmatic muscles and bands, supply the longitudinal circular and oblique muscles of the rings midway between the ganglia; the intervening cords give off a single pair, which are distributed to the deep muscles on each side (see fig. 6).

The *cephalic nerves*, which take their origin in one of the trunks on either side, into which the bilobed supra-pharyngeal ganglion divides, are distributed to the lower surface of the first segment, forming a very delicate organ of touch; another portion of the nerves forms a curious plexus in the pigmentary layer, and is connected with the large clear cells there met with. Mr. Clarke suggests the possibility of these forming a mechanism adapted to the perception of diffused light, though not of distinct vision. That the first segment of the worm, with its nervous plexuses, does form a very important organ of perception, there can be no doubt.

Structure of the Nerves and Ganglia.—In fig. 8 nerve-cells and a portion of a nerve-fibre from the sub-ventral chain are drawn. In fig. 7 a portion of the cord, less highly magnified, is represented. The structure of the various parts of the nervous system of the earthworm, as studied by Mr. Clarke, has yielded most interesting and important results. Each lobe of the cephalic or supra-pharyngeal ganglion is a pyriform sac, which is very thick and convex posteriorly, where it is partially separated from its fellow by a deep notch. This convex portion is opaque white, and filled with a mass of semifluid granular substance, and oval, round, and pyriform cells of various sizes, but often very large. The anterior half, by which the lobes are joined, is merely lined by a lamina of cells, and only at its upper part, its under side having a cell here and there. The interior of this portion is entirely fibrous, and consists of a broad, transverse, commissural band, derived from the pharyngeal collar, and of fibres from the roots of the cephalic nerves. Each crus of the collar enters its lobe on the under side. Some of its fibres curve backwards to the convex vesicular mass; others ascend to, perhaps partly terminate in, the cells near the roots of the cephalic nerves, and the rest cross transversely, as the broad band, to be continuous in front of the notch with that of the opposite ganglion.

The supra-intestinal chain of ganglia, when placed under a $\frac{1}{8}$th objective, displays a remarkable structure. The under surface of the entire chain—cords as well as ganglia—is covered with a lamina of round, oval, and pyriform cells, and on its upper surface a row of cells of the same kind is found along each border. At every point of communication between the branches which form the plexus a minute ganglionic enlargement is seen, from which new branches proceed to form other enlargements of the same kind. As the plexus extends from the chain the ganglionic points diminish in size, while the smaller branches given off from the trunks increase in number, and communicate like a capillary network. The ganglia of the subventral chain have their vesicular substance on the under surface, and consist of about two strata of cells continuous in a lamina across both cords. Along their borders, however, the cells form a thicker layer or column, which extends for some distance along the intervening cords. In form and general appearance the cells are similar to those of the pharyngeal chain, but many of them are larger. Within the ganglia the roots of the nerves diverge in three different ways—1, longitudinally; 2, transversely; and 3, to the gray or vesicular substance. The first, or longitudinal, form a large portion of the nerves, and run in equal numbers in both directions, backwards and forwards, along the whole length of the corresponding cord. In their course some of them near the border separate in succession from the rest and enter the lateral column of cells; others proceed as far as the next nerve, with the roots of which they form loops, and pass out, while the rest continue onwards and, perhaps, in succession form similar loops with distant nerves. Mr. Lockhart Clarke has shown that the same kind of arrangement exists in man and the mammalia as well as here. The second order of fibres are less numerous and, in general, less distinct than the rest. They proceed from the middle of each opposite root, and cross the cords directly. The third order of fibres are those distributed to the vesicular substance. Mr. Clarke was not able, after repeated examinations with the microscope, to trace an undoubted continuity between the cells and nerve-fibres in more than one or two instances, although there is good reason to believe that such a connection exists. Dr. Rorie, in a paper published in this Journal two years since, which cannot certainly bear comparison with Mr. Clarke's,* figures multipolar nerve-cells from the ganglia of the earthworm. His observations are, in all probability, erroneous, as my own entirely confirm those of Mr. Clarke, whose accuracy, care, and acuteness, are, moreover, too well known to be doubted.

Functions and Homologies.—The supra-intestinal portion of the nervous system evidently presides over the operations of the viscera, whilst the sub-intestinal portion is more closely connected with the locomotive function. The supra-intestinal chain is, however, as we have seen, connected by its branches with the sub-intestinal ramifications, and its roots also are closely associated with those of the other nerves arising from the pharyngeal crura. Mr. Clarke considers that it combines the office of a sympathetic with certain other functions which in many invertebrata are entrusted to separate and special centres; such as the labial, pharyngeal, and visceral ganglia in cephalophorous mollusca. By experiments I have satisfactorily demonstrated to myself that the pharyngeal chain is independent of the other nervous centres, although, at the same time, subject to their influence, and can control the suctorial movements of the mouth and pharynx, and is a centre of reflex action. Mr. Clarke has also established this fact by experiment.

Two parts of the human brain are compared by Mr. Clarke to the transverse cephalic band of *Lumbricus*. One is the arched and commissural band of fibres prolonged through the corpora quadrigemina, from the upper and inner part of the fillet on each side. The other part, which is analogous or homologous with the cephalic band, is the corpus callosum. Dr. Rorie, in the paper quoted above, advances the opinion—stating, at the same time, that he reserves his reasons—that the supra-œsophageal ganglia are analogous to the cerebrum of man and the higher mammalia, and to the spinal cord, whilst the ventral chain he regards as belonging to the sympathetic system, and the pharyngeal crura he considers to be the homologue of the vagus. I need hardly say that, as Dr. Rorie brings forward no facts to support this view, and as Mr. Clarke very ably and carefully gives details of structure and anatomy to support his, the opinion of most intelligent persons will coincide with that of the latter observer.

RECAPITULATION.—*The hæmal system* of the earthworm

* 'Quart. Journ. Micro. Science,' April, 1864.

consists of a corpusculated colourless fluid, contained in the somatic cavity, and provided with exits and a series of capillary canals for the entrance of liquid, and of a red-coloured, non-corpusculated fluid contained in three longitudinal trunks and their ramifications. Both are albuminous; the former is homologous with the blood of Insects and Crustacea, and probably performs a nutritive function; the latter is homologous with the water-vascular system of Scolecida, and has an excretory or urinary function through the segmental organs, and a respiratory function, in connection with the oxygen absorbed by the perivisceral fluid.

The nervous system consists of a supra- and a sub-intestinal portion, both of which present the usual components of fibres and cells. The principal centre is the cephalic bilobed ganglion, homologous with the corpus callosum and the commissure prolonged through the corpora quadrigemina. From this in one direction pass the cephalic nerves, in the other the phargyngeal crura, uniting beneath the pharynx to form the subventral cord and ganglia. From the pharyngeal crus four branches on either side unite to form the supra-intestinal chain or plexus discovered by Lockhart Clarke, and homologous with the sympathetic and visceral ganglia of mollusca. Four other twigs on either side are distributed to the pharynx. The muscles of the segments are presided over by the subventral cord. There are no special organs of sense, unless the labial segment should be so considered.

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RECORD *of the occurrence, new to* IRELAND, *with* NOTE, *of a Peculiar Condition of the* VOLVOCINACEOUS ALGA, STEPHANOSPHÆRA PLUVIALIS (Cohn), *and Observations thereon.* By WILLIAM ARCHER.*

THE discovery in Ireland of the very interesting and very beautiful and apparently very rare organism, *Stephanosphæra pluvialis* (Cohn), would in itself alone be worthy of a record in the 'Proceedings' of this society. But inasmuch as, whilst I had a supply of this "Volvocine" in my possession, a remarkable phase or condition in its history—so far as I am aware, not before observed in this form, though not without parallels elsewhere—presented itself to my notice, the value of that record becomes thereby in so far enhanced.

Spending an evening in the month of June last at Bray, I took a walk upon the "Head," promising myself, indeed, not much of interest (save the beautiful view), from its dry and rocky summit. The weather had lately been showery, and during the day a considerable quantity of rain had fallen. This had left behind small deposits of rain-water in a few little hollows amongst the rocks. In one of these tiny pools I perceived the water tinged with a beautiful light-green colour. A few moments' inspection, even without a lens, was sufficient to indicate that this green hue was due to the presence of myriads of some "volvocinaceous" plant; and with a lens I soon perceived, by the annular and band-like green portions of the organisms, as they appeared under so low an amplification, alternately brought to view, that I had had the good fortune to encounter that seemingly rare organism, *Stephanosphæra pluvialis* (Cohn), which Professor Cohn journed from Breslau to Hirschberg to see, and for the occur-

* Read before the Natural History Society of Dublin, May 6, 1863.

rence of which I can find hitherto but six localities, the present making a seventh. These are—Saltzburg, found by Werneck, Zambra, and Von Frantzius; Hirschberg, in Silesia, by Von Flotow and Cohn; summit of Heuscheur, in Grafschaft Glatz, Silesia, by Cohn; Lapland, by Wichura; Schneeberg, Saxony, by Rabenhorst; Scotland, by Strethill Wright; and now, lastly, at Bray Head, Ireland, by myself. It is very probably more common than these few localities might indicate, but these are at least all the records I can find.

As may be imagined, with no small amount of avidity I pocketed a supply of the treasure thus placed at my feet. The specimens so obtained afforded an opportunity in a great measure to follow out the statements made in Cohn's beautiful memoir,* with respect to the organization and development of this plant, such as the *macro-* and *microgonidia*, &c. As regards the latter, nothing further presented itself as to the purport or function of the bodies so called; like Cohn's own original specimens, they were formed and disappeared.

This gathering was extremely free from other organisms. *Chlamydococcus pluvialis* did not present itself, thus, in that respect, unlike Cohn's original supply. A very few specimens, however, of *Gonium pectorale* occurred, but in so trifling numbers that for a fortnight after I had obtained the material I do not believe I noticed half a dozen individuals, while the *Stephanosphæra* existed in myriads. The only examples of animal life to be noticed were a very few lively specimens of a noble rotiferon, a Brachionus.

However, before drawing attention to the peculiar condition alluded to, a very brief description of the organism in question may not be out of place; indeed, such would perhaps be of advantage, if not essential (in the absence of a previous study of Professor Cohn's extended memoirs), to the appreciation of the confessedly imperfect observation which it is the object of this paper to communicate, and which, indeed, is the only new one I have to note that has not been recorded by Cohn; and in doing so I shall not enter into minute details beyond those which bear directly on the subject of this note.

* Cohn, "Ueber eine neue Gattung aus der Familie der Volvocinen," in Siebold und Kölliker's 'Zeitschrift für wissenschaftliche Zoologie,' Band iv (1852), p. 77, tab. vi; also 'Annals of Nat. Hist.,' 2nd ser., vol. x, pp. 321 *et seq.*, 401 *et seq.*, pl. vi; also Cohn and Wichura, 'Ueber Stephanosphæra,' Kais. Leop.-Car. Akademie der Naturforscher; Bonn, 1857. Of the latter memoir there is a short abstract in the 'Quart. Journ. of Microscopical Science,' Vol. VI, p. 131.

The Family of Chlorospermatous Algæ, Volvocinaceæ, to which this plant belongs, is characterised by the individual green cells, being, during the greatest part of their life, active zoospore-like bodies, ciliated, either solitary or combined into definite groups, and either with a common enveloping membrane, until breaking up in carrying out vegetative developmental processes, or without a common membrane. With the exception of the genus Protococcus (Chlamydococcus), which is a single cell, the cells, though thus for the greater part of their existence associated into colonies, maintain their special physiological individuality; and collectively, at the same time, represent but one individual in relation to external objects. With these general characters Stephanosphæra accords; that is to say, it consist of colonies of ciliated cells which originate from a single mother-cell through a series of divisions following a definite law; and, when completed, the colony possesses its own characteristic collective figure and organization. Here there are eight green masses of protoplasm—"primordial cells" (Cohn)—arranged circularly at regular intervals within a common hyaline membranous globe, so as to form an equatorial series. Each primordial cell is furnished with a pair of flagelliform cilia, which protrude through the hyaline globe, and, by their action in the surrounding water, cause the active revolution hither and thither of the aggregate family, that is, of the Stephanospæra-globe. Regarding the direction of the wreath or series of eight primordial cells as the *equator* of the globe, the rotating movement is effected round the axis uniting its *poles*, and its vigorous onward movement takes place in all possible directions.

Scarcely a more charming spectacle can be than a multitude of these elegant organisms vigorously rotating hither and thither, brightly green, and, under a peculiar light, glittering and flashing as they move, now showing a polar, now an equatorial view, or all intervening positions, rapidly passing and repassing, curving, and wheeling, and gyrating, crossing and recrossing each other, huddling and thronging sometimes in numbers together, again starting off, occasionally rotating without advancing or "resting on their oars"—some larger and older, some smaller and younger, some showing young revolving Stephanosphæræ within, some developing "microgonidia," some in one stage, some in another. In respect of beauty and gracefulness, indeed, a number of the larger, gently revolving, emerald-studded globes of *Volvox globator*, executing their elegant revolutions, must, I think, carry off the palm; but their numbers, and the amazing enegy of the gyrations of Stephanosphæra, the remarkable figure of the primordial cells, the differing sizes and curious appearances of the variously developed globes, might cause some to give the latter the preference as a handsome object. Each, indeed, is certainly a charming sight!

To revert, however, to our subject. Notwithstanding that the structure and development of this organism has been copiously detailed in Cohn's cited elaborate memoirs, a brief *résumé* here will be necessary in order to draw particular attention by and by to one or two points in its structure and organization, which I am disposed to think in some measure foreshadow the remarkable phase presently to be adverted to.

Stephanosphæra, then, consists, as we have seen, of a family or colony of eight green, biciliated protoplasm-masses (primordial cells), destitute of a proper cell-membrane, and arranged in a circle, more or less approximately and at even distances from one another, at the equator of a common enveloping, hyaline, rigid membranous sphere, composed of cellulose—the "envelope-cell" ("Hüllzelle," Cohn). Though the normal form of the envelope-cell is spherical, I have occasionally, but extremely rarely, noticed such as possess, even when fully grown, an elliptic, or ovate, or subtriangular, or sometimes even a figure-of-8 shape; such very rare and casual distortions do not seem at all to interfere with the otherwise normal growth and movements.

It is by the action in the surrounding water of the two flagelliform cilia belonging to each primordial cell, protruded directly through the envelope-cell, that the revolving and onward movement of the total organism is effected. The primordial cells present great variety of form—in the simplest condition globular, or nearly so. But in a fully grown Stephanosphæra, when viewed equatorially, these primordial cells very frequently appear to be elongated in a direction toward the poles, and very often to a greater extent in one hemisphere than in the other—reaching sometimes almost to the pole in one, and leaving the other partially empty—that is, an equatorial line in such cases would not cut the primordial cells into equal halves. These, whose general form in this condition in an old family, when viewed equatorially, may be said to be usually broadly fusiform or subelliptic, frequently present several filiform, often dichotomously ramified, more or less attenuated, colourless prolongations of the protoplasm, especially from their opposite ends, sometimes even tuft-like; these are occasionally very divergent laterally, or even project towards the centre of the envelope-cell. When the organism is quite mature these colourless prolongations are most attached to the inner surface of the envelope, but never perforate it. When a Stephanosphæra-globe is seen in polar view the outline of the primordial cells mostly appears somewhat acuminate towards the common envelope, and from such apex the pair of cilia take their origin. The primordial cells possess, immersed in their substance near the middle, two symmetrically-disposed, round bodies, called by Cohn nucleus-like vesicles, and said to possess an internal cavity.* To me, indeed, they appeared quite identical with the so-called "chlorophyll-vesicles" (Näg.) of other plants, to which, indeed, Cohn afterwards compares them.† Such may convey an idea of a perfect family—of a fully-grown Stephanosphæra.

Now, as to the developmental changes connected with propagation, the primordial cells, as described by Cohn, undergo three kinds of changes. I shall first allude to that of "macrospores." The colourless prolongations of the primordial cells become drawn in, and the primordial cells themselves become rounded. A slight elongation of a primordial cell about to vegetate then takes place; it becomes gradually transversely constricted and divided into two cells, which expand slightly from left to right; these two cells become divided each into two, those again into two, thus producing eight; the constrictions, however, taking place only in such directions that the young resultant group presents the form of a flattened spheroid, having somewhat the appearance, when either of the larger surfaces is towards the observer, of a *wheel*. These changes do not take place simultaneously in all the eight primordial cells of an old sphere, but are to be met with in different degrees of advancement. The further growth consists in the development of a delicate common membrane closely investing the young disc-like family, and in the centrifugal separation of the new primordial cells, upon the completion of the several radial constrictions, and in the development of cilia. After escape into the water by the bursting of the original envelope-cell the new envelope-cell of the young family, from being at first of a very considerably depressed figure, gradually expands in the polar direction until the spherical form is attained—the primordial cells meanwhile acquiring their mature appearance and structure. Thus, each parent Stephanosphæra can normally give rise to eight young Stephanosphæræ, though families of but four

* Loc. cit. ("Ueber eine neue Gattung aus der Familie der Volvocinen"), p. 83.
† Ibid., p. 97.

cells occasionally, though rarely, occur (and still more rarely families of five, six, or seven), through arrested subdivisions of the parent primordial cells; whilst I have once or twice met with families of sixteen cells, arising from the "transition generations" (Näg.) being carried one stage further—that is, the (normally) eight cells each dividing once again before arriving at the fully formed or "mature stage," which may in similar manner be called the "permanent generation" (Näg.).

A second change connected with the propagation consists in the disassociation from the hyaline sphere, and the contraction of the primordial cells, as before, into rounded bodies; but in this instance this is followed by the formation round each of a special cellulose wall, through which protrude two cilia, by the agency of which these Chlamydomonas-like cells swim vigorously about, at first within the old parent-globe, afterwards outside it, when they have made their escape by its destruction. Finally, these Chlamydomonas-like bodies come to rest, lose their cilia, and assume a Protococcus-like appearance, or these Protococcus-like resting cells may apparently be formed without an intermediate motile Chlamydomonas-like state. These Protococcus-like cells have the power of increasing in size after their formation, and before any further development. Cohn and Wichura's researches have demonstrated the remarkable fact that not only are these capable of revival upon being covered with water after complete and lengthened desiccation, but that such desiccation is absolutely necessary to induce further changes in the direction of the renewal of the Stephanosphæra-globe. A few hours after being remoistened the cell-contents of these resting-spores become divided into two, then into four (possibly sometimes eight) daughter-cells, the cellulose wall vanishing. These daughter-cells become biciliated, and presently one by one separate and swim freely away as so many pear-shaped zoospores. Afterwards, coming to rest, they acquire a membrane, which at first closely surrounds the contents, but presently expands, and, standing off, leaves the body of the primordial cell in the middle, which protrudes a pair of cilia through the wall, thus again assuming a Chlamydococcus-like appearance. The contents often in this stage present a number of hyaline, frequently branched or forked projections in various directions from the outer protoplasmic layer (like those from the opposite ends of the primordial cells of the mature plant), and which touch the inner surface of the cellulose wall. But after an interval these Chlamydococcus-like structures begin to divide; if the protoplasmic processes exist, they are previously drawn in, and the primordial cells become rounded—a series of self-divisions sets in, similarly to those of the primordial cells of the perfect Stephanosphæra in the first mode of propagation, the cilia become lost, and the process is carried on until the same result is attained—that is, until from each Chlamydococcus-like body an eight-celled, in all respects characteristic, perfect Stephanosphæra is produced. I pass by the time required for these processes, as well as the hours of the day or night with which such developmental changes seem, as in other instances, mysteriously associated.

It may be well here momentarily to draw attention to an instance of the great similarity which often exists at certain stages of apparently essentially quite distinct organisms, and which occasionally more than ordinarily forces itself upon our attention.

I have mentioned that, when I first obtained the material, the presence of *Gonium pectorale* (Ehr.) was indicated by only a very few specimens indeed; but in about three weeks, in one of my bottles, this organism made its appearance in very considerable numbers, and they were remarkably fine and beautiful examples of this elegant form. In all respects they seemed to me to agree with the beautiful figures and description of Gonium given by Cohn.* I may remark that these specimens seemed to me considerably larger and finer than those one usually meets with, and more intensely green. In the material alluded to, which I possessed, numbers of the Gonium were to be found in the various stages of self-division figured by Cohn. But likewise a number of the specimens were present, as is often the case, from which some of the constituent cells of the tablets had been removed by some external force, or insufficiency of mutual coherence; and, moreover, what appeared to be these isolated cells (or occasionally, indeed, dislocated in twos or in threes) were not a few of them to be seen actively urging themselves about in the surrounding water. Now, furthermore, some of the old globes of the Stephanosphæra occurred upon the slide, and some of these showed the primordial cells in the Chlamydomonas-like state above adverted to, and these vigorously moving up and down within the old, often much collapsed, envelope-cell, while some of these had lost their normal number of eight, some, indeed, yet retaining only two or three. Now, at this point I was quite unable to distinguish

* 'Untersuchungen über die Entwickelungsgeschichte der mikroskopischen Algen und Pilze.' Kaiser. Leopold.-Carol. Akademie der Naturforscher, Bonn, 1854, p. 163, tab. xviii, figs. 9, 14, 15, 16, 17.

one of these isolated motile bodies disassociated from a Gonium-tablet from an isolated motile body set free from an old Stephanosphæra globe, both of which, after the emergence of the latter, moved freely about in company; nor, apart from a knowledge of their origin, could either be distinguished, I think, from so many examples of Chlamydomonas had they been present.

But from this I do not mean to argue more than a puzzling resemblance between the two. A single Gonium in the original material would have sufficed to give origin to the multitudes which afterwards made themselves apparent, conspicuous even to the naked eye, by their mass. I should be disposed to hold that here, as elsewhere, resemblance may by no means necessarily demonstrate identity; and although these isolated motile bodies, thus proceeding from Gonium and Stephanosphæra respectively, were so much alike as to be indistinguishable to the eye, for the present I doubt not there must have been between them some more subtle distinction, and that in the progress of development in their natural conditions they would each have gone into their respective mature forms (and this notwithstanding what I have afterwards to advance), although Cohn did not see (nor have I noticed) the isolated cells of Gonium, but only those still undisturbedly *in situ*, become segmented, and directly form a new young Gonium-tablet; whilst, on the other hand, as has been stated, it can be demonstrated by direct observation that in Stephanosphæra the single Chlamydomonas-like primordial cell eventually produces a new Stephanosphæra-globe. Cohn neither in his first nor in his and Wichura's subsequent memoir on Stephanosphæra makes any allusion to any development of Gonium making its appearance in the material which formed the subject of his earlier observations on the former organism; but I find that he incidentally mentions, in his memoir on Gonium,* that on one occasion, at least, a copious development of this latter organism took place in a vessel in which he had been cultivating Stephanosphæra; and that in so great quantities, that the water resembled a green mucus, and in each drop thousands abounded. This is, then, at least a possibly noteworthy coincidence, and the circumstance, *quantum valeat*, is perhaps deserving of this cursory record.

A third developmental change of the primordial cells of Stephanosphæra, connected doubtless in some way with propagation, is that which results in the formation of "microgonidia." Their development is at first like that of the

* Op. cit., p. 169.

"macrogonidia;" that is, the division of the primordial cells into two, into four, into eight, but not stopping here, but again dividing into sixteen, and so on, and finally into an innumerable number of minute, elongate, fusiform, quadriciliate cellules—the "microgonidia." These do not at any stage secrete an envelope-cell, but remain crowded together within the original envelope-cell, inside of which they actively move hither and thither in an amazingly rapid and energetic way, than which there is scarcely any more astonishing sight; these finally escape from the old envelope-cell by its rupture; and losing their cilia, coming to rest, and assuming a reddish colour, become developed by a series of self-divisions and formation of special walls into structures somewhat like in *form* (and I believe in that only) to Botryocystis, or to Kützing's Microcystis or Polycystis; of these any further development is unknown. It has been supposed that these microgonidia, as in Volvox, may be, perhaps, looked upon as spermatozoids; but no such function seems to be confirmed by actual observation. It is, perhaps, more probable that they are homologous rather with the microgonidia of Hydrodictyon, a plant otherwise presenting so very many affinities with Stephanosphæra. Pringsheim has shown that in Hydrodictyon the microgonidia are really structures intended themselves eventually to reproduce the plant in a future season.*

It will be seen that Stephanosphæra differs from its well-established fellow-genera in Volvocinaceæ—not to descend to minor but important details of structure and development—from Volvox, in having the zoospores or primordial cells eight only, and at the equator, not numerous all over the periphery of a sphere; from Pandorina, in having eight only at the equator, not sixteen or thirty-two, arranged in tiers; from Gonium, in having the eight primordial cells within a common spherical envelope, not sixteen, each having a thick coat, cohering by certain points of their surface into a tablet; and from Protococcus (Chlamydococcus), by the cells not being solitary.

Having thus endeavoured to convey an idea of the nature and appearance, of the structure and development of Stephanosphæra, a necessary preliminary to the short and very imperfect note I have to offer, I now proceed to draw attention to the peculiar condition which it is meant to record.

I have mentioned that, at a certain time, the primordial

* 'Berichte der Akademie der Wissenschaften zu Berlin,' 1860; 'Ann. des Sciences Naturelles,' ivme Ser., t. xiv, p. 52; 'Quart. Journ. of Mic. Sci.', N. S., Vol. II, p. 54.

cells in this organism, having become removed from the inner surface of the common hyaline sphere (envelope-cell), and having acquired a rounded figure, may proceed thereupon to further developmental changes, with the object of directly producing each a new young globe, or may assume temporarily either an intervening Chlamydomonas-like or Protococcus-like condition. Now, in certain of my specimens the development of the primordial cells had advanced in this direction so far as the drawing in of the protoplasmic prolongations and the assumption of a rounded form, in which condition they sometimes persist for some time when long in the house in a secluded position, the globes still revolving vigorously and actively. But having isolated a considerable number of these examples on a growing-slide, and on my return to them some hours afterwards, I was very greatly astonished to find the slide to a considerable extent crowded by a number of what appeared to me to be Amœbæ of some undescribed species, and these in active movement, gliding about and crossing each other in every direction. These were certainly not to be seen when I last looked at the slide, and the phenomenon was beyond measure puzzling. I therefore rigidly examined them. It will readily be believed that my astonishment was beyond measure great upon shortly beyond all question identifying these vigorously active Amœba-like bodies with the just previously absolutely quiescent primordial cells of the Stephanosphæra—nay more, in watching the transformation of the latter themselves into the reptant amœboid bodies, putting a parasitic development wholly out of the question: it will readily be believed, I say, that my astonishment was beyond measure great in actually witnessing with my own eyes this, at first sight, sufficiently startling phenomenon. What! a plant, an undoubted true chlorophyll-containing, by cellulose externally bounded, Alga, become metamorphosed into an animal! For my part, indeed, even after witnessing the wonderful change now mentioned, I could not acquiesce in such an assumption; and so far as I can see, in my humble judgment, those who might be disposed thus to understand it would greatly misinterpret the phenomenon.

I shall try to describe these remarkable bodies more fully.

I have spoken of the primordial cells of these examples having become retracted from the inner wall of the hyaline sphere, and having acquired a rounded form within it, as if possibly about to undergo either the ordinary process of self-division, or it might be the Protococcoid or the Chlamydomonas-like developmental condition before alluded to, the movement of the globe itself having ceased. But, upon a closer examination of certain of these, there was to be seen a gentle hyaline convexity or expansion gradually being extended from the green margin of the primordial cell, and again slowly drawn in, whereupon another similar projection took origin close beside the place where the first had vanished. This again receded, to be followed, perhaps, by another in the same or nearly the same situation as the first, or at all events near thereto (Plate VII, fig. 3). Presently the extension and withdrawal of these hyaline prolongations became more frequent and vigorous, while they appeared to be chiefly confined to one hemisphere. Afterwards the mass became somewhat elongated, the hyaline projections more lobose and more changeable, and finally the primordial cell assumed somewhat the *outward* characters figured for *Amœba limax* (figs. 4, 5, 6). The general contour of the so far changed primordial cell, supposing it at rest, might now be described as broadly clavate or pyriform, the narrower end tapering very considerably, and bluntly pointed. From the considerably expanded upper end only the lobate pseudopod-like extensions were projected; and of these generally not more than two or three existed at one time, so that this margin mostly thus presented a trifid or bifid outline. The narrow end seemed to be nearly if not quite rigid; at least, neither from it nor from the sides were any of the pseudopod-like extensions put forth, whilst the narrow extremity itself seemed to possess somewhat of a slightly granulated appearance. All traces of the conspicuous pair of "chlorophyll-vesicles" (for as perfectly homologous with the bodies *so-called* in other algæ I regard them) had vanished—the green contents, keeping their colour, had become more decidedly granular; the granules, which were very crowded and abundant, and of varying sizes—the variations, however, taking place within very narrow limits—were apparently quite free from each other, and with the alternating movements of the lobate extensions became rolled onward, I might almost say, just as so much shot (of somewhat differing sizes) in a caoutchouc bag might be, supposing it endowed with a like innate automatic mobility. I could find no trace of a nucleus, nor of a contractile vesicle, as in a true Amœba; however, if such really existed, I fancy the extreme density and abundance of the opaque green, granular contents would have prevented their being noticed; and I may add, there was not a single instance of any foreign organic body to be seen in their substance. But, to borrow the terms made use of for a true Amœba, the "endosarc" and "ectosarc" (so to speak) were abundantly well differentiated. The latter, I apprehend, more correctly regarded as actually the so-called "primordial utricle," was hyaline, presenting a border of nearly equal width all round, and at all parts of the external margin, except at the attenuated extremity, was very clearly and sharply defined; at the narrow, mostly bluntly pointed extremity, as I have already said, the margin presented a somewhat granular appearance, or at least not a smoothly defined outline. Beyond the limits of the inner boundary of the hyaline border the contained green granules did not infringe, no matter how energetic or changeable the movements of the pseudopodal processes (figs. 4, 5, 6).

The changes described did not take place by any means simultaneously in all the eight primordial cells of any Stephanosphæra-globe; but while one, perhaps, might have attained the complete amœboid state, another might be still in the simple condition of a rounded uncoated cell, without as yet any apparent intention to undergo the wonderful change described, whilst several of the others might exhibit various intervening phases between both conditions (fig. 3). During the changes of the primordial cells described, the old common hyaline envelope-cell of the Stephanosphæra became collapsed and burst, or, it may be, more or less dissolved, and from its trammels the now reptant amœboid primordial cells, by means of what were decidedly their own automatic movements, by degrees mostly all succeeded in becoming one by one wholly emancipated.

A pseudopod was projected from the broader rounded anterior extremity of one of the so greatly modified primordial cells, not slowly—not, as it were, hesitatingly—but with great vigour and considerable rapidity. The hyaline lobose expansions were generally extended to about a quarter or a third of the whole length of the total amœboid body; and no sooner had one began to be projected than a rapid flow of the granules at once took place into it, but still not infringing on the hyaline border. This was scarcely accomplished when another similar lobose expansion was projected from the opposite side of the frontal or anterior margin, and thus, by drawing into it a similar influx of the granular contents, rapidly obliterating the former. One, two, or three (rarely more) of these lobose expansions, were mostly evident at a time, but, of course, in various degrees of expansion and retraction, an influx of the granules taking place into that most recently formed at the expense of the others, the newest advancing always onwards beyond the others, and thus was a rapid reptant movement executed (figs. 4, 5, 6). Their onward progress was often made in a tolerably straight line; but, of course, curves and sweeps, sometimes even somewhat abrupt, were effected, the broader frontal margin being always carried in advance, the attenuated extremity always at the posterior.

In this way these amœboid bodies travelled over the field with quite surprising rapidity, crossing and recrossing each other in all directions. Under a low power, insufficient at first sight to show the amœboid or "rhizopodous" mode of progression, these reptant bodies might possibly have momentarily called to mind so many minute green Planariæ, their crawling movement partook so much of a regular gliding character.

So rapid was the action of the pseudopodal extensions and that of the onward flow of the general mass, and so energetic was the locomotive power of these remarkable amœboid bodies, that, not unfrequently, one of these primordial cells which had fully assumed this condition, prevented by some cause or other from becoming wholly extricated from the old Stephanosphæra-globe, was actually able to drag about along with it (like hermit-crab and his whelk-shell) not only the old envelope-cell, but the perhaps still therein contained seven other more or less changed primordial cells; and, all the while, apparently not much retarded nor materially incommoded by the incumbrance!

It may be worth while, *en passant*, to note the analogy in the differentiation of the extremities of these amœboid bodies with that of Dr. Wallich's lately described *Amœba villosa** —the tapering, faintly granulate, posterior extremity seeming to correspond to the villous rounded organ in the actual Amœba, described and figured by Dr. Wallich. This appears at least a curious point in common. In both the narrowed extremity was always posterior, the pseudopods always being given off from the opposite or anterior portion, and in both, hence, the onward progression was more direct than in most similar bodies, as well as more rapid; though, so far as I can see, if we could imagine one of Dr. Wallich's Amœbæ pitted against one of my Amœbiform bodies, the former, I fancy, would have been beaten in the race!

I have, indeed, never seen any actual Amœbæ, nor do I imagine anybody else, whose movements were so rapid and power of locomotion so vigorous as those of these amœboid bodies of Stephanosphæra. One might almost fancifully imagine them endowed with a will, and in an evident hurry to get somewhere, but unfortunately with a bad

* 'Ann. Nat. Hist.,' 1863, vol. xi, 2nd ser., pp. 287 *et seq.*

memory, and always forgetting what their destination should be, or with what object they set out; or, as if they each had lost something, and all were laboriously and diligently making the best use of their locomotive powers, under the hallucination that there might be a hope of fortuitously stumbling upon it unawares!

After having, I might almost say, *disported* themselves in the manner described for a period from about twenty-four to thirty-six hours, their locomotive powers began to wane and their energy and agility to flag; presently their onward progress became gradually slower and slower, and the lobose pseudopodal processes alternated more and more lazily and languidly, until, by degrees becoming more and more inert, they finally one by one became altogether still. At this point, I greatly regret, my observations on this marvellous condition also came to an end. Just as they had all or nearly all acquired a rotund protococcoid figure, having been obliged to leave them, the slide, upon which they were, became dried up during my absence, nor could I find at any other period any more of these Stephanosphæræ undergoing this remarkable phase. But, from finding in the bottle whence these were taken, numbers in the protococcoid condition, it is probable, had these special examples not been interrupted or thwarted in their development, that they too would have passed from the amœboid to the protococcoid condition.

I presume I need not here delay by urging the now, I believe, universally acknowledged claims of Stephanosphæra, and of the remaining Volvocinaceæ, to rank in the vegetable kingdom. Their whole affinities are with certain algæ of the Chlorospermatous class. *Hydrodictyon utriculatum*, an indubitable alga (not found in Ireland), presents at every step of its history points in common with Stephanosphæra; and both Hydrodictyon and the Volvocinaceæ are closely related to Pediastreæ, and to the genus Polyedrium (Näg.), &c. &c. So intimate is this affinity, that I conceive those who would now refer Volvocinaceæ to the animal kingdom would be compelled to include Hydrodictyon and Pediastreæ in the transfer, and, so far as I could see, by an inevitable sequence, the whole of the Confervoideæ (Chlorospermeæ) likewise; which, I need hardly remark, would be simply absurd.

There was a time when locomotion effected by the agency of cilia was regarded as an infusorial or animal characteristic; now it is well known that very many undoubted vegetables, in some phase of their existence, are provided with these appendages. There was a time when the existence of the so-called "eye-speck" was regarded as a peculiarly animal indication; it is now well known that the active spores of many undoubted algæ possess this red dot; nay, some unicellular plants, whose whole life seems to be passed in a still condition, very beautifully exhibit this characteristic. There was a time when the presence of a "contractile vesicle" was looked upon as an animal characteristic; but this too shows itself in plants—for instance, Gonium. There was a time when contractility, though merely indicating itself by a capacity of altering relative length and breadth, or of taking and recovering an external impression, was regarded as purely an animal mark; but many vegetable cells (zoospores) possess it. There was a time when the presence of starch was regarded as a strictly vegetable characteristic; but this product has been found in the animal kingdom—for instance, Amœba. And yet, so far as I know, there are but few of the organisms exhibiting any of these puzzling or apparently contradictory phases just alluded to which the most experienced observers have lately, *merely on that account*, thought fit to remove in their conceptions from the one kingdom to the other. I pass by the futile and uncalled-for efforts of some to form an intermediate kingdom between the animal and the vegetable kingdom. And surely, then, it appears to me, if certain organisms in the one kingdom in the course of their life-history temporarily undergo or simulate those phases which I have alluded to more especially characteristic of some organisms belonging to the other kingdom, it is, perhaps, at least *not more* surprising, after all, that a strictly vegetable cell should assume temporarily an amœboid condition. It appears to me that not one of these contradictory temporary phases seems in the least to prove the actual and essential convertibility of an organism belonging to one kingdom into the other. It is quite true, indeed, that any one looking at one of my amœboid bodies for the first time, and knowing nothing of its origin, could hardly but believe that it was a true Amœba, but so peculiar and distinct, even at first sight, as that it could not be mistaken (so far as I can see) for any described Amœba, but would naturally have been looked upon as a new species. But all misconception as to these points becomes altogether done away with, and any such assumptions become wholly set aside, when we *know* that it was no Amœba at all, but only an amœboid state of the vegetable Stephanosphæra; and had it been so described by any one as a new Amœba, in ignorance of its nature, it is probable that, some time or other, as the result of subsequent observation, it would, as a species, have shared the fate of many of Ehrenberg's *quondam* Infusoria, now known to be zoospores of algæ, &c.

But, what the special import of this curious and remarkable exceptional temporary condition in Stephanosphæra, which I have sought to describe, might be, I cannot dare to take upon myself to conjecture. However, if we seek for and find precedents or examples in the vegetable cell, though some of them may be evinced even in a much less marked degree, of that peculiar contractility exhibited by this organism, while it would not detract from nor diminish the marvel, it would at least lessen the surprise natural on at first witnessing or considering the phenomenon.

Let us look back, then, in the first place, for a moment, to one or two conditions of Stephanosphæra itself, and I think we shall find that a similar phenomenon presents itself to that forming the subject of this paper, but in a far less marked, therefore, at first sight, in a far less notable and surprising degree.

Let us refer to the typal full-grown Stephanosphæra;* and, as has been stated, we frequently find the protoplasm of the primordial cells drawn out at each extremity into several filiform, somewhat branched, colourless prolongations, mostly in contact with the inner surface of the hyaline envelope-cell. We find, preparatory to the primordial cells undergoing the Protococcoid or other intermediate developmental condition, that these protoplasmic elongations are drawn in. Now, except as regards the length of time occupied in the process, I do not see any essential difference between this and the action of the pseudopodal processes in my amœboid bodies—the one, in the ordinary course of its existence, takes hours to project and again to withdraw what, with equal right, may be called "pseudopodal processes," while in the other the act was momentary. It is true that, in describing these protoplasmic prolongations in the primordial cells, Cohn and Wichura† suggest that these in the young Stephanosphæra adhere, here and there, at certain points, to the inner surface of the envelope-cell; and that during the expansion of the latter, as it approaches maturity, these prolongations of the protoplasm may thereby be gradually drawn out. But one frequently sees some Stephanosphæræ in which the primordial cells are not thus drawn out into these slender prolongations; indeed, I find them constantly so when kept some time in the house in semi-obscurity, and therefore these do not seem to be due to a structural peculiarity, but to the innate power

* Cohn., l. c., pl. vi, 2, 4, 5, 6, 7.

† 'Ueber Stephanosphæra,' loc. cit., p. 16.

of the primordial cells to put them forth. Nor, again, when present, do they all seem to reach the inner surface of the envelope-cell, and some even finely drawn out appear to project obliquely inwardly. Similar extensions of the protoplasm are, in other stages of development of Stephanosphæra, to be seen figured in Cohn and Wichura's memoir,* which in the course of development are again drawn in; so also in Chlamydococcus. Now, it seems to me that this ordinary behaviour of the primordial cells in the development of this organism, and the action of my rapidly reptant amœboid bodies (precisely the same primordial cells), are manifestations of one and the same phenomenon, differing only in the degree of intensity with which they are evinced.

(*To be continued.*)

On the Discovery *of* Arachnoidiscus ornatus *and* A. Ehrenbergii, *at* Malahide, *Co.* Dublin. By Captain F. W. Hutton, F.G.S., Deputy-Assistant-Quartermaster-General at Dublin.

On the 14th December, 1864, I made a gathering of diatoms at Malahide, from a small pool of brackish water near the sea, and west of the railway; the pool was apparently above the reach of the highest tides, but the water in it was very salt. On the 16th I boiled a small portion of this gathering in nitric acid, and dried it on a slide for examination, and amongst the other diatoms I was surprised to find a beautiful specimen of *Arachnoidiscus ornatus*. (See fig.)

X 150

X400

I then carefully examined the rest of the gathering, but could only detect one specimen of *A. Ehrenbergii* in it. The other diatoms in this gathering were *Epithemia musculus*, *Cocconeis scutellum*, *Coscinodiscus radiatus*, *Actinocyclus undulatus*, *Surirella gemma*, *S. salina*, *Nitzschia sigma*, *N. dubia*, *Amphiprora alata*, *Navicula didyma*, *Pinnularia cyprinus*, *Pleurosigma strigosum*, *P. angulatum*, *P. acuminatum*, *P.*

* 'Ueber Stephanosphæra,' tab. ii, 12, *a*, *b*, *c*.

fasciola, *P. littorale*, *Denticula* (sp. ?), *Melosira nummuloides*, and a few frustules of *Biddulphia aurita*. Ten of these, according to Smith, inhabit the sea, six either the sea or brackish water, and two brackish water only. I think that these two frustules of Arachnoidiscus must be considered *boná fide* Irish specimens, and not adventitious, for the following reasons:—I have never worked at, or had in my possession, any guano or fossil diatomaceous earth; but in February last I had a small piece of sea-weed from China given to me, from which I obtained about a dozen specimens of *E. Ehrenbergii*, but none of *A. ornatus*.

Luckily it so happened that both the glass slide and the dipping-tube which I used in examining the gathering from Malahide were quite new, and had never been used before. The bottle also into which I collected these diatoms never had had anything but fresh-water diatoms, &c., in it. The only other thing that came in contact with the gathering was the test-tube in which it was prepared, and in which I might, perhaps, have boiled the sea-weed from China which I have before mentioned; but even if so, the test-tube has been in constant use ever since for preparing other, chiefly fresh-water, British diatoms, and had been washed out and cleansed dozens of times since the Arachnoidisci were in it. No rag of any sort had touched that first portion of the gathering in which I found *A. ornatus*, and of course I took the precaution of using an entirely new one in examining the rest of the gathering. I have carefully examined the test-tube since, and am quite satisfied that no others remain in it, as so large and distinct a diatom is easily recognised with an inch object-glass.

Taking, therefore, into consideration the fact that a frustule of *E. Ehrenbergii* was found by M. de Brébisson, actually, I believe, attached to a specimen of *Sphacelaria olivacea*, Ag., sent to him from Ilfracombe by Mr. Ralfs, it appears to me more probable that these specimens of mine are really British than that the two frustules should have remained in the test-tube for ten months, notwithstanding repeated boilings and washings, and should have at last come out both together with a quantity of other diatoms whose habitat is precisely similar to their own.

REVIEW.

Catalogue of Objects in the Museum of the Microscopical Society of London, 1864.

It has always been to us a matter of some surprise as well as regret that the authorities having the direction of great public museums in this country have hitherto taken no steps in the direction of exhibiting to the numerous persons seeking instruction and amusement in such places that vast field of life and structure which is opened out by the microscope. It is no less strange than true, that not only is our national collection destitute of the means necessary for rendering the public conversant with the minuter forms of life, and the details of form in the higher animals, but even to the student no facilities *whatever* are afforded in the domain of microscopic research by that institution. It would be deemed probable by most persons that in a museum, one of whose chief directors has obtained great reputation as an odontologist, there should have been a collection of sections of various recent and fossil teeth, adapted for examination with the microscope, and arranged for comparison, not to speak of the series of well-mounted insects, Annelids, and other smaller and almost invisible animals, that might have been looked for in the zoological department. But this is not the case; neither is there a collection of microscope-sections of teeth, nor any series of specimens mounted for use with that instrument. The student of comparative histology and minute zoology and botany would be left entirely to his own resources and those of his private friends, were it not for the existence of two collections in London to which he can gain access, and which, however incomplete, when we consider what a public collection of microscopic preparations ought to be, are nevertheless eminently useful and interesting, and tend far to supply the deficiency which we have noticed elsewhere.

The histological collection of the Royal College of Surgeons is now open to the microscopist for purposes of comparison and examination. We need not point out how valuable such a collection as this must be to any engaged in microscopic research. The number of slides containing objects for observation with the microscope numbers 12,149. They are most excellently arranged, catalogued, and ticketed, and are kept in a large cabinet with seven or eight tiers of drawers, each about an inch deep, and two feet by one in area. The drawers are ticketed on the outside, so as to render their contents more easily available, and a systematic arrangement is adopted, the whole collection being divided into a physiological series, a pathological series, and a natural history series. The natural history series includes all preparations for the microscope of animals, plants, and minerals, with the exception of the Vertebrata, which are classed separately as a physiological and pathological group. This arrangement is most excellent, and adds greatly to the convenience and utility of the collection. The numbers of specimens are seen in the following list, taken from the report of the distinguished conservator of the museum, Mr. Flower.

PHYSIOLOGICAL SERIES.

Elementary Tissues	1250
Structure of Special Organs:	
The Skeleton	1182
The Teeth	1010
Organs of Digestion	618
Organs of Respiration	240
Nervous System and Organs of the Senses	540
Circulatory, Urinary, and Generative Organs	600
Hewson's Preparations	100
Dr. T. J. Todd's Preparations (chiefly showing the processes of inflammation, repair, and regeneration of the tissues in the lower vertebrate animals)	850

PATHOLOGICAL SERIES.

Diseases of various Tissues and Organs	*420

NATURAL-HISTORY SERIES.

Mineral Kingdom, including Coal	672
Vegetable Kingdom	1740
Animal Kingdom:	
Protozoa and Porifera	540
Zoophyta and Echinodermata	932
Mollusca	505
Annelida and Insecta	800
Crustacea and Arachnida	150
Total	12,149

* Exclusive of 448 Specimens of Diseases of the Eye.

This extensive and valuable collection was chiefly formed by the late Professor Quekett, but has been considerably added to by the purchase of specimens from Dr. Tweedy J. Todd (of Brighton), and Mr. Nasmyth; also by a fine series illustrating the structure of the spinal cord, prepared by Leuhonek, in Lockhart Clarke's method. In every drawer there are specimens of the greatest interest, and most are remarkable for the beautiful manner in which they have been prepared. The series of teeth is particularly fine, including the dental organs of all the groups of Vertebrata; and indeed there is not a specimen in the whole collection which is not especially interesting, either on account of its rarity or the skilful manner in which it has been manipulated. During the past year, under the superintendence of Dr. Mury, the whole of the collection has undergone a careful examination, useless specimens have been rejected, and specimens badly prepared have been remounted, whilst every object has been ticketed with its name, and with a number referring to a manuscript list, which it is hoped will soon be published. We may mention here that we observed that all the specimens in the collection were kept lying flat on the drawer, and not in racks. It is, we believe, most important that this arrangement should be universally adopted, as, in the course of time, almost any description of mounting will run if the slide be tilted. The histological collection of the Royal College of Surgeons is open for general inspection every Wednesday, and the student may gain access at other times. A microscope of first-rate quality and powers is placed ready for use, and every facility is afforded by the excellent curators.

The collection of the Microscopical Society of London is the only other collection of microscopic objects in London not entirely private. The catalogue of this collection, which has lately been published for the accommodation of members of the Society, is now before us. Though by no means so extensive a collection as that belonging to the Royal College of Surgeons, there are many series of specimens in it of much value, either on account of their rarity or as illustrating important observations published in the Society's 'Transactions' or elsewhere. The total number of specimens is about 1300, and all are carefully ticketed and referred to in the Catalogue. By far the greater part of the specimens have been presented to the Society by distinguished men of science, who have prepared the slides themselves in the course of their researches in various subjects where the microscope forms an important auxiliary of observation. Thus, we observe sixty-three slides illustrating the structure of the shells of the Mollusca, presented by Dr. Carpenter. The section of the shell of the recent *Rhynconella psittacea* is, we notice, entered in the catalogue as *Atrypa psittacea*. Surely the compiler of the Catalogue could not have meant to expunge the genus Rhynconella from the Brachiopoda, and amalgamate it with Atrypa; this must be a slight oversight. To Professor Hyrtl, of Prague, the Society is indebted for twenty-four beautiful injections of the kidneys, intestines, &c., of various animals. Mr. Crum, of Glasgow, has enriched the collection by thirty-four slides of cotton-fibre, variously prepared and mounted, which illustrate a series of researches, published not long since, by that gentleman. The richest part, however, of the Microscopical Society's cabinet is that which contains its series of diatoms. From every quarter of the globe there are examples of these minute organisms, some presented by naturalist-travellers, others by residents in the distant regions whence they come, others, again, casually observed among they contents of a bottle of sea or river water. A group of various forms is presented by Mr. G. Blenkins, taken by him from the Tchernaya River, Sebastopol; others are there from Calcutta, Hong Kong, the Andaman Islands, and Melbourne.

The Catalogue, which must prove very serviceable to the members of the Society, is arranged in an alphabetical order; when such words as Diatomaceæ, Shell, &c., are arrived at, the various specimens belonging to that series are arranged underneath them; but they also occur in the proper alphabetical order, indicated by their names.

It would be unfair to institute a comparison between the two collections we have been noticing. That of the College of Surgeons is, of course, by far the larger, and exceeds the Microscopical Society's particularly in histological specimens; but the cabinets of the latter contain very many specimens which are well worthy of the attention and observation of the student. One peculiar and very admirable feature about the management of the collection of the Microscopical Society is that the members of the Society are allowed to take out twenty slides from the collection at a time, and retain them for three weeks, thus establishing a system, with regard to the microscopic objects, similar to that adopted in the management of circulating libraries. The plan appears to us most excellent.

We heartily recommend those of our readers who are really interested in the use of the microscope, and have a little leisure time, to make the best of their way to Lincoln's Inn

Fields, and see some of the beautiful objects there preserved; amongst them they are sure to find specimens of special interest to themselves, perhaps illustrating points of form or structure at which they may have themselves been working; and those who are members of the Microscopical Society we beg to remind of the fact that they are at liberty (subject to certain restrictions) to have twenty specimens from the Society's cabinet at a time—a means being thereby afforded them of leisurely and carefully examining many typical or rare specimens.

There can be little doubt that all who take a sincere interest in the progress of biological science will also take an interest in these public collections of microscopic objects. They cannot show that interest more appropriately than by presenting to one or other of these collections rare or unique specimens in their possession, or series illustrating original discoveries. Many an observer will go to great trouble and expense to mount certain objects for observation under the microscope; when once seen, drawn, and described in the chronicles of some scientific society, they are of little or no further use to him. How, then, can he best dispose of such specimens? Surely there could not be a more satisfactory method of ensuring their safe preservation and accessibility to future observers than is adopted in presenting them to one of these two large collections. It would, perhaps, be well if histological and pathological specimens were added to the series already so well developed at the Royal College of Surgeons; whilst specimens of general natural history, Diatomaceæ, Bryozoa, &c., should be handed over to the Society's cabinet.

We leave these suggestions for the consideration of our readers, in the hope that they may bear some fruit, trusting that some of those who have read these remarks may soon examine for themselves these two public collections of objects mounted for the microscope, and that it will not be long before a third, far larger, and far more comprehensive collection, shall have been developed in connection with our great National Museum.

[redacted]

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

Conjugations of Navicula serians, N. rhomboides, and Primularia gibba. By H. T. Carter, F.R.S. ('Ann. and Mag. of Nat. Hist.,' March, 1865.)—This is a most valuable and remarkable paper, and one which cannot fail to attract much attention from microscopists, more particularly those who are engaged in the investigation of the Diatomaceæ. Only thirty-two species of the Diatomaceæ are recorded as having been seen in a state of conjugation, and nine years ago, when Mr. Carter published his descriptions of three species undergoing that process, twenty had been observed, so that no great progress has been made in this branch of inquiry. Mr. Carter returns to it now, having been anxious, he states, to satisfy himself of the presence of a transversely ringed siliceous sheath enclosing the sporangial frustule, which was observed by Dr. Griffith, in a Navicula form. His observations have been made on the three species above-named, obtained from bogs in the neighbourhood of Budleigh Salterton, in Devonshire, and enveloped in a gelatinous mass. We extract his description of the conjugation in *Navicula serians*, Rg.:—"1. Two frustules, varying a little more or less in size, approximate themselves. 2. They secrete a gelatinous substance around them, which becomes covered by a delicate pellicular membrane. 3. The sarcodal sacs force open respectively their frustules through the fissiparating divisional line, and carrying with them their contents, now all undistinguishably mixed together, approach each other and unite into one (?) spherical mass called the spore or sporangium. 4. The sporangium divides itself equally into two spherical sporangial cells, each of which forms around itself a thick opalescent capsule. 5. The capsules respectively divide in their equatorial lines, and expose the sheaths of the sporangial frustules. 6. Th sheaths become elongated, and at the same time pre thread-like rings on their surface, diminishing graduall thickness towards each extremity, but in close approxi scopic eyes have been much overlooked. They consist of a black or reddish pigment of very definite structure, impressionable by luminous rays, and in immediate relation to the nervous system in those animals which possess one. Photoscopic eyes have been met with in the Sipunculidæ, in certain Annelida,* and especially in the Hermellæ, described by De Quatrefages. The photoscopic eyes of Asteracanthion have long been known as pigment spots situated at the end of each ray. They are, however, more fully organized, and more certainly visual organs than was once supposed. They occupy a small papilla near the end of each ray, in the interambulacral furrow, which receives a filament from the ambulacral nervous trunks, enlarged beneath into a ganglion. The spiniform calcareous processes surrounding this tubercle can be closed down upon it by muscles, thus forming a sort of eyelid. When placed under the microscope the oculiferous papilla is seen to consist of red pigment indented and covered over by a gelatinous medium of lenticular form, the whole being intimately connected with the nerve filaments. The gelatinous medium serves to concentrate the light, and it is considered by M. Jourdain that we have here the most perfectly organized photoscopic eye.

Observations on the Structure of the Nervous System in Clepsine. By E. Bandelot. ('Comptes Rendus,' Nov., 1864.) —The nervous chain of Clepsine is of the same type as that of the other Hirudineæ. One of the ganglia examined shows two elements—the fibrous and the cellular. The fibrous portion appears as a median ribbon, the cellular consists of six capsular inflations, which appear to contain unipolar cells, varying in size from the $\frac{2}{100}$th to $\frac{4}{100}$th millim. Each of these contains a nucleus of large oval form, with enclosed nucleoli. The produced extremities of the cells are connected with radiating fibres. The various ganglia are found to be composed more or less pairs of simple ganglia, according as they contain more or less of the cellular capsules. Cells are attached also to very fine lateral branches, and a gastric system is ascertained to exist in Clepsine, showing that the gastric network detected by Faure in the leech is the analogue of the stomato-gastric of other annelids.

A paper on '*The Development of some Opisthobranchs*' appeared last quarter, by Mr. Alexander Stuart, of St. Petersburg, in which he traces the growth of the ovum, and its intimate structure at various stages of development. A paper on the tissues of the Echinodermata is also published by the same author, in which he says that he has accurately ascertained

* See Mr. Lankester's paper on the Earthworm, p. 111.—Ed.

that the bodies of these animals consist of three well-defined, distinct, component tissues:—1, of an epithelial layer, with small round cells; 2, of a strong muscular layer; 3, of an obvious connective tissue, with exceedingly strong intermediate substance, analogous to what in vertebrates is known as hyaline substance. (See 'Köll. und Sieb. Zeitschrift,' Jan., 1865.)

On the Circulation of the Blood in the Spiders of the genus Lycosa. By Ed. Claparède. ('Annales des Sc. Nat.,' Nov., 1864.)—The distinguished author of this interesting paper remarks, in the first instance, that injection is not a satisfactory method in the investigation of the circulation of the spiders. He has endeavoured to secure young spiders when transparent, and submitted them to the microscope. Those of the species *Lycosa saccata* (Holm.) were found most favorable. The works of Blanchard and Newport,
of Dugès, have come under the particular notic
Claparède. The Lycosæ observed were taken imm
after hatching and before the moult, which takes
the mother's ovigerous sac. The heart, or dorsal
situate in the median line, semicircular in profile,
form in transverse section. At different parts i
lateral diverticula, arranged in pairs, of which there
of these the posterior are the least developed. At
of each pair of diverticula there is a pair of thos
like button-holes first discovered by Strauss in ins
since detected in most Arthropods. They are calle
author "venous orifices." At the moment of di
blood rushes into the heart by these orifices.
valves to these orifices in the young Lycosæ,
depending merely on the general muscular fi
The blood escapes from the heart by the tho
by a tubular posterior or caudal aorta, when
cates with a wide lacuna, occupying the *pygidiu*
of the spinners. The heart itself is situated in a
the pericardial lacuna, whence all the blood enter
is derived. The details of the circulation and
its vessels are entered into most fully by M. Cla
the views of Blanchard contested. The cir
Lycosa is stated to be essentially lacunar, and M
affirms that the vascular networks and reticulatio
Arachnidæ figured by M. Blanchard in his
'Organisation du Règne Animal,' are quite erro
have no existence at all.

Dr. Leonard Landois continues his exhaustive
on the anatomy of the *Pediculi* parasitic on man.

paper the details of the alimentary, muscular, prehensile, circulatory, respiratory, and reproductive systems of the *Pediculus vestimenti*, are elaborately worked out. Another remarkable paper on insect anatomy, as developed by the microscope, is that by Dr. S. Bach on the skeleton and the muscles of the head of *Termes flavipes*. The chitinous parts of the head are first carefully described and illustrated, and then the muscles are enumerated as follows, their attachments and functions being further discussed:

Muscles of the upper jaw.—1, m. flexor magnus mandibulæ; 2, m. flexor brevis mandibulæ; 3, m. extensor mandibulæ.

Muscles of the lower jaw.—1st group—1, m. adductor cardinis; 2, m. adductor cardinis externus; 3, m. adductor cardinis internus. 2nd group—m. adductor stipitis rectus; 2, m. adductor stipitis obliquus; 3, m. flexor stipitis. 3rd group—1, m. flexor maxillæ; 2, m. extensor maxillæ. 4th group—1, m. adductor palpi maxillaris; 2, m. abductor palpi maxillaris. Besides these belonging to the lower jaws, there are—1, m. extensor phalangis secundæ palp. max.; 2, m. flexor phalangis tertiæ palp. max.; 3, m. extensor phalangis tertiæ palp. max.; 4, m. flexor phalangis quartæ palp. max.; 5, m. extensor phalangis quartæ palp. max.; 6, m. flexor phalangis quintæ palp. max.; 7, m. extensor phalangis quintæ palp. max.

Muscles of the upper lip.—1 and 2, mm. levatores labii; 3, m. depressor labii.

Muscles of the lower lip, &c.—1st group—m. levator menti s. partis basilaris; 2, m. abductor menti s. partis basilaris. 2nd group—1, m. adductor labii; 2, m. abductor labii; 3, m. adductor palpi labialis; 4, m. abductor palpi labialis. 3rd group—1, m. extensor phalangis secundæ palpi labialis; 2, m. flexor phalangis tertiæ palpi labialis; 3, m. extensor phalangis tertiæ palpi labialis.

Muscles of the tongue.—1st group—1, m. levator linguæ; 2, m. retractor linguæ anterior. 2nd group—1, m. retractor linguæ posterior; 2, m. protrusor linguæ. 3rd group—1, m. retractor internus linguæ.

Muscles of the feelers.—1, 2, mm. flexores antennæ; 3, m. extensor antennæ; also m. extensor phalangis secundæ antennæ, m. flexor phalangis secundæ antennæ, m. flexor communis antennæ, m. extensor communis antennæ.

Muscles of the gullet.—1, 2, mm. levatores faucis; 3, 4, mm. detrusores faucis; 4, 5, mm. laterales faucis. The above enumeration of muscles serves to show what is to be ascertained from the head of a single insect by careful and elaborate research; for further details we must refer the reader to the paper itself. (See 'Kölliker und Siebold's Zeitschrift,' Jan., 1856.)

The Egg-shells of Birds, from a Histological and Developmental Point of View, is the title of a valuable paper recently published by Dr. Hermann Landois. This distinguished microscopist describes, first, the general structure of the shell of birds' eggs. He then gives details as regards no less than sixty-six species of birds, and afterwards enters into the question of the formation and growth of the egg-shell in the parent bird. In an appendix to the paper the eggs of two forms of reptiles are considered. Dr. Landois has made extensive use of the nitrate of rosaniline in his researches, which promises to form a valuable aid to investigation in the hands of the microscopist. (See 'Kölliker und Siebold's Zeitschrift,' January, 1865.)

Observations on the Structure of the Nervous Tissue by a New Method. By P. Roudanovsky. ('Comptes Rendus,' Dec. 22, 1864.)—The method proposed and made use of by the author of this remarkably interesting paper is as follows: —1st. Prepare with a Valentin's knife sections of the nervous tissue, frozen by a temperature of from 10 to 15 degrees Reaumur. 2nd. Colour them by means of infusion of cochineal or carmine. 3rd. Cover the pieces with Canada balsam, or with a special mixture composed of concentrated "icthyocolla," six or seven parts, to eight parts of glycerine. The observations made by M. Roudanovsky by means of this method are of great interest. With regard to the structure of the spinal nerves, he draws the following conclusions, the manipulation he adopts probably tending less to the distortion of structure than that used by other observers:

1st. In examining a transverse section of one of these nerves one perceives that the primitive element of the nerves are tubes with a pentagonal or hexagonal configuration.

2nd. The walls of the nerve-tubes formed by connecting tissue present in all cases, by their continuity, a veritable reticulum.

3rd. The same tissue forming the walls of the tubes gives rise to, in some directions among the tubes themselves and among the bundles of tubes, cavities or reservoirs, by means of which the nutrient fluids are enabled to operate.

4th. The isolated appearance of nervous tubes is an artificial phenomenon.

5th. The cylinders of the axes are coloured by the cochineal as well as the walls of the tubes; the cylinders of the axes appear in the centre of the tubes under the form of knotted fibres.

6th. In a bundle of nervous tubes the cylinders of the axes give rise to transverse fibres, which traverse the walls of the tubes and communicate with the transverse fibres of the other cylinders.

7th. In the entire length of a cylinder of the axis the groups of transverse fibres which part from a section of axis-cylinder are not found placed at the same level, but at a nearly equal distance from one another.

8th. The transverse fibres of the axes are met with in the anterior and posterior roots of the spinal nerves, but it is possible that they may be wanting in the others.

9th. We know that the cylinders of the axes are surrounded in the nerve-tubes by the myeline (white substance), which scarcely ever colours with cochineal, and in the pieces prepared with Canada balsam it has always the aspect of an amorphous granulated mass.

10th. Various sized tubes enter into the composition of the bundles of nerve-tubes, viz., large, fine, and very fine. The fine and very fine tubes vary in position and number; they occur in the anterior and posterior roots of the spinal nerves, particularly the latter, and have the same structure as the ordinary large tubes.

11th. It is very possible that the fine and very fine tubes belong strictly to the brain, where they are found as predominating, if not exclusive, elements of all the white substance.

12th. Each nerve contains, as it were, an anatomical substratum of brain.

Then follows some further details with regard to the structure of the central organs, which appear to be of considerable interest. The results of the pathological investigations of the author are, however, the most important, bearing, as they do, on the nature of the action of narcotics, &c. They are given as follows:

1st. After having poisoned cats, dogs, and rabbits, by strychnine, nicotine, opium, and chloroform, the author remarked that they all modify or alter the nerve-tissue.

2nd. The most energetic of these poisons alter the nerve-cells and their branches; the other poisons, such as chloroform, opium, and alcohol modify the white substance.

3rd. The alterations after nicotine were indicated by the strong pigmentation and destruction of the nerve-cells with their prolongments, but this only in the spinal cord, where the vagus and hypoglottic nerves commence. In this case (nicotine) the nerve-cells and their branches assume a deep-brown colour, and have an aspect of disorganization.

4th. Under the influence of these poisons the author remarked that there was congestion of the blood-vessels of the nerve-roots of the spinal cord, accompanied by an increase in volume of the interstitial reservoirs or cavities.

5th. From all that the author adduces we may conclude that a single drop of an energetic poison like nicotine is sufficient to kill a big animal, not because it chemically upsets the various metamorphoses of the system, but because the poison destroys the little organs like nerve-cells which are the origin of the principal vital nerves.

6th. The effect of opium and chloroform on the myeline is to give it the appearance of a number of little brilliant bodies united, instead of being amorphous.

Structure of the Frog's Cornea.—Dr. Von Recklinghausen describes certain movable corpuscles visible in the cornea of the frog, when properly treated. He argues the existence of channels and lacunæ in the cornea, from the movement of these corpuscles. The invisibility of the channels or lacunæ themselves is, according to this gentleman's view, owing to the fact that they contain a fluid of the same refracting power as the corneal tissue. ('Schmidt's Jahrbücher,' 1864, ii.)

The Retina of the Whale.—This has been made the subject of investigation by Herr Ritter, who describes the structure of the granular layer in that animal:—The layer consists of three kinds of fibres. 1st. The fibres of the limiting membrane. 2nd. The branching of the nerve-cells. 3rd. The processes of the rods and cones. The fibres of the limitans interweave and form a beautiful meshwork, coarser near the "ora serrata." The processes of the rods branch throughout this network, and finally form the branches of the cells properly so called. In the centre of the retina the processes of the rods run straight, and rarely combine; as they approach the "ora serrata" they combine more frequently, and become broader. Hence the granular layer in the centre is narrower, and consist of finer fibres. Herr Ritter proposes the name *outer fibrous layer*, instead of granular layer, which he considers objectionable. ('Henle und Pfeufer's Zeitschrift,' vol. xxi, part 3.)

Structure of the Kidney.—According to the observations of Mr. B. Wells Richardson, the Malpighian tufts of the kidney have not one, but two efferent vessels; thus, this gentleman confirms the observations of Beale and Virchow. A writer in one of our contemporaries suggests that the quasi-second tube may belong to a subjacent uninjected tuft, and, owing to the thickness of the section, appears to originate in the upper and more visible tuft. ('Dublin Med. Press,' vol. ix, p. 489; and 'Pop. Sc. Rev.,' Jan., 1865.)

NOTES AND CORRESPONDENCE.

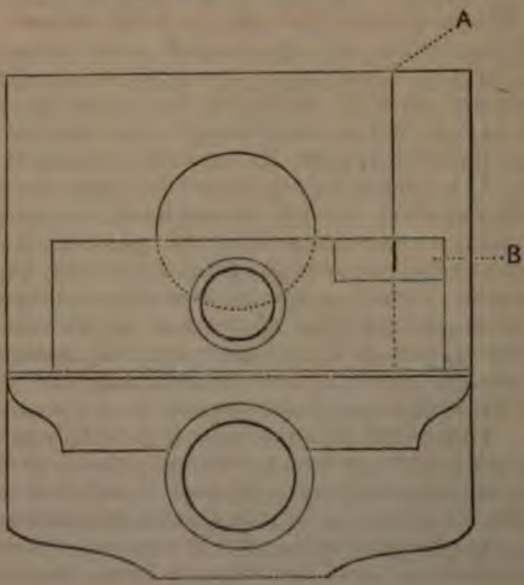
Bacillaria paradoxa in Fresh Water.—The occurrence of *Bacillaria paradoxa* in fresh water having been announced as a new fact in the last number of the Journal (p. 66), I am induced to state that in the 'Botanical Gazette' for 1851 I recorded the detection of this species in a gathering from ditches near the river, a short distance above the town of Stafford. I may add that on more than one occasion after the publication of that notice I found the Bacillaria in gatherings from the same system of ditches, and on both sides of the river. It is remarkable that although Stafford is far from the sea, salt-loving Phanerogams have been found in its neighbourhood, *e.g. Glaux maritima* (L.) and *Rumex maritimus* (L.). There are salt works about five miles from the town in the direction of the localities for these plants, but the district where I found the Bacillaria is in the opposite direction and far removed from their influence.—Robert C. Douglas, Stoke Lacy Rectory, Bromyard.

Improvement in the Lieberkuhn.—In the examination of opaque objects with a binocular instrument it is no slight advantage to have the quantity, the quality, and the direction of the light, under complete control; with the ordinary Lieberkühn this is by no means the case, for although its advantages are very considerable, it is not without an accompanying *dis*advantage which materially lessens its usefulness. The great flood of light arising from the mass of converging rays thrown down *in every direction* upon an object tends to obliterate the appearance of all delicate surface-markings, through the want of a defining shade and shadow to render them apparent. In this respect, with the lowest powers, the bull's-eye condenser and the side reflector are in the ascendant; but with the medium powers the obliquity with which the light requires to be directed to avoid the end of the object-glass causes too much loss by reflection from the surface of the cover, and the use of the Lieberkühn then becomes indispensable. Now, if we *cover up a portion of the reflecting surface* of the Lieberkühn, we shall be enabled to obtain any proportion of oblique light in one particular direction, and then, *by rotating the Lieberkühn upon the object-glass,* may bring it to bear upon every part successively, without having to alter the position of the object. In this way the most delicate structure—such as the barbs upon the very beautiful and nearly transparent spines of *Opuntia tunicata,* which are scarcely to be detected by the whole light—may be brought out into full and bold relief. The elegant arrangements assumed by crystallized silver can scarcely be seen to advantage in any other way, and the exquisitely beautiful and varying forms which are brought out by the changing play of light so obtained give it somewhat the appearance and charm of a moving panorama of dazzling whiteness. The plan I have adopted is to fix a triangular piece of thin, dull-black paper upon the silver with gum, and, *when dry,* to trim off the projecting parts from the centre and circumference with a sharp penknife, so as to give it a neat appearance. The tube of the Lieberkühn should move freely upon the object-glass, and be provided with a milled ring, so as to be easily rotated between the finger and thumb. In the absence of the ring a few coils of narrow tape, or a strip of paper fixed with gum, will be found to answer the purpose sufficiently well.—W. KENCELY BRIDGEMAN, Norwich.

A Simple Object-Finder for Students' Microscopes.—During the last year I have been using a simple addition to the stage of my microscope, which acts as a most efficient object-finder. I find it most accurate with all powers up to the $\frac{1}{8}$-inch object-glass.

The diagram shows the arrangement, and represents the stage of a student's microscope as made by Smith and Beck. In order to use this finder with a microscope, it is necessary for the object-carrier to be well fitted, and move easily and accurately in the vertical direction. The object-carriers of all good students' microscopes are, I believe sufficiently well fitted, and I find that of Messrs. Smith and Beck answers perfectly.

The finding line (A) is a fine, black, engraved line marked on the stage of the microscope, near its right margin, vertical to the object-carrier, and parallel to its plane of movement, at about one inch and two tenths from the centre. A small piece of paper, or of gummed label (B), three fourths of an inch long and one fourth of an inch wide, attached to the upper surface of the slide, where it overlaps the finding-line, completes this simple apparatus. It is used thus:—An object being in the field to which it is desirous to recur, the observer moves his head to the right, so as to get a view of the finding-



line and label; he then with a pen makes a line on the label in apparent continuation of the finding-line. In order to find that object at any future time it is only necessary to place the slide on the stage, and adjust the microscope so that the object may not pass through the field unobserved, then push the object-carrier fully down, placing the slide so that the line on the label is again in apparent continuation with the finding-line, when, by moving the object-carrier upward, the object will be seen to enter the field.

In marking the line on the label it is necessary to observe whether the pen is "sighted" with one or both eyes, and to use either habitually, otherwise an inaccuracy in replacing the slide will result, which, being magnified by the power of the microscope, will prove material.

It has occurred to me that the finding-line might be marked on the object-carrier, or on a small plate attached to it. I have tried it so placed, but, whether from habit or not, I find the line on the stage the most convenient. If, however, the object-carrier was imperfectly fitted I think it would be better to place the line upon it.—THOMAS POWELL (*Dublin Quarterly Journal of Medical Science*).

'The Metamorphoses of Man and the Lower Animals.'—Allow me to thank you for the very favorable notice of my translation of Professor Quatrefages' last work which appeared in your January number, and at the same time to offer a few remarks in reply to the (as I conceive unwarrantable) strictures of the reviewer on the opinions expressed in my preface. It is said of Sidney Smith that when he desired to write an impartial critique he confined his study of the volume under consideration to the title-page and cover. My reviewer does not resemble the great humourist, for, if I am not mistaken, there is a strange resemblance between many of his paragraphs and those of the work under review. For this, however, perhaps I have to be thankful, inasmuch as in those instances where he has deviated from the more easy path he has been more censorious and, to my mind, less impartial. Thus, while he awards the highest tribute of praise to the distinguished author, a proceeding which was certainly but just, he seems to have been, shall I say, desirous to fall foul of the translator in as many cases as possible. To be brief, I may observe that the reviewer has urged three distinct charges against me, and that some of these charges, though supported by a certain amount of evidence ingeniously abstracted from the entire mass, cannot stand for a moment in the face of the "whole truth." I am accused, first, of either ignorance of the English equivalents of the French decimal measures, or of a "disregard for the comfort" of my readers. The second portion of this accusation is almost too absurd for comment. It can hardly be said that one who devotes months of study to the translation of a treatise, by the publication of which he obtains nothing in the form of an adequate pecuniary remuneration, could be guilty of disregarding "the comfort of his readers." Now, in regard to the statement that my introduction to the French measures argues an ignorance of their British value, I need only remark that the distinguished translators of Professor Kölliker's 'Manual of Histology' are open to a similar imputation, and yet, I believe, their production is by some regarded as the very *beau ideal* of translations. Without, however, endeavouring to shield myself behind authorities, I can state that my reasons for employing French measures were, 1st, that I considered them infinitely more convenient and uniform than our own; and, 2nd, because prior to undertaking the labour of introducing M. de Quatrefages' essay into this country, an energetic attempt was made to bring about the employment of the decimal system in England. The reviewer's remarks must apply equally well to those who use the French measures in their laboratories, and register temperatures by the *centigrade* thermometer.

The second matter which appears to have aroused my reviewer's ire relates to my opinion that *geneagenesis* and *metamorphosis* should not be intimately associated. This view he stigmatises as "puerile," and yet does not advance a single fact in support of his conclusion, although he certainly does afford what I presume he would term a reason. To the latter, which is truly about as sublimely comprehensive a generalisation as has been framed for some time, I would respectfully request attention. It is as follows:—"The intimate association of metamorphosis and geneagenesis is undoubted, both being part of a series of changes undergone by a living being in thecycle of its existence."

However pretty the foregoing may appear (and I confess that at first sight it read so well and impressed me so forcibly that I almost cried *peccavi*), it hardly stands the test of analysis. If by the "cycle of its existence" the author means the entire life of an independent individual, then the expression means nothing, inasmuch as geneagenesis would extend beyond such a term. I take it, therefore, that this "cycle of existence" embraces the period between the two ova, and upon this view I still contend that, although there may be a sort of abstract relationship between the two phenomena, that association is certainly not *intimate*. I conceive of metamorphosis proper as that process by which an individual, in the ordinary sense of the word, is brought from the condition of ovum to the final phase which, as an individual, it is permitted to attain. Geneagenesis, to my mind, is a kindred but, as it were, adventitious phenomenon, which steps in to complete what I should term the "zoological individuality" of the being in which it presents itself. My idea may or may not be in accordance with that finely drawn code of metaphysical distinctions which some naturalists delight in; and though I am not yet convinced that it is puerile, I will not say that there is a shade of senility about my reviewer's censures. The development of thought through the medium of the brain, and of flippancy of expression through the intervention of the tongue, are both the results of changes undergone by a living being in the "cycle of its existence," and yet we do not, at least in some instances, perceive that the two are so *intimately associated.*

Another point on which my reviewer takes me to task is my scepticism as to the existence of what I suppose he would term a "vital principle." In this case I have been done a gross injustice. By the suppression of a portion of a sentence I am made to assert that all the phenomena which living beings present can be explained by physical laws. The writer observes—"Dr. Lawson's objection to the statement that vital operations are not to be explained by reference to the known laws of force is certainly trivial and unnecessary." Could anything be more unfair than this? In my preface to the work under notice I wrote—"When he assumes that vital operations are not to be explained by a reference to the known laws of force, as it exerts itself through matter, *and are only explicable on the supposition of a vital power,* we must decidedly express our dissent."

Here, assuredly, is no advocacy of the view imputed to me in the notice, but simply an expression of disbelief, *i. e.* of no belief whatsoever. I have always opposed the doctrine of a vital force as one of those mediæval "Will o' the wisps" which, by leading men from real facts, induced them to satisfy their minds with mere terms, like phlogiston, phusis, catalysis, &c. But, on the other hand, I am not one of those who believe that we are yet in a condition to explain life thoroughly. It is my opinion, however, expressed elsewhere,* that we are making rapid strides towards an elucidation of the mystery of life. Impartial readers must at once perceive that either my reviewer was bent upon my utter annihilation, and allowed his intelligence to be swayed by bias, or possibly fancied that the impetus of his strictures lent an air of criticism to his composition.

Feeling that assertions which, to a certain extent, impugn one's character as a teacher of science, demand a distinct and unequivocal repudiation, and apologising for the length of this reply.—I am, &c., Henry Lawson, M.D., Co-Lecturer on Physiology and Histology in St. Mary's Hospital Medical School.

[Out of respect for Dr. Lawson as an editor we insert his letter. Having handed it to the gentleman who wrote the review, we give an extract from his reply; and as the matter is not one that can further interest our readers, we must here close the controversy.

* *Vide* 'A Manual of Animal Physiology,' p. 12.

"In the first paragraph of his letter Dr. Lawson thanks the editors of the Journal for the notice of his book, which he considers very favorable. It is, of course, a very great satisfaction to his reviewer to know this, and to find that Dr. Lawson disapproves only of the three charges which he himself quotes. Now, it is useless for Dr. Lawson to find fault with my opinions because I find fault with him for his. He allows the three charges which I made, viz., that he had not translated the weights and measures; that by a merely fanciful use of words he endeavours to quarrel with his author about the use of certain terms and the relations of certain phenomena; and, 3rd, that he again is at the pains of expressing his disapproval of M. de Quatrefages' views as to vital force, &c., in a paragraph which has all the appearance of being put in to show the very advanced ideas of the young English school typified by Dr. Lawson, as opposed to the antiquated notions of the French school represented by M. de Quatrefages. Dr. Lawson allows the undoubted truth of these charges; what he dislikes is my opinion given about the facts they express and their object."]

Remarks on Objectives.—I must beg leave, through the medium of your pages, to counteract some misapprehension likely to have been fostered by some "Remarks" on my published observations on deep objectives, which appear at p. 21 of the January number of your Journal.

The author of these remarks seems much disposed to—

> "Fling at one's head conviction in the lump,
> And join remote conclusions at a jump—"

for by what process of logic (other than that which, in the old story, identifies the horse-chestnut and chestnut horse) an opinion can be evolved from any published observations of mine that "the objectives of Messrs. Powell and Lealand, from the $\frac{1}{12}$th to the $\frac{1}{25}$th, were the best in the Exhibition, I am at a loss to conjecture. I am, moreover, in a position, as juror and reporter, to state authoritatively that no such opinion as the author attributes to them was ever entertained by the International Jury of 1862. I have on all occasions unhesitatingly expressed my admiration of the skilful and excellent workmanship of Messrs. Powell and Lealand, but to ascribe to them the exalted *pre-eminence* which the author of the "Remarks" assumes is quite another matter. For my own part, I have always carefully abstained from any observations on the comparative merits of productions of the leading opticians, as it would be extremely difficult to determine whether the best objectives of A are or are not equal to those of B or of C.

In relation to my remarks on the comparison of the $\frac{1}{12}$th and $\frac{1}{25}$th I believe I am correct in stating that neither the author of the "Remarks" nor his friend (p. 24) have ever seen the objects on which the comparison was made; his remark, therefore, that my $\frac{1}{25}$th must have been out of order is not entitled to much weight, more especially as the comparison was made with Dr. Beale's $\frac{1}{25}$th, with which he is constantly working. The opinion of the "friend" that my $\frac{1}{12}$th is "certainly not to be compared with the $\frac{1}{25}$th" is for the same reason equally invalid.

Will the author of the "Remarks" kindly point out the expression from which he infers that my objective was an old one, with a new anterior combination? Has the word "originally" misled him? From his verbal criticism of my expression "some," he has deduced an inference not warranted by the facts themselves, although my statement of them may, perhaps, bear such an interpretation. "The $\frac{1}{12}$th" (p. 25, l. 3) can only mean Dr. Beale's $\frac{1}{12}$th, and I have no reason to doubt the correctness of his remark.

The author's remarks are wound up with some observations that, to my mind, are strongly suggestive of an old adage—"Save me from my friends."—CHARLES BROOKE.

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PROCEEDINGS OF SOCIETIES.

Microscopical Society, *January 11th*, 1865.

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

E. R. Lankester, Esq., Downing College, Cambridge, and Dr. Davy, Kent Lodge, Ryde, were balloted for and duly elected members of the Society.

A paper by H. J. Slack, Esq., "On the Vinegar Plant," was read, and the thanks of the meeting returned to Mr. Slack for the same. (See Trans., p. 11.)

Anniversary Meeting, *February 6th*, 1865.

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

Edmund Gill, Esq., 67, Castle Road, Kentish Town, was balloted for and duly elected a member of the Society.

Reports from the Council on the progress of the Society, from the Object Committee, and from the Auditors of the Treasurer's accounts, were read. (See Trans., p. 16.)

The President delivered an address showing the progress of Microscopical Science during the past year.

These reports, together with the President's address, were ordered to be printed and circulated in the usual manner.

It was resolved that in the ninth rule, relating to the election of honorary members, the words "who shall be persons not residing in Great Britain," be omitted.

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

As President—James Glaisher, Esq., F.R.S., F.R.A.S., &c.

As Treasurer—C. J. H. Allen, Esq.

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

Four Members of Council:

Thomas Brand, Esq.
H. Deane, Esq., F.L.S.
Richard Hodgson, Esq., F.R.A.S.
H. J. Slack, Esq.

In the place of—

James Glaisher, Esq., F.R.S.
Dr. Millar, F.L.S.
Rev. J. B. Reade, F.R.S.
S. C. Whitbread, Esq., F.R.S.,

who retire in accordance with the regulations of the Society.

Resolved that the thanks of the Society be returned to Charles Brooke, Esq., for his services as President during the past year.

March 8th, 1865.

JAMES GLAISHER, Esq., F.R.S., President, in the Chair.

On taking the chair, the President addressed the meeting as follows:—When I was first asked to become your President, I said that I was the wrong man to fill such a position, as I thought that the President of this Society should be an eminent microscopist, which I am not; as, beyond the possession of two or three microscopes, which, from being incessantly occupied in other pursuits, I have been unable to make very much use of, I have little or no claim to such a position. My objections, however, were overruled, and I was selected by your Council, and afterwards elected by yourselves. It is therefore my duty to make the best of it, and be as good a President as I can. Still I feel that there will be many instances in which I shall have to throw myself upon your indulgence in respect to my ignorance of subjects upon which your President ought to be able to speak with authority.

The first step I have taken in my new office has arisen from the fact, that the last number of your Journal had but little more than a single page devoted to the proceedings of three of your meetings! Now, I had been present myself at those meetings, and at all of them business of an interesting character had taken place, particularly at the last. You will recollect we had at this meeting the admirable address of your late President upon practical working with high powers. It was afterwards a matter of great grief to me that I had not his remarks, and those of Mr. Beck, and Mr. Lobb, and others, to refer to, in consequence of having no one here to take them down for us.

The first thing I have done, therefore, is to endeavour to remedy this; and you will notice that there is a gentleman here to-night for the first time who will take short-hand notes, and preserve for the benefit of those who cannot attend, the valuable rem

Council when I say that they feel that if you are determined to work with them in making the Society successful, we can together command success. For myself, I will give as much time as I can to your interests, and uphold the dignity of the Society as far as possible; and if we all go in for success, success will be sure to crown our exertions. (Loud cheers.)

David Joy, Esq., Middlesboro-on-Tees, and J. Oxenden, Esq., 4, Richmond Terrace, Bayswater, were balloted for and duly elected members of the Society.

A paper by Dr. Greville "On Diatomaceæ," was read. (See Trans., p. 24.)

A second paper "On Photomicrography, its application and results," by Dr. Maddox, was read. (See Trans., p. 35.)

At the conclusion of this paper the President called upon Mr. James How, of Foster Lane, who then, by means of the oxy-hydrogen lantern, exhibited upon a screen about twelve feet in diameter a very beautiful collection of transparent prints from Dr. Maddox's negatives. The definitions of some of the diatoms, photographed with a $\frac{1}{12}$-inch object-glass, were truly marvellous, and their representation by means of the lantern called forth repeated bursts of applause. The extraordinary delineations of minute structure which were thus displayed before a large audience afford strong reasons for believing that photomicrography will rapidly extend itself and displace the work of the diagramatic artist by its more perfect rendering of hitherto unperceived beauties.

The PRESIDENT having invited the meeting to make any remarks upon Dr. Maddox's paper,

Mr. R. BECK said it was then too late in the evening to discuss the paper very fully. The subject of microphotography was, he thought, quite deserving of an entire evening. He wished to point out, however, that at present the representations were mostly those of flat and opaque objects.

The PRESIDENT.—Well, we will not despair of being able to secure still better results after what we have just seen. Photomicrography is not to be estimated by what it has yet done, but rather by what it holds out the hope of doing, and I am sure that this the first step in the progress will meet with your hearty approval, and I hope that a vote of thanks to Dr. Maddox will be passed by acclamation. I would ask you, too, to give an equally unanimous vote of thanks to Mr. How, who has so kindly attended and exhibited the photographs. We must consider that the representation to-night is by no means a fair specimen of what the objects really are. The screen which has been employed is a very temporary affair, and I dare say many who sat near it will have noticed that, in consequence of its shifting about, the picture was not always in the same plane, and it was therefore impossible to get a good focus. I hope, however, that Mr. How is only breaking ground to-night, and that the next time we shall see him will be at our soirée; we can then give him a suitable room entirely to himself. If he will come and show us these beautiful

[redacted]

objects then, when the ladies will have an opportunity of examining them. I am sure he will not be alone in the [illegible]. I therefore, with very great pleasure, beg to move that the best thanks of the meeting be conveyed to Dr [illegible] for his paper and to Mr. How for the representation of the objects. [illegible] At the meeting for May I have a paper on [illegible] by Dr Wilcox, a short communication from Dr [illegible] on [illegible] clip, and the paper by Dr [illegible] to which I have already alluded. Mr. Deane is here to-night and I don't know whether five minutes would not be well bestowed in hearing some few observations from him upon the importance of microscopic investigations; I will therefore ask Mr Deane to occupy just that five minutes, and then I will adjourn the meeting.

Mr. Henry Deane.—The remarks that I have to make are simply with a view to showing the great practical value of the microscope under circumstances where evidence is required to trace the source of a substance which has been used, whether properly or improperly, but which it is desirable to trace with as much accuracy as possible. I was lately taken down to a place near Shepton Mallet, where a murder had been committed upon a child seven months old, by means of corrosive sublimate—bichloride of mercury. The murderess of the child was the wife of a farmer in a good position in life, and highly respected: she had, a month previously, obtained a packet of Steedman's powders, which are powders used for children who are cutting their teeth, and I believe that they are very useful powders, and contain nothing likely to cause harm. It appears that, having given the child one of these powders, which did it a great deal of good, the mother caused another to be administered a month afterwards when the father was away, he having mixed the first one himself, so that she did not see it. The mother mixed this second powder, and ten minutes after it had been administered by the little maid the child was dead, the effect of bichloride of mercury being to close the glottis and stop the respiration, so that the effect in the case of a child like that would be that it would expire almost instantly. The doctor was called in and a post-mortem examination was made, and upon a thorough examination of the remaining powders it was found that there was one packet which was not like the five others that were left with it, and on testing it it showed very conclusively that it contained corrosive sublimate. Of course there was an inquest, and a strong impression got abroad that, by some surreptitious means or carelessness, this corrosive sublimate had got amongst the proper powders in the factory where they were made up. I happened to be a very old friend of the proprietor of these powders, and he came to me, at the suggestion of his solicitor, and asked me to go down with my microscope and see if I could make out anything as to the sources of the powders. It appeared that the shepherd had had a lump of corrosive sublimate in his pocket during the last season, which he use for the purpose of destroying the "fly" in the backs of his shee

Many of you will know, no doubt, that this "fly," as it is called, is a very destructive pest indeed, and in some seasons many sheep may have to be destroyed in consequence of its ravages. The best and quickest way of getting rid of the larvæ of these insects, which are deposited in the tick of the sheep, is to touch up the sore place with a bit of corrosive sublimate. When the shepherd returned his piece of sublimate to his master it was put into a drawer in a bureau to which nobody would have access, in a particular room where some other things for sheep-dressing and farming purposes were kept. In the course of the evidence it was elicited that there was such a piece of corrosive sublimate in this drawer, and that the police had got possession of it; and as the coroner had intimation that I was going down for the purpose of examining it with the microscope, he obtained a portion of the piece of sublimate which was kept in the bureau, and also of the sublimate which was mixed with the Steedman's powder. On examining these in his presence, I found that they were identical. And why? You would think that the two lots of corrosive sublimate would be very free from extraneous matters which could serve to identify it! I saw that they were identical, however, and that the powdered lot came out of the larger parcel, from the circumstance of its containing particles of the saneous discharge of the matter from the sheep's back, and also portions of a fibrous substance, which proved to be rubbings-up of the shepherd's pocket; so that whoever had committed this frightful crime had taken a portion of this lump of sublimate, and crushed it up evenly, but not very finely, as it was still a rather coarse powder, and had mixed it up in the child's medicine, without any suspicion that there was a possibility of detecting the source from which it had come. There were in each the same little particles of saneous discharge, the small particles of wool, and the rubbings-up of the pocket in which it had been carried, which rendered the origin of the poisoned powder perfectly unmistakable; but of course no one could swear to the guilt of the person by such evidence, because all the farmers in the neighbourhood kept sheep also, and every one used mercury in the same way; and it would therefore be likely to be stained in the same way, and therefore it might have come from another place; but I think I should be very safe in saying that the poisonous substance was derived from the lump of mercury in the farmer's drawer. At all events, the evidence that was given went to show the impossibility of the mistake having been made in the warehouse of the proprietor. It acquitted the manufacturer of any blame, of course; but you see what a dangerous position every manufacturer of medicines is in when he is liable to have his powders removed, poison substituted, and a charge like this laid at his door. A friend of mine had to pay something like £2500 last year, where he ought not to have paid anything. I mention this investigation simply to show how desirable it is, in a case of suspected carelessness on the part of a doctor, that the microscope should be employed, where possible, for the purpose of clearing up any doubts upon the matter. (Cheers.)

The President.—I think that is one of the best practical illustrations we could have of the value of the microscope, and it is a great argument in favour of extending its application to medical investigations. I am sure we are much indebted to Mr. Deane for bringing the subject before us. I have nothing more to announce now but that our next meeting is adjourned to the 10th of May next.

The thanks of the Society were returned to Dr. Maddox for his paper, and to Mr. How for his illustrations of the same.

The President announced that, in consequence of communications received by the Council, the award of the medals had been entirely annulled.

The meeting then adjourned for refreshments and conversation. It should be mentioned that Mr. How exhibited during the evening several stereoscopes, in which Dr. Maddox's stereoscopic photographs of microscopic objects were shown on glass and on paper. The same gentleman also displayed several large micro-photographs, one of which—a magnificent specimen of the sycamore-leaf insect—was placed in the patent graphoscope, and was a point of attraction to all present.

A paper on "Remarkable Objects extracted from the Honeycomb," by Edmund Gill, Esq., was read by F. C. S. Roper, Esq. The author drew attention to some curious objects found in honey, of which he forwarded well-executed drawings. He finds them generally of a deep-golden or pale-yellow colour, with some of a faint rose tint. They resemble in form some of the Desmidiaceæ; and on placing some of the honey in water, in about three weeks masses of elongated cells are formed, each of the cells having four or more granules in each. The author concludes by stating that he considers them worthy of illustration and description.

PRESENTATIONS TO THE MICROSCOPICAL SOCIETY.

January 11th, 1865.

	Presented by
Celestial Chemistry and the Physical Constitution of the Stars and Nebulæ, by W. Burr, Esq., F.R.A.S., F.C.S.	The Author.
Intellectual Observer, No. 36	The Editor.
Popular Science Review, No. 14	Ditto.
Canadian Journal of Industry, Science, and Art, No. 54	Ditto.
Journal of the Linnean Society, No. 31	The Society.
The Annals and Magazine of Natural History, No 85	Purchased.

February 8th.

Traité Elementaire d'Histologie, par J. A. Fort, Paris, 1863	The Author.

	Presented by
The Foot of the Fly, its structure and action; elucidated by comparison with the Feet of other Insects, &c., Part I, by Tuffen West, Esq.	The Author.
On some Conditions of the Cell-wall in the Petals of Flowers, with remarks on some so-called External Secondary Deposits, by Tuffen West, Esq.	Ditto.
Remarks on some Diatomaceæ new or imperfectly described, and a new Desmiæ, by Tuffen West, Esq.	Ditto.
Journal of the Proceedings of the Linnean Society, Vol. 8, No. 30	The Society.
The Annals and Magazine of Natural History, Nos. 84 and 86	Purchased.

March 8th.

Quarterly Journal of the Geological Society, No. 81	The Society.
Journal of the Linnean Society, No. 32	Ditto.
Intellectual Observer, No. 38	The Editor.
Photographic Journal, No. 154	Ditto.
On extreme and exceptional Variation of Diatoms in some White Mountain Localities, &c., by Dr. F. W. Lewis	The Author.
A Treatise on Logic, pure and applied, by S. H. Emmens, Esq.	Ditto.

W. G. Searson, *Curator.*

Dublin Microscopical Club.

17th November, 1864.

Read the minutes of the preceding evening meeting, which were passed and signed.

Dr. Frazer exhibited crystals of the rare urinary deposit "cystine," in process of crystallizing from an alkaline fluid.

Mr. Archer showed a minute Rivulariacious plant from the Chalk in the south of England, kindly given to him by Admiral Jones. This plant he felt unable to refer to any of Kützing's genera, at least satisfactorily. The "phycoma" (to employ Kützing's term) consisted of an aggregation of filaments radiately disposed, and, to the naked eye, forming orbicular dots, like so many "full stops," and seated in little concave depressions, as if excavated by the plant, in the Chalk. The individual filaments were minute, slightly tapering, with a single basal heterocyst, extremities not attenuated, truncate, the tubes not closed. If one did not know the plant in the Chalk, Mr. Archer said that, meeting a single filament, it might be taken for Kützing's *Mastichonema caespitosum*, but the heterocysts at the base of the filaments were larger here than in that form.

Mr. Vickers exhibited a series of slides from the Bath Microscopical Club of zoophytes, beautifully mounted, with the tentacles fully displayed. He also showed Polycystina as opaque objects, and rendered beautifully white by having been previously heated to redness. He announced that he had received some also in an unprepared state, and would readily exchange with members of the club for other materials or preparations.

Mr. Crowe showed fine and lively specimens of *Stephanosphæra pluvialis* and of *Gonium pectorale.* These had been obtained by moistening some of the mud from the Bray-head locality, which, when taken, had become quite desiccated by the recent dry weather, and which, thus treated and placed near the light, had developed a population of these beautiful organisms almost as rich as in summer.

Mr. Crowe likewise showed a minute infusorium, enclosed within a hyaline rigid cyst, in active writhing movement. The animal had a wreath of cilia at one extremity, and was doubtless a Vorticella or some related animal, just awaking from its encysted condition.

Dr. Foot exhibited what appeared to be specimens of a Bacterima in great multitudes and of exceeding minuteness, discovered by him in the urine of a patient. These moved vigorously about in the manner of these organisms, with a wriggling movement, sometimes executing a summersault in their progress. Dr. Foot had noticed these organisms so very shortly after he had obtained the fresh urine that he believed they certainly existed therein before emission. He considered that they exhibited a moniliform appearance, and that they showed an undulatory movement, and might thus appertain to Vibrio.

Mr. Archer mentioned that he had not been able to see the latter character in Dr. Foot's specimens, but it is possible that two forms existed in the material. To him they seemed very like *Bacterium termo* (Duj.). Cohn has a genus Zooglœa, consisting of a gelatinous mass, pretty coherent, and of a somewhat white colour, having imbedded in it bodies scarcely, if at all, distinguishable from Bacterium, and which, when separated from the mucous mass, wriggle away in the water in the characteristic manner. Some of this production Mr. Archer had shown at the July meeting. Cohn then regarded *Bacterium termo* (Duj.) as but gonidia, as it were, of his *Zooglœa termo.* Dr. Foot's example showed no mucous matrix, therefore Cohn's conclusions did not seem quite justified. Mr. Archer would regard the whole of the Vibriones as plants, and, indeed, as oscillatariaceous algæ—structure, colour, and even the movement, seeming to him to establish that view. He conceived that, like Oscillatoriaceæ in general, they grew enveloped by a tube; this tube he felt satisfied he had seen in a Vibrio. He conceived also that he perceived the bluish-green tint of "phycochrome" in their substance; and as to their movement, it seemed but a modification of the equally enigmatical movement of Oscillatoria and Spirulina; nay, even in certain Nostochaceæ a certain amount of movement is evidenced not unlike that of Vibrio.

Dr. Barker had before found Bacteria in urine.

Mr. Tichbourne exhibited a longitudinal section of the wood of the soap-bark-tree of South America (*Quillaria saponaria*). He then read the following extract from a memoir by Professor S. Bleckrode, Delft, Holland:—"The bark is remarkable for its density, as it sinks in water. . . . The cause of this is the immense quantity of mineral substances which it contains. . . . . The ash consists almost entirely of carbonate of lime, which forms 12 per cent. of the whole, and appears as small crystalline needles, isolated or in groups, in the cells of the liber, not only between its concentric rings, but in every part of it. These glitter in the sun, resembling under the microscope the arragonite form of the crystallized carbonate of lime. The carbonate-of-lime crystals are generally characteristic of plants in which mucilaginous and pectinic substances are formed abundantly." Mr. Tichbourne said, from some experiments of his own, he was of opinion that Professor Bleckrode was in error. The crystals were evidently not carbonate of lime, as they were seen under the microscope to dissolve very slowly when placed in dilute hydrochloric acid, and without the evolution of gas. If they were carbonate of lime they would dissolve instantly in the acid, with a copious evolution of carbonic acid. They were evidently some organic compound of lime, which would, of course, yield carbonate of lime on gentle ignition, and thus probably arose the statement. Mr. Tichbourne said that the quantity of bark at his disposal did not admit of his determining what this organic substance was, but he hoped shortly to be able to do so.

Dr. Frazer said that the crystals found so abundantly in quillai bark appeared, from his investigations, and from a careful examination of their microscopic form, to be compounds of bimalate of lime.

15*th December*, 1864.

Read the minutes of the preceding monthly meeting, which were passed and signed.

Dr. Barker showed five living specimens, which had been growing upon a specimen of *Dytiscus marginalis*, of an Opercularia supposed *O. articulata*. The superior lip, supported by a muscle giving the same somewhat the appearance of an operculum, gives the name to the genus, and distinguishes it from Epistylis. The present specimens were large, broadly elliptic when shut in, and corrugated at the upper extremity; the peduncle stout, and beautifully and finely longitudinally striate. Without a reference to Stein's figures, and more accurate descriptions, it would not be easy to come to a more decisive opinion as to the species from the descriptions in Pritchard; but it at least was the first instance of any species of the genus having been shown at the Club.

Mr. Archer showed specimens of *Gonionema velutinum* (Nyl.), for the loan of a specimen of which apparently very rare lichen he had to thank Admiral Jones. Mr. Archer showed the apothecia under a low power as an opaque object, and a small fragment of the thallus under a higher power. He likewise showed a fragment from the only fertile specimen of *Scytonema myochrous* which he had ever found, for the purpose of comparison, to show the great affinity in the thalloid structure of the two plants; but there could not be a doubt of their being utterly specifically distinct, both to the naked eye and under the microscope.

Dr. E. Perceval Wright exhibited a section of a substance found encrusting the human bladder in a case that came under the notice of Dr. Fleming. The general appearance of this substance was that of a rough nodulated mass, dense in structure, and of a hard, bony-like appearance. On examination of sections made of the substance itself, as it was taken out of the bladder, and also after long maceration in dilute hydrochloric acid, it revealed no true bony structure; and although Dr. Hassall had written that he had discovered bone-cells in this substance, yet Dr. Wright could not agree with him as to their existence, nor did he think the members of the Club would either. True bone owed its origin in the adult being either to a conversion from cartilage or to a development from periosteum; and structures that arose from the surface of an altered mucous membrane should not be regarded as bone, but as calcareous deposits. Rokitansky had called such structures by the name of anomalous bone, but this was likely to mislead. The point to be insisted on was that such structures were not developmentally or histologically to be considered as bone.

Mr. Crowe showed fine and numerous specimens of Campylodiscus.

Captain Hutton showed a specimen of *Arachnoidiscus ornatus* found by him in a gathering lately made at Malahide; this would make the second record of any form of Arachnoidiscus being found in Britain. Captain Hutton had had but once in his possession foreign specimens of this form, and that long ago. His tubes and apparatus had been much used since, and it could not, therefore, be at all probable that this specimen could have remained attached to a dipping-tube ever since, and now made its appearance. He believed that the present was a genuine instance of the occurrence of this fine form in Ireland, and he was the more inclined to feel certain of its reality in that Arachnoidiscus had been already found by Ralfs in the south of England, though it had been questioned that he had made some mistake by the accidental intrusion of a foreign example.

19th January, 1865.

Read the minutes of the preceeding meeting, which were passed and signed.

Read a letter addressed to Dr. Barker by Rev. Mr. Furlong, of Bath, introducing to his notice Mr. Adolph Leipner, of Bristol; also one from the latter gentleman stating his desire to enter into correspondence with the club in the way of exchange of specimens or of any material.

Ordered, that Mr. Archer acknowledge receipt of these polite communications, and at the same time mention that the club would be happy to reciprocate as far as lay in its power; but few, if any, of the members were at present employed to any extent in putting up preparations.

Dr. E. Perceval Wright exhibited a specimen of *Tomopteris onisciformis* which he had taken in Bantry Bay. Whilst collecting some floating Actinozoa he saw a transparent worm-like creature swimming in the water, and at once secured it in a glass collecting-jar. It lived in confinement some days, but, having been slightly injured by the compressor, it died. Dr. Wright described the chief anatomical peculiarities of this strange form, giving a detailed account of the long atennæ-like organs which are found on either side of the head, and of the curious tail-like portion. He suggested that perhaps many of the known forms of Tomopteris might be nothing but "parent stocks," as described by Louis Agassiz, and that the tale-like portion might develop itself into a fertile individual. In conclusion, he adverted to the papers of Pagenstecher and Carpenter on this little annelid, and trusted that before long something would be known of its development.

Mr. Archer then showed specimens of the debatable plant *Chroolepus ebeneum*, and showed its structure (as he regarded it) under the microscope to consist of a linear or confervoid series of cells, bounded by what he might term a cortical investment of separable filaments composed of much thinner and colourless cells; in a word, showing a structure of thallus quite like that of the lichenous genus Cœnogonium; of this genus he showed Schavendener's figures in the 'Flora' for 1862, and Nylander's in 'Annales des Sciences naturelles' for 1861, in order to show more intelligibly what was meant, his object being to argue that, inasmuch as this plant (*Chroolepus ebeneum*) has a thalloid structure like that of Cœnogonium, in all probability the former plant is not an alga, but a lichen, as in it the linear central series of cells would, quite as well as in Cœnogonium, represent the gonidial stratum of a typical lichen, and the cortical investing filaments would in like manner represent the fibrous element. Therefore, though no fruit had been as yet ever seen in the plant *Chroolepus ebeneum*, Mr. Archer would hazard a prediction that, when discovered, it would be found to produce apothecia like Cœnogonium. In any case it is by no means congeneric with *Chroolepus aureum*, as even its thalloid structure and appearance, irrespective of fructification, seem to forbid its being placed near the plant mentioned.

Dr. Moore showed scales taken by him from the frond of *Nothoclæna sinuata*, which formed very pretty objects for the polariscope. He found that these scales presented very different forms according as they were taken from the upper or under side of the frond. In the one instance they were much branched and divided in a dendroid manner, or somewhat, as it were, like one or two staghorns issuing from a common base; in the other they were oval and brought to a point, the margins undulate or notched.

Mr. Vickers exhibited various diatomacean slides, also some of diatomacean deposit from Moran, in Seville, obtained through Mr. Stokes.

16*th February*, 1865.

Read the minutes of the preceding meeting, which were signed.

Mr. Dixon showed Coscinodiscus, sp., Dictyocha, sp., and sponge-spicules, from Spain.

Dr. E. Perceval Wright exhibited a minute species of annelid from the coast of Donegal, which he thought was as yet undescribed. It belonged to the Polychœta, and to the section Sedentaria, and was nearly allied to Siphonostomum (Otto). The length of the animal was about half an inch.

The Rev. Eugene O'Meara called attention to the fact that it had been frequently stated at the meetings that diatomacean forms would in all likelihood be found in coprolites. Having recently procured some powdered coprolite, through the kindness of a friend, he had submitted it to a careful examination, in hope of realising the anticipations that had been entertained. This pulverized coprolite had been, he was informed, ground in a mill, and was afterwards treated with acid. The result of this investigation was that no diatomacean remains—no trace of organization of any kind—was discovered. More satisfactory were the results of an examination of a piece of rock from Malta, procured by Captain Hutton. In this stone three diatomacean frustules were found—two Pinnulariæ of the same species, the other form, a Navicula, so like *N. elliptica* as to leave on his mind little doubt of identity. Mr. O'Meara likewise brought under the notice of the meeting three species of Grammatophora found on seaweeds from the Friendly Islands.

Mr. Vickers showed *Triceratium areolatum* obtained from Barbadoes earth furnished by Mr. Stokes.

Dr. Frazer showed cavities in silica containing fluid.

Mr. Archer showed a slide of Desmidiaceæ obtained from Mr. A. Leipner, of Bristol, collected near Dresden, and he brought it forward chiefly to show the identity of the forms thereon with those found in our own mountains, and all rather common species. These were *Micrasterias denticulata* (though marked on the accompanying label *M. rotata*, thus showing the widespread confusion which seems to exist as regards these two, indeed, very well-marked and quite distinct species), *Euastrum ampullaceum*, *E. didelta*, *E. ansatum*, *E. verrucosum*, and *Hyalotheca dissiliens*. All these were perfectly identical with Irish forms. Mr. Archer, likewise, whilst on the subject of Desmidiaceæ, drew the attention of the meeting to a paper lately publishsd in 'Oversigt af Kongl. Vetenskaps, Akademicus Förhandlingar, Stockholm' (1864), by T. J. Cleve, entitled "Bidrag till Kännedomen om Sveriges sötvattensalger af familjen Desmidieæ," in order to remark briefly on one or two points suggested by the observations of that writer. Cleve, while he justly says that some of the specific distinctions are founded on minute characters, states that, after the most careful comparison of the known forms discovered by him in Sweden with the figures and dried examples from other countries, he has been unable to detect any differences, thus, as Mr. Archer thought, confirming so far his own views. There was one point in which Mr. Archer could not coincide with Herr Cleve, and that was in the value as a generic character to be attached to the fact of the zygosphore being spinous or smooth. In his remarks following *Arthrodismus convergens*, Herr Cleve states that he has found this species near Upsala in a conjugated state, and that the spores were globular, smooth, and *without* spines. Upon this latter circumstance he was disposed to constitute a distinct genus for this form, separate from *Anthrodismus incus*, whose spores are beset with numerous acute subulate spines.

Now, it is a character laid down in all books (Ralfs, De Brébisson, Pritchard, De Bary) that the short, deeply constricted forms have spinous zygospores; the elongate, slightly or hardly at all constricted, and the filamentous forms, smooth zygospores. But Mr. Archer had lately found some of the former, such as several species of Cosmarium, with smooth, non-spinous spores, and the filamentous *Sphærozosma vertebratum* with spinous spores. It is well known that other species in the same genera have the spores of the opposite character in the respect alluded to; and it follows, therefore, that this circumstance is of specific, not generic, signification. Therefore Cleve would be wrong in placing *Arthrodismus convergens* in a genus distinct from *A. incus* and its congeners, merely on account of the interesting fact of the smooth zygospores of the former. In regard to *Penium Thwaitesii*, Cleve makes the remark, as if it were singular, that he has seen the chlorophyll-contents formed into plates, and radiating from the longitudinal axis of the cells towards the periphery. But this is simply a generic character of the genus Penium. Cleve figures the example of the Closterium which he would refer to *C. lanceolatum*, but he does so doubtfully. Mr. Archer thought this form not *C. lanceolatum*, but a short specimen of his own *C. Pritchardianum*. This latter form Mr. Archer took occasion to mention he had since taken again at Howth, and again conjugated and maintaining all its characters both of frond and zygospore. Herr Cleve describes in his paper several new species, which Mr. Archer thought well established.

Captain Hutton exhibited slides of Galway serpentine containing Eozöon. He stated that in the winter of 1862-63 Sir W. Logan sent specimens of serpentine from the upper portion of the lower Lamentian formation, and which he supposed to be of organic origin, to Dr. Dawson, of Montreal, for microscopic examination. Dr. Dawson at once pronounced them to be portions of a huge Foraminifer, which he named *Eozöon Canadense*, and which, he said, probably formed reefs in those seas equal in size to the coral reefs of the present day. These statements have been confirmed, in every respect, by Dr. Carpenter, who adds that he believes that a more thorough examination of some of the Silurian fossils (such as Stromatophora), hitherto marked amongst corals and sponges, will prove that they are really, like Eozöon and Receptaculites, gigantic Foraminifera. Captain Hutton's attention was drawn to the subject by a letter in the 'Geological Magazine' for the present month, from W. A. Sanford, F.G.S., of Wellington, Somerset, in which he says that he had sent slides of Irish green marble from the Binabola Mountains, Connemara, to the editor, which slides he thought contained Eozöon, and Professor Rupert Jones confirmed the supposition. Captain Hutton therefore obtained some specimens of the serpentine from Dr. A. Carte, prepared them, and found them to contain markings in all respects similar to those figured in vol. xxi, part 1, of the 'Quarterly Journal of the Geological Society,' and which he therefore presumed were Eozöon. Captain Hutton also exhibited a diagram, drawn to scale, of the maximum thicknesses of the various sedimentary rocks, as at present known, from which it appeared that the horizon of the "Lingula-flags" occupied a position just half way between the horizon of Eozöon and the most recent formations, from which he inferred that the interval of time between the Eozöon and the Lingula-flags was, at least, equal to that between the latter and the present day.

Aberdeen Microscopical Society.

This Society held its annual meeting in the Grammar School, on Tuesday, the 10th January, at 7.30 p.m. The Society has been in existence for little more than a year, and already numbers upwards of seventy members. Nine meetings had been held during the previous year, at each of which very useful papers were read, some being of great excellence and involving a great amount of research. At the meeting above referred to the following gentlemen were elected office-bearers for the ensuing year:

President	Dr. Ogilvie, Aberdeen University.
Vice-Presidents .	Professor Nicol, Aberdeen University. Mr. H. A. Smith, 3, King Street.
Secretary	Rev. A. Beverly, Grammar School.
Treasurer . . .	Mr. Geo. Walker, 77, Union Street.

Committee . . { Dr. DICKIE, Aberdeen University.
Dr. FIDDES, King Street.
Dr. DALBY, H.M.S. Winchester.
Rev. WM. BARRACK, Grammar School.

After the routine business was transacted the rest of the evening was devoted to a display of microscopes and microscopical apparatus. Several members had put themselves to a very considerable trouble to bring together as useful and interesting a number of objects for exhibition as possible. The following papers have been read before the Society during the past year:

9th Feb., 1864.	Dr. Dickie, "On Two Fossil Earths from Ireland."
	Mr. H. A. Smith, "On the Principle involved in the Construction of the Binocular Microscope."
8th March, 1864.	Mr. H. A. Smith (assisted by Mr. G. W. Wilson), "On Microphotography."
12th April, 1864.	Mr. G. Wilson, "On the Stereoscopic Effects of the Binocular Microscope."
	Mr. H. A. Smith, "Notice of the Kellner Eye-piece."
	Mr. A. Clark exhibited a Collection of the Zoophytes of Aberdeenshire.
10th May, 1864.	Dr. Ogilvie, "On the Structure of Shell."
14th June, 1864.	Dr. Dickie, "Hints on the Making of Cells."
	" "On Two Fossil Earths from Ireland."
	Mr A. Stephen Wilson, "On the Meaning of the Phrase *Stereoscopic effect*, as applied to the Binocular Microscope."
11th Oct., 1864.	Mr. A. Clark, "A Descriptive List of the Diatoms found by him and Mr. R. Leys in the Peterhead Deposit."
8th Nov. 1864.	Dr. Dickie, 1. "On the Detection of Certain Poisons by means of the Microscope."
	" 2. "The Microscopic Structure of Meteorites."
	" 3. "A New Binocular Microscope."
	" 4. "The Structure of Photographs, as seen under the Microscope."
13th Dec., 1864.	Mr. Wm. Scott Aitken, "On Microscopical Drawing and Measurement," and "Hints on Mounting."

When the subject admitted or required it, all these papers were abundantly illustrated by means of preparations under the microscope or by drawings.

BIRMINGHAM NATURAL HISTORY AND MICROSCOPICAL SOCIETY.

AT the microscopical meetings of this Society held during the past quarter the following papers have been read:

On Feb. 7th the President, Mr. Hughes, read a paper on "Sponges." It commenced with a review of the history and opinions on the animal or vegetable nature of the class, from Aristotle down to the present time. Professor Grant's first discovery of the ciliary processes was explained, and the investigations and discoveries of Dr. Bowerbank, as given in his recent work, treated upon. It was clearly shown that the sponge is animal *sui generis*, but of a very low type, and the strongest proof adduced, according to Dr. Bowerbank, is that sponge, like Sertularia, Zoophytes, and silk, contained *fibroine*, a substance nowhere met with in the vegetable kingdom. The paper was illustrated by diagrams and microscopical preparations.

On Feb. 14th Dr. James Hinds read a paper on "The Comparative Anatomy of the Blood." The development of the blood-cells, as described by Dr. Wharton Jones, was traced through the invertebrate sub-kingdom, and the analogies of the granule and colourless cells explained. The blood-cells of the vertebrate sub-kingdom were especially dwelt upon, and the various views with reference to them enunciated. The differences subsisting between the cells of the oviparous and the mammalian vertebrates was particularly explained, reference being made to the researches of Hewson, Jones, and Gulliver. The paper was illustrated with numerous microscopical preparations and with diagrams.

On March 14th Mr. Thomas Fiddian read a paper on "The Siliceous Epiderms of the Diatomaceæ." The author supported the theory of their vegetable origin, and not animal, and argued that their motion through the water was not to be ascribed to an exercise of will, but was merely motion caused by the vital action of the cell. The nature of the epiderm was minutely explained, and also the workings of the various species of diatoms. In conclusion, Mr. Fiddian said that the comparative success of microscopic research, in reference to Diatomaceæ, proves the great value of the achromatic microscope; that we owe much to it, and that the best way of showing our gratitude to it is a constant endeavour to understand, improve, and use it. The paper was illustrated by specimens of infusorial earths from Algiers, Italy, Barbadoes, Richmond (Virginia), Bermuda, and Sweden, and by mounted slides.

During the quarter the following papers have also been read, *i. e.* "On the Silkworm," by Mr. J. Scott; "On the History and Objects of the British Association for the Advancement of Science," by Mr. C. Pumphrey; "On the Coal Fields of South Staffordshire," by Mr. L. Percival; "On the Hawfinch," by Mr. E. Buckley; "On Fixed Vegetable Oils," by Mr. F. Polglase;

"On the Natural History of Gutta Percha," by Mr. J. Pumphrey; and "On Two Years in Italy," by Mr. G. Henton.

Amongst the specimens which have been exhibited were a large number of skins of birds from Upper Bolivia; shells of *Succinea picta;* a specimen of Hippocampus; the Pallas sand-grouse; the unctuous sucker, or sea-snail; a beautiful collection of minerals from the Imperial Austrian mines of Agordo; and a specimen of smoky quartz from Mont Blanc. A section of this latter was also shown under the microscope, to display the globules of water which it contained.

A large and valuable addition has lately been made to the Library of the Society, through the liberality and kindness of Dr. Bell Fletcher, who presented to the Society the whole of the publications of the Ray Society. To mark the appreciation of the gift, Dr. Bell Fletcher has since been elected an Honorary Vice-President of the Society. Several further additions have also been made to the Library through the kindness of members or by purchase.

Mr. George Dawson, M.A., Dr. G. F. Evans, Mr. H. Heaton, Mr. C. Ratcliff, F.L.S., F.G.S., Dr. James Russell, and the Rev. W. Wakefield, M.A., have qualified as Honorary Members of the Society.

ORIGINAL COMMUNICATIONS.

On the Pedicellariæ *of the* Echinodermata. By William Bird Herapath, M.D. Lond., F.R.S. London and Edinburgh.

(With Plates IV. & V.)

These remarkable forceps-like bodies have not received that attention from microscopists which their beauty and peculiarities demand, and many observers have wholly mistaken their significance, as even the names by which they are known bear witness—pedicellus, originally meaning a little louse or parasite. It is evident that these bodies were formerly considered parasitic to the animals on which they were found, and of independent vitality; whilst their general form and appearance are nearly as much unknown to microscopists and naturalists, as must be acknowledged from the fact that one of these calcareous pedicellariæ, on account of its remarkable resemblance in form to the head of a mammal, was even recently announced as such, and as having been found at the bottom of the Atlantic Ocean, in deep-sea soundings, by a celebrated well-known naturalist; this specimen having been exhibited by him at the meeting of the British Association, at Cambridge, and it excited considerable discussion amongst naturalists; some of whom were disposed to consider it to be "the dactylos or movable claw of a minute crustacean," and various other opinions were formed of its nature. But Mr. Busk, from a comparison with the valves of one of the pedicellariæ of *Echinus lividus*, and another of *Amphidetus communis*, conjectured that it was the pedicellaria of an unknown Echinus, in which view all must concur who compare the figure of the object given in the 'Microscopical Journal,' Vol. IX, page 39, with the extensive series now exhibited of the author's photographs of the various pedicellariæ of our British Echinodermata. From these photographs it will be seen that the object in question is a valve of that form called pedicellaria globifera, but that it does not belong to any of our British Echini, although closely resembling one of those of *Echinus miliaris*, one of our commonest Echini.*

The collection and investigation of these pedicellariæ has been a work of considerable time, having occupied the author during the leisure moments of several years; these researches were in progress at the time of the discovery of the so called Atlantic mammalian jaw, but their publication has been delayed from various causes, the principal being the difficulties attendant upon making the photographs, and the extensive nature of the inquiry necessitating the making of numerous preparations of a delicate character from animals difficult to obtain.

With regard to the probable nature of the pedicellariæ, a growing feeling has arisen amongst naturalists that they are organs peculiar to the animals upon which they are found, and that, like the bird's-head processes on the polyzoon, they were organs of defence or prehension, which, although not absolutely necessary to the existence of the Echinoderm, were yet as peculiar and special to the genus, and even indicative of the species, as the form of a tooth or the character of a bone. It will be seen from these numerous photographs that these views were well supported by examples, and that whilst great general resemblance in form may be traced to the pedicellariæ of the various species comprising the genus Echinus, yet there are many which are capable of recognition as being indicative of the species, and totally different from those of the genus Amphidetus, Spatangus, or Uraster, with which they may be compared, so that the author has no hesitation in stating that, in the same way that one animal may be recognised by its tooth, or an Echinus by its spine, it would be equally possible to assert positively that a certain pedicellaria belonged to *Uraster glacialis*, to *Echinus sphæra*, or to *Amphidetus communis*. Further, that although the general form of pedicellariæ of *Uraster rubens* present great similarity to those of *U. glacialis*, and those of *Echinus miliaris* agree remarkably in character with those of *Echinus lividus* or *Echinus sphæra*, yet there are abundant differences and peculiarities in their appearance to indicate to the practical eye to what particular species it may belong.

The author has hitherto only found pedicellariæ in the genera Uraster, Spatangus, Amphidetus, and Echinus, having examined many other genera of Echinodermata for them ineffectually, more especially Comatula, Ophiocoma, and Ophiuridæ.

* It is much more like the pedicellaria of *Cidaris palpilata*, as it wants the long terminal tooth of *Miliaris* (March, 1865).

Amongst the family of the Asteriadæ the genera Cribrella, Palmipes, Solaster, Astropecten, and Asterina, are apparently equally deficient in true pedicellariæ.

Amongst the Echinidæ the author has had no opportunity of examining Cidaris, *Echinocyamus*, *Echinarachnius*, or *Amphidetus roseus;* consequently he can give no definite opinion on these genera or species, but he thinks it probable that the latter, at least, may possess these pedicellarial organs.* The Holothuriadæ, together with the other cirrho-vermigrade Echinodermata, also want pedicellariæ, for it is here scarcely necessary to remark that the calcareous spicula and perforated plates existing in these Echimoderms are the analogues of the pentagonal plates constituting the shell of the Echini, whilst the oral tentacles are quite free from calcareous appendages.

In the genus Synapta the perforated plates and anchor-shaped appendages may possibly be thought to bear some near resemblance to pedicellariæ, but a closer inspection of these peculiar bodies will convince us that these perforated plates are also the analogues of the pentagonal plates of an Echinus shell, whilst the anchors are merely modifications of the spines, and are used as organs for prehension or locomotion, and assist the animal in raising its vermiform body to the mouth of its tube, the anchors being withdrawn during the period of contraction of the Synapta, and contribute little or nothing to the powers of defending the animal from the attacks of its predatory enemies. It will be seen that the pedicellariæ of the genus Uraster have been well illustrated in two individual species, *Uraster rubens* and *U. glacialis,* and that they are very different in form from those of the genera Spatangus, Amphidetus, and Echinus, all of which possess pedicellariæ consisting of three calcareous blades, whilst the Urasters have invariably two blades in each pedicellarial head.

Amongst the Echini the species *miliaris*, *sphæra*, *Flemingii*,

* Since this paper was read at the Bath meeting, the Rev. A. M. Norman has most obligingly placed at the author's disposal his valuable collection of pedicellariæ of British Echinodermata; amongst them are those from the genera Luidia, Goniaster, Stichaster, Asterias, and Asterina, amongst the Asteriadæ, and those of the genera Echinocyamus, Cidaris, Bryssopsis, and Spatangus, amongst the Echinidæ. The Rev. A. M. Norman agrees with the author that the orders Crinoidea and Ophiuroidea are deficient in pedicellariæ, whilst the Asteroidea and Echinoidea mostly possess them.

Some of these preparations have been described by Mr. Norman, in his paper "On the Genera and Species of British Echinodermata," in the 'Annals Nat. History,' Feb., 1865, which contains also some very important alterations in the nomenclature.

lividus, two varieties, and *neglectus* (Forbes), have furnished numerous illustrations, and an Echinus from the Mediterranean has also been examined, the pedicellariæ of which were so closely analogous in form to those of the British *neglectus* that the author was fully prepared to find that a comparison of its other characters with those of that species would confirm their identity, and it subsequently did so, without any possible doubt, an instance which may be considered the strongest possible proof of the truth of the proposition "that the forms of the pedicellariæ are peculiar to the species."

The pedicellariæ of some Echinoderms (more especially *Uraster rubens*, *Echinus sphæra*, and *Amphidetus communis*) have been partially described and incorrectly figured by various observers—Müller, Sars, Munro, Oken, and Sharpey.

Müller appears first to have given them the name by which they have been hitherto known, and he conceived them to be parasitic animals, which opinion Lamarck, Cuvier, and Schweigger, more or less adopted, but Munro, Oken, and Sharpey, regarded them as organs of the animal of whose purpose and function we as yet know nothing. It appears to be generally established as a fact that the pedicellariæ continue their movements even hours after the animal has been crushed to pieces, and, to all appearance, dead; yet such apparently independent movements, cannot be satisfactorily adduced at the present day as evidence of individual vitality, as the existence of such involuntary motions in the lower animals depending on muscular irritability and reflex excito-motory actions are well known to all physiologists, whilst even the leg of a man has been observed to move vigorously some time after amputation. In describing the Echinodermata Professor Forbes frequently employs the word spinules as a synonym for that of pedicellariæ, but this alteration is, without doubt, an innovation which does not recommend itself for general adoption, as many Echinodermata wholly destitute of pedicellariæ possess little spines which are totally different in form from those minute organs which we are now engaged in investigating. And although the name pedicellariæ involves an undoubted misconception of the true function of the little pincer-shaped organs described, yet it is far preferable to retain this term, with a mental reservation that we now know them to be no parasites, than to use a term bearing such a wide signification as spinules, and so inadequate to the comprehension of the bodies really meant by the term.

All pedicellariæ agree in having a calcareous framework of great beauty, consisting of several pieces united together, and covered by a fleshy, sensitive, musculo-membranous envelope, continuous with the common integument of the animal.

The pedicellariæ of the genera Amphidetus, Spatangus, and Echinus, possess, in addition, a calcareous style or stem, which is also covered by a prolongation from the skin or gelatinous envelope of the animal, and the basal end of the style is enlarged for articulation with a smaller knob or elevation upon the shell, adapted to its reception, in a ball-and-socket-like movement.

Few objects are of greater beauty than the pedicellariæ of the Echinodermata, as the highly reticulated character of the structure, the brilliant transparency of the crystalline substance, and sparkling, gem-like elegance, fully testify. But all these characters may be elicited by ordinary examination in the microscope, with transmitted, reflected, or oblique rays falling upon them. Yet the highly doubly refracting properties of carbonate of lime or Iceland spar, of which they are composed, make them still more lovely objects when they are examined by polarized light and the selenite stage, but without the analysing crystal above the eye-piece. Under these circumstances the pedicellariæ themselves become their own analysers, by double refraction; and the transparent, colourless valve of pedicellariæ becomes either red or green, blue or yellow, according to the thickness of the selenite plate beneath them. Some Echini, as *E. lividus* and *E. neglectus* (Forbes), are well supplied with a deep-blue colouring matter, which gives a beautiful tinge to the spines, which is not removed upon boiling in strong potass lye. The pedicellariæ under these circumstances also possess the purple tint of the spines, the colouring matter existing in some sort of combination with the crystalline carbonate of lime. These coloured objects remind one of brilliant sapphire gems, profusely decorating the wondrously constructed Echinoderm, less costly and far more elegantly cut than the far-famed jewels of Her Majesty, but destined to be hidden in the dark abyss of ocean's depths until brought to light by the researches of the naturalist, and rendered evident by the lenses and mirrors of the microscopist.

When it is desirable to examine the movements of these organs it is advisable to remove a portion of a living animal and insert it in a small trough of sea water, and watch the pedicellariæ with a low-power objective upon the stage of the microscope. But when it is only desired to examine the structure of the pedicellariæ it is better to remove the organ with a scissors or small forceps, and, having placed it on a slide with a small quantity of glycerine containing a little caustic potash, shortly the musculo-membranous indusium becomes transparent, if not dissolved; and all the calcareous elements become apparent, but still not sufficiently clear for photographic purposes. Under these circumstances it is necessary to boil up each animal in distilled water containing a tolerable quantity of caustic potash, which dissolves all the fleshy coverings, and the calcareous pieces are made clean and transparent. In many instances, if the boiling has been carefully stopped at the proper time, the two or three blades constituting the forceps-like appendage remain in conjunction, and are then very much more instructive preparations to the microscopist. In order to remove these pedicellariæ from the other calcareous débris of the Echinoderm it is necessary to allow all matters to subside and decant the supernatant alkaline solution; and, having removed all traces of potass by frequent washings and subsidence with successive portions of distilled water, it only remains to agitate the whole well together with a steady circular motion, and after some moments' repose pour off the supernatant water which contains the pedicellarial blades in suspension. On repose these subside, and may be then removed by a dropping tube, placed on a slide, dried, and mounted in Canada balsam in the usual way.

The objects now exhibited in photographs have all been so prepared by the author himself, and are, consequently, authentic specimens, and have all been photographed to one scale for comparison with the same lens and camera. They are under the same identical circumstances in each particular case, so that relative size may be taken into consideration as one of the elements of difference.

The objectives used were a Ross's inch and half-inch, two beautiful lenses, in which the visual and actinic foci rigidly corresponded, which of course contributed much to the beauty of the photographic pictures, the absolute accuracy of which is only limited by the degree of penetration of the lens. Direct solar light has been in all these micro-photographs an absolute necessity; the *image of the sun* being actually necessary to the formation of an image possessing the intensity requisite for photographic printing purposes.

A general view of the pedicellariæ of an animal was first taken with the inch, giving about twenty diameters; then each form of pedicellarial blade was separately taken with the half-inch, giving a magnifying power of fifty-five diameters.

As this paper is still far from complete in the determination of many points of great interest for the coming sections, the author would feel deeply indebted to any reader who would kindly supply him with specimens of the following Echinoderms—*Spatangus purpureus*, *Echinus lividus*, *E. melo*, and other of the rarer forms met with on our coast. He is also desirous that they should be freshly dredged, as in the cabinet the pedicellariæ almost always drop off and are lost. He finds that dried powdered salt is the best material in which to pack them for his purpose.

It only remains to conclude these introductory remarks by sincerely thanking the following friends and gentlemen for their kind assistance, viz., the Rev. A. Percival, of Scilly; Professor Wyville Thomson, of Belfast; Dr. Steele, of Dublin; Mr. Gallienne, of Guernsey; Mr. C. Stewart, of Plymouth; Mr. Bean, of Scarborough; Mr. Leipner, of Clifton; Mr. A. S. Reed, of Tenby; and more especially the Rev. A. M. Norman, of Houghton-le-Spring; to all of whom the author is indebted for various valuable specimens of our British Echinodermata.

Asterias rubens (Linnæus).
Uraster rubens (Forbes).

The late Professor Forbes, in describing the pedicellariæ of the *Uraster rubens*, says—"Those on the body and upper spines differ in shape from those on the spines immediately bordering the avenues. The former are much shorter and blunter in the blades than the latter. The calcareous forceps of which their heads consist are united in an integument of a soft, granular tissue, which envelopes the forceps when closed; and this apparatus is mounted on a bulging body of a similar substance, which crowns the round and flexible peduncle, sometimes simple, sometimes branched, each branch having a similar termination. He could detect no vibratile cilia on their stalks, but there appeared to him to be ciliary motions within the blades. When the star-fish is alive the pedicellariæ are continually in motion, opening and shutting their blades with great activity; but when cut off they seem to lose that power. If they be not distinct animals, as Müller fancied, for what purpose can they serve in the economy of the star-fish? If they be parasites, to what class and order do they belong? What is their nature, what their food? Truly these are puzzling questions. These organs, or creatures, have now been known for many years, have been examined and admired by many naturalists and anatomists, have been carefully studied and accurately delineated, and yet we know not what they are. This is but one of the many mysteries of natural history, one of those unaccountable things which we know and know not, of those many facts in nature which teach us how little is man's knowledge and how wondrous and unsearchable is God's wisdom. It is folly and vanity to attempt to account for all facts in nature, or to pretend to say why the great Creator made this thing or why he made that, and to discover in every creature a reason for its peculiar organization. It is but another form of the same vanity, having satisfied itself of the discoveries it has made, to pretend to praise the all-wise Maker's wisdom in so organizing his creatures. That God is all-wise is a revealed truth; and whether the organization before us seem excellent or imperfect it matters not; we *know* it is perfect and good, being the work of an all-wise God."

Dr. Sharpey says, also, in describing those of *Uraster rubens*—"During life these forceps-like blades are continuously open in a fresh and vigorous specimen, and instantly close upon being touched by a pin, and grasp it with considerable force. The particular use of these prehensile organs is not apparent; their stem, it may be observed, is quite impervious."

The peculiar movement of the calcareous blades are produced by muscular fibres existing in the external musculo-membranous indusium, and an abductor muscular bundle may be traced which serves to separate the two blades from each other, whilst they are closed by equally powerful adductors, all acting under the will of the animal. These muscular fibres generally have some calcareous point of attachment, and thus the spines and fenestral walls are generally well clothed with the pedicellariæ; but where pedicellariæ are found in the fenestral spaces these muscular bundles are attached to the firm coriaceous tegument of the star-fish, which integument closes in great measure the aperture of the fenestra, but yet possess numerous openings to allow of the transmission of sensitive prolongations of the internal membrane as tactile organs.

Professor Forbes says—"Both disc and rays of the star-fish are reticulated, and at the angles of the reticulations arise conical blunt spines, the bases of which are surrounded by circles of thickly studded spinules (pedicellariæ). In the spaces between the reticulations are numerous small-cleft, pincer-shaped, flattened, pedunculated spinules. The edges of the ambulacral avenues are bordered, first, by thickly set, long, thin, tapering spines, which have frequently several spinules projecting in a radiant manner from their inner side near the tips. Next to these are transverse rows of stout spines, similar to those on the rays above, but larger and stronger. There are generally three in each row, and their bases are surrounded by tufts of spinules (pedicellariæ). In very young specimens the pincer-like spicules are frequently wanting." ('British Echinodermata,' p. 84.)

These pedicellariæ are sessile in some cases or pedunculated in others, but the genus Uraster is distinguished by the pedicellariæ invariably having two blades, sessile in the greater number of instances; and of two characters, either solitary or aggregated.

The solitary sessile pedicellariæ are found generally disseminated over the dorsal aspect of the rays and disc, situated in the areolæ of the skeleton, and attached to the margin of the fenestræ. This form of pedicellariæ may be denominated valvate, or the sheep-shearing-shaped forceps, from its similarity to the shears, and from this circumstance the author has named them "forficiformes." They are very numerous on every animal of the genus Uraster, and are more readily discerned in dry specimens.

This genus also possesses two kinds of aggregated pedicellariæ—one valvate, the other pincer-shaped.

The spines bordering the ambulacral groves are frequently seen covered with a flock of these pedicellariæ, which have the same valvate or forficiform appearance as the solitary form previously noticed, but the blades of the shears are generally longer and more acute—in fact, more "mandibulate" in form.

Both these valvate forms agree in having a basal portion and two blades; each blade is pointed and gouge-like, with transparent cutting edges running nearly three quarters of their length, and appearing with higher powers finely dentated. The basal portion seen from above consists of two adherent cup-like cavities, somewhat quadrilateral in form—an oblong parallelogram, the angles of which are rounded. The margins of these cup-like cavities serve for the articulation of the broader ends of the blades, and when opened the whole organ presents the shears-like form described.

The second form of aggregated pedicellariæ wholly differs from the former, and consists of only two, having no basal portion. These are truly forceps-like in form, each blade crossing the other by a joint, not unlike the hinge of a pair of scissors or pincers, and having a dentated jaw-like margin, putting one in mind of a dog's-tooth forceps, hence called "forcepiformes." They occur around the bases of the dorsal spines in dense clusters, of some hundred or more to each spine, in *glacialis*, but are far less numerous in *rubens*.

The fleshy base of this mass of pedicellariæ occasion that icy look of the spine whence the specific name *glacialis*.

On pressing out a portion of this fleshy peduncle it is easy to find the long, twisted, muscular ropes, running through the fleshy mass to the base of each pedicellaria, there dividing into two branches, one for each blade of the forceps. Polarized light renders this structure more evident. These forcepiform pedicellariæ are also found in solitary individuals attached to the marginal base of the fenestræ. The best method of seeing these pedicellariæ is to dissect off the dorsal integument of the star-fish, dry it between two plates of glass, boil it in turpentine, and mount it in a cell in thin Canada balsam, boiling to expel air-bubbles, and placing a glass cover on, as usual. Polarized light exhibits these calcareous organs splendidly.

In addition to these pedicellariæ, common to both the *Uraster rubens* and *glacialis*—but all are of far larger size in the latter species—we find an enormously large "maxillæform" pedicellaria in the *glacialis*, which is peculiar to this species; it appears in greatest numbers along the margin of the ambulacral groves, and is usually "solitary." It is coarsely dentated around the jaw-like edge, with large serrated teeth, interlocking with those of the opposing blade, and its base is attached to the double, cup-like, terminal joint, as in the mandibulate and forficiform varieties, which it differs from in possessing a rounded, expanded, jaw-like end, instead of a pointed conical tip. These pedicellariæ have not been previously described or figured by any observer.

It is usually pedunculated, the peduncle being long, fleshy, and tubular, without any calcareous style.

This pedicellaria is also valvate in form, like the mandibulate and forficiform varieties.

The following measurements have been very carefully made in 10,000ths of an English inch.

	URASTER RUBENS.			URASTER GLACIALIS.		
Ped. forficiformæ .	Mean	·0262	...	Mean	·0353	...
" .	Max.	...	·0320	Max.	...	·0490
" .	Min.	...	·0200	Min.	...	·0206
P. forcepiformæ .	Mean	·0090	...	Mean	·0160	...
" .	Max.	...	·0093	Max.	...	·0166
" .	Min.	...	·0086	Min.	...	·0133
P. mandibulatæ .	Mean	·0160	...			
" .	Max.	...	·0186			
" .	Min.	...	·0126			
P. maxillæformæ .				Mean	·0713	...
" .				Max.	...	·0755
" .				Min.	...	·0420

(To be continued.)

RECORD *of the occurrence, new to* IRELAND, *with* NOTE, *of a Peculiar Condition of the* VOLVOCINACEOUS ALGA, STEPHANOSPHÆRA PLUVIALIS (Cohn), *and Observations thereon.* By WILLIAM ARCHER.*

(*Continued from p.* 132.)

IT may be said that the primordial cells of the mature plant do not change place within the envelope-cell; but there are circumstances, even though the force were more energetic than it at all can be, which prevent this. The pair of flagelliform cilia projecting through the extremely minute openings in the wall of the primordial cell into the water, and the majority of the protoplasmic prolongations reaching to contact with its inner surface, where they doubtless for a time adhere, tend to suspend the primordial cell in its place. But even when these are not fully extended, and besides the slowness and comparative feebleness of the process, the prolongations existing at opposite ends simultaneously and the contents being of a compact and comparatively firm character, not loose and disintegrated as afterwards, as evinced by the constancy in position of the two "chlorophyll-vesicles," there is no flow in any direction of the contents, nor any reptant motion. There is, I think, to some degree, a certain amount of foreshadowing, as it were, of the differentiation of the extremities, so conspicuous in my amœboid bodies, in the ordinary primordial cells; it will be noticed that these are often far more copiously drawn out into the described filamentous prolongations at one end than at the other, which is more attenuated; and one end of each of the primordial cells is often drawn much more into one hemisphere of the globe than the other.

Now, the foregoing remarkable considerations seem to have excited comparatively little notice; and it is only when such characteristics are evinced so forcibly as that the primordial cells crawl rhizopod-like about that they strike us with wonder. The amœboid bodies described become propelled constantly in one direction, because the pseudopodal processes are given off only at one extremity, and the influx of the granular substance of the mass is, of course, obliged to follow in that direction.

But the assumption by the primordial cells of Stephanosphæra of an amœboid condition is not without a parallel in another volvocinaceous alga. Dr. Hicks has described an amœboid condition of the "zoospores" of the far more

* Read before the Natural History Society of Dublin, May 6, 1863.

familiar *Volvox globator*.* In this organism some of the gonidia increase in size, become colourless; but, containing some brown or reddish particles, become detached from the circumference of the sphere, and acquire the power of protruding and retracting at various points the outer protoplasmic layer (primordial utricle), just like so many true Amœbæ. By this power they glide along the inner surface of the sphere. Dr. Hicks enters into some arguments to prove that these are really the modified zoospores or gonidia of the Volvox, and not true Amœbæ, which have entered the Volvox, and have devoured each a zoospore equal in size to itself, and then digested it. His arguments, indeed, that it is an actual change of the gonidium itself, seem irrefutable.

But the amœboid bodies of Volvox differ in some particulars from those of Stephanosphæra. In the latter they do not become colourless, as in the former, but retain, as has been stated, their green contents, but in a more disintegrated and loosely granular condition; they do not contain any reddish particles, as in the case of Volvox. In the case of Stephanosphæra, as has been stated, the extremities of the amœboid bodies are definitely distinguishable as an anterior and a posterior end, from the former only of which are the pseudopodal processes protruded, whilst in the amœboid bodies of Volvox there is apparently no such differentiation of the ends, and the processes are put forth in any direction. Dr. Hicks has not seen the amœboid bodies of Volvox to leave the old sphere and move about in a free condition. In the amœboid bodies of Stephanosphæra I have not seen any indications of a further change into the oval ciliated bodies described by Dr. Hicks.

In his very interesting paper alluded to the same author cites two other cases of vegetable amœboid bodies observed by him. He describes a change of the cell contents of the radicles of a moss into an amœboid state: the contents of certain cells became detached from the cell-wall and collected into one or more ovoid masses, which sometimes became segmented; their colour became temporarily changed to a reddish or reddish-brown, presently they lost colour, except a few reddish granules, as in Volvox, and became essentially amœboid, travelling up and down the cells. Shortly they withdrew the pseudopodal processes, and became rounded and ciliated all over, beyond which Dr. Hicks' interesting observations were not extended. To these cases Dr. Hicks' adds

* 'Quart. Journ. of Microscopical Science,' Vol. VIII, N. S.; 'Transactions of the Microscopical Society of London,' p. 99, Pl. VI (1860), and Vol. II, N. S., p. 96 (1862).

another, that of the amœboid transformation of the "gonidia" of a moss. The "primordial utricle" or outer protoplasmic layer became enlarged, at first feebly sending out short and rounded lobose processes. Afterwards the green contents vanished and the whole body became colourless, containing a few reddish-brown granules and some vacuoles; the processes became more elongate, and finally quite amœboid, moving freely about.

To the foregoing may be doubtless added the case referred to by Hofmeister,* in giving an account of the structure of the "spore-mother-cell" of a particular moss, of which he writes—"The cell contents, which are plainly surrounded by a thin layer of soft matter, very like a delicate membrane, swell slightly, or not at all; they (the cell contents) lie freely in the inner cavity of the cell, in the form of a closed vesicle, surrounded by watery fluid. Individual points of the primordial utricle sometimes exhibit slow expansions and retractions, similar to those of the inferior animals; for instance, the smaller Amœbæ" . . . . This is most probably a case in point, although the cell contents, still enclosed within the parent membrane, in the instance thus recorded, were not at liberty to remove.

The only other published record of what truly seems an actual case in point, which I have met with, of a locomotive power due to an amœboid motile contractility in an *undoubted* vegetable cell, is that by Schenk.† This author describes the nucleated, colourless, uniciliated zoospores of *Rhizidium intestinum* (a plant destitute of chlorophyll), as capable, during certain intervals, of moving about by the protrusion of amœboid processes, each thus generally presenting a constantly changing two-, three-, four-, or five-lobed figure, the lobes projecting in various directions, or for a time without lobes, and drawn out and very slender, whilst the internal movement of the granules was exactly that of an Amœba. After some alternations of a still and a slowly contractile condition, and of an active movement by aid of the cilium with which each is provided, the zoospore finally assumes an elliptic figure, comes to rest, loses the cilium, and developes (*more suo*) into a new young Rhizidium plant.‡

* Hofmeister, 'On the Germination, Development, and Fructification of the Higher Cryptogamia' (Ray Society's Publication for 1862), pp. 1623.

† 'Ueber das Vorkommen contractiler Zellen im Pflanzenreiche.' Würzburg, 1858.

‡ Since this paper was read I have noticed a memoir by de Bary and Woronin, published in 'Berichte ueber die Verhandlungen der naturforschenden Gesellschaft zu Freiburg, i. B.' (1864), entitled "Beitrag zur Kenntniss der Chytridieen," in which those writers (p. 30) state of the

Carter, too, speaks of a condition apparently "rhizopodous" of the contents of the cells of *Spirogyra crassa*;* but he has lately seen fit to alter his views. He now thinks that this was not really due to an amœboid condition of the contents of the cell itself, but rather, if I understand his remarks aright, to a true rhizopod, whose germ had been included by some means within the mass of protoplasm, or that it was a development of the parasitic plant *Chytridium endogenum* (A. Br.). Judging from the analogy of the other cases cited, it does seem, indeed, not improbable that it may have been likewise an example of an amœboid condition of the protoplasm, though it seems possible that this, as well as the development of Braun's *Chytridium endogenum*, may have been witnessed by him. Unfortunately his paper, which is published merely in abstract from the 'Journal of the Bombay Branch of the Royal Asiatic Society,' is without illustrations, and it is difficult to gain an exact idea of what the phenomena really were which it is intended to record. But he seems to describe a truly rhizopodous state of the so-called "monads" (zoospores) enveloped from the Chytridium, which may really be the case in point, and which at least remind us of the phenomena described by Schenk as regards the zoospores in the closely related parasitic plant, *Rhizidium intestinum*, before alluded to. Carter likewise seems to speak of a "polymorphous" condition of the shell contents in the Characeæ;† but the plants under examination by him, so far as I can venture to judge, seem to have been in an abnormal and decaying condition, and had apparently become the prey of some parasites—nay, he speaks himself‡ of the *hole* by which the parasite might have found its way into the infested plant. That the whole was in an unhealthy condition I venture to think, from his speaking of the occurrence of a transparent mucus, with a great development of *Bacterium termo* (Duj.), (mucus and Bacterium taken together being *Zooglœa termo*, Cohn), and always indicative of the decay of the mass amongst which it makes its appearance. Therefore

zoospores of *Synchytrium Taraxaci* (de Bary et Woronin) that "they [often] creep about in an amœboid manner, which lasts some time, finally, however, assuming a round form and coming to rest."......Synchytrium is a new genus, very closely related to Chytridium and to Rhizidium, upon which latter Schenk's observations above adverted to were made.

* 'Annals of Nat. Hist.,' 2nd ser., vol. xix, p. 259.

† 'Observations on the Development of Gonidia from the Cell Contents of Characeæ," &c. ('Ann. Nat. Hist.,' 2nd ser., vol. xvi, p. 1); also "Further Observations on the Development of Gonidia from the Cell Contents of Characeæ" ('Ann. Nat. Hist.,' 2nd ser., vol. xviii, p. 101).

‡ 'Ann. Nat. Hist.,' vol. xvi, p. 21.

I should venture to exclude any of the conditions forming the subject of Carter's observations on Characeæ from the same category as that of Stephanosphæra, Volvox, Rhizidium, &c., forming the subject of this paper; that is, I should imagine, they do not form an example of an amœboid condition of vegetable protoplasm, but are actually foreign parasitic growths, with the exception possibly (as above indicated) of the zoospores of the Chytridium.

I have mentioned the case of the zoospores of Rhizidium as the only other instance, besides Dr. Hicks', I have found recorded of a strictly amœboid condition of an *undoubted* vegetable cell.* For, as by so experienced and masterly an observer as Professor de Bary the hitherto so-called Myxogastric Fungi have been accounted as belonging to the animal kingdom, the amœboid condition of these organisms cannot be quoted as occurring in "*undoubted*" plants;† but that that group of organisms, while their reproduction appears to be vegetable, should present an intervening, though more prolonged amœba-like condition, seems, I should venture to suppose, no more to demonstrate their animal nature than do the temporary amœboid states of Stephanosphæra, of Volvox, of the Moss, or of Rhizidium, prove that they belong to the animal kingdom, seeing, as is well known, that all their analogies and affinities are with plants, and their true position cannot for a moment be doubted. Professor de Bary, while admitting the force of certain analogies presented by unquestionable plants, contends that in his "Mycetozoa" (Myxogastres) the free power of motion occurs, with a greater intensity, and persists through a greater section of their developmental processes, than is at all approached by any plant.‡ But at least the free power of motion, externally of the enveloping protoplasmic mass, and internally of the thereby induced flowing granular contents, and the consequently reptantly locomotive power of the whole, could not occur in greater intensity nor more energetically in any "*Mycetozoon*," nor in any true "*Amœba*," than in the thus remarkably temporarily modified primordial cells of Stephanosphæra. Had, therefore, de Bary been aware of this condition of the latter, or those of Volvox and the Moss, put forward by Hicks, I venture to think that, perhaps, he would not have insisted so strongly on the extreme view he has

* See, however, the previous foot-note alluding to de Bary and Woronin's paper on "Synchytrium," lately published, l. c.

† De Bary, "Die Mycetozoen," in Siebold and Kölliker's 'Zeitschrift für wissenschaftliche Zoologie,' Band x, p. 88.

‡ Loc. cit., p. 166.

taken as regards the Myxogastres. That within the substance of the protoplasmic mass of the Myxogastres foreign organic bodies have been found, is beyond question; these, however, have been confined, I believe, to the spores of the plant (?) itself. As to the significancy of the fact, however, and into the discussions which have taken place thereon, I cannot dare to enter.*

The analogy of the phenomena here described in Stephanosphæra with that which is known of the development of the Gregarinida will be sufficiently apparent, the so-called "pseudo-navicellæ," like my "primordial cells" of the Stephanosphæra, upon leaving the cyst within which they were generated, passing into a temporary amœboid condition; and though this, indeed, may be nothing more than an analogy, yet it is decidedly still worth noticing. Nor has the similar analogy existing between the Myxogastres (Mycetozoa, de Bary) and the Gregarinida been failed to be urged by de Bary in argument for the validity of his conclusions in regard to the animal nature of the former.† But the arguments drawn from this analogy could not, at least, be considered equally valid if similarly applied in both instances; for, if this analogy with Gregarinida were admitted to have equal force in the Volvocinaceæ (here apparently exceptional, and less permanent, as the peculiar condition which gives rise to it may be) to that which de Bary considers it has and lays claim to for it in Myxogastres, its application must, I think, lead to deductions, as regards the chlorospermatous algæ in general, so sweeping and comprehensive as to be totally unreasonable and altogether untenable.

I might, perhaps, have referred to one or two other cases, *possibly* similar to those I have cited of an amœboid condition of the protoplasm within the vegetable cell. I say *possibly* similar; for as the records are not sufficiently copious or exact, it does not seem at all certain whether such may be really cases in point or may be instances of the actual ingress from without of a true animal. Cienkowski's observations‡ show that his *Monas parasitica* can make its way into a vegetable cell from without, as he witnessed it, through the cell-wall, within which it puts on an amœboid condition. I venture to imagine that it may be possible that some of Carter's cases may have been similar to that described by

* See *ex. gr.*, Hoffman, in 'Botanische Zeitung,' 1859, p. 202; Wigand, in Pringsheim's 'Jahrbücher für wiss. Botanik,' Band iii, p. 1; Cienskowski, ibid., Band iii, p. 325; de Bary, in 'Flora,' 1862, pp. 264 *et seq.*

† 'Flora,' 1862, p. 303.

‡ Cienskowski, "Die Pseudogonidien," in Pringsheim's 'Jahrbücher für wissenschaftliche Botanik,' Band i, 1857, p. 371, t. xxiv, 2, 3, 4.

Cienskowski, although I am not aware that the observations of the latter have been confirmed by any other observer.

In case observers should in future meet with vegetable cells showing Amœba-like structures within, special attention should therefore be paid to this point, as to whether they are foreign intruding parasites, or are really due to any phase or change of condition of the protoplasm of the vegetable cell itself. There cannot be a question, however, as to the accuracy of Dr. Hicks' and Professor Schenk's observations, and that a parasite had nothing to do with the phenomena they describe. And that the primordial cells themselves of Stephanosphæra actually became temporarily changed, as I have described, and not that they each became the choice morsel of a *burglarious* Amœba is, likewise, beyond the faintest shadow of a doubt.

But, leaving out of view the Myxogastres, as well as any such cases possibly, but only conjecturally, similar to the authenticated instances here cited, I fancy it would not be difficult to find further examples, far less pronounced and far less striking, it is true, than in Stephanosphæra, Volvox, Moss, or Rhizidium, of that automatic contractility which in these established cases makes itself so remarkable, as even to present phenomena characteristic of a true Rhizopod.

Let us take a look, for instance, at the figures of the zoospore of Œdogonium at the moment of its escape from the parent-cell.* The contents of a cell destined to become a zoospore become withdrawn from the cell-wall, and somewhat contracted into a subelliptic figure; at one side there makes itself apparent a pale space, which is the place whence afterwards is to originate a crown of cilia. The parent-cell-wall splits, and the zoospore makes its egress, often through a space actually too small to allow it to pass without a modification of its form; and this, in such instances, is really what takes place. It may be said that its motions are assisted by the cilia; but they have not yet begun to play, nor, if they had, could they cause that alteration of figure, "like that of a Euglena, from second to second," of which Cohn speaks.† There can, I think, be no doubt but that the zoospore here, in such accidentally difficult cases, is mainly assisted in its birth by its own innate contractility. Nägeli,‡

* See the following, *e.g.*:—Cohn, 'Untersuchungen über die mikroskopischen Algen und Pilze,' t. xx, figs. 1, 2, 22, 23; Pringsheim's 'Jahrbücher für wissenschaftliche Botanik,' Band i, 1857, t. i, figs. 13, 14, 15; Vaupell, 'Iagttagelser over Befrugtningen hos en Art af Slægten Oedogonium,' figs. 4, 11, 12.

† Loc. cit. ('Untersuchungen über d. mikr. Alg. u. Pilze'), p. 231.

‡ 'Pflanzenphysiologische Untersuchungen.'

and, apparently following him, Vaupell,* seem to urge that an exosmotic action operates upon the young zoospore, inducing the phenomena described. Cohn likewise,† in such cases (speaking of the zoospores of Vaucheria and Hydrodictyon), where the so-called primordial utricle (outer protoplasmic layer) presents contraction and expansions, seems to have arrived at the conclusion that such alterations of figure are wholly due to the taking up and withdrawal of water, and not to any special inherent contractility. The very interesting experiments upon Spirogyra, Closterium, &c., which Cohn describes, seem to prove only that by the alternate absorption and withdrawal of water the cell contents become contracted or expanded as a whole, that is, become alternately changed in bulk and density; but it does not to me appear that such experiments call forth anything like "rhizopodous" phenomena, such as those described in this paper, nor will the results of such experiments account for them. The former (that is, automatic contracility) is, I venture to believe, far more likely to be the true solution. Many other similar instances in zoospores (for instance, Vaucheria), as is well known, might be here cited. Yet, in his elaborate memoir on *Protococcus pluvialis* (Kütz.),‡ published previously, the latter observer seems to dwell upon the similarity of the contractile phenomena presented by the primordial utricle of that remarkable organism to those shown by Euglena and Astasia; and he bases thereupon certain comparisons of the vegetable protoplasm to that of the animal, leading him to the conclusion that these are quite analogous, correctly regarding (as I conceive) *Protococcus pluvialis* as a plant, and assuming Euglena to be the animal. However, his own very interesting observations on Euglena,§ as well as those of others, seem rather to point to the conclusion that this puzzling organism is really a phase of a plant. Hence, as I conceive, it seems to have needed such observations as those of Dr. Hicks, and that on Stephanosphæra here recorded—that is to say, evidence of automatic rhizopodous movements in undoubted plants—to complete the proof of the similarity of the animal and vegetable protoplasm.

Again, in our search for analogous cases, as regards cells which are not zoospores, let us refer to the figures of my

* Loc. cit. ('Iagttagelser,' &c.), p. 29.

† Loc. cit. ('Untersuchungen über d. mikr. Alg. und Pilze'), pp. 228, 230.

‡ 'Zur Naturgeschichte des *Protococcus pluvialis* (Kütz.)." In abstract, in Ray Society's Publication for 1853.

§ Ibid., p. 733.

Mesotænium mirificum, which I brought before the society during last session.* Here the contents of a single Mesotænium cell escape therefrom without conjugation through a lateral or terminal or variously disposed opening, effected by the raising up of a lid- or valve-like portion of the membrane of the parent-cell. During this act the emerging contents are often much constricted by reason of the narrowness of the aperture by which they make an exit, and after emergence the mass becomes rounded. Now, Mesotænium is a plant which does not generate zoospores, and whose developmental stages are regarded as quiescent, yet here the protoplasmic mass, wonderful as it may (at first sight) appear, actually comes forth into freedom, through an opening very considerably smaller than even the narrowest diameter of the former. This paradox is solved by witnessing the phenomenon:—a lobe-like extension—I might write a pseudopodal process—is protruded through the opening; a portion of the contents is slowly drawn after, thus relieving the mass behind, which contracts upon itself; and the gradual extension and expansion of the portion outside the old membrane by degrees draws with it the whole; and its purpose, whatever it portend, is gained—that is to say, the whole protoplasmic mass and contents have acquired their freedom, and the old parent-membrane is discarded and deserted. What immediately becomes of the "chlorophyll-plate" in this process I cannot say, but the whole contents become more granular, in which I suppose the plate likewise takes a part; or possibly it becomes consolidated in the centre, causing the dark central spot in the spore-like body formed by the emerged contents—it, at all events, affords no obstacle to a process which at first sight, and until it is properly considered, appears almost like a feat of *legerdemain*.

Not to multiply examples, let us refer, lastly, to the *modus operandi* of the process of conjugation in the genus Spirogyra. Two filaments in juxtaposition about to conjugate put forth from opposite cells, as is well known, short tubular processes, lined by a similar extension of the "primordial utricle" bounding their contents. This, indeed, so far seems to be only a process of *growth*, comparable to that which takes place in a joint of Cladophora when about to give forth a branch, or to that of the apex of the tubular filament of Vaucheria, &c. &c. But in the conjugating joints of Spirogyra an actual contact and resorption of the intervening septa having taken place, so as to produce an uninterrupted connecting canal,

* 'Proceedings of the Natural History Society of Dublin,' vol. iv, part i, pl. i, figs. 21, 22; also 'Quart. Journ. of Mic. Science,' vol. iv, p. 109.

there thereupon occurs a contraction of the cell-contents of the conjugating joints. Presently one of these protoplasmic masses passes over through the canal, to combine into a single spore with that in the opposite cell. Now, the collective mass which is about to pass over is actually of greater diameter than the transverse canal through which it has to make its way. This, of course, can only be effected by a process essentially similar to that which the cell contents adopted or underwent in the curious exceptional case in the Mesotænium described by myself,—in other words, by calling into play its own inherent contractile power.

It is true that Professor de Bary,* in speaking of the wonderful phenomenon of the seeking out of the germ-cell on the part of spermatozoids, and of the not less wonderful phenomenon of conjugation, suggests that in the former instance the active ciliated spermatozoids, and in the latter the conjugating protoplasmic masses, are impelled by a kind of *attraction* exerted upon the other on the part of that which in either instance is the receiving cell. But, granting that the motive force impelling in its normal direction the protoplasmic mass which actually passes over may be an *attraction* on the part of the other (this, indeed, must be a *mutual* attraction in those Conjugatæ which form their spores halfway), yet this does not affect the *modus operandi* of the actual change of place, that is, the means by which the locomotion is effected. In Œdogonium, Sphæroplæa, &c., this presumed attraction, then, draws over into its sphere bodies moving by cilia; but in Spirogyra it acts upon bodies, if I be right, moving their little distance in an amœboid manner. In either instance this presumed attraction may influence the ultimate direction of the movement of the bodies acted upon, but cannot excite that movement, nor can it affect the mode of progression. That it cannot excite it even in Conjugatæ is certain, as in the case of the Mesotænium observed by me, above cited, no such attractive force could exist: there was no conjugation; and the exit of the "primordial utricle" with contents was, so to speak, a purely spontaneous action —a purely automatic relinquishing of its previously apparently too narrow limits, and, as I have above endeavoured to convey, by a kind of motion to all intents and purposes "amœboid" in its character.

In all these cases active mobility is evinced by the protrusion of what may be called, indeed, pseudopodal extensions; and the result, as in Amœba itself, is not only change of form, out actual locomotion.

* 'Untersuchungen über die Familie der Conjugaten,' p. 59.

It may be asked, where is the rolling, onward flow of the granular contents in the Mesotænium alluded to, and here, so characteristic and conspicuous in my amœboid bodies, and requisite to carry out the analogy? I believe the flowing movement of the contents in the latter is due to its granular condition; the granules, free and distinct from each other, are urged on by the contractile power of the bounding protoplasmic mass; they therefore naturally assume a flowing movement, to a certain extent resembling that of the blood-discs in the vessels of the higher animals. In the latter instances, on the other hand, the contents have not become all so finely and freely disintegrated, and the whole contents are simply compressed and so moulded by the contractile power of the bounding protoplasmic mass as to become adapted to pass through a comparatively narrow outlet. In both instances the solid contents seem to be passive, and are urged along by the contractile power of the external protoplasmic mass. In the one instance, the contents, loosely granular, are powerfully and rapidly acted upon by momentary and even fitful changes of the lobose expansions and the contractile efforts of the protoplasmic mass, and the granules *flow*. In the other the contents, still maintaining a coherence and much of their original disposition, are slowly (but surely) acted upon by the gradual, and except at intervals imperceptible, but not less actual, contractile power of the protoplasmic mass, and they are thereby *carried with it*. Even in the latter instance there does exist a certain amount of the same kind of movement of the solid contents as in the former; but as the whole process is so greatly slower, and the contractile force comparatively so much less energetic, it is not so perceptible. In my mind the analogy is exact—the difference is in degree.

Now, let us for a moment imagine an *Amœba princeps* or *diffluens* imprisoned within such a rigid cyst as that of the parent-membrane of my *Mesotænium mirificum*, or within the cavity of a joint of a Spirogyra, and with only one narrow aperture, considerably smaller than itself by which it could possibly get free. Now, further, let us suppose our *Amœba* acted upon by the impulse to get out,—there can be no doubt but that it could perform the feat—and its *modus operandi*, so far as I see, would not essentially differ from that of the true vegetable cell, in actually effecting the same object in the course of its own natural developmental vital processes.

Starting, then, from such cases, and passing on through the more decidedly reptant amœboid bodies of Rhizidium, of the Moss, of Volvox, we arrive at the vigorously, and actively and freely crawling, energetically and comparatively rapidly locomotive, amœboid bodies of Stephanosphæra. We must regard, I think, the whole as manifestations of one and the same phenomenon—in the first lasting for a shorter period, and more feebly and slowly evinced; in the latter persisting for a longer period, and in the cases cited gradually more and more energetically and decidedly displayed, until (leaving the Myxogastres aside for the present), in the case of Stephanosphæra this extraordinary condition seems to culminate.

If this reasoning be correct, then, contractility, *amœboid* contractility—for I can find no more comprehensive and expressive single adjective term—must be accepted as an inherent quality or characteristic, occasionally more or less vividly evinced, of the vegetable cell-contents, and this in common with the animal; in other words, that the nature of the protoplasm in each is similar, as has indeed, as is well known, before been urged on grounds not so strong; thus reserving Siebold's doctrine that this very contractility formed the strongest distinction between animals and plants, as he assumed it to be present in the former and absent in the latter of the two kingdoms of the organic world. Therefore an organism whose known structural affinities, and whose mode of growth and of ultimate fructification, point it out as truly a plant, but of which, however, certain cells may for a time assume a contractile, even a locomotive, quasi-rhizopodous state, must not by any means on this latter account alone be assumed as even temporarily belonging to the animal kingdom, or as tending towards a mutation of its vegetable nature. And from this it of course follows that an organism whose structural affinities and reproduction are unknown, but which may possibly present an actively contractile, even locomotive, power, need not on this latter account be assumed as therefore necessarily an animal. In the former category fall the Volvocinaceæ and Rhizidium; in the latter category Euglena and its allies, the so-called Astasiæan Infusoria, suggest themselves; and these must of course wait until their reproduction and history are better known before we can feel satisfied as to their true position, yet it seems highly probable that these will presently, if they do not even now, take their place amongst admitted plants.

Several writers have indeed, from time to time, as is well known, put forward the (now, I think, generally accepted) view that the protoplasm of the vegetable and the sarcode of the animal cell are identical in nature; and, in seeking for analogies as regards contractility in the vegetable protoplasm as compared with the animal, and as demonstrative thereof, special attention has been directed to several of the now familiar phenomena displayed by certain vegetable cells. Such are the vibratory movements of cilia, and drawing in of these, the circulatory movements of the cell-contents, as in the hairs of the stamens of Tradescantia, &c., the contractile vacuole in Gonium, Volvox, &c., and so forth. But while these are, I think, unquestionably to a considerable, but more limited, extent, manifestations of the same phenomenon, it seems to me that none of these cases present so exact an analogy, strongly as they may indicate it, with the rhizopodous contractility, as do the amœboid bodies of Stephanosphæra, of Volvox, of the Moss-radicles, and of Rhizidium. The amœboid bodies of Stephanosphæra seem to display this rhizopodous contractility in greatly the most marked or exaggerated degree, as their vigorous and energetic powers of locomotion indicate; in them, and indeed in those of Volvox, of the Moss, and of Rhizidium, the pseudopodal processes and their mode of protrusion and withdrawal, the flow of the granules, and the locomotion of the whole body, were in all respects analogous to the similar phenomena evinced by a true Amœba.

But I need hardly add, after what has been advanced, that I do not suppose for a moment that there was in these cases actually an absolute conversion of the vegetable cell into an animal. In the case of the Stephanosphæra and of Rhizidum this condition is certainly but very temporary—a few hours at most, and the quasi-animal condition becomes relinquished for the strictly vegetable. In not one of the cases cited were there to be seen any foreign bodies of any kind within the substance of the amœboid structures. It may be said, indeed, so far as this bears upon the question, that it is only negative evidence; and in the case now brought forward there were very few, if any, foreign bodies at all existent in the material under examination. In his memoir, describing his recent and masterly researches on certain minute parasitic Fungi,* Professor de Bary makes the statement that not once in the course of his researches has he met with any case which would induce him to the view that any single one of those parasites owes its origin to the changed contents of any cell, or of any intercellular fluid, of the infested plants. How much the more unlikely, then, is it that a true animal could have such a beginning, if the contents of the cells of the host-

* 'Ann. des Sciences Naturelles,' iv série, tome xx ("Botanique"), p. 5; also 'Flora' (1863), p. 163.

plant cannot give origin to a Fungus—another denizen of the vegetable kingdom!

The advocates of a "third kingdom," intermediate between the animal and vegetable, as well as those who hold that, there being no distinction between animals and plants, an organism may be at one time an animal, at another a plant, or that the one may give birth to the other, will each, I suppose, think they can draw support from the facts adverted to in this paper. In my mind they are opposed to the arguments of both. Those who even in this day contend that Volvocinaceæ are animals will doubtless feel themselves confirmed in that view, on account of their occasional amœboid state, and on account of the parallelism to a certain extent with the Gregarinida. But what of Spirogyra, of Mesotænium (Conjugatæ), of Rhizidium (which probably should be referred to Fungi)—of Dr. Hicks' Moss? When, or at what point, do they cease to be vegetables, or are these varied organisms always animals? "No!" say the advocates for a half-and-between kingdom—"Nor plants either—they belong to the 'Protozoa' or 'Phytozoidea,' or 'Primalia,' or the 'Regnum primegenum.'" If so, must all the Confervoideæ, all the Algæ—must Dr. Hicks' Moss? Truly this "intermediate" kingdom would form a most heterogeneous and incongruous assemblage, here and there transferred—nay, even sometimes violently disrupted, from both sides. Those who may, perhaps, think this to be exaggeration, I would refer to Owen's 'Palæontology' for "Protozoa;" to Perty, for "Phytozoidea;"* for "Primalia," to a paper published not later than May, 1863, "On a third kingdom of Organized Beings," by Thomas B. Wilson, M.D., and John Cassin;† and for the "Regnum primigenum," to a paper by John Hogg, M.A., F.R.S., &c.—the last supported by a gaudy if not quite convincing diagram.‡

Either hypothesis, instead of removing or even smoothing any difficulties, seems to me to multiply them manifold, and to involve far greater dilemmas, and to plunge us more deeply into doubts and perplexities, than those with which we find ourselves obliged to contend, when, as I venture to conceive,

* Perty, 'Zur Kenntniss kleinster Lebens-formen,' p. 22.

† 'Proceedings of the Academy of Natural Sciences,' Philadelphia, No. 3, 1863, p. 113. The latter writers, indeed, think to make short work of the difficulty, by consigning the whole of the Algæ, Lichens, Fungi, Spongiæ, and Conjugatæ, to the "Primalia."

‡ "On the Distinctions of a Plant and an Animal, and on a Fourth Kingdom of Nature," by John Hogg, M.A., F.R.S., in 'Edinburgh New Philosophical Journal,' vol. xii, N.S., p. 216.

the phenomena of nature and the simple facts are rightly and properly viewed.

To say (with Schenk and many others) that there is no actual distinction between the animal and vegetable kingdom, whatever may be *intended* to be thereby conveyed, so far as I can see, is simply to say that a germ or partially developed organism may go on to find itself, when matured, at random, or as chance or circumstances may direct, either an animal or a plant, that is, that it is at one time an animal, at another a plant, or *vice versâ*. If people confined themselves to saying that certain phases in the development or history of certain organisms belonging to either kingdom are sometimes very difficult indeed, nay, with our present limited acquaintance with them, perhaps impossible, to distinguish from similar phases of certain other organisms belonging to the other kingdom, then acquiescence becomes a matter of course. For, as I venture to think, it is only the development of an organism from its germ until it in turn reproduces its germs —its origin and destiny—the nature of its ultimate fructification—what it grew from, and what it ends in—its *tout ensemble*, in fact—and *no isolated or single phase or temporary condition in the course of its development*, even though protracted—that can decide the point as to its true nature. So far as I can at present see, the fallacy seems to me to lie in the assumption that a correct diagnosis as to the plant or animal nature of any organism ought to be made in a moment, at any given stage upon which we accidentally alight. It is true, indeed, that of very many of these doubtful or uncertain organisms, as they ordinarily present themselves to us, the life-history—the beginning and the end—is as yet very imperfectly known; upon such it would, of course, be premature to attempt to decide; nor can I see that such cases militate against the view here sought to be expressed.

> "Non semper ea sunt, quæ videntur, decipit
> Frons prima multos"—

is doubtless oftentimes as true of many of these lowly beings, in their way, as it is of men.

Unger, with the so-called cell-circulation in the vegetable, as well as the movements executed by ciliated zoospores, in his mind's eye, expressed himself thus—"The animal nature is in the plant, as it were, caged"—as if he would say, as it were, that if it could only escape its thraldom, it would be an animal. He would doubtless have considered himself doubly fortified in this view, had he known that a protoplasmic vegetable mass can (and does occasionally) assume an actually reptant amœboid state. But I do not see that such a view is in truth justified, so far, at least, as present knowledge goes. That a plant is a plant, and an animal is an animal throughout, we must I think certainly as yet hold, notwithstanding that certain phases of the one may under certain circumstances temporarily simulate certain phases of the other. I conceive that we must, in our present state of knowledge, continue to believe that these free amœba-like reptant masses of vegetable protoplasm *cannot*, any more than the isolated motile ciliated zoospores or spermatozoids, be of animal nature; for—although, for a while, with more points in common with certain true denizens of the animal kingdom than is ordinarily the case in the vegetable cell—(so far as we can *at present* see) the former, viewed retrospectively, have had an origin different from the animal which they may simulate, and, viewed prospectively, have before them a different destiny.

Whether I may eventually be right or wrong in the opinions in this paper ventured to be put forward (and in regard to which it were folly otherwise to aver than that I am not so wedded to them as to be unprepared to relinquish them on sufficiently cogent evidence on the other side, though as yet I feel compelled to hold a present belief in their soundness), or whether such opinions may accord with those of others—the *fact* will still remain the same, that the membraneless primordial cells of the vegetable Stephanosphæra temporarily became amœboid, and crawled about as quasi-rhizopods; nor will that fact *per se* have lost its interest, I trust, on account of my tedious and awkward method of handling it. I add this, then, as another example of such a phenomenon to those already recorded in Volvox, Moss-radicles and Rhizidium, as one more humble contribution to the as yet indeed but comparatively slender stock of facts gleaned from the vegetable side of the organic world which bear on the question which I have ventured to discuss, and from which, when by degrees hereafter enlarged and strengthened, it is to be hoped that ultimately the Truth, as regards that question, may be evolved.

The TREMATODE LARVA *and* ASCARIS *of the* CARCINUS MŒNAS.

By W. C. M'INTOSH, M.D., F.L.S.

(With Plate VIII.)

Carcinus mœnas is pre-eminent amongst the higher Crustacea for its marauding habits; but it pays a heavy penalty in becoming the abode of numerous parasites. The young of the Common Mussel attach themselves to the eye-sockets, and, appropriating the cavities, cause the destruction of the eyes, which, protruding, become a site for *Membranipora pilosa*, or fall off. The same shell-fish attaches itself (sometimes in numbers) to the central groove on the inferior surface of the cephalo-thorax, binding the tail thereto by its byssus, and proving more troublesome in that situation than a large Pachybdella. It occasionally blocks up the branchial slits, or seriously interferes with the functions of the respiratory organs, by lodging in the branchial cavity, and fixing the external whip (of the third pair of foot-jaws) to the outer wall by its threads. The pits of the internal antennæ also suffer from their inroads, so as sometimes to cause the debatable functions of this organ to be sadly impeded. In a large male Carcinus, for example, there were ten small Mussels under the abdomen, one blocked up the left anterior branchial slit, and the right eye was unhoused and projecting by another of these curious molluscs. The crab also bore Balani on various parts, a considerable patch of *Lepralia hyalina* on the left under side, a compound Ascidian covered most of the corresponding right region, and extended, in company with *Membranipora pilosa*, over the dorsum. These are but a few of the external parasites of this active Crustacean.

With so many external parasites, the occurrence of numerous, if not different, internal ones, is perhaps less surprising. In dissecting out the nerves of a specimen minute specks were found on the branches of the great thoracic ganglion, adhering apparently to the sheaths of the nerves and following them in their distribution, occasionally in groups of two and three. The same bodies also abounded in the liver. Under a lens they were seen to be small glassy ova, with opaque white internal markings. In upwards of forty Carcini examined they have been found in every specimen, irrespective of sex, from three fourths of an inch across the carapace upwards. In well-marked cases they occur in hundreds, attached to the ducts and blood-vessels of the liver, between the papillæ, and crowded together like clusters of grapes. Scarcely a soft texture in the interior, with perhaps the exception of the heart, is free from their inroads. A series of specimens shows them in the muscles of the stomach, those in the neighbourhood of the heart, and in the generative organs. Injection of the arteries with vermilion brings out those attached to them with great clearness. Season does not seem to affect their presence, structure, and stage of development. On the whole, they are most numerous in males.

On placing an egg under the pressure of a thin glass cover, and magnifying 180 diam., the aspect is as shown in Pl. VIII, figs. 1 and 2. The egg-case (fig. 4) is very tough, and apparently consists of two layers marked by minute striæ and specks; but the outer cannot always be seen, and is probably due to a delicate investment derived from the surrounding tissues. The contained living embryo differs little in apparent age and development in the various crabs. The parasite has a gentle gliding movement in the egg, and, when at rest, is susceptible of stimulation; for it becomes active when slight and intermittent pressure is applied, or when the effects of evaporation are felt. They will live for sixteen hours or more after immersion in weak spirit. The margin of the embryo *in situ* is observed to be finely crenate for about half the circumference. It lies in a doubled or coiled position, as in fig. 1, where the embryo is seen in profile. A front view is given in fig. 2. On pressing with force on the egg, so as to cause it to burst, it is found that the embryo generally emerges with the broad end containing the large cells first, and sometimes the small end clings firmly to the interior of the capsule, from the fact, afterwards to be explained, of its being plentifully supplied with minute recurved spikes. This is easily illustrated by placing some ova in fresh water for a few days, and allowing the egg-capsules to burst.

Fig. 3 represents various views of the embryo under the high power of a dissecting lens. A single individual, magnified 180 diameters, is shown in fig. 5. It crawls about after extrusion with an undulating motion, like a Planaria, altering the outline of its body at pleasure, and throwing it into wrinkles; but the lower end in this figure generally remains largest. At the upper or small end is observed a circular oral sucker (*h*, fig. 5) from which an œsophagus proceeds downwards, dilating after a short progress into an ovoid sac (*g*) (? if the homologue of the pharyngeal bulb of a Cercarian), and, again contracting to its original size, passes down the middle of the body, gradually widening as it approaches the larger end of the animal, and dividing into two wide ducts (alimentary cæca), which fork outwards to the sides of the body. This bifid portion (*f*, *f*) was filled with opaque cells and granules. Another (ventral) sucker (*b*) is situated a short distance below these ducts, in company with a smaller globule (*e*) placed above (in front of) it, and two larger circular masses (*c* and *d*) on each side. The former masses (*c*, *c*) were large granular structures, more opaque than the others. The large compound cells lay in two groups (*k*, *k*) just within the margin of the body, and when undue pressure was applied, they escaped through a central pore at *a*. These cells (fig. 6, *a*) occupied rather more than two spaces of the $\frac{1}{2500}$th of an inch, and had in their interior a great number of minute clear granules endowed with motion. The delicate cell-wall soon burst, and the little transparent granules (fig. 6, *b*) spread themselves over the field of the microscope, and moved slowly amongst each other. About four of these bodies in a row traversed a space of the $\frac{1}{2500}$th of an inch. They were all of equal size and perfectly round.

The space of the embryo not already indicated was filled, as shown in the figure, with small cells and granules, some of which—detached—are drawn in fig. 7. Two pale tubes (*m m*), apparently the excretory of Dr. Cobbold, or the urinary of Van Beneden,* curved backwards from the oral sucker, and became indistinct in the region of the alimentary cæca. One half of the body, from the small end downwards, was covered with minute spikes, which were largest in the neighbourhood of the sucker. The spikes projected downwards, *i. e.* towards the swollen end of the animal, and hence the readiness with which they entangled the embryo in its exit from the ovum, as before mentioned. A portion of the investing membrane with these bodies is shown in fig. 8, × 280 diam.

A similar ovum, and contained embryo, occurs in the liver of *Cancer pagurus*, but much more sparingly. The case is somewhat tougher, and the embryo seems to have a closer rasp-arrangement of spikes. None were found in an adult female Lobster, but an extended examination might prove more successful.

There are various ways by which the ova might have been introduced into the above-mentioned sites, and it would be interesting to ascertain if the mussels, of which the *C. mænas* is so fond, are connected therewith. It is a curious fact that the embryo seemed nearly of the same age in every specimen, and that no other form of this species was met with. In all probability it attains little further development in the body of the crab, but awaits the ingestion and digestion of the Crustacean by such fishes as the Cotti, Gadi, and others, in whose

* Cobbold, "Entozoa," p. 26.

stomachs it becomes a complete Distoma. Such fishes, again, as the *Lophius piscatorius*, that prey upon their fellows, may also become the future hosts of this parasite egg, as the following example will show. Two years ago I cut from the stomach of a large Lophius, in company with nine Flounders, a *Cottus bubalis* about a foot long, with an abdomen extraordinarily distended, a state due to the presence of two entire specimens of the *Carcinus mœnas*, each upwards of two inches across the carapace, in its stomach, besides the partly digested débris of others.

In two cases an Ascaris was found amongst masses of liver removed from the *C. mœnas*, and carefully preserved for investigating the former parasite. The first was unfortunately lost before a minute examination was made; the second, about three quarters of an inch in length, is shown magnified by a dissecting lens in fig. 9. It presents the usual ascaroid structure, the head, seen × 80 diam. in fig. 10, having four short and blunt spikes at the sucker tip, and there being a transparent membranous collar a little behind the proboscis. The central canal was opaque for the anterior fifth, then presented the curiously coiled aspect of a rope with its strands, which appearance, however, became indistinct near the tail. The posterior dorsal portion of the body of the worm curved rapidly downwards, and terminated in a well-marked caudal appendix (fig. 11, × 80 diam.). Just in front of the little tail was a very distinct rounded body (fig. 11, *a*), with a double outline and granular contents, and there were indications in the same region of one or two others of similar formation. There was a small papilliform projection at the tip of the tail. The intestinal canal was chiefly filled with granules, and there were many oil-globules in the general cavity of the body.

It is possible that this worm, swallowed with fragments of a fish, may have perforated the digestive cavity of the crab and lodged in the liver; but appearances were not in favour of the supposition in either of the specimens. Besides, were this mode of entrance common with such forms, the Tetrarhynchi, Echinorhynchi, and others, would sometimes be found elsewhere than simply amongst the débris of fishes in the stomach, for instance, of the *Cancer pagurus*, caught by bait in the usual manner.

Crystallization *and the* Microscope.—No. II.

By Thomas Davies, Esq.

(With Plate VIII.)

Though our knowledge of crystallization is at present far from satisfactory, yet it would be impossible to give anything like a complete description of the laws already laid down in so short a space as these observations must fill. For this reason it will be preferable to examine such salts as may be justly termed *"representatives"* of certain classes.

In the first part the examination of santonine called out certain facts, many of which are equally applicable to all crystalline structure—influences of temperature, insoluble atoms, impurities, and other accidental disturbances. We will, however, now consider what new results we meet with when certain salts are mixed together; and by this mode of treatment, perhaps, we obtain the most beautiful objects for the microscope and polarized light. It is necessary, in most instances, that this mixture should be peculiarly intimate, and frequently where this is thought to be the case it is found, when the microscope's aid has been invoked, that there has been little else save a mingling of particles, which, by mutual interference, have prevented anything like uniformity of design. To obtain this mixture in a perfect state salts must be fused or dissolved, and the fusion be allowed to cool, or the solvent evaporated after solution; but the treatment must be varied with the salt we are using. It must also be remembered that certain mixtures produce precipitates, some of which are "curdy," and little suited for microscopic objects. With these we shall not now meddle.

In the first paper santonine was chosen as a specimen of rearrangement of crystalline form after fusion. A little further on we will consider a mixture of sulphate of copper and magnesia, where the treatment partakes, in some degree, of evaporation as well as fusion. But we will now make a few observations on an instance where, certain salts being very intimately mixed, a "substitution" or "replacement" of part of one by the other takes place, and thus a new and frequently permanent salt is produced. This branch is but imperfectly understood at the present time. In many instances the results obtained from exceedingly slight alterations of proportions are widely different; but this, I deem, is not *always* caused by a total want of those forms we are awaiting, but a certain part of one salt has appropriated the necessary quantity of the other, whilst the unchanged mass interferes with its neighbouring particles to such a degree that all visible evidence of the required formation is lost. This is, I think, proved by the fact of one perfect form being frequently found in the midst of a mass of uninfluenced salt. Still, in some cases the forms grow by well-defined gradations from the oblique prism to the perfect circular "flower."

Before, however, proceeding to these particular specimens which I purpose to discuss in this paper, I will mention an interesting example of crystallization which was thrust upon my notice in this town. A bread-baker, whose shop was very large, with plate glass windows, generally had the lower parts of these beautifully "*obscured*" with some of the finest crystalline forms I had ever seen. On inquiry I found that the agent employed was ordinary sulphate of magnesia; but as this salt has generally small crystals, I begged for more exact information. Then I learned that the salt was dissolved in *hot* BEER, and the glass covered with the solution. But on the formation of the crystals there was little uniformity or beauty visible. The hot bread was then brought from the oven and laid upon shelves around the shop, which was very soon filled with a dense vapour. The crystals upon the windows were now redissolved, whilst the clearance of the vapour was so very gradual, and the amorphous syrup-like action of the *beer* at the same time aiding to prevent any sudden formation of crystal, that instead of being particularly minute many of the circles were three or four inches in diameter, and the whole was exquisitely beautiful. From my own experiments I am convinced that the size was appreciably increased by a restraining action (as I may term it) of the beer, so that where any crystal was called to life there was less chance of any interfering formation arising in its vicinity from sudden dryness or want of body, though the gradual removal of the bread's vapour was the most active agent in the matter.

After this digression we will resume our examination of cases where two salts are used together. As an agent in this class sulphate of magnesia, is very valuable.

SULPHATE OF ZINC AND MAGNESIA.—The sulphate of magnesia, commonly termed *Epsom salts*, belongs to System V of Crystallization, being formed in oblique rhombic prisms. It contains seven atoms of water, but six of these are driven off by a comparatively low heat, the remaining atom requiring a great degree to remove it. When it is crystallized alone upon the slide it usually displays very little beauty of design, but I have found it resembling a mass of fern-fronds particularly closely, though this form was an accidental one. The sulphate of zinc belongs to the same system, and takes the same form as the sulphate of magnesia. As an object alone, however, for the microscope, it is more valuable than the latter, as when the solution is allowed to flow over the slide crystals are formed reminding one of long feathers, the colours of which with a selenite plate are very beautiful. Sulphate of zinc contains more than 40 per cent. of water in its crystals, part of which may be replaced by alkaline sulphates, and thus double salts be formed.

When the double sulphate is wanted, an almost saturated solution of the two salts is made with distilled water, in the proportion of about three parts of zinc to one of magnesia. If this solution is spread evenly upon the plate and allowed to evaporate slowly and undisturbed, long, well-defined crystals are formed, with particularly frequent examples of grouping, which adds much to the beauty of the slide. Here, two individual specimens are united in the centre, where the junction is so perfect that one would be almost inclined to put it down as a true form, did crystals ever exhibit "reentrant" angles; there, a group in which the crystals are numerous and intimately joined in the centre, resembling a star with many rays; and other irregular and grotesque combinations, which greatly increase the interest of the slide as an ordinary microscopic object.

The above is a specimen of "substitution" (before mentioned), where no peculiar means are made use of to obtain any uncommon crystalline forms; but we will now consider an example of the Class 2, named in No. XVI, where all or part of the water of crystallization is driven off and afterwards reabsorbed from the atmosphere. Perhaps no salt will prove so demonstrative of this as the sulphate of copper and magnesia; and, although the salt has been before described as a simple microscopic object, we will here discuss the deductions which are forced upon the mind when cause and effect are studied.

Sulphate of Copper and Magnesia.—Sulphate of copper is *usually* placed in System VI of crystallization, *i. e.* the doubly oblique prismatic.* It contains five atoms of water,

* About this crystal, however, there are different opinions. Dr. Pereira, in his 'Lectures on Polarized Light,' referred it to System VI, on the authority of Gustav Rose and most of the other eminent German crystallographers. Dr. Miller, in his 'Elements of Chemistry,' has placed it in the same class, stating, however, that "although the sulphate of copper does not crystallize alone with more than 5 Aq., yet, when mixed with sulphate of

one of which may be replaced by alkaline sulphates, thus producing double salts of great beauty. By a great degree of heat it is rendered anhydrous, becoming a white powder; but it is again converted *blue* by the addition of water. The sulphate of magnesia has been already described. About three parts of pure sulphate of copper and one of sulphate of magnesia must be taken and dissolved in distilled water, in such proportion that the solution may be almost saturated. A small quantity of this is spread evenly upon the central portion of the slide, which must then be held over a spirit or gas lamp until fusion in its water of crystallization has proceeded to such a degree that, upon touching the film with a needle, the matter may be drawn into threads. The amorphous substance upon the glass will now, upon cooling, take flower-like forms here and there, or these may be started at pleasure by breaking the surface with a fine needle-point, and especially quickly where breathed upon. A slight warmth at the fire will stop the growth in any desired state, or by again allowing to become cool a fresh band of petal-like branches may be added. If covered with pure balsam at any moment the increase is stayed, and may then be mounted as usual; but the preparation is less liable to change when there is no chance of any continued action going on from the uncovered portions of the film.

This preparation I have before described, but what I am about to say would not be complete without the above relation.

I think that my numerous experiments and results justify me in stating that it is by the absorption of water alone from the atmosphere or other vehicle that crystallization takes place. In proof of this one or two facts are almost sufficient. When the slide is finished and ready for covering with balsam, wherever the surface of the film is broken and allows moisture to reach the inner portion a fresh circular crystal arises, and grows in a similar manner to those formed at first. Again, in a dry hard frost I have worked with the same solutions and apparatus that have given me great success, and during three days of industrious work I have not obtained a single

iron, it, like this salt, assumes 7 Aq., and then is isomorphous with the ferrous salt" (*i.e.* belongs to System V). Mr. Brooke, in the 'Encyclopædia Metropolitana,' and others, term it an *oblique rhombic prism*, thus referring it to System V, the same as sulphate of magnesia, before mentioned.

It would be vain in me to attempt to decide any question betwixt such men; but I must say that, from my own experience, I am forced to subscribe to the last opinion. I believe that few salts combine in this way that are not of the same class, but I am now seeking for some law in this matter.

good specimen. When thaw came no failures of the same kind teased me, and the crystals were as flower-like as they had been before.

But some have found that, in spite of every care as to the covering the edges of the salt with balsam and mounting immediately, an "under-growth" of smaller forms has arisen and spread over the whole field, thus robbing the large crystals of that unity which is part of their charms. I have never found this to be the case where the balsam used for mounting has been pure; but when either *turpentine* or other solvent has been added to dilute it this second crystallization is aroused either immediately or requires months, according to the quality of solvent added. If the ordinary chloroform-balsam is applied the slide is one mass of crystals in a few minutes; but when a small quantity of turpentine has been added to the balsam it requires weeks to produce a like effect, and progresses very gradually; yet the result will as certainly be the same. In these cases I have made many experiments, and arrived at the conclusion that it was always my old enemy, water, that was teasing me; and when we remember that turpentine has water in it, and that ether will not dissolve water and yet always contains four or five per cent. mixed mechanically with it, no improbability is involved in this, as it seems to me, almost inevitable conclusion. Added to these facts, the very minute quantity of water required

Photograph No. 1.

to start the crystallization afresh, even a slight breath sufficing, renders this explanation, I think, trustworthy.

We will now consider the influence of the magnesia in the double salt:

Photograph No. 1 shows crystals of sulphate of copper in prisms, magnified 200 diameters, this being the received form of the salt.

Photograph No. 2 illustrates the result of adding a *small* quantity of magnesia. A considerable influence is exerted over the copper; but there is only slight action upon the "radii," their circular and broken forms not being of sufficiently decided appearance to call to mind their resemblance to a flower. Perhaps it might humorously be described as a flower whose leaves were slowly unfolding.

Photograph No. 2.

Photograph No. 3.—Here the full complement of magnesia has been added, the flower is in perfection, and the crystals in full form and beauty. This slide has been mounted three years, and has not undergone any visible change.

When the double salt is crystallized upon a smooth surface it seldom shows itself in any form except the circular one, resembling flowers in greater or less degree; but in one or two instances I had noticed imperfect rhombs at the *edges* of the slides. I therefore made a saturated solution of the salt, and allowed it to crystallize very slowly and undisturbed. From some numbers of experiments I obtained

Photograph No. 3.

four specimens of pure and decided form, the largest of which was about one-tenth of an inch in diameter. Some of these I exposed a long time to the atmosphere, but could not perceive any results from that exposure, as the salts were perfectly unchanged.

As we are not here wishing to give the treatment required by each salt, but the different *classes of treatment*, it will not be lost time to bring forward a most beautiful crystal produced in a manner rather foreign to the last:

TARTRATE OF SODA.—Tartaric acid belongs to System V, the oblique prismatic, and gives very fine colours with polarized light. When crystallized, however, upon a slide the forms are not particularly striking, as there is no uniformity in the design. The centre of each crystal may be well defined, but just in the midst of the rays an irregular angular mass is often placed, destroying all beauty of design; and crystals without these intruders are extremely rare. It may be also mentioned that carbonate of soda belongs to the same system of crystals. To prepare—a strong solution of tartaric acid in distilled water should be made, and the acid neutralized by the addition of carbonate of soda. This solution must then be spread evenly upon the glass slide and the whole warmed, but not raised to any great degree of heat. There will then remain upon the slide an amorphous film, with which nothing must come into contact. In a dry place, protected from all chance of dust, it must then be laid; and in a time, varying from two or three days to as many weeks, the crystals will have risen up in particularly handsome shapes. In circular specimens the cross is always very decided, an example of which I send in Photograph No. 4. Where there has been interference a wave is sometimes called forth, very closely resembling No. 2, crystal of santonine, in 'Microscopical Journal,' October, 1864, but the waves are more regularly formed, and rendered still more beautiful by the well-defined cross. In another slide, where some impurity had caused the formation of crystals to commence unusually early, the waves went from that point with such uninterrupted long sweeps that it is certainly no exaggeration to call it a sea of colour when on the stage, even without any selenite plate to assist. Some few slides I have covered with the solution, and never could call forth any crystal of decided form upon them, either by long keeping or the application of heat.

Enough for the present concerning different classes of crystallization. From these it is plain that, though the *system* to which the forms belong is seldom changed, the crystals are so varied as microscopic objects that an intimate knowledge of the substances is required to recognise them. As an example of this may be quoted SNOW—this belongs to System III, the rhombohedic, yet the forms are so varied that, perhaps, nothing shows a greater number of exquisitely beautiful designs. In a paper read by T. G. Rylands, Esq., before the Scientific Section of the Historic Society of Lancashire and Cheshire, April 26th, 1855, and printed for private distribution, forty different forms of crystal are given, some of which are of most intricate design, and of such variety that none except those who had studied the subject could believe that they were the same substance.

It appears to me that the science of crystallization is yet in a very imperfect state, and requires much investigation. Let every one, therefore, who studies the subject give his experience, so that all knowledge of it may be brought together, and thus we shall arrive at results otherwise unattainable.

On a New Genus *of* Alcyonidæ. By E. Perceval Wright, M.D. Dub., F.R.C.S. Ireland, F.L.S., Professor of Zoology in the University of Dublin.

(Plate IX.)

The western coast of Ireland has always been regarded as good collecting ground by the naturalist; and yet, so far as its marine fauna is concerned, it may be said to be altogether unexplored. This is true, not only of its invertebrate, but even of its vertebrate animals; and any young ardent zoologist will still find plenty of work to do among the western Phocidæ and Fish, and almost a new field in the shell-less Molluscs, Annelids, and Cœlenterata, of Donegal, Sligo, Mayo, Clare, and Kerry. At one time, I had hoped to have been able to investigate the marine fauna of western Cork and Kerry, making Bearhaven and Ventry my headquarters; but since my report on this subject to the British Association in 1857 professional engagements have prevented me from devoting the requisite time to this pursuit. I have, however, in the course of this spring, received, by the kindness of W. Harte, Esq., C.E., County Surveyor for the northern district of Donegal, several small collections of marine animals from Rathmullen, in that county; and as these all for the most part bore easily the carriage by night to Dublin, I have been able—reviving them with the help of several large aquaria —to add some new species to the Irish fauna. With care, I have thus received in perfect health such delicate creatures as *Pectinaria Belgica*, *Eolis alla* and *Drummondi*, *Siphonostoma uncinata*, *Hydra tuba*, and others; but none of them more interesting than the little solitary Alcyonarian Actinozoon which it is the object of this paper briefly to describe.

According to Milne-Edwards's* arrangement, adopted without any very material modifications by Greene† and Carus‡, the Alcyonaria are divided into three families—the Alcyonidæ, the Gorgonidæ, and Pennatulidæ. The first of these contains, as sub-families, Cornularinæ, Telestinæ, Alcyoninæ, and Tubiporinæ. The Cornularinæ are distinguished by having the polypes either isolated or arranged side by side on a stoloni-

* 'Histoire Naturelle des Coralliaires,' par H. Milne-Edwards. Paris, 1857.

† 'Manual of the Sub-kingdom Cœlenterata,' by Joseph Reay Greene. London, 1861.

‡ 'Handbuch der Zoologie,' von Peters Carus and Geestaecker. Leipzig, 1863.

form or membranous cœnosarc. It is to this family that we must look for the forms to connect the Zoantharian Actinozoa with the Alcyonarian. Representative groups occur in both orders, Zoathus resembling Sarcodictyon, and Haimeia having somewhat the appearance of an Actinea; but still the one order contains polypes furnished with but eight tentacles, and having their somatic chambers some multiple of four; the polypes of the other have tentacles more or less numerous, but never eight, and their somatic chambers a multiple of five or six.

As a rule, all the Alcyonaria are aggregated forms, in this presenting a contrast to the Zoantharia, which contain whole families of solitary or isolated polypes. This was so universally the case, that even the discovery of a solitary Alcyonarian, called by Milne-Edwards *Haimeia funebris*, appears not to have convinced some of the writers on this subject that it was an exception to the rule; and Professor Greene disposes of the anomaly by saying that "it may yet prove to be an immature form."* It is apparent, however, on the perusal of the 'Manual of Cœlenterata,' that (though a most valuable contribution to the advancement of science, when regarded from an educational point of view), its author had evidently no practical personal acquaintance with the Alcyonaria, and so this surmise must be taken *quantum valeat*. It is true that the description in the 'Histoire des Coralliaires' is meagre in the extreme; but still there is no young state of any Alcyonarian polype which at all resembles Haimeia. Feeling convinced of this, and looking for an opportunity of satisfying my mind on this point, it was with great pleasure that I recognised among a small gathering of old marine shells and Hydrozoa collected by Mr. William Harte, C.E., on the coast of Rathmullen, co. Dublin, and obligingly forwarded to me, an old valve of *Cardium Norvegicum*, which seemed to have on it a minute isolated Alcyonarian. This I at first thought to be the *Haimeia funebris* of Milne-Edwards; but, unfortunately, the only details in its diagnosis being negative, and there being no drawing of the species, I could not satisfactorily determine this point. These little creatures lived in a large aquarium for a period of more than six months, during which time they were constantly under my observation. I fixed the shell quite close to the glass front of the tank, and was able to use in their examination a two-inch and inch-and-half lens, without disturbing them in the slightest; they were by no means timid, but kept their row of

* Loc. cit., p. 208.

pinnate tentacles constantly expanded. Sometimes one or more of these tentacles would fold over the oral cavity, the others remaining on the watch for prey. They were most active at night and in dark weather. In the daytime the tentacles were almost always completely retracted, leaving the eight knob-like portions at their base in close approximation around the mouth. Now and then, apparently after periods of great good health, when the polypes had been feeding voraciously, the whole column would be retracted, and nothing but a minute button remain visible. At such periods the polypes resembled very young specimens of *Actinoloba dianthus*. During the whole period of their existence, there was never the slightest appearance of a beading of any kind, nor was there any trace of a stoloniferous cœnosarc, such as one sees in Sarcodictyon. In comparing these polypes with those of this last-named genus, one is struck at first sight by their resemblance; but this is, after all, nothing more than exists between the isolated polypes of any genus of Cornularinæ. It may not, however, be amiss, before venturing to give a diagnosis of this new form, to compare it with what is known of the polype of Sarcodictyon. Forbes' figures of the two species at present known (*S. colenatum* and *catenata*) are so very unsatisfactory,* not to say slovenly, that we have had recourse to Mr. Gosse's more elaborate figures and careful description of the latter of the two species instead.† He says —"The creeping band (cœnosarc) is about an inch in length; on it are five polypes; they bear a very close resemblance to a minute Sagartia, and are invested with a pellucid epidermis, which is thown by contraction into annular folds; the disc is surrounded by eight marginal tentacles, each of which is fringed with two rows of pinnæ; the exterior surface of these latter is studded with oblong tubercles; these enclosed a few cnidæ. The most careful scrutiny failed to detect even a single spiculum in the texture; but in dried specimens of a Sarcodictyon from the West of Ireland I found the spicula conspicuous, though not very numerous. The colour is of a slight reddish hue." In my specimens there was not the slightest appearance of a cœnosarc; the basal portion of the polype was entire and convex; there was no apparent annular constriction on contraction; although they exceeded Mr. Gosse's specimens somewhat in size, yet there was no appearance of colour on either the body or in the stomach or ovaries. A careful examination revealed no cnidæ; but the whole base

* 'History of British Zoophytes,' by Dr. Johnston,' ed. 2, plate 33; and 'Transactions of the Roy. Soc. of Edinburgh, vol. xx, pl. 9.

† 'Annals of Nat. Hist.,' 3rd series, vol. ii, 1858.

was studded with short star-shaped spicula; long dendritic spicula were found at the base of and on the outside of the tentacles; a few at the base of the pinnæ. In being retractile, and in the absence of spicula, this new form, as also the *Haimeia funebris* of Milne-Edwards, shows undoubted affinities to the genus Cornularia, while they are abundantly distinct from it and all other known genera of Alcyonaria on account of the absence of a cœnosarc. In one of my specimens well-developed ova were present at the base of the body, in the somatic chambers. It might not be inexpedient to divide the family of the Alcyonidæ into four (excluding the Tubiporidæ), instead of three, sub-families—one for the recetion of isolated forms, which should be called Haimeinæ; including the genera Haimeia; and the one to be immediately described. Cornularinæ, including the genera Cornularia, Sarcodictyon, Anthelia, Sympodium, &c. Telestinæ, with the single genus Telesthe. Alcyonidæ, with the genera given by Milne-Edwards. Excluding the Tubipores, better elevated to the rank of an independent family.

Every such classification must, however, be considered but provisional, until more is known of the development of the isolated and aggregated Alcyonarians. Unfortunately, an unavoidable absence from home caused the death of my specimens, from the great evaporation of the water rendering what remained too salt to support life, so that I was unable to add anything to the facts known on this subject. As neither this form nor Sarcodictyon would appear to be rare on the west coast of Ireland, I hope yet to be able to investigate this matter still further.

HARTEA, nov. gen.

Polyp solitary; body cylindrical, fixed by its base, not giving rise to buds or to the development of a cœnosarc; tentacles eight, pinnate, knobed at their base; the basal portion of the body thickly studded with small star-shaped spicula; base and body of tentacles with long, dendritic spicula; mouth central, with two lips; somatic chambers eight.

Hartea elegans, nov. spec.—The characters of the genus those also of the species; but, in addition, the height of the polype, when fully expanded, is three quarters of an inch; it is of a clear white colour, save the basal portion, which is darker. There are no glandular spots on any part of the body; the secondary tentacles are generally borne more or less erect on the primary tentacula, not provided with cnidæ. I have called this genus after Mr. Harte, who has done and is doing much to increase our knowledge of the fauna of Donegal, one of the most interesting and least-known counties in Ireland.

Sub-family HAIMEINÆ.

Haimeia funebris, Milne-Edwards.
„ ? *primula* Dana.
Hartea elegans, nov. gen. and spec.

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

Kolliker und Siebold's Zeitschrift.—The number of this journal issued for the passed quarter contains but two papers; both are on microscopical subjects, and both are eminently worthy of the attention of English observers. The first is by Professor Claus, of Marburg, "*On the Organization of the Cypridinidæ,*" and contains a valuable *résumé* of our knowledge of these crustaceans, as well as some novel observations and suggestive remarks from the author. A well-executed plate illustrates this paper. The second paper, which occupies the bulk of the journal, is one of those elaborate, careful, and valuable contributions to science, which characterise the scientific periodicals of Germany. It is entitled "*On the Eye of some Cephalopoda,*" and is written by Professor Hensen, of Kiel. The paper is illustrated by nine plates, the execution of which is such as quite to put to shame the careless and sketchy performances exhibited as illustrations in many of our own scientific periodicals. The minute anatomy of the eye and its adjuncts, and the histology of each of their component parts, are fully and elaborately described. Professor Hensen's researches on the retina in Sepia appear to be particularly valuable. The subject matter of the paper is arranged under the following heads:—1st, the eye-capsules; 2nd, the membranes of the eyeball; 3rd, the lens; 4th, the retina, its investing membrane, nervous layer, network, cell-layer, pigment-layer, layer of rods, and homogeneous membrane; 5th, the connection of the retinal elements; 6th, the optic ganglion. The observations of Professor Hensen refer principally to Sepia, but the eyes of other genera—Nautilus, Loligo, &c.—are noticed, and also those of some Heteropoda and Lamellibranchiata.

Max Schultze's Archiv fur Mikroskopische Anatomie.—This journal has just made its appearance, and, if an opinion may be formed from an examination of the first number, promises to form a very valuable acquisition to microscopic observers. It is to be published four times in the year, at Bonn, under the editorship of Herr Max Schultze, Professor of Anatomy, and Director of the Anatomical Institute in that city. Amongst others the following distinguished men of science have promised their contributions to its pages—De Bary, V. Carus, Ecker, Eberth, Frey, Gegenbaur, Harting, Hensen, Klebs, Kölliker, Krohn, Kühne, R. Leuckart, Leydig, Pagenstecher, Siebold, Stein, and Weismann. The first paper is by the editor, "*On an Object-glass adapted to producing Heat, and its application in researches on the Blood.*" By an ingenious contrivance, described and figured in the journal, Professor Schultze has succeeded in constructing an object-glass which will heat the object under examination, and he has thus been enabled to observe the effect of an increase of temperature on blood and other fluids.

"*On the Anatomy and Physiology of the Pulmonifera,*" is the title of the second paper, which is contributed by Fr. Leydig, of Tübingen. The first part of this paper refers principally to the nervous system and organs of the senses, and minute histology of the nerves. Of the ear in these animals, the author observes that his investigations upon Arion, Limax, and Helix, give the following general results:—The capsule in all has the form of a shortly stalked vesicle. The short stalk is only rendered perceptible by great care in the preparation. The short stalk serves to form a connection with the brain, and does not lead at all to the exterior of the head, so that consequently, when the parts under consideration are not altered through pressure or elsewise, the capsule appears sharply defined in all its remaining circumference, with a free border. The rest of the paper is devoted to the consideration of the admission of water into the body, and its delivery through the kidneys. The researches of Moquin-Tandon, Lister, Rossmassler, Gegenbaur, Draparnaud, and others, on this subject are discussed and referred to.

A paper "*On a new kind of Amœboid Cells,*" by M. la Valette St.George, is amongst the other papers. A short notice of the author's observations was given at the thirty-third meeting of the German Naturalists and Physicians, at Giessen, in 1864. The cells described, and carefully figured, are observed in the immature testes of various animals, the author's observations being made principally on the calf, guinea-pig, and pigeon. Very remarkable cells, exhibiting various amœboid movements and provided with one or more nuclei, are described, and the effect of the admixture of various fluids on their form and structure is also noted.

Herr Hugo von Mohl contributes a very lengthy paper *"On a new Adaptation of the Screw Micrometer,"* which appears to be of considerable importance; for details we must refer our readers to the 'Archiv.'

The paper of Dr. Richard Greef, of Bonn, *"On the Nervous System of the Arctiscoida (Tardigrada, Doyere),"* is perhaps the most interesting in the number. It is beautifully illustrated by a large drawing of the disposition of the nervous system in *Arctiscon Milnei* and smaller detailed figures. We hope to give a more lengthy notice of this paper in our next number.

"On the Histology of the Cestodea," by Dr. Edward Rindfleisch. The author has investigated the minute structure of the cestoid worms in a very careful manner; he enumerates four kinds of corpuscles which occur in the homogeneous substance of these animals, which are distinguished by the arrangement of their substance in layers, by their calcification, and the action of carmine on them when treated with that dye. They are—1st. Corpuscles which become dyed intensely red, are entirely homogeneous, and contain no lime. 2nd. Corpuscles which become dyed blood-red, with concentric layers, and are also free from lime. 3rd. Corpuscles becoming dyed blood-red, with concentric rings, in the centre of which a clear shining spot shows the commencement of the calcification. 4th. Corpuscles (ringed or homogeneous), which are free from dye and are entirely calcified.

Another paper by the editor, entitled *"A Contribution to the Knowledge of the Light-giving Organs of Lampyris splendidula;"* one by Fritz Müller, of Desterro, *"On the Marginal Vesicles of Aglauropsis;"* and a notice of Thiersch and Müller's injecting fluids, complete the list of original papers in the first number of this very valuable journal. We trust our new contemporary may meet with its well deserved success.

Archiv fur Naturgeschichte. Third Part, 1864.—This periodical contains the second part of a paper by Dr. Richard Greef, on *"The Bell-like Uterus and the Ovary of Echinorhynchus."* We have not yet seen the later numbers of the journal.

The Archivo per la zoologia, l'anatomia, e la fisiologia, published at Modena, and edited by Professor Giovanni Canestrini, of that university, contains the continuation and conclusion of a valuable paper by Sign. E. Oehl, *"On the Alteration and on the process of Renovation of Cut Nerves in the Frog,"* illustrated by two plates. Those of our readers interested in the physiology of the nervous system, will find this a valuable contribution to science.

Comptes Rendus.—March to June, 1865.—There have been very few papers of interest to microscopists laid before the Academy during the past quarter, and therefore there is little for us to abstract from the 'Comptes Rendus' of that body. We give a brief abstract of a paper by M. de Barry, on cortical fibre. Of the two parts of a dicotyledonous stem, the ligneous and the cortical, it is well known that the second only contains that sort of fibres known as liberian or cortical fibres. The author in his paper describes certain supplemental fibres, not localized, but mixed with the tissue of the wood. In Loranthaceæ he observed for the first time in his researches on vegetable parasites cortical fibres *en mélange* with the woody tissue. These fibres, though sometimes disposed nearly with symmetry on the sides of the woody bundles, are, on the other hand, sometimes solitary, and in *L. Europæus*, *L. sphærocarpus*, and in an undetermined Loranthus fixed on a *Citrus*, are more often arranged in groups. Many Leguminosæ also have cortical fibres mixed with the tissue of their wood. *Medicago arborea* displays groups of these fibres, some rounded, others elongated, the first placed at the interior of the ligneous bundles, the second more often situated on the edges of the bundles and in contact with the medullary rays. *M. lupulina* has a similar arrangement of fibres, and the same may be observed in the genus Ulex. In Loranthus the fibres are dispersed in small numbers, in the Leguminosæ we observe large aggregations. The author then proceeds to point out that the disposition of the cortical fibres may be referred to three types:—1st. The cortical fibres are well localized, occupy given places, and are symmetrically attached to the ligneous system, (*Piper*, *Antidaphne*, *Viscum albeum*.) 2nd. The cortical fibres are dispersed without order in the mass of the wood, (*Medicago*, *Ulex*, several *Loranthi*.) 3rd. The cortical fibres are, some disposed symmetrically with regard to the wood, as in the first type; others scattered in the middle of it, as in the second type (*Viscum aphyllum*, *articulatum*, &c.).

The Annals and Magazine of Natural History.—April to June, 1865.—In the April number of this journal we have a valuable paper by Mr. J. Carter, "*On the Fresh- and Salt-water Rhizopoda of England and India*," being a continuation from vol. xiii of the magazine. The principal species treated of by Mr. Carter in this paper are *Actinophrys oculata*, Stein.; *A. Eichornii*, Ehr. (of which he states he has only observed two specimens in India); *Collodictyon triciliatum* a new genus and species, having analogies with Bodo; *Euglypha spinosa*, a new species from South Devon; and *E. globosa*, also a new species from the same locality. Mr. Carter makes some very interesting remarks, when speaking of *Actinophrys*, with regard to the production of vacuoles; he regards both the nucleus and the contractile vesicle in the Rhizopods as furnishing but unimportant characters for specific distinction. The paper is illustrated by a carefully drawn plate, which however, has a rather confused appearance.

The same number of the 'Annals' contains an interesting account of the Nigua, Chigoe, Jigger, or sand-flea of tropical America, translated from a paper, by Professor H. Karsten, published in the 'Bulletin of the Soc. Nat. Moscow.' The animal is excessively small, being only half the size of the ordinary flea, but nevertheless manages to make itself excessively annoying by burrowing under the toe-nails of unfortunate travellers, and producing inflammation. The author describes minutely the external skeleton of the animal, and its penetrating, sexual, and other organs.

Professor Gulliver continues his observations "*On Raphides*," and the more they are extended the more they would seem to show the importance of these beautiful objects, and their organic cells, as natural characters in systematic botany. In his "practical applications," he mentions that, if any British Dicotyledon be found abounding in raphides, it must be referred to one or other of the three orders Balsaminaceæ, Galiaceæ, or Onagraceæ. And thus these orders of our plants, being so isolated from their allies of other orders, are eminently entitled to be characterised as raphis-bearing plants. He has figured the raphides in the ovule of Onagraceæ, and states that this character is present in the seed-leaves, thenceforth in the leaves, and generally diffused throughout the species at all periods of its existence. Hence he considers that, when the diagnostic holds good, as between an Onagrad and Hippurid, there is no other single difference at once so fundamental and universal between the plants in question as that those of one order are raphis-bearers, while the others are not so.

But as we have yet seen no confirmation, extension, or correction of his researches, we may remark that at this season materials are bountifully spread before us for examination, and which might be made the subject of very interesting and instructive inquiries in the country. Indeed, the biography of species, and especially observations on the cell-life, of our native plants, would be a very delightful rural pursuit, and not unlikely to prove useful to science, thus affording a rational extension of country enjoyments, in which the ladies of our families might not only participate, but probably assist in enlarging our knowledge of both physiological and systematic botany. With respect to the three orders just mentioned, the raphidian character has been found by Mr. Gulliver to hold good of all the exotic species which he has hitherto examined. But, on a subject so novel, he insists that observations must be multiplied before we can arrive at certain conclusions. Bearing this in mind, we may note that among the orders of exotic Dicotyledons, which he suggests, after a comparison of them with their neighbours of other orders, will prove to be characterised as raphis-bearers, are Nyctaginaceæ, Phytolaccaceæ, and Vitaceæ. And it is very remarkable that the vast genus Mesembryanthemum appears, as far as his observations have yet gone, to be distinguished by the profusion of raphides from all its allies. As to Monocotyledons, the Dictyogenæ signally differ, in the possession of this character of raphis-bearing, from their neighbours in the lineal series of the natural arrangement. Pontederaceæ abound in raphides, which scarcely appear, if at all, in the Alismal Alliance; and raphides are regularly abundant in some sections, and as constantly wanting in others of Liliaceæ; plentiful in Orontiaceæ, and very scarce in Juncaceæ; appearing and disappearing in different orders of Enogens; especially abundant in Araceæ; and finally ceasing altogether in Potamogetonaceæ, Naiadaceæ, Cyperaceæ, and Gramineæ. At least, Mr. Gulliver has not yet found true raphides in any of these four orders, nor in our native *Cryptogameæ Ductulosæ*. Throughout Professor Lindley's Aral Alliance, comprising the orders Pistiaceæ, Typhaceæ. Araceæ, and Pandanaceæ, Mr. Gulliver finds raphides abounding; while, on the contrary, he has not found them at all either in the orders Graminaceæ, Cyperaceæ, Restiaceæ, or Eriocaulaceæ, of the immediately preceding or Glumal Alliance. On the other hand, Professor Lindley's Hydral Alliance, comprising the orders Hydrocharidaceæ, Naidaceæ, and Zosteraceæ, turns out to be devoid of raphides, although they abound in the orders of the next succeeding or Narcissal Alliance. Again, while Pontederaceæ is a raphis-bearing order, neither of the next three orders (Butomaceæ, Alismaceæ, and Juncaginaceæ) is so characterised. But it should be borne in mind that, under the term raphides, Professor Gulliver only includes the bundles of needle forms occurring in the oblong cells. Sphæraphides, or other crystals, he regards as so common in vascular plants as not to be easily reduced to order. And yet he observes that the sphæraphides of Chenopodiaceæ and Tetragoniaceæ are so exactly alike as to add another link to the affinity so admirably noticed by Lindley between these two orders.

Miscellaneous.—*Eozoon Canadense.*—The discovery of this very interesting and remarkable fossil, has excited much discussion and attention lately in our scientific periodicals. The papers on the subject published in the last number of the 'Journal of the Geological Society,' will give our readers ample information on the strictly geological part of the question, as well as the mineralogical composition of the *Eozoon,* which has been investigated by Dr. Sterry Hunt. In the 'Popular Science Review' for last April a very interesting essay on the nature, history, and affinities of this fossil, appears from the pen of Professor Rupert Jones, illustrated by a well-executed plate. 'The Intellectual Observer,' on the other hand, has secured the services of Dr. Carpenter, who has contributed an article on the *Eozoon* to the May number of that periodical. The animal nature of the fossil and many details of structure are ably pointed out in this paper, which is illustrated by a very beautiful chromo-lithograph representing a portion of the fossil, as well as another uncolored plate. And now, after all the excitement and interest which has been occasioned by the discovery of a fossil Rhizopod in the Laurentian rocks, the oldest stratified deposits, two gentlemen, Professors King and Rowney, of Galway, write to the editor of the 'Reader' to express their conviction that *Eozoon* is not a fossil at all, but a simple physical production; they have made their observations principally on the supposed *Eozoon* of the Connemara marbles, which, however, is not of Laurentian age, and have, they say, reluctantly, but deliberately come to this conclusion.

NOTES AND CORRESPONDENCE.

Maltwood's Finder.—Although I prefer, when only four or five different kinds of objects are to be noticed in a slide, to mark them with pen and ink, placing (apparently) over each one dot to the form which is most frequent, and a short straight line or a semicircle also above the object when less frequent, or a triangle or circle of dots or a circle around the object when still more scarce, there can be no doubt that the finder proposed by Mr. Maltwood is superior to all others when it is thought objectionable to disfigure the cover with ink, or when the ink is liable to be rubbed off, which it is when not mixed with a little sugar or isinglass. My present object is to call attention to the various modes of using the finder, so that at present, when one receives a slide from a correspondent, his system of notation must first be ascertained, and then each object noted on the label have its marks changed to make them uniform with the other slides in the receiver's cabinet, thus rendering new labels necessary.

But first let me notice that, although I have three of these finders, one from Smith and Beck, another from a different London optician, of whose name I am uncertain, and the third from Bryson, of Edinburgh, none of these correspond with the directions given by Mr. Maltwood in the 'Micro. Journ.,' VI (*Trans.*), p. 60, last line, and p. 61, line 5. It is there proposed that the figures representing the *latitude* should be written in the *upper* part of each square, and those of the *longitude* in the *lower* part. In all the finders I have seen this is reversed, the *upper* row representing the *longitude* (east longitude of maps), and the *lower* the *latitude* (south). This has to be kept in view in the following observations.

The first and greatest difference in the notation arises from Mr. Maltwood not having specified which end of the slide was to be placed next the stop (that is, on the left hand). Smith, Gregory, and perhaps all others previous to the finder coming into use, placed the label on the right hand of the observer, the label or top of the letters on the label indicating the *top of the slide*, the other end being the bottom; but from supposing that the arrow-head on the finders sold indicated the top, and not the bottom (as I am informed by Mr. Coppock, of Smith and Beck's firm, was intended), many have got into the practice of placing the label or top of the slide also next the stop (on the left). The microscopists of Edinburgh, Hull, and some of those in London, place the label next the stop; those of Glasgow, Liverpool, and most (as I understand) of those in London, retain the method of Smith and Gregory, and place the label or top of the slide on the right hand. Uniformity in this respect, to enable one to consult a slide marked by another, is very desirable, if not absolutely necessary.

But supposing that this point was settled, another difference arises in the notation. One method is to consider the lines bounding the cell or square as similar to those of longitude and latitude drawn on a map. The interior of the square occupied by the numbers may be subdivided into sixteen parts by four imaginary vertical and horizontal lines. Thus, if the square was $\frac{20}{30}$, an object on the vertical boundary of the square on the left hand would be registered as 20 exactly, or if on the right hand by 21; and the longitude between these would be 20·25, 20·5, or 20·75, according to its place within the square. Thus, also, the upper edge or line of the square would be called 30, the lower limit 31, and the latitude between these registered as 30·25, 30·5, or 30·75. An object a little—say one fourth—below the top line, and about three fourths from the left-hand boundary, would be registered by $\frac{20·75}{30·25}$, or if in the very centre of the square by $\frac{20·5}{30·5}$, the line separating these numbers (as in vulgar fractions) being merely to connect them together.

All the other methods (and, if I rightly understand Mr. Maltwood's observations, this was his intention) view the figures as indicating the square itself, not its limiting lines, so that an object found *within* the walls of the above square would be marked $\frac{20}{30}$. But here there are two modifications in use. —One is to view a line (as in fractions) drawn to separate the upper and lower figures (as $\frac{20}{30}$) as representing the lower side of the square of $\frac{30}{20}$, or, in other words, that $\frac{20}{30}$ is not the same as $\frac{20}{30}$, but is synonymous with $\frac{30}{20}$, or rather $\frac{30}{21}$, and indicates that the object lies in the upper half of the square $\frac{30}{21}$. Here the line converts the upper figures from longitude into latitude, and the lower ones from latitude into longitude. So far as I know, this mode is adopted by very few, and it has no doubt arisen from using a high power (as a $\frac{1}{4}$-inch objective), in place of a $\frac{2}{3}$-inch or 1-inch, when registering the objects; the field of view then consisting of the half of two adjacent squares, when the object lies near the bottom of a square, or below the top of the adjacent one below.

The other method is to consider the line as a mere vinculum, or bond of connection, between the upper and lower figures, and which may or may not be used without altering the meaning of the numbers registered. Here, also, are three very slight variations. The one is, when the object lies on the right hand or the lower edge of the square, or half way to the next square, either on the right or below, to draw a line there, with an ink-dot on it to denote as nearly as possible the position of the object. The second variation is to express this, not by a line, but by the decimal ·5, thus:— $\frac{20{\cdot}5}{30}$, or $\frac{20}{30{\cdot}5}$, as the case may be; and if at the lower right-hand angle of the square, it would be noted by $\frac{20{\cdot}5}{30{\cdot}5}$ third variation is to apply two lines at a right angle, at the angle of that quarter of the square at which the angle lies By the first method mentioned this position would be indicated by $\frac{21}{31}$, and by the second either by $\frac{30}{20}$ or $\frac{30}{20}$

If great accuracy were required, the first of these methods is, no doubt, the best; but as the difference between the finders as made by the same optician amounts often to half a square, and if by others to sometimes more than a whole square, such minuteness seems quite unnecessary—of course, I mean when one correspondent sends a slide to another; but even for one's own cabinet, if the finders used be broken, the minute subdivisions may be of no value when a new one is procured. The second mode, of making the upper row of figures represent longitude by aid of a line of separation, is liable to great objection from its being easily omitted accidentally when intended to be drawn. On the whole, then, the third mode (any of the variations), which is sufficiently accurate for enabling any one to discover the object, appears to be the simplest; but whichever mode is to be adopted, whether for mere notation or for the position of the slide, uniformity is necessary, and it ought to go forth to the public with the authority of the Microscopical Society of London, or, at least, of Mr. Maltwood himself. From want of some definite method I have had sometimes to spend two or three hours in search of a registered object sent me before I discovered it or the system of notation employed, whereas an ink-dot would have brought me to it in a few seconds.

I need scarcely add that, in registering or finding objects in a slide, direct light from the mirror ought only to be used, the effect of oblique light, or of a condenser of any kind, being to alter the apparent position of the object, sometimes to a very considerable degree if a low power be not used.

A.

March 20, 1865.

Beck's Treatise on the Microscope.—I have lately been reading with some attention and much interest Mr. Richard Beck's 'treatise on his achromatic microscopes; for though at first sight it may appear a mere illustrated trade catalogue, a more careful inspection will convince any one that it contains many valuable and practical hints relative to illumination and manipulation; whilst, besides the plates exemplifying his own instruments, there are more than a dozen others representing objects of general interest. These are carefully and beautifully executed, especially those of the Arachnoidiscus and the section of deal. But I do not refer to his book for the purpose of praising it, but with the view of criticising two statements contained in it.

At p. 30, in speaking of the appearance of the Podura scale, as seen by reflected light under the 1-8th and 3rd eye-piece, Mr. Beck says—" We have the following results with this particular object, as shown in pl. xi, fig. 2, the arrow at the left-hand side indicating the direction of the light. When the markings are at right angles to the direction of the light (as at A), they are illuminated on the side furthest off; when they lie in the same direction as the light, with their narrow ends pointing to it (B), the broad ends appear like brilliant spots; but when this direction is reversed (C), the light from the points is so slight that the scales appear to have lost their markings altogether. Now, if the object were an opaque substance, this result would be a convincing proof that the markings were depressions; but as we know it to be transparent, it follows that these particular appearances can only be produced by elevations."

Now, I cannot say that I see this *sequitur* at all; and I fancy that Mr. Beck's argument is based upon false principles, inasmuch as he has ignored one of the principal conditions of all objects viewed under the compound microscope, viz., that their apparent position is reversed. In the case we are alluding to I cannot help considering, with all due deference to such an eminent optician and microscopist as Mr. Beck, that the transparent Podura scale is rendered, under the circumstances, practically opaque, and that in the example B the broad ends of the markings are *really* directed towards the left hand and source of light, and, being elevations, are, of course, illuminated; but as everything is reversed under the microscope, these illuminated ends appear on the right side, or that furthest from the light. Of course, the same argument applies to his cases A and C—the bright sides are *really* nearest the light, and are simply thrown over to the other side by the reversing power of the microscope.

Again, in p. 63 it is stated that the magnifying power may be easily ascertained by comparing the magnified stage micromatic lines traced by aid of the camera lucida with a rule divided into inches and tenths; but in such calculations particular care must be taken that the distance from the edge of the camera lucida to the paper is exactly ten inches, as this is the standard distance of distinct vision with the naked eye. Though I am aware that this is a very generally accepted maxim, I fancy it may be an erroneous one, and that, to ascertain the exact magnifying power of any particular microscope, the paper should be the same distance from the prism as the eye-piece is from the micrometer on the stage, which will depend on the length of the tube, which varies considerably in different instruments. If I am wrong, I hope Mr. Beck will be kind enough to prove it to me, either practically or mathematically.—F. H. LANG, President, Reading Microscopical Society.

Angular Aperture.—In the report of the microscopes exhibited at the International Exhibition, 1862, from "the able pen of Mr. C. Brookes, F.R.S.," as printed in the Journal for April, 1864, it is stated that "an admirable method of determining the *available* angle of aperture of an objective was suggested to the jury by Professor Govin, of Turin, &c. &c." Mr. Brookes apparently was not aware when he prepared that report, and many of your readers may not be so now, that Professor Govin's method is precisely the same as that described in the Journal for July, 1859, p. 256, by Mr. P. Gray, 7, St. Paul's Villas, Camden Town. Any one who takes the trouble to examine the matter carefully will find that they are alike, the only difference being in the position of the microscope. It is not necessary to convert the instrument into a telescope by placing a series of lenses above the eye-piece; the naked eye, without any eye-piece, is far better, and gives a clearer sight of the edge of the strips of paper. I have an excellent quarter-inch glass, by A. Ross, and by the above method it possesses an angle of aperture of 83½°. Mr. Gray's quarter-inch glass had an aperture of 82½°. I have thought it right to bring this matter before your readers, as Mr. Brookes ought to have been able to tell the jury that the method of Professor Govin was then known in England. —W. FORGAN, 3, Warriston Crescent, Edinburgh.

Errata.—In the April number of the Journal several printer's errors were allowed to stand, owing to the printer not sending proofs. The reader is requested to make the following corrections:

Page	99 of the Journal,	line	6, for *Annelidæ*, read *Annelida*.
"	"	"	" 20, insert between *the* and *ambulacral*, *pseud-hæmal and*.
"	"	"	" 26, for *Clenophorous*, read *Clenophorous*.
"	"	"	" 29, for *Asteropods*, " *Arthropods*.
"	102	"	" 28, " *fig.* 9, " *fig.* 1.
"	103	"	" 40, " *one*, " *us*.
"	"	"	*omit* the last five words.
"	114	"	in the Bibliography, after *D'Udekem* read for *Fal.*, *Jul.*
"	115	"	line 3, for *Tris*, read *Iris*.
"	136	"	" 6, " *Leuhonek*, " *Lenhossek*.
"	"	"	" 15, " *Mary*, " *Marie*.
"	139	"	" 2, " *Primularia*, " *Pinnularia*.
"	140	"	" 38, " *Ternstræminaceæ*, read *Ternstrœmiaceæ*.
"	141	"	" 4, " *Orchiduceæ*, " *Orchidaceæ*.
"	161	"	" 22, " *murderess*, " *mother*.

[redacted]

PROCEEDINGS OF SOCIETIES.

Microscopical Society.

May 10th, 1865.

James Glaisher, Esq., F.R.S., President, in the chair.

A communication from Dr. Maddox on "A Wire Spring Clip" was read, and a specimen of the clip was handed round for inspection. ('Trans.,' p. 84.)

The Secretary read a paper from Dr. Greville "On some New and Rare Diatoms." ('Trans.,' p. 43.)

The President, who spoke in high terms of the beauty of Dr. Greville's drawings, proposed a vote of thanks to that gentleman, which was unanimously carried.

A paper on "Paraffin Oil, as applied to Microscopic purposes," by Mr. Hall, was read. ('Trans.,' p. 87.)

The President, after remarking on the importance of the subject of illumination, said that a paper like Mr. Hall's, containing a series of facts which were highly valuable as facts, hardly called for discussion. He, however, should have been glad if carbonine as well as belmontine had been taken into account in the paper. He also suggested a simpler mode of expressing the fractions in Mr. Hall's table, which Mr. Hall said he would adopt.

Mr. W. Wenham read a paper "On the Prismatic Examination of Microscopic Objects," by Mr. William Huggins. ('Trans.,' p. 85.) Mr. Wenham said—I have assisted Mr. Huggins in making some of his investigations, and the results are rather remarkable. We so far differ from Mr. Sorby that we are able to make an analysis of the smallest microscopic object, such as the smallest portion of a blood-disc mounted in the ordinary way. We can get a strong spectrum, and the power of the object-glass gives a better result. There is, however, one difficulty which remains to be got over—you do not see the object definitively. You have first to ascertain the spot where you make the analysis with the microscope, and then apply the spectroscope to the eye-piece. This remains to be improved on, and it occurs to me that it can be done by means of the binocular microscope. We found, too, some curious results from investigating opaque objects. In all spectral analysis the difficulty is to get a monochromatic light. Generally we get a spectrum of some sort, but from the surface of many opaque objects the reflected light is perfectly monochromatic.

The PRESIDENT remarked that in matters of this kind persons generally ran "neck and neck" with each other, and proceeded to announce that Mr. Browning had, like Mr. Huggins, been engaged on the subject of the application of the spectroscope to the microscope, and that he had promised a paper on the subject which he hoped would lead to further investigation and discussion. Certainly the spectroscope made the microscope more valuable than before, and he had been greatly delighted by the results shown by the microscope with the spectroscope attached.

Mr. SLACK observed that the important paper of Mr. Huggins ought not to be allowed to pass without remark. In Mr. Sorby's arrangement the prism was placed beneath the stage of the microscope, and the spectrum magnified, say, with a one-inch objective. By this means the absorption bands could be seen in infinitesimally dilute solutions of blood. After viewing these bands in an extremely dilute solution, with the help of the microscope, the same solution was tried with an ordinary spectroscope of considerable dispersive power, and no absorption bands could be discerned. Mr. Browning at once suggested the cause, viz., that the dispersion was too great, and it was found that an inferior spectroscope of less dispersive powers enabled them to be seen. Considerable dispersion is necessary when the separation of closely adjacent lines is to be effected; but too much dispersion spreads and thins out delicate absorption bands to such an extent as to render them invisible. From experiments I made at Mr. Browning's, I think it probable that a new form of direct spectroscope, recently devised and made by him for Mr. Gassiot, will be found suited to the display of very faint absorption bands, without the assistance of a microscope. By the arrangements of Mr. Huggins, in which the spectroscope was used as an eye-piece, a more extensive range of experiments could be made, not only in viewing the spectra of opaque objects, but in noticing the changes that took place in cell-contents, either through natural processes, or by the application of reagents.

Dr. G. C. WALLICH, M.D., F.R.S., read a paper "On the Structure and Affinity of the Polycystina." ('Trans.,' p. 75.) Dr. Wallich added that as he had in this paper taken occasion to differ from some of Dr. Carpenter's views upon the subject, he had written to that gentleman, inviting him to attend the meet-

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ing. Dr. Carpenter, however, had replied, expressing his inability to be present, on the grounds of recent illness and pressure of professional duties.

The PRESIDENT, after alluding to the very wide field for discussion opened up by Dr. Wallich's paper, proceeded to express the great pleasure and gratification with which it was received, and tendered especially his own personal thanks, the paper having been given at his (the President's) request.

A vote of thanks was unanimously awarded to Dr. Wallich, after which Dr. Wallich said he should be glad to place some specimens at the service of the Society. The President took the opportunity of urging on the Members the importance of keeping the cabinet of the Society supplied with specimens; and though he regretted the facilities for placing them at present enjoyed were not all that could be wished, he trusted to see some improvement in that respect.

DUBLIN MICROSCOPICAL CLUB.

16th March, 1865.

THE minutes of the preceding evening meeting were read and confirmed.

Read the following letter from Professor W. H. Harvey, M.D., F.R. & L.SS., conveying his thanks for having been elected an Honorary Member of the Club, which was ordered to be entered on the minutes:

"4, WINTON ROAD, LEESON PARK;
"*16th January*, 1865.

"My dear Mr. Archer,—I have duly received your letter of the 14th, informing me that I had been elected an Honorary Member of the Microscopical Club, an honour which I thankfully accept.

"I cannot but feel gratified at this expression of the regard of the members of the Club, although I know that I am but little entitled by anything that I have done to such an honour. If anything could enhance the compliment in my eyes, it is the fact that I have been thought not unworthy of occupying a position beside so distinguished a microscopist as Admiral Jones.

"Believe me, very faithfully yours,
"W. H. HARVEY.

"WM. ARCHER, Esq.,
"*Hon. Sec., Microscopical Club.*"

Dr. Barker exhibited a fine example of that handsome Infusorium, *Carchesium polypinum*, and especially interesting as supplementing the exhibition of Opercularia at the December meeting.

Mr. Tichbourne exhibited a section of devitrified glass. The specimen of glass from which it was taken was procured from Messrs. Chance Bros. & Co., of Birmingham. Mr. Tichbourne remarked that it was a well-known fact that when glass is slowly cooled that portions become very infusible and opaque. This devitrification must be carefully distinguished from a crystallization that sometimes proceeds from over-heating the glass: in this latter case certain of the alkaline bases are volatilized, and crystals are found disseminated through the mass having a different composition to the vitreous matter. Dumas' definition of this phenomenon is as follows:—"Devitrification is a crystallization of glass due to the formation of definite compounds infusible at the temperature existent at the instant of devitrification." This definition is more applicable, in Mr. Tichbourne's opinion, to the specimens produced by over-heating, than to the one which was exhibited upon the table, which might be looked upon as proceeding from a physical change. In the specimen from which the section had been made it would be perceived that the devitrified portion had assumed the appearance of little masses about the size of small peppercorns, which were perfectly opaque. Each mass is detached from the vitreous portion, the fracture in most cases not entirely surrounding the crystalline sphere, and consist of vacuous spaces. As might be inferred from this fact, the density of the devitrified variety is greater than the vitrified. Although it was difficult to separate the two portions perfectly, the following were the results, in Mr. Tichbourne's hand:

Vitreous portion . . .	2·435 sp. gr.
Devitreous portion . . .	2·460 „

This increase in density is observed in all substances of a vitreous nature upon their assuming the crystalline form (arsenious acid, for instance). If the section is made so that it cuts through the axis of one of the warty masses, it will be seen that the crystals become more regular and larger towards the centre, and that therefore the interior becomes perfectly transparent, although it retained the crystalline character: the opacity of the external part being due to the smallest irregularity of the crystals. The crystallization was beautifully seen in the centres of some of these masses, forming fine microscopic objects.

Mr. Crowe showed Raphides from Shallot.

Mr. Archer showed a form of volvocinaceous plant, which *à priori* might be looked upon as an undescribed species of Gonium. He had found this before, in May last, on the occasion of the excursion of the Club to the Vale of Ovoca, and, again, in a gathering made by Dr. Barker, and subsequently by himself in the Phœnix Park. This little organism seemed to differ from

Gonium pectorale in having the constituent cells, but four only, not sixteen; also in the form of the cells, which were much drawn out towards one side of the little tablet, that, indeed, whence the cilia originated; seen laterally, they showed an ovate outline. Self-division of the cells took place much as in *G. pectorale*, but stopping, of course, when divided into four; and here a possible further distinction presented itself in that—whilst in *G. pectorale* the self-division is successional, here it appears to be simultaneous. This, however, is a question, so far as it may bear, open to further examination; at least, Mr. Archer had not found any constituent cells of these little tablets otherwise than undivided or divided into four; he had not seen them halved or divided into two daughter-cells only. Mr. Archer showed side by side a moving tablet and a vegetating one, showing the four daughter-cells, emanating from a single gonidium.

Dr. Frazer showed some nicely prepared sections of Galway serpentine, and exhibited the structure lately so much debated, and referred to the Foraminifera—*Eözoon Canadense*.

Dr. Moore showed a Tabellaria taken by him at Lough Luggela: this Mr. O'Meara promised to identify.

Dr. Barker exhibited specimens of a remarkable little organism which seemed to appertain to Astasiæa. This was very minute, fusiform, exceedingly slender, twenty or thirty times longer than broad, extremities acute, colour dull green, containing scattered dark granules, exhibiting under a high power a molecular movement: at about a quarter the length of the whole organism from one extremity, there was a narrow linear, about twice or thrice as long as broad, garnet-coloured, red dot ("eye-speck"), which seemed somewhat to project from the general outline of the body. There was no flagellum evident, yet this singular little organism was endowed with active powers of locomotion; it would swim with great rapidity in a given direction for some time, suddenly stop and swim back, without turning, in a direction possibly the exactly opposite, or it would remain quiescent for a time, usually again starting off after a slight delay with greater or less rapidity. This curious production occurred in considerable numbers in a gathering made in one of the ponds in the Park, but their vivacity did not last long, and soon they were to be found only in a still condition.

Mr. Archer stated that, guided by Dr. Barker, he had made a gathering from the pond pointed out, and had obtained even, if possible, a still greater quantity of this organism. He thought it could, for the present, be only referred to Astasiæa: he had noticed a certain amount of flexibility in it: many were found curved somewhat, and retaining this form in a still state: on one occasion (he reminded Dr. Barker) that they had together seen an individual with one extremity somewhat prolonged into a fine tale-like extension, apparently inflated or capitate at the end. In some of the specimens which Mr. Archer had taken he had found the contents of the quiescent individuals in some instances undergoing division, some being found with the contents divided into two, others into four, and others into eight—in the latter instance the individual portions presenting a subtriangular outline, owing to the peculiar way in which the lines of division seemed to run; the diameter of the organism being now nearly as broad again as in the ordinary condition, and the acute extremities hyaline. Notwithstanding the apparent absence of flagella, all this seemed to point to an affinity with Chlorogonium.

Rev. Eugene O'Meara, A.M., referred to a paper by W. H. Heys, Esq., in the last number of the 'Quarterly Journal of Microscopical Science,' No. XVII, January, 1865, p. 19, "on mounting microscopical preparations in Canada balsam and chloroform," and stated that he had tried the experiment with the most satisfactory result. To illustrate this he showed a slide containing *Biddulphia pulchella*, which, when mounted, appeared indeed unsatisfactory; but after a few days the cells were penetrated by the medium. The students of microscopical science are placed under an obligation to Mr. Heys for his kindness in making known so good a method of mounting preparations in Canada balsam.

Mr. O'Meara also exhibited several figures of diatomaceous forms found by him since last meeting in gatherings from the Friendly Islands, directing special attention to two species of Cocconeis. One of these he considered identical with Dr. Greville's *C. punctatissima;* the other was a very curious form, possessing, in addition to the characters of Cocconeis, the appearance of "canaliculi," somewhat similar to those which occur in Surirella. He added that Podocystis had occurred frequently in the gathering, and that he had found several frustules of *Synedra robusta* for which the only habitat mentioned in Pritchard's 'Infusoria' is Corsica.

Dr. E. Perceval Wright exhibited a small actinozoon, which he believed either to belong to the genus Haimeia (Milne-Edwards), or, more likely still, to be undescribed. All the Alcyonarian Actinozoa are gregarious — giving rise by budding to variously shaped masses: some of the best-known forms being the genera Alcyonium, Virgularia, Pennatula, &c.; but in the first sub-family, Cornulariadæ, the polypes are not, as a rule, very much aggregated. In the polype now exhibited there was, however, no trace of a cœnosarc, though it had been under observation for some months, and this alone was sufficient to assign it to the division of Cornulariadæ, distinguished by the polypes being "simple, not aggregated, tubular, and retractile." The question then was, did it belong to the only genus thus typified? but unfortunately this genus is described by none save negative qualities, and the species has for its diagnosis "Polypiéroide brunâtre haut de 3 ou 4 millimètres," which is totally insufficient to characterise a species. There can be no doubt as to the individual exhibited being an adult form—the characteristic alcyonarian spicules are found both at the base of the polype and along and at the base of the tentacles—these latter are completely retractile. Should this form not constitute a new species of Haimeia, it is proposed to form it into a new genus called Hartea, after the gentleman who kindly sent it to Dr. Wright, along with other marine creatures from Rathmullen, County Donegal.

Mr. Archer desired to place on record on the minutes of the Club, the occurrence in Ireland of a well-marked and interesting Palmellacean alga, *Mischococcus confervicola* (Näg.). This form had been first shown to him by Dr. Barker from a gathering made in the Phœnix Park, and its characters are so distinctive that Mr. Archer at once perceived its identity. At the present late hour of the evening he would not expatiate upon it or its mode of growth, but would merely refer to Nägeli's figure in 'Gattungen einzelliger Algen' (t. ii, f. D), and remark that, notwithstanding that these simple forms had been ignored by some (*e. g.* the authors of the 'Micrographic Dictionary')—an unadvisable course pending the want of knowledge as to their reproduction or origin—it might perhaps by others be regarded as not altogether an uninteresting addition to our Cryptogamic Flora, inasmuch as, so far as Mr. Archer knew, *Mischococcus confervicola* had not been seen by other eyes than its discoverer's, Professor Nägeli.

20th April, 1865.

Read the minutes of the preceding monthly meeting, which were confirmed.

Dr. E. Perceval Wright exhibited the circulation of the blood in the branchiæ of *Hypocthon anguinis*, brought from the Magdalena Grotto, Adelsberg, within the last few days, by Mrs. G. Orr Wilson.

Mr. Archer showed specimens of the new Saprolegniaceous plant, *Aphanomyces stellatus*, De Bary, in fruit, showing the oogonium which contained the oospore and the collateral male branchlets (antheridia). He also brought forward specimens showing the characteristic cluster of zoospores, proving the plant to belong to De Bary's genus Aphanomyces. He likewise, for the purpose of comparison, showed specimens found in the same gathering of *Saprolegnia monoica*, Prings., in full fruit, showing oospores and antheridia, as well as sporangia ready to emit their zoospores. By the aid of the figures in De Bary's and Pringsheim's papers on these curious organisms, in Pringsheim's 'Jahrbücher für wissenschaftliche Botanik' (I, t. xix, xx ; II, t. xix, f. 11, 12, 13), he endeavoured to give an explanation of the structure and fructification of these curious organisms, and of their generic characters, leaning to the view that they must be regarded rather as fungi than algæ, on account of their being destitute of colouring matter, and of their essentially parasitic habit; whilst their production of zoospores and characteristic fruit could no longer be adduced as an argument for their algal affinity, inasmuch as De Bary had found undoubted fungi producing zoospores, and a fructification essentially resembling that of Saprolegniæ. Mr. Archer's specimens had been found on effete frogspawn, and it was, perhaps, remarkable that these two forms occurred together. It would be, of course, impossible, as every one knows who has examined these organisms, to trace individual branches very far among the confused and inextricable tangled mass made up by them, in order to see if there were a possibility of their having a common origin. But, at least as far as it could be traced, no such circumstances were recognisable, and the two plants could be well distinguished everywhere. Aphanomyces is a much smaller, shorter, and more slender plant than Saprolegnia, whose fructification, both as regards the sporangia (zoospore-cases), and the oogonia (oospore, or fertilized-spore-cases), towered far above the much more diminutive and slender threads and fruits of the Aphanomyces.

Dr. Moore showed an Alga, composed of simple green-cells, in order to draw attention to a fibre connecting them together, a rarity in these growths.

Mr. Archer was disposed to regard this plant as *Botrydina vulgaris*, which undoubtedly possessed the fibres pointed out by Dr. Moore, although they are not in Hassall's figure, giving, however, in other respects an apparently truthful idea of its structure.

Dr. Moore likewise showed some fibrous substance given to him by Dr. Carte, and found underground, and stated by the finder to be the hair of the Elk. Dr. Carte had determined that it was not hair, and had handed it to Dr. Moore, supposing it to be vegetable. Dr. Moore thought this production an alga, and closely related to the oscillatoriaceous genus Microcoleus. It presented curled and twisted fibres, nearly colourless, and often splitting at the extremities into a tuft.

Mr. Archer was disposed to be very cautious as to admitting this production as an alga, but supposing it really to be such, he conceived that it bore much resemblance to some scytonematous genus than to Microcoleus—such as Dasyglœa or Schizosiphon. He thought he saw something like a solitary thin central axis, and that the tufting at the extremities was due rather to a slitting up of the outer investing portion itself than to a spreading of fibres contained within a common tube.

Dr. Barker showed *Spirogyra inflata*, and explained the phenomenon of conjugation as exemplified thereby.

Mr. Vickers exhibited specimens of *Corallium rubrum*, and of a species of Salicornaria found by him in the Bay of Naples.

Mr. Archer showed an organism referable to Ehrenberg's genus Trachelemonas found in some gatherings made by Captain Hutton in the County Donegal. The lorica was elliptic, large and opaque, and chiefly remarkable for a whorl of short spines borne at the anterior end, in number probably ten or fifteen. The motion of the organism was very active and rapid, revolving on its axis during progression, thus rendering this crown-like series of spines to appear more numerous than they were really found to be when it could be examined in a still or comparatively quiet state.

Captain Hutton called attention to the cell contents of the perichætial leaves of *Fontinalis antipyretica* (L.). He stated that if these leaves are examined in spring, while the fruit they surround is young, every cell, except those near the base of the leaf, will be seen to contain a grumous mass of golden-brown colour, which entirely fills it, with the exception of a small empty space at each end; the cell-wall being of a pale green.

On investigation this brown substance gave the following reactions:

1. Simply heated, it turned bright green.
2. Hydrochloric acid had but little effect upon it cold, but when heated, it dissolved it, and turned it a very pale-green colour.
3. Sulphuric acid turned it first a bright green, then pale yellowish-brown.
4. Iodine turned it bright green. On the addition of sulphuric acid it became dark reddish-brown, small quantities of gas being given off.
5. Pernitrate of mercury (Millon's test) rapidly dissolved it without changing the colour. When heated, it turned into a pale-yellow transparent mass.
6. Chloriodide of zinc (Schultz's test) turned it pale green.
7. Alcohol turned it green, but did not dissolve it.
8. Æther—the same.
9. Pettenkofer's test. The syrup turned it pale green. On the addition of the sulphuric acid, gas was given off copiously, and the colour became bright green, which turned with heat to a reddish-brown.

With tests 4 and 6 the cell-wall showed the characteristic reaction of cellulose very distinctly. From these investigations Captain Hutton was of opinion that this substance was merely some modification of chlorophyll, and he pointed out that, both in colour and behaviour with reagents, it seemed to be very similar to, if not quite identical with, the endochrome of the Diotomaceæ. Unfortunately the specimens of Captain Hutton, exhibited, had been kept in a tumbler of water for nearly a month, and consequently the peculiar colour of the cell contents had in a great measure disappeared, and the whole had become more or less green.

Mr. Archer ventured to think that the reddish colour seen in the moss-leaf exhibited (though, upon a hasty examination he would not dare in the least to impugn the accuracy of Captain Hutton's experiments) was due rather to a reddish tint assumed by the cell-walls than to the cell contents. Some protonematous growths have red and brown cell-walls, but, at the same time, distinctly green cell contents.

Rev. Dr. Dickson exhibited some crystals, under the polariscope, found by him in a liqueur called Trapistine, manufactured by the monks of the monastery "Grace Dieu," near Besançon. The same crystals were obtained from a liqueur called "Grande Chartreux," manufactured by the monks of the convent bearing the same name not far from Grenoble. Although sugar is of course contained in considerable quantity, Dr. Dickson believed that there was another organic substance probably obtained from a plant. Dr. Dickson promised to pursue his examination of these crystals and to give additional information on another occasion.

Manchester Literary and Philosophical Society.

Microscopical Section.

First Ordinary Meeting, Session 1864-5.

17*th October*, 1864.

Joseph Sidebotham, Esq., President of the Section in the Chair.

Mr. J. B. Dancer, F.R.A.S., read a paper "On a Contrivance for regulating the amount of Light transmitted from the source of Illumination to the Mirror of the Microscope." When viewing certain objects by transmitted light, and particularly with oblique illumination, a very slight alteration in the quantity and direction of the light produces a marked difference in the appearance of the object, especially in Diatomaceæ, where a proper management of the light shows lines or markings invisible under ordinary direct illumination. The apparatus now exhibited is one easily made at a trifling cost, and consists of a circular disc of blackened tin or cardboard ten or twelve inches in diameter, with a number of perforations of various shapes and sizes—circular, cross-shaped, wedge-shaped, &c.—the centres of which are about 3 inches from the centre on which the disc, placed perpendicularly, rotates. The form of perforations found generally most useful are parallel slits—slits at right angles to each other—wedge-shaped and circular openings. The objects under view must be well illuminated in the direction required, and then the disc, supported by a pillar, is placed between the source of light and the concave mirror, when a few trials will determine the best form of aperture. The markings of *Pleurosigma fasciola*, *angulatum*, &c., may be seen by its aid under powers which would not show them with any arrangement of achromatic condensers, and it also has the good property of shading all but the amount of light required from the lower portion of the microscopic stage and stand. The disc might be attached to the lamp, but it appears to work better on a stand, and is susceptible of various modifications which will readily suggest themselves to the microscopist.

Mr. W. H. Heys exhibited specimens of leaves of the vegetable marrow, showing reticulated markings somewhat similar to those of Symphytum, and presented a slide to the cabinet.

Mr. Sidebotham stated that in sweeping over herbage for Coleoptera and other insects, he had found some very curious seeds, to one of which, *Sanicula Europea*, he thought attention had not hitherto been drawn, though well deserving of it. Those of Henbane and Daucus were also most singular.

Mr. Linton exhibited the elegant tufted stigmas of *Poterium sanguisorba*, and the very singular calyx of the gum Cistus, which almost might be mistaken for the skin and scales of a fish.

January 16*th*, 1865.

The following note from Mr. Dancer, addressed to the President of the ection was read:

"Sir,—I beg to state that, since our last meeting, I have carefully examined, with various powers of the microscope, the cotton hairs whilst undergoing dissolution in Schweizer's ammoniacal solution of copper. I am inclined to the belief that cotton hairs do not contain spiral vessels properly so called. I think that the spiral apparatus, which has been described by Mr. C. O'Neill and Mr. Heys as spiral vessels, can be clearly traced to a mechanical action which the solvent exerts on the vegetable cell. At some future time I hope to illustrate this to the section.

"Yours truly,

"'J. B. Dancer."

Mr. Heys explained that he had not intended to describe the cotton hairs as containing spiral vessels, in the botanical sense of the term, but had spoken of the appearance within them as that of a spiral thread.

Mr. Watson read a communication "On the plumules or Battledore Scales of the Lycænidæ," in which he showed that they will serve the purposes of identification by exhibiting generic and specific alliances, and differences similar to those found in the plumules of the Pieridæ, described by him in a previous paper. Fifty-three figures of the plumules, drawn by Mr. Sidebotham, were shown as illustrations of the subject. He said the points he desired to insist upon as likely to be useful in this investigation were—That the plumules were always identical in individuals of the same species, and mere varieties can therefore be detected by this test; and that, in very closely allied species which are difficult of distinction by the more ordinary characters, these scales will be often found to be different.

Mr. Sidebotham read "Notes on the Development of the Wings of Lepidopterous Insects." He said that their great and rapid increase of size soon after the insect emerges from the chrysalis is caused by air, taken in through the spiracles, being sent into the vessels of the wings; the membrane is expanded in consequence, and the scales, which were before packed under each other as closely as possible, are made to slide out until they remain in the fully developed wing like the tiles of a roof. He exhibited preserved specimens of the Currant moth and the Tiger moth, with the wings both in their small and in their expanded state, also a coloured sketch of one of them, and it was seen that in the unexpanded state the wings lie flat, without any folding, and all their markings are a correct representation in miniature of what they ultimately become.

ORIGINAL COMMUNICATIONS.

Some Remarks *on the* Structure *of the* Horse's Foot. By John Hepworth.

In comparing the anatomy of the anterior extremity of the horse with the human arm, its representative, I have come to the conclusion that the vascular do not secrete the horny laminæ, the generally received opinion being *that they do.*

In order to make myself clearly understood, it will be necessary to give a general outline of the anatomy of the foot.

The external parts of the foot consist entirely of horn, constituting the hoof. The internal parts consist of bones, ligaments, and tendons, besides structures peculiar to the foot.

The hoof, or insensible parts, is the covering nature has provided for the protection of the internal or sensible parts of the foot. To the common observer it appears to consist of one entire or indivisible case; but the anatomist finds, by subjecting it to maceration, that it resolves itself into three separate pieces—the wall, the frog, and the sole. The wall, or crust, is the part of the hoof which is visible while the foot stands upon the ground. On taking up the foot, we find the wall protrudes beyond the other parts all round, making the first impression on the ground, and evidently taking the largest share of bearing. Its origin is at the coronet (the crown of the hoof, where the hair terminates); from thence it descends in an oblique direction in a well-formed foot, at an angle of about forty-five degrees, to the bottom, where it embraces the sole, and terminates in a circular projecting border. The anterior and lateral parts of the hoof are formed entirely by the wall; but at the posterior part, instead of the heels of the wall being continued one into the other, so as to complete the circle, they become inflected, first downwards, afterwards forwards and inwards, and are elongated in the latter direction until they reach the centre of the bottom of the foot, where they terminate. These inflections or processes of the wall constitute the bars. Altogether, the wall may be said to form about two thirds of the entire hoof.

The wall is divided into the toe, the quarters, the heels, the superior or coronary border, the inferior or solar border, the laminæ, and the bars or appendages.

The toe forms the bow or front of the hoof, and comprehends about two thirds of the superficies of the wall.

The quarters are the portions of the wall intermediate between the toe and the heels.

The heels are the two protuberant portions of the wall, by which it is terminated posteriorly.

The superior or coronary border is the circular, attenuated, concavo-convex part, entering into the composition of the coronet. Its extent is marked exteriorly by the whitish aspect it exhibits, and also by some partial separation and eversion of the outer flakes of horn around its junction with the wall below. Externally, it assumes the same character as the wall below it; but its internal surface is altogether different. Instead of possessing laminæ, the surface is smooth and uniformly excavated, being moulded to the form of the sensitive coronet, and everywhere presenting numerous pores for the purpose of receiving the secreting villi. Superiorly, the coronary border presents two edges, having a groove between them for the reception of the terminating border of the cutis (true skin). It is this groove that marks the separation of the coronary border into two parts—the internal edge, belonging to the inner part, which is the beginning of the wall itself; the external edge to the white band, by which the other is embraced, and to which Mr. Clark has in particular drawn our attention, under the appellation of "coronary frog-band." This covers the proper or veritable coronary border of the hoof, having through its fibres a sort of dovetail connection with it. As it recedes backwards it grows broader, so that its breadth becomes doubled, being about half an inch broad in front and one inch behind. Vertically, it is thickest in its middle, its inferior edge, like the superior, becoming attenuated, until it grows so fine as to end in imperceptible union with the substance of the wall, giving it its beautifully polished surface; from the heat, however, to which the hoof is artificially exposed, the inferior border often splits from the crust and becomes everted, becoming at the same time of a whitish colour. Posteriorly, we find it continued round the heels of the wall and frog, and from thence across the back of the cleft, forming altogether a complete circle. It is fibrous in texture, and the fibres pursue the same direction as those of the wall.

The inferior or solar border constitutes the ground or wearing surface of the wall, and is the part to which the shoe is nailed, and requires paring down every time the horse is shod. Such is its exuberant nature, that, like the human nail, were it not continually kept worn down, or broken or cut off, it would elongate very considerably and gradually turn up, exhibiting forms not only of the most unsightly but even grotesque description, and proving incommodious to a degree to be almost entirely destructive of progression.

The laminæ consist of numerous narrow thin plates or processes, arranged with the nicest order and mathematical precision upon the internal surface of the wall. They extend in uniform parallels in a perpendicular direction from the lower edge of the superior border down to the line of junction of the wall with the sole, and are so thickly set that no part of the superficies remains unoccupied by them. They are likewise continued upon the surfaces of the bars. In the recent subject they are soft, yielding, and elastic; but from exposure they become dry and rigid. Every lamina exhibits two edges and two surfaces. By one edge it is attached to the wall; and the other, which is somewhat attenuated, hangs loose and floating within the cavity of the hoof. The surfaces, which are two, are *smooth*, and, considering the magnitude of the lamina itself, of enormous extent. Mr. Bracy Clark procured from the late Thomas Evans, Esq., LL.D., mathematical teacher of Christ's Hospital, a calculation of what their united superficies amounted to; and it appeared to afford an increase of actual surface more than the simple internal area of the hoof would give of about twelve times, or about 212 square inches, or nearly one square foot and a half. Their composition is horny. By means of its laminæ, the wall presents a superficies of extraordinary amplitude for the attachment of the coffin-bone. A structure consisting of similarly formed laminæ envelopes the bone, and these are dovetailed in such a manner with the horny laminæ as to complete a union which, for concentrated strength, combining elasticity, may vie with any piece of animal mechanism at present known to us.

The bars are processes of the wall, inflected from its heels obliquely across the bottom of the foot. In the natural healthy foot the bars appear, externally, as elongated sharpened prominences, extending from the bases of the heels into the centre of the foot, between the soul and the frog; posteriorly, they are continuous in substance with the wall, with which they form acute angles; anteriorly, they stretch as far as the point of the frog, constituting two *inner* walls or lateral fences between that body and the sole.

The sole is the arched plate entering into the formation of the bottom of the hoof, or, to adopt Sainbell's definition, "it is that part which covers the whole surface of the foot, excepting the frog." The superior surface is unevenly convex; the inferior correspondingly concave. The former is everywhere pitted with numerous circular pores running in an oblique direction, the marks of which remain evident upon the inferior surface likewise. These pores are the impressions made in the soft horn by the villi of the sensitive sole, from which the horny matter is produced. They also form the bond of union between the horny and sensitive soles, which is of a nature so strong and resisting that it requires the whole strength of a man's arm to effect their separation—an operation of a cruel description, that was wont to be practised in times past, under the fallacious notion that "drawing the sole" was extirpating the malady.

I have quoted Mr. Percivall's work on the 'Anatomy of the Horse;' and having gone as far into it as will be sufficient to illustrate my subject, I shall now state what he says about the functions of the coronary substance and the sensitive laminæ. He says—"The wall is produced by the coronary substance. Its villi convert the blood circulating through them into a soft, pulpy, gelatinous matter, which, by exposure, becomes hard horn, descending from the villous point that produced it in the form of a tubular fibre down to the sole, &c. The sensitive laminæ make no addition to the substance or thickness of the wall, *they simply produce the horny laminæ*, arranged along its interior; as one proof of which, the wall measures as much in thickness at the place where it quits the coronet as it does at any point lower down. Other demonstrations of this fact come every day before such practitioners as have to treat canker, sand-crack, quittor, and other diseases of the foot."

As my remarks will be chiefly directed to the laminæ, I would beg particular attention to one or two points; one is, "that the horn is protruded beyond the sole, and receives the principal weight of the animal;" the other is, "that after the cruel operation of the old farriers, of drawing (removing) the sole," the horse was still able to walk, the weight being supported upon the inferior border of the crust, showing that the animal was actually suspended by the laminæ. Some horses weigh a ton, and must in walking support nearly half their weight on each foot alternately; and this we might have supposed *à priori* would have torn the coffin-bone (os pedis) from the wall of the hoof. If you fancy two volumes, with leaves of vellum, slightly moistened and locked together leaf by leaf, containing one thousand to twelve hundred pages, it will give a good idea of the arrangement of the two sets of laminæ, and the difficulty of separating them. I have a specimen of hoof in which I have counted five hundred and ten laminæ, including the bars. Mr. Percivall has met with six hundred. The sensible and insensible laminæ are not only united singly, but doubly. Mr. G. Fleming (Veterinary Surgeon to the 3rd Hussars) has discovered lateral processes on the laminæ similar to the featherlets of a quill (Pl. X, fig. 1, *c*), which he has called laminellæ; they appear to be given off from the laminæ in single fibres; by examining a thinly cut section with polarized light, they will be very clearly seen.

The wall of the hoof is hollowed at the upper and inner side, leaving the front edge thin, and forming an ovoid cavity, the posterior edge being much lower than the anterior. The coronary substance is adapted to, and imbedded in, this groove, which is perforated by innumerable orifices, through which the villi (fig. 2) pass down into the wall parallel with its front surface. They are about $\frac{5}{16}$ inch long, and covered with numerous blood-vessels. These villi secrete the wall, and, I believe, the laminæ also. If a transverse section (Pl. XI, fig. 1) be carefully examined, it will be found that round each orifice there are annular rings, with dark-coloured cells; the structure is not unlike bone, but the cells have no canaliculæ. I believe them to be pigment-cells, although more distinct with a high power than those in whalebone, with which I have compared them. These cells extend into the laminæ, and there are vestiges of them to the very extremities, to be seen with a good quarter-inch objective. The horn-cells also evidently come out from the wall, giving the laminæ a fibrous appearance. There is no line of demarcation between the substance of the laminæ and that of the wall, which would be the case if they were secreted by another set of vessels. I drew some injected villi from the wall, to which were attached many of the pigment-cells, and which adhered so firmly to the basement membrane, that I could not remove them by washing and brushing rather roughly. I have not been able to detect the least appearance of any such cells, either on the sensible laminæ or their vessels. I met with an instance where these laminæ gave off several *villi** about

* Messrs. Lawson and Fleming consider this an unusual distribution of the villi.

two thirds down the wall, into which they dipped, taking the same direction, and, no doubt, performing the same functions as those from above. Under these circumstances, and, I believe, under these only, the vascular laminæ *do contribute* to the formation of the wall, and through the medium of the wall to that of the horny laminæ also; the ends also become villous, and, penetrating the sole, filling up the spaces between the horny laminæ which may be traced beyond it. The villous appears to be the essential form for the secretion of horn in the foot of the horse; that of the sole, frog, &c., are also secreted by villi. I do not think the fact of the wall being as thick at the top as at the bottom is any proof "that the vascular secrete the horny laminæ." As regards sand-crack, quittor (separation of the sensible and insensible laminæ, by abscess or inflammation), there is a secretion thrown out to protect the sensible laminæ, when exposed; but I am assured by an experienced veterinary surgeon* that it is not horn. He says that after operation for sand-crack (removing a portion of the wall of the hoof), the sensible laminæ become covered with soft material, which becomes hard and white. This appears only a temporary provision, as the cure is not complete until the horny covering has been again supplied from the coronary substance. It is not improbable that this is calcareous matter, as it is formed by the vessels which penetrate the bone, and that it becomes absorbed as the horn progresses. I have had no opportunity of examining this substance with the microscope; that would decide the question at once. The sensible laminæ are very vascular, and the question might be asked, Why so, if they have no secretory process to carry on? I would answer that, with the constant tension they are subject to, not only by the weight of the horse, but the concussion in travelling on hard roads, if they were not highly organized, they could not perform the functions allotted to them, but would soon lose their vitality; and further, if the horny laminæ were *tacked on*, if I may use the expression, they would be torn away. I have examined sections of hoofs of the cow, deer, hog, buffalo, and sheep. In that of the deer the formation of the laminæ commences before it reaches the interior surface of the wall; and in the hog there are horny bundles *in the wall*, which taper off and form the laminæ; these may be examined either with or without polarized light. The coronary frog-band, a portion of which is represented in fig. 4, is more highly organized than I had anticipated. Its villi are distinctly seen

* Mr. Lawson, Veterinary Surgeon, Manchester, and one of the Examiners at the London Veterinary College.

penetrating the semi-horny substance of which it is composed. Several rows of hair pass through its upper attenuated edge, the roots of which are amply supplied with sebaceous glands; the capillaries are very well seen in the specimen sent. It is the homologue of the inflected skin at the base of the human nail.

I hope these few remarks may lead some one who has better opportunities of investigating the matter to take up the subject.

On a New Method *of* Illumination.
By Count Francesco Castracane.

[The following letter from Count Francesco Castracane to R. P. Angelo Secchi originally appeared in the 'Atti della Academia pontificia de Nuovi Lincei,' t. xvii, 1864, and has been forwarded to us by Sig. Castracane for publication, as he thinks the method of illumination therein recommended is one deserving of more notice than it appears hitherto to have received, and also because he entertains a hope that his desire to be assisted in the execution of the work he has proposed to himself may receive some support from English diatomists. Sig. Castracane has favoured us with a sight of some of his photographic figures of diatoms, with respect to which we can only say that we have never seen any to compare with them for minuteness and clearness of definition; and if he be equally successful in his projected work with other species, it cannot fail to be one of the greatest interest and importance to all who are concerned in the same branch of microscopic inquiry.]

A Letter from Signor ab. Conte Francesco Castracane degli Antelminelli to R. P. Secchi.

In return for the kind interest you have taken in my faint endeavours to promote one among the numerous useful applications of the photographic process in scientific research, I am desirous of explaining to you how far I have advanced in the subject; and I do so with the more alacrity in the anticipation that you may be willing to aid me very largely by your advice.

Having been for a long time familiar with the various researches on the chemical action of light, which, since the marvellous discovery of Daguèrre, constitute the whole of the photographic art, I have for several years endeavoured to find a useful employment for my leisure hours in the application of photography to the reproduction of the wonders of nature as disclosed in the microscope. With this object, I have procured a very perfect microscope, constructed by the late Professor Amici. But I soon perceived that in order to employ the microscope at all usefully demanded a full knowledge of the instrument and of the use of each of its parts, and especially as to the means of modifying the direction and intensity of the light. In order to overcome the difficulty arising from the want of this full knowledge of the instrument, I availed myself of the assistance of the works of Dujardin and of Quekett; but I was still more assisted in this regard by some practical lessons which I had the good fortune to receive from Professor Amici. Amongst various other methods of proceeding, the professor showed me, and induced me to try, a mode of illumination discovered by himself for general use with the microscope, but which had not been at that time made publicly known. The method in question consisted in the employment of one of the component rays of the solar spectrum, which was made to fall on the mirror of the microscope, or on his lenticular prism. I was enabled to make large use of this kind of monochromatic light with great convenience after I had obtained a large heliostat, furnished with a mirror of thirty by fifteen centimètres, newly constructed by Dubosc, of Paris, on the plan and under the direction of M. Foucault. With the aid of this instrument, placed at a short distance from the microscope, I could obtain a field wholly illuminated by homogeneous coloured light. This kind of light, being incapable of further decomposition, appeared to me calculated to obviate any defect in the achromatism, either in the objective or ocular, as well as to get rid of those fringes caused by interference which are formed especially round the margins of objects. As regards the estimation of the power of the various objectives belonging to my microscope, it may be remarked that, whilst with white light I was able to see the structural characters of *Pleurosigma angulatum* as a series of points with the fifth and stronger objective, and with the fourth simply as lines, with the monochromatic light the points were exhibited with the utmost distinctness, not only with the fifth and quarter and with the lowest eye-piece, but could be seen with equal distinctness with the third, which has much less magnifying and penetrating power, and which, with ordinary white light, afforded a somewhat cloudy image. At present I have been unable to determine exactly the different degree of penetration obtainable by the use of the different coloured rays; but think it may be stated that the best optical results are derived from the green and turquoise-blue. I have said the *optical* results, because, with respect to the chemical or actinic effects, which will present a greater interest to me, I am unable at present to say anything. In the mean time, however, I am endeavouring to adapt the monochromatic illumination to the apparatus which I employ for the obtaining of photographic representations of microscopic objects; and I regret this delay the more because I believe the best result may be expected from the adoption of this mode of illumination, which opinion has decided my choice of the mode best adapted for the execution of a work which I flatter myself may be of some utility in the study of a branch of natural history.

The work I have proposed to myself, and towards which I have already made some trials, is an atlas of living and fossil diatoms, native and foreign, and as complete as I may be enabled to render it, trusting in the aid I may hope to obtain from those who have made these organisms a special subject of study; and at the same time neglecting no opportunity (as I have already done) of adding to a beautiful small collection which I have procured from MM. Bourgogne, of Paris, and Smith and Beck, of London. But before entering upon such an undertaking, I was desirous of ascertaining whether it would be possible to reproduce some of the minute particulars which are presented in the siliceous skeleton of these curious organisms, amongst which are some which exhibit such extreme minuteness of detail that, not being capable of being resolved except by the better class of instruments, they have been selected by microscopists as tests of the penetration and definition of the better and more powerful objectives. And as among these *Pleurosigma angulatum* is so difficult to be made out in its most minute structural peculiarities, "which," as observed by Griffith and Renfrey in the 'Microscopical Dictionary,' "are invisible by direct light, however large or small may be the aperture of the object-glass, or however perfect its definition" (although this does not accord with the fact that my fifth objective shows them to perfection with direct and central illumination)* I have, consequently, tried to obtain a photographic figure of this diatom, and have procured it with the utmost possible distinctness and sharp-

* Although the case may have been as stated at the time the 'Micrographic Dictionary' was printed, it is, as is well known, widely different now, when we have abundance of object-glasses fully capable of defining the markings of *P. angulatum*, and on still more difficult tests, with direct light.

ness, and thus am able to confirm the truth of Mr. Wenham's observation with respect to the hexagonal form of the cells which clothe the internal surface of the valve. This success has emboldened me to undertake the work, and afforded me an opportunity of presenting you with a specimen of it in a few photographic figures of various diatoms, which I think may suffice to prove the utility of photography in microscopic researches, whilst I believe it may be asserted that the photographic reproduction will have the advantage, not only of being an authentic representation of the form of the objects observed, but of faithfully reproducing, at least, as much as we have succeeded in discovering by the eye applied to the microscope.

This is as much as I have hitherto been able to effect, and a sketch of what I propose to do in the future, if my courage is sustained by your kind co-operation and that of those who may be generously disposed to assist me.

NOTES *on* BACILLARIA CURSORIA.
By T. P. BARKAS, Esq.

IT may not be uninteresting to some of your readers to know that *B. cursoria* is to be had in great abundance and very frequently on the Northumberland coast. Within the last few years I have made scores of gatherings from the sea-beach and rock-pools extending from the mouth of the Tyne to Cullercoats, a distance of about one and a half mile, and at least one half of those gatherings contained the curious frustules of *B. cursoria*. There is a large pool at the mouth of the river Tyne which is left shallowly filled with water at every tide, and is situate near the high-tide mark, from which pool I have obtained frequent gatherings of Diatomaceæ, and it is remarkable to observe how the leading species on each occasion continue to change. In a gathering made on the 18th April I found several Actinoptychus, varieties of Coscinodiscus, &c.; and on the 8th May last I obtained almost pure, and in great abundance, *Nav. pseudo-libellus*, n. sp., discovered by Mr. Atthey, and described by Mr. T. West in the 'Trans. of the Tyneside Naturalists' Field Club,' vol. iv, p. 321. On the 16th of May I took another gathering from the same pool, and found it consisted, for the most part, of varieties of Pleurosigma, with only an occasional frustule of *Nav. pseudo-libellus*. On June 5th another gathering from the same locality contained almost exclusively *B. cursoria* so abundantly that, when viewed upon a slide, the field of the microscope presented the appearance of a racecourse with rows of frustules pushing and running in all directions. Specimens of this beautiful diatom I forwarded, living, to Mr. Norman, of Hull; Mr. Baker, of Liverpool; and Dr. Donkin, of Newcastle, the latter gentleman being the discoverer and describer of the variety. (See 'Quart. Jour. Mic. Sci.,' Vol. VI, New Series, p. 16.)

There are a few features in relation to *B. cursoria* worthy of notice. First, that in all specimens I have gathered they are entirely covered with a kind of gritty matter, as though they were enveloped in some adhesive mucus which caused small particles to adhere to them. This condition is peculiar to *B. cursoria*, as the other Diatomaceæ in the same gatherings are clean, and free from attachments of any kind. The second is, that the force with which they move appears quite disproportionate to their size and apparent strength. Dr. Donkin, in his excellent description of them in the article before referred to, says he has observed them push away "*A. arenaria*, a species at least six times their own size." I have frequently seen them push away particles of foreign matter, and that with the greatest apparent ease, at least one hundred times larger than all the frustules combined; and what is more remarkable still is, that they not only push the accumulated particles away when they are in their direct line of motion, but, if they merely touch them in passing, they drag them after them as though they were literally held by some magnetic attraction or strong cement. Third, Dr. Donkin very graphically describes one phase of the curious motions of *B. cursoria*,* viz. that in which the frustule on one side of a cluster appears fixed, and the other frustules move past each other in rapid succession. I have seen that motion frequently; but I have also frequently seen the frustule which at one time was fixed become loose, and the frustule at the opposite side of the cluster fix itself, and the remainder move with great freedom. I have also observed the same cluster free at both sides, and each side move at the same time in opposite directions, somewhat similar to the motion of *B. paradoxa*, as described in Smith's 'Synopsis.' I have also observed the centre frustule become stationary, and those at each side rush backwards and forwards with great speed. I have seen frustules, to the number of fifty, grouped together, move rapidly until they formed a

* 'Quart. Journ. Mic. Sci.,' Vol. VI, p. 17.

continuous line their entire length, and then as rapidly return in the opposite direction.

The cause of the motions of *B. cursoria* is still a vexed question, and I must confess that no theory yet propounded at all touches the solution of their mysterious movements. They move more rapidly and spasmodically than any other diatom. Dr. Donkin, in p. 16 of Vol. VI, 'Quart. Jour. Mic. Sci.,' observes that he has only seen *B. cursoria* in one aspect, and he has fallen into the error of describing the S. V. as the F. V. I have several prepared slides in which both views are well exhibited, and that which the doctor describes as F. V. is S. V., the F. V. being broader, without median line, and with rows of punctæ on each side.

Dr. Donkin observes ('Quart. Jour. Mic. Sci.,' Vol. VI, p. 18), "Whether the filament is at first *attached*, and afterwards *free*, as in *B. paradoxa*, I cannot positively decide, although I believe it to be *free*, owing to its only occurring in the shallow furrows on the beach, where there is not a single vestige of vegetable life, except the free species of diatoms with which it is mixed." I have found it frequently on the open beach, but never in such large numbers as in the pool at the mouth of the Tyne, and the habitat is surrounded by rocks densely covered with algæ. This fact shakes the inference expressed by Dr. Donkin. They may originally be attached species. I shall be glad to forward living specimens of *B. cursoria* to any microscopist in exchange for diatoms not obtainable in this locality. Since writing the foregoing I made another gathering from the same pool, on Tuesday, June 13th, 1865. The weather had been fine and bright for several days, and I expected to find Diatomaceæ very abundant. I was disappointed, as the gathering consisted of a few groups of *B. cursoria*, and a sprinkling of Pleurosigma and Navicula. On examining this gathering of *B. cursoria*, I witnessed another feature in their movements which I had not before observed. Two frustules, which were detached from a larger group, instead of sliding backwards and forwards as before described, rolled from side to side, as though one end were fixed upon a pivot; and the remarkable phenomenon to which I desire to direct attention is this, that the small gritty particles on one side of the right-hand frustules moved freely backwards and forwards, in a hurried manner, along the edge of the frustule, as though they were occasionally driven by cilia, or as if they had automatic or voluntary motion. I observed that they moved when the diatom remained stationary.

OBSERVATIONS *on* MICRASTERIAS MAHABULESHWARENSIS (Hobson) *and* DOCIDIUM PRISTIDÆ (Hobson). By WILLIAM ARCHER.

HAVING for some time made the species of Desmidiaceæ an object of study, I naturally take an interest in any literature upon that Family of Algæ from any part of the world with which I may have the pleasure to meet.

In the 'Quarterly Journal of Microscopical Science'* Mr. Julian Hobson, Bombay Staff Corps, Mahabuleshwar, has lately described, and figured by woodcuts, two species, natives of that district, one belonging to the genus Micrasterias (Ag.), the other referred to Docidium (Bréb.), both of which, however, as it appears to me, have been previously described—the former by Dr. Wallich, but, as I venture to conceive, with an erroneous view as to its specific claims, and consequently, as I should be disposed to hold, under an incorrect designation; whilst the latter, I think, is more than likely to be identical with a species of the late Professor Bailey's—belonging, however, rather to Triploceras (Bailey) than to Docidium (Bréb.).

It may seem rather premature, and argue somewhat of temerity in one who has never seen a specimen of either of the forms in question, to venture an opinion; but, as I have made myself acquainted with the British species most nearly related to the former, and have obtained from my friend Mr. William Kaye, of Hong-Kong, a well-executed original drawing, by Dr. Lauder, R.N., of what I believe to be identical with the latter, I may be, perhaps, excused if I venture to call attention suggestively to, and to contrast the descriptions and figures of, what appear to me to be the same two forms, each respectively differently designated by Bailey, Wallich, and Hobson.

Dr. Wallich, some time ago, described and figured a Micrasterias, under the name of *M. morsa* (Ralfs), var. δ†; and if those interested in the matter will compare with it the, perhaps, a little vague description and figure given by Mr. Hobson,‡ I think it will be admitted that both apply to and represent the same identical form. Dr. Wallich, indeed, depicts the end lobes of his plant as serrated, whilst Mr. Hobson gives those of his as entire; moreover, the latter, in his de-

* 'Quart. Journ. Mic. Science,' N. S., Vol. III, No. 11, July, 1863, pp. 168, 169.

† 'Annals of Nat. Hist.,' 3rd series, vol. v, p. 277, pl. xiii, fig. 10.

‡ Loc. cit., p. 168.

scription, in a puzzling and contradictory manner, calls "the surface of the frond covered with small granules bordering the whole of the sinuses," so that we are obliged to rely almost wholly on his figure; but of the identity of these two plants there can, I think, be no doubt.

It is to be regretted that Dr. Wallich in his paper has spoken of the species referred to as *M. morsa* (Ralfs), whereas, the name *M. Americana* (Ehr.) having the priority, it should have the precedence. It will therefore be understood, that when I refer to *M. Americana*, it is equivalent to *M. morsa* as alluded to by Dr. Wallich, and I mean by the former name precisely the same identical plant. Dr. Wallich, indeed, himself draws attention to this in a note.

This presumed form, then, of *M. Americana* (Ehr.), which I can do nothing else than assume as identical with *M. Mahabuleshwarensis* (Hobs.), Dr. Wallich makes *var.* δ of that species of which he considers *M. Americana* the type, and along with it he would include both *M. Baileyi* (Ralfs), and *M. ringens* (Bailey)—the two latter indeed, forming but a single variety of the assumed species *M. Americana*. But in this conclusion I feel bound to say, with much deference, that I cannot at all concur. Dr. Wallich, indeed, seems to overlook, and I regard the consideration as very worthy of attention, that Professor Bailey, *who had seen the living forms*, has, in his published list,* enumerated the whole three, that is, *M. Americana*, *M. Baileyi*, and *M. ringens*, as so many distinct species. I admit, indeed, that the short technical characters given by Dr. Wallich would almost, if not quite as well, apply to the actual *M. Americana* (Ehr.); but, paying attention rather to his subsequent general description, and to his, I have no doubt, very graphic figure, and comparing them with Ralfs' figures,† or, even better still, with an actual specimen, surely, I think, abundant differences will present themselves to any one who examines them. Dr. Wallich himself, indeed, in describing his form more at large, points out briefly its distinctive marks; but then he considers these as only of importance sufficient to induce him to regard the form in question as a variety of *M. Americana*.

But I must urge that if, in distinguishing species in this family, differences—tangible, readily describable, constant (at least in British species, even if often less striking, I believe them, on the whole, to be constant) characteristic *differences* are to be lost sight of and ignored, and only *resem-*

* 'Smithsonian Contributions to Knowledge,' "Mic. Obs. made in S. Carolina, Georgia, and Florida," p. 29.

† 'British Desmidieæ,' p. 74, t. x, 1.

blances to be sought for and taken into account, I do not see any limit to the doing away with any number of species, nor to the consolidation of perhaps a whole genus, or even of groups of genera, as single species. Imbued, however, with the views which he holds as regards the Desmidiaceæ, Dr. Wallich considers that the twenty (and upwards) species belonging to the genus Micrasterias "are reducible to less than half that number without infringing on a single reliable distinction." From this opinion I venture, indeed, to dissent. So far as I can see, I do not think it is possible to reduce their number in our books by more than one or two. Parenthetically, I may here, perhaps, just mention those cases. I allude to *Micrasterias Crux-Melitensis* (Ralfs), and *M. furcata* (Ag.). The former only of these have I myself seen; but before I read Dr. Wallich's statement of having met in India "every state intermediate" between these two, I was disposed to suspect their actual difference. Now, it is to be noted that Dr. Wallich does not in any other instance, while grouping together forms under a common specific designation, speak of "every state intermediate." The other instance *may* be *M. truncata* (Bréb.) and *M. crenata* (Bréb.). With these *possible* exceptions, I do not, at least at present, see the smallest reason to interfere with the established species in this genus.

The consolidation and combining of well-marked species would appear to me quite as much to be deprecated on the one hand, as the wholesale making of species on accidental differences on the other. Far be it from me to aver that in this family all the individuals of any certain species seem to be, as it were, cast in the same mould. Even in the very form in question (*M. Americana*) I have noticed sometimes one of the segments without the vertically set processes of the end lobe—in fact, like the figure in Ralfs.* The segment wanting these processes may have been the younger, and not fully grown; I have not seen a frond in which they were wholly absent on both segments. I have met *M. denticulata* with an almost entire semi-orbicular segment, something like that of *Cosmarium Ralfsii*, and again one segment somewhat like a nondescript Euastrum. Again, *Docidium Ehrenbergii* sometimes presents a contracted inflated segment, somewhat like a nondescript truncate Cosmarium. I have seen a Euastrum with one segment, as it were, double, giving the entire a somewhat Y-shape; and other examples might be cited. Can it be assumed that any such is likely at the next repeated process

* Op. cit., t. x, 1 d.

of self-division to lay the foundation, as it were, or become the primordial individual of any other described or undescribed so-called species? Surely not—such are simply monstrosities. Nor do I mean to aver that minor differences, of probably but temporary character, and which cannot be accounted monstrosities, do not occur. Species, indeed, vary here as elsewhere, but by no means so materially as in some other groups; and I believe I may state that in British forms, so far as my experience indeed goes, such trivial variations are but rarely carried to that extent that there is any doubt or difficulty as to the actual species, that is, as to identifying a form under observation with examples of the same form with which one has previously become familiarised. What is gained by the grouping together a number of allied but well-distinguished forms under a common name as presumed varieties of a single species? I do not believe that it is more in accordance with Nature, nor even is it in our books likely to be more convenient. The very fact of recognising them as varieties presupposes and acknowledges their distinctions. If those distinctions be constant and permanent, it is surely better, even if only to avoid the inevitable periphrasis and cumbrous circumlocution and resultant confusion in one's mind, to give each a name, or having got one, to allow it to retain it. It seems to me that, no matter how we may arrange it in our books, our pools, (and may I venture so far to reason upon analogy, and dare to add that I doubt not, those of India?) will persist in offering to us the distinct forms, and, as a rule, resolutely withhold the gradational ones. Is it not more convenient, then, when we call each of these to mind, or speak of them, to have each associated with its name, than to be obliged to refer to them as var. α, β, γ, or δ, of a certain supposed standard or typical form—this latter, not in itself, perhaps, more decidedly or distinctly separated from any of the so-called varieties than are they from each other, nor less so; and possibly all not less distinct from each other than each is distinct from some neighbouring form, though it may be honoured by its name? I conceive, then, that the ultimate forms in this group which the waters present should be considered as species, and each coupled with its name. Perhaps I may be thought to contend for a mere word; and that, in urging for the rank of *species* for each of these forms, it is a kind of begging of the question. But I am not contending for any rank for them, nor for any more or less restricted application of the term species. Let them be called ultimate forms, or any other name, or give them *no* systematic standing; but let *each* have its own name, and do not confuse the student by a too copious and arbitrary employment of Greek letters.

These "ultimate forms" ("species" to me) conjugate only with each other—in the few instances which have been traced so far, they reproduce their exact like from the spore—they seem always readily distinguishable one from another; therefore I conceive that with those who would arbitrarily combine certain groups of them together (not indeed generically, but) under a common specific name, rests the *onus probandi* as regards the opposite side of the question.

To revert, then, to the forms included by Dr. Wallich under one common specific name, *M. Americana*, *M. Baileyi*, *M. ringens*, and his *var.* δ. The second and third forms, *M. Baileyi*, and *M. ringens*, seem to be excluded from the immediate affinity at least of the first and fourth, by the want of the curious additional obliquely disposed, more or less nearly vertical processes, one springing from each of the front surfaces of the terminal lobe, characteristic of the latter. Now, it seems to be hardly admissible, in order to fit them in here, to presuppose the existence of these processes merely from a certain amount of agreement in general contour, and the more so, as they are neither alluded to nor figured in their original descriptions by either Bailey or Ralfs.* If these authors did not see them, then, it is to be presumed they did not exist. Moreover, these two forms themselves seem to be distinguished from each other by *M. Baileyi* being punctate all over, while *M. ringens* is without puncta, and possesses a marginal series of granules bordering the sinuses. Irrespective of these characters, however, unless the non-reconcileable intermediate forms be discovered, these two forms as figured and described, if persistent, as Professor Bailey seems to convey, appear to me to represent quite distinguishable species, not only from the two other forms with which Dr. Wallich has associated them, but also from each other. In regard to *M. Americana* and Dr. Wallich's var. δ, equivalent to *M. Mahabuleshwarensis* (Hobson), both of which indeed agree in possessing on the end lobe the secondary processes springing more or less obliquely as regards the plane of the frond, it yet seems to me that here even more abundant differences *inter se* actually exist. The former occurs in this neighbourhood (rarely, however), and I feel pretty well acquainted with it, and I must own that I should be beyond measure astonished to encounter the latter in our Dublin pools; but, even supposing

* Bailey, loc. cit., p. 27, Pl. i, fig. 11; and Ralfs, op. cit., p. 211, t. xxxv, fig. 4.

that it did turn up, I should never, indeed, for one moment, imagine that I had met with but a variety of the known British form. I venture to think they differ, indeed, as much as two allied species need or can. To me, indeed, there appears a greater affinity in character of surface between *M. expansa*, var. γ (Wallich),* and the form in question, than between the latter and *M. Americana* (Ehr.). In the two forms just pointed out the character of the margins of the lobes, too, is alike; but the lateral lobes in Dr. Wallich's "var. γ" are not bipartite, and the end lobe wants the vertical processes. I have, of course, never seen *M. expansa*, nor *M. arcuata*, nor "var. γ:" but I feel bound to say, even though it be but conjecturally, that all three seem to me to be abundantly distinct.

In *M. Americana* the lateral lobes are short and broad, more or less conspicuously divided in a dichotomous manner by both a primary and secondary very shallow, simple incision, their sublobes short, expanding, the ultimate subdivisions more or less acutely dentate; in Dr. Wallich's var. δ (*M. Mahabuleshwarensis*, Hobson), the lateral lobes are narrow, not divided in a dichotomous manner, but by a single deep and wide sinus, the margin serrated; the two sublobes produced, divergent and tapering, their extremities bi- or tridentate. In the former the empty frond appears with scattered puncta, in the latter without puncta, but with a marginal series of granules bordering the sinuses.

It may be, indeed, that I may never have the pleasure to see an actual example of this form, but I must own, nevertheless, that I must for the future (at least *ad interim*) look upon it in my mind's eye as quite a different thing from *M. Americana*, and must regard it, not as "var. δ" of that species, but as the quite independent, yet thereto nearly related, species, bearing the (unfortunately rather cacophonous) name, *Micrasterias Mahabuleshwarensis* (Hobson).†

* 'Ann. Nat. Hist.,' 3rd ser., vol. xiii, fig. 9.

† Since this paper was written I have met with a paper by Professor A. Grunow on certain Diatomaceæ and Desmidiaceæ from the Island Banka,* in which that author describes and figures a Micrasterias called by him *Micrasterias Wallichii*, which seems very closely related to the above-dilated-on *M. Mahabuleshwarensis*, but still, I believe, a distinct species; therefore I am pleased to find that so experienced an observer as Grunow is of the same opinion as myself upon that form—that is, he cannot coincide in the view that Wallich's plant (= *M. Mahabuleshwarensis*, Hobs) is only on

* Grunow: "Ueber die von Herrn Gerstenberger in Rabenhorst's Decaden ausgegebenen Süsswasser-Diatomaceen und Desmidiaceen von der Insel Banka," &c.; in Rabenhorsts 'Beiträge zur näheren Kenntniss und Verbreitung der Algen,' Heft ii, 1865, p. 1.

I now turn to the other form described by Hobson—his *Docidium Pristidæ*. In the month of June last I received from my friend Mr. Kaye, at present resident at Hong-Kong, amongst others, a drawing (Plate VIII, fig. 1) from the pencil of Dr. Lauder, of a form of which I was at once quite disposed to regard as *Triploceras gracile* (Bailey).* I was somewhat surprised a few days after, on the 'Quart. Jour. Mic. Sci.' for July, 1863, making its appearance, to find what I am equally disposed to regard as the same plant described and figured† as a new species; but in regard to this, of course, not having seen the actual specimens, I can venture only to offer an opinion. Mr. Hobson says his plant can hardly be the *Docidium* (*Triploceras*) *verticillatum* (Bailey), inasmuch as in the former the teeth are sharp, not obtuse, as in the latter; and in this I would agree with him, as *D.* (*Triploceras*) *verticillatum* has been more lately restricted by Bailey, in which species the teeth or projections are emarginate. But I think if reference be made to Ralfs,‡ Mr. Hobson will find the projections equally sharp at their summits as in his own figure; and Bailey's figure, clumsy as it is, seem to show the character of the ends more like Mr. Hobson's drawing. Mr. Hobson seems to be unaware that Professor

a variety of *M. morsa* (properly *M. Americana*). Grunow's plant seems to me well distinguished from Wallich's—that is, from *M. Mahabuleshwarensis*—the description and figure, by Hobson, of which latter Grunow had not seen—first, by the basal inflation of the segments; and secondly, by the deeply trifid lateral lobes of the former; and thirdly, as it seems to me, by the end lobe, apparently from the figure diverging into four equally radiating processes, none of which stand vertically to the plane of the frond. Grunow, it is true, is disposed to think that the plant figured by Wallich as (what I venture to call the assumed) "*var. γ*" of *Micrasterias expansa* (Bailey)—the (assumed) "*var. δ*" of *M. morsa* (properly *M. Americana*) and his own *M. Wallichii*, may all three be but varieties of one species. Grunow even supposes that Wallich may have overlooked in his "*var. δ*" of *M. Americana* the basal inflations which appertain to *M. Wallichii;* but Dr. Wallich is undoubtedly too excellent and accurate an artist to omit so conspicuous a character. But Dr. Wallich makes his "*var. γ*" of *M. expansa* at least specifically distinct from "*var. δ*" of *M. Americana;* however, as above stated, I should think there is a greater affinity between these two forms than between *M. Americana*, "*var. δ*" (*i. e. M. Mahabuleshwarensis*) and *M. Americana* (Ehr.) proper. All three I should venture to hold as quite distinct, and I think I am justified in retaining this view until the non-reconcileable intermediate forms turn up. Why, I would with all deference ask, so much assumption, when the plants are there, quite distinct, to speak for themselves?

* 'Brit. Des.,' t. xxxv, 9 c.; also 'Smithsonian Contributions to Knowledge,' Bailey, "Mic. Obs. in S. Carolina, Georgia, and Florida," p. 38, Pl. i, fig. 10.

† 'Quart. Journ. Mic. Sci.,' N. S., Vol. III, p. 169.

‡ Op. cit., Pt. xxxv, fig. 9, c.

Bailey, apparently quite justifiable from his having seen "great numbers of each kind," had more lately considered this form as distinct from *Triploceras verticillatum*, and it is described by him* under a distinct name, *Triploceras gracile*. It seems to me, then, that the characters of the body of the frond in both Bailey's and Hobson's forms are alike, and that the only difference lies in those of the terminal processes, which the latter in his description, without any more accurate explanation, merely alludes to as "of very peculiar form," and as "differing greatly" from those of Bailey's form. Judging from the figures only, this difference seems to lie in the terminal processes of the former being somewhat irregularly subdivided, instead of apparently rather regularly three-lobed; but the lower end of Hobson's figure is less irregular, and not quite like that of the upper. We have seen, indeed, that slight irregularities sometimes occur in many of these forms, and I must confess I hardly see grounds sufficient to retain Mr. Hobson's name. My impression, then, is that both the Hong-Kong plant and *Docidium Pristidæ* (Hobson) will eventually turn out to be nothing else than *Triploceras gracile* (Bailey). Those, indeed, who may not be disposed to acknowledge Triploceras as a genus well distinguished from Docidium, will call it rather *Docidium gracile*; but, to my knowledge, not any forms yet described seem to show a transition or intermediate structure between the truncate extremities of Docidium (*Bréb.*) and the lobed extremities of Triploceras (*Bailey*); and until such a species presents itself, so far as I can see as yet, the distinctions between the two genera seem to be sufficiently well founded to be maintained.

* Loc. cit., p. 38.

REVIEWS.

How to Work with the Microscope. By LIONEL S. BEALE, M.B., F.R.S. Third Edition. London: Harrison.

THERE are few persons to whom modern microscopic research is more indebted than to Dr. Lionel Beale. It is to his pen that we owe a larger series of works on the structure and uses of the microscope than to any other living man. One of his earliest and most useful works was 'The Use of the Microscope in Practical Medicine,' which may be said to be the manual by which the medical student more especially works. In addition to this general contribution to the literature of his profession, we have from his pen writings devoted to more special subjects. Thus, in his work on 'Urine and Urinary Deposits,' he has given, not only the general results of microscopic observations on urinary deposits, but has added a large number of observations of his own. The nature of these deposits he has illustrated by a series of 'Illustrations of Urine, Urinary Deposits, and Calculi,' published in a separate form. In his 'Archives of Medicine' he has contributed a series of papers showing how thoroughly he understands the practical application of the microscope to the elucidation of the nature of disease. His contributions to the 'Philosophical Transactions,' and his papers in our own pages on the structure and formation of nervous centres, and the ultimate conditions of cell-formation, stamp him as one of the most sagacious observers and original thinkers of the modern European school—as one amongst the few British microscopists who may take a place by the side of Kölliker, Schwann, Schultze, Schleiden, and the great school of German microscopic observers. For this reason he has been worthily selected as the editor of the late Dr. Todd's 'Clinical Lectures,' and also as the colleague of Mr. Bowman in the production of a new edition of Todd and Bowman's 'Physiological Anatomy.' To have such a man for a guide is the privilege of those who are students of the microscope in England; and in this volume on 'How to Work the Microscope' we have the master sitting down to instruct the humblest labourer in the field of microscopic investigation. Nor has he spared any pains in striving to make his work useful to those who are beginning to use the microscope, for he says in his preface—"No work can be higher or more useful than that of assisting to make men original thinkers in any department of science, and of encouraging original work. Working books by working men will do far more towards those ends than the most brilliant discoveries; and the author believes that working men cannot labour more usefully than by endeavouring to make others work." This is a noble aim, and worthy a great teacher. We wish we could see men of science more generally impressed with the fact that their labour is useless unless it benefits others, and that the great end of all scientific research should be the elevation of our common humanity by the widest possible extension of a knowledge of its discoveries.

We shall not attempt to criticise the details of a work which, in the course of a few years, has passed into a third edition. Our readers, however, ought to know what improvements have been made in the present edition. In his preface he refers to the fact that, since the publication of the first edition of this work, Messrs. Powell and Lealand have succeeded in making, at his request, an object-glass magnifying 1800 diameters. He also expresses a hope, which has since been realised, that he shall receive from the same makers a power as much superior to this $\frac{1}{25}$th as that is to the old $\frac{1}{16}$th. In the subsequent parts of his work the author joins issue with those who think that nothing is gained by the use of such high powers; and he has shown by his own researches that, with careful manipulation, results as accurate and as fully to be relied on may be obtained by $\frac{1}{50}$th as by $\frac{1}{4}$th of an inch, and that a new world is revealed to those employing the high powers, which is hidden from those who employ the lower.

The new matter added to the present edition is more than twice the amount of the original edition. The author has still further improved upon the method of injecting and preserving tissues originally recommended by himself, and adopted with success by so many recent observers. In this edition the details of his method of preparing and examining tissues are given, and for the first time made public.

A new feature also of this edition is a chapter on taking photographs of microscopic objects. This chapter has been revised by Dr. Maddox, to whom microscopists owe so much for applying photography to the illustration of microscopic objects. Dr. Beale supplies with this edition a photographic plate of microscopic objects taken directly from the object. The delineation of the objects is so accurate and minute that Dr. Beale has thought it necessary to supply a lens with his book, in order that his readers may use it whilst studying the book. This certainly is a novelty, and suggests the possibility of some one writing a work on a particular department of microscopic research, and supplying a set of specimens and a compound achromatic microscope gratis to the purchaser of each copy of the work.

Dr. Beale alludes to the fact that the first attempt at illustrating microscopic subjects by means of photography was done in the first volume of the New Series of the 'Transactions of the Microscopical Society,' and published in this Journal for January, 1854. We have a copy of this plate before us, and we think it fully justifies continued attempts at using photography for microscopic illustration. In our copy the distinctive characters of the proboscis of a fly magnified 180 diameters are perfectly retained; and although they bear no comparison with Dr. Beale's plate, yet it clearly indicates that no fear need be entertained of the permanence of such illustrations, when entrusted to competent hands. And now, it may be inquired, why has not photography been more extensively employed to illustrate microscopic papers? We reply, for ourselves, that it is a matter of expense. As far as any estimates of expense for such plates as we have needed is concerned, we may say at once that they have never been less than three times the expense of the same illustrations by stone or wood. It has seemed to us that the advantages to be gained would not justify the expense, and this is the reason of photography not being used by ourselves. At the same time we should like to have it known that we are open to communication from any photographer who would undertake to reproduce microscopic objects for the illustration of our papers.

Although Dr. Beale has departed from the form of the lecture, which his work originally assumed, and divided it into chapters and sections, he has not departed from the easy style of the lecture, nor failed to throw in as he has proceeded his opinions on the great physiological questions of the day. Thus, he ends a chapter on the "cell" with these remarks:

> The living cell, then, consists of *germinal matter* and *formed matter*. The first is the matter upon which alone growth, formation, conversion, and multiplication depend, and these *vital* processes never occur unless germinal matter, with its marvellous vital power, is present.

The formed material owes its properties partly to the changes occurring in the matter when in the living state, partly to the external conditions present when the living matter was undergoing change, in fact, at the moment of death; so that I distinguish vital from the physical and chemical changes of living beings, and maintain that in all, matter exists in two states; the first being that in which the vital changes go on, while the last is the seat of chemical and physical alterations. That force of power which compels the matter to assume temporarily the peculiar state characteristic of all living matter, but of living matter alone, I call *vital power*. Of its real nature we know nothing; but although, in the present state of knowledge, we can form no conception of the nature of this wonderful power, there are, it seems to me, very strong arguments against the notion, now very prevalent, that it is a kind of ordinary force, or that it corresponds to what we call the peculiar *property* of each different inorganic substance, by virtue of which each exhibits certain constant crystalline forms, certain constant behaviour towards other substances, &c.

"From my observations, I can draw but one inference with regard to vital power, namely, that it is not any modification of any known ordinary force. It is not another mode of motion. It is only manifested under certain conditions, but it does not *result* from those conditions. That it does not correspond to the *properties* of ordinary inanimate bodies is evident, from the fact that it is a power capable of being transferred from complex particle to particle, and not only controls the manifestation of ordinary forces, but gives rise to the formation of certain compounds and structures, which are only to come into use at some distant time. A fully formed organ is not first represented by a microscopic organ of precisely similar structure, but by a mass without structure at all, and the fully formed tissues are preceded by the production of several less elaborate structures. Hence this 'vital power' governs not only the present changes which present matter is to undergo, but prepares in advance for changes which are to occur at a future time. It prepares, as it were, for the formation of structures long before the compounds are produced from which those structures are to be made. While ordinary force seems for the most part to affect the surface of masses, vital power acts from the very centre of the most minute particle—new power seems, as it were, to be for ever emanating from the very centre of particles of matter already under the influence of this power. While ordinary force may change its form, it cannot cease or be annihilated; but there is no evidence to show that vital power changes its form, while, as far as is known, it may be said to cease—since no one has yet proved that, when living matter dies, any kind of force is set free; and, although it has been asserted that more force is taken up in the formation of a brain-cell of a man than in the formation of a vast quantity of vegetable tissue, there is no evidence in favour of such an hypothesis but the dictum of speculative writers."

Had we the time and space, we certainly should join issue with Dr. Beale on his notion that "vital force" is not a modification of any known force. We have now almost a complete demonstration that the physical forces are correlated, and represent one another, if not absolutely different forms of the same force. The same argument which demonstrates the relation between motion and heat will demonstrate the relation between heat and vital force; and we are forced to believe that, as heat is motion in the red-hot poker and the liquid water and gaseous steam, so the same force is exhibiting its agency in the growth and changes of the vegetable and animal cell.

We conclude our notice of this admirable volume by an extract from that department of the work intended for the instruction and guidance of young hands:

"319. *Of Recording Microscopical Observations.*—Taking notes of microscopical observations is a subject of great importance. The observer must endeavour to acquire the habit of describing in words the appearance of objects under the microscope. This is probably not so easy as would at first be supposed, although undoubtedly many persons are able to describe what they see much more correctly, and with greater facility, than others. Accuracy in describing microscopical specimens can only be acquired by practice, and I think it a most excellent rule to take notes of the appearances of every object submitted to examination. The time is well spent, and much of what is so described is retained in the memory. The notes should be short, and should consist of a simple statement of points which have been observed. *Inferences* should be carefully avoided, and nothing should be stated without the observer being thoroughly satisfied of its accuracy. If he is not quite certain of any observation, he should express his doubts, or place a note of interrogation after the statement. The use of indefinite terms should be avoided as much as possible, and whenever any particular word is used, a definite meaning should be attached to it. Much confusion has arisen from the use of terms which have not been well defined. Thus, the word '*granule*,' by many authors, is applied to a minute particle which appears as a small speck even when examined by the highest powers, as well as to a small body with a perfectly clear centre, and with a well-defined sharp outline, which would be more correctly termed a small '*globule*.' So, again, the term '*molecule*' has been employed in some cases synonymously with '*granule*,' but it would obviously be wrong to speak of a small globule as a molecule. It seems to me very desirable to restrict the terms 'granule' and 'molecule' to minute particles of matter which exhibit no *distinct structure* when examined by the highest powers at our disposal, and the term 'globule' to circular or oval bodies of all sizes which have a *clear centre*, with a *well-defined dark outline*. Other examples of the use of insufficiently defined terms might be pointed out. If an observer makes use of a term which is generally employed without any definite meaning being attached to it, he should describe at length the meaning which he assigns to it, and should, of course, use it only in this one sense.

"320. *Exactness of Description* should always be aimed at, and we must remember that with a little trouble this exactness may be obtained with the use of a small number of words. That appearance of precision which is often attempted by employing long useless descriptions cannot be too much condemned. So, also, the practice of some, of describing every object in the field of the microscope without the smallest knowledge of any one of them, has been the cause of much ridicule, and has brought microscopic observation into great disrepute. Some have thought to gain the credit of being accurate observers by carefully measuring every object they see in every diameter, and putting down in numbers the results of this useless ceremony.

"Such reports show that the author is thinking more of himself than his subject. He attempts to acquire a character of extreme minuteness of observation, instead of striving to advance the real interests of the science which he professes to serve—and instead of endeavouring to exite in the mind of the reader a desire for more extended knowledge and a wish to take part in a similar investigation, he perpetually gives undue prominence to himself. He who feels a real love for his subject will try all he can to enlist others in the same cause; he will try to remove all difficulties of investigation, and endeavour to express what he has learned himself, in language which shall be intelligible to all. A certain mysterious air pervading the description of an observation—an evident desire to coin new words—and exaggerated statements of the importance of the facts observed, are quite misplaced, where all should be clear, simple, and intelligible to every one—and too often show indifference to the subject on the part of the author, and a want of consideration towards unlearned readers. Nothing, I believe, has been productive of so much pain and sorrow to earnest men who have devoted long lives to the prosecution of different branches of natural science, or retarded the real progress of scientific inquiry, more than that affectation of precision, and minute verbose and pompous style of description, which has been fashionable among some microscopists, and which pervades the writings of several authorities in this imperfectly developed branch of investigation in the present day. All this is mere pretence, and not real, earnest, useful work—distasteful to every scientific man and discouraging to every student. An extreme minuteness in description is by no means a proof of accuracy of observation. In this manner science becomes encumbered with unnecessary words, and earnest students are often intimidated when they commence investigations for themselves."

Rust, Smut, Mildew, and Mould: an Introduction to the Study of Microscopic Fungi. By M. C. Cooke. London: Robert Hardwicke.

There are few persons possessing a microscope who have not examined more or less attentively the various forms of common moulds which attack our cheese, pears, grapes, and almost every eatable thing. A very superficial examination of these objects will show that they possess a great variety of structure, and are fully deserving patient investigation. It has not, however, been an easy thing to get to know what has been done with regard to the structure and functions of microscopic fungi. Most botanists have been aware of the laborious researches of the Rev. M. J. Berkeley, and his descriptions of all forms of British fungi in the last volumes of Sir W. Hooper's 'British Flora.' But these were not accompanied with plates. The researches of Mr. Currey, the Secretary of the Linnean Society, on microscopic fungi, are also well known; but then he has published no systematic work, to which the student of the microscopic forms of fungi could appeal. Under these circumstances nothing could be more welcome than an attempt to give such an account of the more common forms of these fungi than has been done by Mr. M. C. Cooke, in the pages of our excellently conducted contemporary, the 'Popular Science Review.' An account of these fungi, embracing all the families which are strictly microscopic, has appeared from time to time, with very clear and easily understood illustrations; and they have now been collected together, so as to form an introduction to the study of microscopic fungi.

Mr. Cooke has evidently studied his subject with great diligence, and is perfectly aware of the best monographs which have been published, both in this country and the Continent. As a specimen of the style and matter of the work, we give an extract from Mr. Cooke's directions to the young collector:

"Having found a plant infected with some rust or brand, and by means of a pocket lens assured yourself that it is such, although the power is insufficient to tell what it is, collect as many leaves as you are likely to require; place them flat one upon the other, to prevent their curling up at the edges, should the weather be hot, and yourself far from home, and lay them in your box; or if you should take in preference an old book with stiff covers, place them separately between the leaves of your book, and they will be in still better condition, if you desire to preserve them. Arrived at home with the results of your trip, proceed at once to lay them between folds of blotting-paper, submit them to a gentle pressure, and change the papers daily until your leaves are dry, not forgetting to keep a scrap of paper with each collection, stating date and locality, to which, after microscopical examination, the name may be added. When thoroughly dry, your leaves may be preserved for reference in old envelopes, with the particulars endorsed on the outside. Fungi on leaves will generally be examined to the greatest advantage in the fresh state, but, if too much pressure is not employed in the drying, it will not be difficult even in that condition to make out their characteristic features. Care must be taken, by changing their position, that moulds of other kinds do not establish themselves upon the specimens in drying, or that when dried they do not fall a prey to *Eurotium herbariorum*.

"If it is intended to add these leaves to your herbarium, or to form a special herbarium for them, they should be mounted on white paper, first by affixing one or two leaves by means of thin glue to a paper about four inches square, on which the name, date, and locality may be written, and attaching several of these *species*-papers to a larger or *genus*-paper, or by devoting each larger paper to a species, adding in future other varieties, and enclosing all the *species*-papers of the same genus within a folded sheet, on which the name of the genus is written.

"We have adopted, for our own herbarium, the 'foolscap' size. A sheet of paper receives within its fold the specimens of a single species; these are affixed to the right-hand page, when the sheet is open, and a small envelope is attached by its face to the same page at the bottom, in which loose specimens are kept for minute and special examination, or as duplicates. When the sheet is folded, the specific name is written at the right-hand lower corner, or, what is better, a strip containing that name and its number is cut from a copy of the 'Index Fungorum,' kept for the purpose, and gummed in its place. The remainder of this page, which is of white cartridge paper, is occupied with memoranda referring to the species enclosed, sketches of the spores, synonyms, references to descriptions, &c. All the species-papers of each genus are placed together within a sheet of brown paper, half an inch larger in each direction, with the name of the genus written at the left-hand corner. A piece of millboard, the size of the covers, when folded, separates each order.

"When a leaf, or other portion of a plant, is to be examined under the microscope, with the view of determining the genus and species of its parasite, it may be fastened with small pins to a piece of sheet cork, two or three inches square, and about one eighth of an inch in thickness, such as used for lining entomological cabinets, and so placed under a lens that it may easily be brought into focus, and both hands left at liberty; or a dissecting microscope may be used for the purpose. From one of the pustules the spores may be removed on the sharp point of a penknife, and placed in a drop of water on a glass slide. A thin glass cover is placed over the drop of water, and the slide is submitted to examination. For further satisfaction it will often be found necessary to make carefully a thin section of a pustule, and place this under the microscope, a more troublesome but also much more satisfactory method. Reference to the Appendix will soon determine the name and position of the fungus, provided it belongs to the section to which this volume is devoted.

"If it is thought desirable to mount the spores as permanent objects, there is no obstacle to such a proceeding. The spores of the different species of *Aregma*, of *Triphragmium*, and many of the *Puccinia*, will be worth the trouble. We have tried several media, and only adopted glycerine or balsam; either of these, especially the former, if the greater difficulty of securely closing can be overcome, will answer the purpose."

Nor let any one suppose that the work of explaining these minute organisms is one of mere amusement alone. In the very names of rust, smut, mildew, and mould, we have suggested to us the destruction of our forests and the loss of our crops; and the student of these forms will find that it is only by an intimate knowledge of the nature of the fungi which produce these destructive diseases of plants that man can expect to control or prevent their attacks. The study of the microscopic forms of fungi attacking plants has led to researches with regard to those attacking men and animals; and it is now well understood that some of the most inveterate forms of disease amongst the mammalia are dependent on the attacks of minute fungi. So analogous are the diseases produced in plants and animals by the attacks of fungi, that some speculators have not hesitated to affirm their belief in the fungoid nature of the poison germs which produce the more alarming contagious diseases that afflict mankind. It is only by the aid of the microscope, and the suggestions of such theories as the above, that we can ever expect to make out the nature of those poisons which, generated in one body and conveyed to another, produce such terrible destruction of our race. Wherever the truth lies, it cannot be determined but by an accurate observation of facts; and as these facts cannot be made visible to the naked eye, to the microscope we must look for unfolding these great mysteries of our lives. Mr. Cooke does not, however, dwell on the forms of fungi which attack the human body. This is less to be regretted, as the subject, as far as it was understood, has been illustrated by Robin and Küchenmeister. The work of the last-named author has been translated into English and published by the Sydenham Society. We give another example of Mr. Cooke's book in the description of a very common form of fungus occurring on a very common plant, and which enables any person with a microscope to take a peep at the field of research comprehended in Mr. Cooke's volume:

"What is the external appearance presented by the 'white rust' of cabbages, and allied cruciferous plants, is soon told. During summer and autumn it occupies the surface of the leaves and stems of the shepherd's purse (*Capsella bursa-pastoris*), with elongated narrow white spots like streaks of whitewash, and later in the season the leaves of cauliflowers and cabbages become ornamented with similar patches, arranged in a circular manner, forming spots as large as a sixpence. Wherever these spots appear, the plant is more or less deformed, swollen, or blistered, even before the parasite makes its appearance at the surface. These white pustules have a vegetative system of ramifying threads which traverse the internal portion of the plants on which they are found; these threads constitute what is termed the *mycelium*. Not only when the plant is deformed and swollen with its undeveloped parasite do we meet with the threads of mycelium in its internal structure, but also in apparently healthy portions of the plant, far removed from the evidently infected spots. These threads are unequal in thickness, much branched, and often with thick gelatinous walls filled with a colourless fluid. They creep insidiously along the intercellular passages, and are provided with certain appendages in the form of straight thread-like tubes, swollen at their tips into globular vesicles. These threads do not exceed in length the diameter of the mycelium which bears them. The appendages communicate in their interior with the mycelium, and contain within them the same fluid, which at length becomes more watery, and the terminal vesicles have their walls thickened, so as to resemble, on a casual observation, granules of starch. Dr. de Bary conceives that these appendages serve a similar purpose to the tendrils or suckers of climbing phanerogamic plants; *i.e.* to fix the mycelium to the cells which are to supply the parasite with nourishment. As these appendages are always present, it is easy to discover the mycelium wherever it exists among the tissues of an affected plant.

"The white pustules already alluded to contain the fruit of the parasite. Bundles of clavate or club-shaped tubes are produced upon the mycelium beneath the epidermis of the infested plant, forming a little tuft or cushion, with each tube producing at its apex reproductive cells, designated 'conidia.' These conidia appear to be produced in the following manner:—The tips of the clavate tubes generate them in succession. At first a septum, or partition, divides from the lower portion of the tube a conidium cell; this becomes constricted at the septum and assumes a spherical shape, at length only attached by a short narrow neck. Beneath this again the same process is repeated to form another and another conidium in succession, until a bead-like string of conidia surmount each of the tubes from which they are produced. At length the distended epidermis above is no longer able to bear the pressure of the mass of engendered conidia within, and is ruptured irregularly, so that the conidia, easily separating from each other at the narrow neck, make their escape.

"As long since as 1807 M. Prevost described the zoospores, or moving spores, of these conidia, and his observations were confirmed by Dr. de Bary three years since, and are now adverted to by him again in further confirmation. If the conidia (white spherical bodies ejected from the pustules of the 'white rust') are sown in a drop of water on a glass slide, being careful to immerse them entirely, they will rapidly absorb the water and swell; soon afterwards a large and obtuse papilla, resembling the neck of a bottle, is produced at one of the extremities. At first vacuoles are formed in the contents of each conidium; as these disappear, the whole protoplasm (granular substance filling the conidium) becomes separated by very fine lines of demarcation into from five to eight polyhedric portions, each with a faintly coloured vacuole in the centre. These portions are so many *zoospores*. Some minutes after the internal division, the papilla swells and makes itself an opening, through which the zoospores are expelled one by one, without giving any signs of movement of their own. They take a flat disc-like or lenticular form, and group themselves about the opening, whence they have been expelled, in a globular mass. Soon, however, they begin to move, vibratile ciliæ show themselves, and by means of these appendages the entire globule oscillates, the zoospores disengage themselves from each other, the mass is broken up, and each zoospore swims off on its own account.

"The free zoospores are of the form of a plano-convex lens, obtuse at the edge. Beneath the plane face, out of the centre, and towards that point of the margin which during the movement of the zoospore is foremost, is a disc-shaped vacuole with two cilia of unequal length attached to its margin; the shorter ciliæ is directed forwards, and the longer in the opposite direction, during the evolutions of the zoospores.

"The zoospores are produced within from an hour and a half to three hours after the sowing of the conidia in water. They are never absent if the conidia are fresh, or even a month old, but beyond this period their artificial generation is very uncertain. This little experiment is a very simple and instructive one, and may be performed by any one who will take the trouble to follow out these instructions."

But the most useful part of this volume to the advanced student is an appendix, in which the author gives a classification and scientific description of the fungi which have been more generally alluded to in the previous pages of the work. For those who have not their hands already full of work, and prepared to strike into a new field, we promise them a mine of interest in Mr. Cooke's pages, and a world of undiscovered beauties to work in.

A Treatise on the Construction, Proper Use, and Capabilities of Smith, Beck, and Beck's Achromatic Microscope. By RICHARD BECK. London: Van Voorst.

IT is not often that the makers of scientific instruments are the most skilful exponents of the principles of their structure or the authors of discoveries made by their use. Nevertheless, many departments of practical science afford exceptions to the rule—none more so than the inventors and makers of improvements in the microscope, and every microscopist will recollect that Joseph Jackson Lister, after he had overcome the difficulties of making a compound achromatic microscope, set to work to make observations therewith, and produced a series of highly interesting observations, which were published in the 'Philosophical Transactions,' on some of the lower forms of Tunicated Mollusca. It may not be generally known that, so little was the microscope appreciated as an instrument of research by those who conducted the business of the Royal Society in 1838, that when Joseph Jackson Lister sent his first great paper to that society, on the construction of achromatic glasses, and accompanied it with various observations on the mechanical parts of the instrument; and the paper was sent back to him on this account, with a request that, as the microscope was, after all, a mere toy, he would omit any reference to what he considered mechanical improvements. In this fact we see how dangerous it might be to commit the interests of science to any select body of men, and that it is only in the perfect freedom of voluntary association that science can progress. The Microscopical Society was shortly after founded, one of the great objects of which was to cultivate those scientific researches by which this "mere toy" of the Royal Society might be made available for the profound scientific researches for which it was adapted. One of the indirect results of the rejection of the Royal Society of Mr. Lister's practical suggestions was his connection as friend and adviser of certain microscope-makers in London. From these houses have issued the most perfect microscopes that have been constructed in accordance with Mr. Lister's principles. No one of these houses has been more distinguished than that of Smith, Beck, and Beck, and in Mr. Richard Beck, the author of the present volume, we have a remarkable instance of the combination of the finished mechanician and accomplished observer. Previous, however, to Mr. Beck entering the field as an author, the late Mr. Andrew Ross, the founder of one of our great microscope-making houses, had written a valuable work on the physical principles involved in the manufacture and in the structure of the microscope. This work originally appeared as an article in the 'Penny Cyclopædia,' and may claim priority over all the works that have been devoted to the history and structure of the microscope during the last quarter of a century.

The present work is not intended to serve as a history of the manufacture of microscopes or of microscopic observations of optical principles. But it gives an accurate account of the structure and capabilities of Smith and Beck's instruments. It is hardly necessary that we should say that whatever the microscope demands for its intelligent and successful application is provided by this establishment, hence this work becomes a most useful text-book to all who are seeking for the best means of conducting microscopic researches. The work consists of a detailed account of the various parts of which a microscope is composed, and commences with a description of first- and second-class achromatic microscopes. All the apparatus for the working of such microscopes is described, and is followed by plain directions for the use of the microscope. These directions include remarks on the various kinds of illumination, and the apparatus which have been invented for assisting illumination. In the remarks made by Mr. Beck on illumination reference is made to the use of test-objects for measuring both the defining power of the object-glasses and the means of illumination employed. Whatever instruments are employed, these remarks will be found useful. A considerable space is devoted to the consideration of the subject of polarized light to the microscope, and all the apparatus required is described. Mr. Wenham's binocular microscope is then described, and the principle of its construction defended against the attacks of those who are in favour of the old monocular form of instrument. The increased demand for binocular instruments seems to indicate that the old arrangement is doomed. Men of fifty, who have for thirty years used the monocular instrument, may repudiate the more recent instrument, but as long as the fact remains than men see better with two eyes than one so long will it happen that those who have once appreciated the advantages of a binocular microscope will not think of going back to the instrument which only allows the use of one eye.

After describing first-class instruments, Mr. Beck then gives an account of the third- and fourth-class instruments. Most persons are aware of the nature of the instruments which, under the name of the Popular, Universal, and Educational Microscopes, have been manufactured by Messrs. Smith and Beck. The work finishes by a chapter on the instruments and materials used in mounting objects.

To those who are the fortunate possessors of one of Smith and Beck's first-class compound achromatic instruments this volume will be found exceedingly useful in enabling them to understand the applications and capabilities of their instrument. To all interested in the structure of the microscope this volume, giving an account of the actual work of one of those great houses to which Mr. Lister has succeeded in giving something of the reputation of his own great name, will be found to contain a vast amount of useful and interesting matter.

The work is published in large octavo, and is illustrated with twenty-eight most beautifully executed plates. Most of these are devoted to the illustration of the apparatus described, but some of the plates are devoted to the illustration of test-objects. Some of these are remarkable for the faithful manner in which microscopic structure is depicted. We would especially refer to the beautiful drawing of the tarsus of the *Tegenaria atrica,* a very common form of spider, in which the various minute hairs covering this organ are given in the most complete and accurate manner. The figure, again, of *Arachnoidiscus Japonica,* a beautiful diatom first found in sea-weed from Japan, is quite an achievement in illustration, and seems to indicate the importance of giving different aspects of even minute objects like diatoms. There is also a beautiful plate of Polycistina on a dark ground, and another of polarized objects, all instructive in relation to the use of the microscope, and suggestive of the way in which microscopic objects may be represented.

Hardwicke's Science Gossip: a Monthly Medium of Interchange and Gossip, for Students and Lovers of Nature. London.

One of the great means of diffusing a knowledge of natural objects and natural laws is a sound and cheap scientific literature. With regard to the great mass of cheap literature, it costs little enough, but then on scientific subjects it is frequently unsound and mischievous. It may be very amusing to those who read only for amusement to have natural facts served up in a funny way, but for the purposes of instruction such literature is positively injurious. It is on this account that we most cordially welcome 'Hardwicke's Science Gossip.' The contents of the work, as far as it has proceeded, are full of interest, and the articles are written in a style to be understood by the most uninstructed in the great natural facts of the world in which they live. All branches of science are contemplated in this journal, but its contributions are mainly derived from those who are devoted to the study of natural history. Microscopic subjects are not neglected, and there are several interesting communications by microscopical students. We commend this new journal most heartily, first to our readers, who will all be interested in its contents, and next to that large class of young persons who, with literary tastes and leisure, are anxious to utilise their knowledge. Miscellaneous reading is seldom profitable, however amusing. Let any one have a pursuit, whether it be botany, zoology, astronomy, or the microscope, or all these combined, he will find his reading turned to a purpose, and in the course of time will feel that the world is wiser and better for the improvement he has made of his opportunities.

'Science Gossip' is capitally illustrated, contains twenty-four pages of large octavo letterpress, with double columns, and is published monthly at the low price of fourpence. It is really the cheapest scientific journal that has yet been published.

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

GERMANY.—**Siebold's und Kolliker's Zeitschrift.**—The third part for the year of this most valuable and interesting journal has just been received in England, having appeared rather late. The first paper it contains is entitled "*Researches on the Sclerotic of Fishes,*" by Theodore Langhans, and is illustrated by two finely executed plates. The paper appears to be the result of a most complete and extensive series of observations extended through a vast variety of forms of fishes. The author treats, in particular, of the histology and minute structure of the fibrous capsule of the eye. Doctors Hermann and Leonard Landois contribute a most valuable paper "*On the Histological Elements of the Bodies of Insects,*" in which they point out the distribution of the various tissues entering into the composition of the insect's organism. Elias Mecznikow sends some "*Contributions to the Knowledge of the Chætopods,*" which are of some interest. The genera which he particularly makes the subjects of his remarks, are Fabricia, Syllis, and Spærodorum, and also a new genus and species, *Microphthalmus Sezelkowii*, which he describes; two plates accompany this paper. Perhaps that which will most interest the readers of our Journal is the last, by Dr. Ernst Höckell, "*On the Sarcode-bodies of the Rhizopods.*" Dr. Höckell gives a very masterly exposition of the views now entertained with regard to "sarcode," and advances his own opinion on the question. The nature of sarcode, and its modifications in the various parts and in various forms of the Protozoa, is set forth in twenty-one concise statements, which are remarked upon in succeeding pages. A coloured plate, well executed, illustrates this paper.

Muller's Archiv.—No issue of this journal has been received by us since February, 1865.

Max Schultze's Archiv.—The second number of this journal, which was so well inaugurated last May, has not yet appeared. Our Continental brethren do not allow their meditations and reflections to be haunted by any anticipations of the quarter-day; they calmly wait till their inclinations tend in the direction of publication.

Studien des Physiologischen Instituts zu Breslau. — This Journal, of which we have the third number before us, is edited by Professor Dr. Rudolf Heidenhain. It contains some valuable papers on human physiology and histology, as well as others on comparative physiology. "*Anatomical Researches on a Human Embryo of* 28—30 *Days*" is the title of a paper by Dr. W. Waldeyer, who also contributes a memoir "*On the Anatomy and Physiology of the Lymphatic hearts of Rana and Emys Europæa.*"

Wurzburger Naturwissenschaftliche Zeitschrift.—Professor Kölliker has published in this journal some observations made by him upon the histology of the Hydrozoa and Ctenophora in the Firth of Clyde. In these animals he distinguishes three kinds of connective tissue. One forms the tentacles of the hydroid polyps, and all the solid tentacles of the Medusæ. It presents the appearance of a series of cells (*muscular cells* of Keferstein) occupying the axis of the tentacle. These cells possess no contractility; at least, the tentacles of the Æginidæ and Trachynemidæ which present this structure are rigid. The contractile tentacles owe their contractility to a muscular layer situated between the cellular axis and the external epithelium. This cellular axis is only a dependence of the internal epithelium which lines the digestive cavity (Hydroids) or the marginal canal (Medusæ). It probably acts as an elastic organ antagonistic to the muscular layer. The second kind of connective tissue is a substance destitute of cells, which forms the umbrella of all the simple Medusæ, including the gelatinous substance of the natatory bells and covering-laminæ of the Siphonophora. Sometimes this substance is entirely homogeneous, sometimes it is traversed by numerous fibres very like the elastic fibres. In an Æquorea these fibres are attached to a membrane capable of isolation, placed beneath the epithelium of the convex surface of the umbrella. The third form is the well-known gelatinous substance, with disseminated cells, of the umbrella of the higher Medusæ. Professor Kölliker agrees with Professor Virchow in denying the existence of these cells in *Cyanæa capillata.*

In connection with this subject, we may draw attention to the very valuable work which Professor Kölliker is now bringing out, and which every English microscopist who wishes to work to good effect, to the furtherance of truth and knowledge, should get. We mean his **Icones Histiologicæ.** The histology of the Protozoa has been carefully illus-

[redacted]

trated, and succeeding numbers will complete the histology of the animal kingdom, giving observers something like a starting-point from which to commence their labours, and a standard round which to range themselves when entering on this field.

Wiegmann's Archiv for 1865 contains, amongst other papers of interest to microscopists, a valuable essay by Dr. Khron, on the male generative organs of *Phalangium*. Some interesting facts bearing upon the homologies of male and female reproductive glands are brought forward.

FRANCE.—**Comptes Rendus.**—This publication appears to have been particularly destitute during the past quarter of any papers of special interest to microscopists; as also does the—

Annales des Sciences Naturelles.—M. Hesse, however, contributes some accounts of his "*Investigations on New or Rare Crustacea of the French Coasts*," one of which, *Notopterophorus Bombyx*, is found parasitic in the interior of *Phallusia intestinalis*.

ENGLAND.—**Annals of Natural History.**—We cannot but regret that we are not able to place some record of the work of those leaders of zoological inquiries, the Scandinavian naturalists, in the pages of our chronicle. But it seems that no journals are published by them, excepting the annual proceedings of their scientific academies. We may, however, draw attention to two papers by Dr. Otto Mörch, of Copenhagen, which appeared in the August number of the 'Annals.' The first is on the "*Homology of the Buccal Parts of the Mollusca*," the second on the "*Operculum and its Mantle.*" Though not strictly microscopical in their nature, these papers are of such interest and value that we cannot lose the opportunity of drawing the attention of the reader to them.

In the same number Professor Gulliver has a paper on the raphides of *Vitaceæ*, an order which stands, lineally, in the centre of Professor Lindley's Berberal Alliance of seven orders, and with the affinities thus indicated in the "Vegetable Kingdom:"

Araliaceæ.
Berberidaceæ.—VITACEÆ.—Pittosporaceæ.
Rhamnaceæ.

Professor Gulliver arrives at remarkable results. After having examined numerous specimens of all the allies and relations of the central order, he finds them devoid of raphides; while in every instance of the many species which he has examined of that central order—Vitaceæ—he has always found

an abundance of raphides. Hence he concludes that this is as good an example of a raphis-bearing order among exotic Exogens as Balsaminaceæ, Onagraceæ, and Galiaceæ, are instances in our native plants of that class.

And this is not the only interesting fact, for he shows that *Leea* is truly a raphis-bearing genus. Thus, it still further proves its true affinity with the order, and gives evidence of the perspicacity of Lindley in retaining *Leea* under Vitaceæ, notwithstanding the opinions to the contrary of Von Martius and other eminent botanists.

Surely such proofs of the importance of raphides and their organic vesicles as natural characters afford good illustration of Dr. Lankester's remarks in the 'Quart. Journ. Mic. Soc.' for Jan., 1864, concerning the necessity for further research into the minute details of the cell-life of the members of the vegetable kingdom, and of the great value of microscopic observations in this direction. We may now hope that systematists will perceive the necessity of more attention in future to this interesting and important subject.

Professor William King, who has lately excited Dr. Carpenter's ire by daring to doubt that *Eozoon Canadense* is an organic phenomenon, replies in the same number of the 'Annals' very amply to a counter-charge of inaccuracy, renewed by Dr. Carpenter. The matter under discussion is the "*Histology of two specimens of Rhyncopora Geinitziana.*" Professor King contends, as he did some years since, that the shells of these Brachiopods are *perforate*. Dr. Carpenter, on the other hand, says that they are merely *punctate*, and in the columns of the 'Reader' has (so says Professor King) attacked his opponent with personalities. Thus stands the matter at present. It seems strange that a decision cannot be arrived at as regards a matter of fact; but we have seen it so before.

In the July number that most valued and indefatigable Nestor of botanists, Dr. Greville, describes some new genera and species of those little plants, his researches on which have contributed so much to the reputation of the 'Transactions of the Microscopical Society of London.'

The species described belong to the genera *Palmeria* (new), *Asterionella, Surirella, Creswellia, Hemiaulus, Amphiprora.*

The Rev. W. A. Leighton, B.A., communicates a paper on the gland of the phyllodium of *Acacia magnifica*, which he has carefully investigated by means of the microscope. He states that "the stamens, and indeed every portion of the floral whorls, will be found beautiful and interesting objects, as from their extreme transparency the cellular tissue and the spiral vessels are distinctly displayed, without any dissection or other preparation than being placed in a drop of water.

Messrs. Parker, Jones, and Brady, conclude their essay on the "*Nomenclature of the Foraminifera*" in the same number (July). There is also a paper "*On the Presence of certain Secreting Organs in Nematoidea*" by Alexander Macalister, of the Royal College of Surgeons of Ireland, which is of particular interest as appearing at the same time as the valuable paper of Mr. Charlton Bastian on the Nematoids, which we shall notice below. Four series of glandular organs have been already described in different Nematoids, and Mr. Macalister now describes an apparatus which is entitled to rank as a fifth kind of secreting organ, separate in function from any of those at present known. Those already recognised are—1st, the salivary cæca of *Gnathostoma* and *Strongylus;* 2nd, the glandular walls of the œsophagus of *Ascaris,* described by Cloquet; 3rd, the intestinal cæca common in many species; and 4th and last, omitting the reproductive glands, the curious tubular organ described by Siebold in the *Strongylus auricularis* and others, opening near the middle of the body on the ventral aspect. To these four it is proposed by the author to add a group of organs which he has discovered in the *Ascaris dactyluris,* Rud, a small white entozoon, infesting in enormous quantities the large intestines of *Testudo græca.* The glands are four ovate or pyriform bodies, attached to the inferior portion of the intestine, just at the point where there is a constriction which separates a dilated portion from a small narrow rectum. The bodies are evidently glandular; but Mr. Macalister is at a loss to find their homologues in other invertebrates, and conjectures that they may form a renal apparatus. Be this as it may, in the aquatic larva of a dipterous insect, the *Corethra plumicornis,* are to be found four long cæcal tubes, of glandular structure, in an exactly similar position, attached to the wall of the intestine and opening into it. These also may not improbably be renal organs; and we would just draw attention to the similarity existing between these bodies (at present imperfectly described) and those discovered by Mr. Macalister.

Professor Gulliver, whose continued observations on raphides we have chronicled above, has also some interesting notes on the pollen-grains of various species of *Ranunculus.* His observations are thus stated:—*R. auricomus,* pollen-grains round and smooth, and $\frac{1}{800}$th of an inch in diameter. *R. acris,* pollen-grains round and smooth, and $\frac{1}{840}$th of an inch in diameter. *R. repens*, round and smooth, and $\frac{1}{866}$th of an inch in diameter. *R. bulbosus*, round and smooth, and $\frac{1}{787}$th of an inch in diameter. *R. hirsutus*, pollen-grains smoothish, with three depressed scars, and $\frac{1}{888}$th of an inch in diameter. *R. arvensis*, pollen-grains round, *rough*, and so much larger than those of the other species as to measure $\frac{1}{170}$th of an inch in diameter. The roughness remains when the pollen-grains are treated either with dilute acids or water.

Proceedings of the Royal Society.—"*The Croonian Lecture.*"—Dr. Lionel S. Beale, of King's College, has this year been honoured by the office and duties of Croonian Lecturer, the subject of his lecture being "On the Ultimate Nerve-fibres distributed to Muscle and some other Tissues; with Observations upon the Structure and Probable Mode of Action of a Nervous Mechanism." Most of our readers will, doubtless, be acquainted with those various essays of Dr. Beale which have from time to time been noticed in these pages, and also those memoirs which he has communicated specially to our Society or Journal. The whole question is in this lecture reviewed, the latest researches of its author given, and a very firm case made out, which we should think both Professors Kühne and Kölliker combined will find it difficult to successfully attack. The fact is that the whole cause of dispute between Dr. Beale and foreign observers is this:—Dr. Beale has the finest glasses in the world to work with, and consequently sees more, and further into these structures, than his opponents. Their differences are thus stated by Dr. Beale:—"With regard to the ultimate arrangement of nerves in muscle, the conclusions of Kölliker accord more nearly with my own than those of any other observer. Kölliker agrees with me in the opinion that the nerve lies upon the external surface of the sarcolemma; but what he regards as ends or natural terminations I believe to be mere breaks or interruptions in fibres which, in their natural state, were prolonged continuously. And there is this further broad difference between foreign observers and myself, that while they consider that each elementary muscular fibre is very sparingly supplied with nerves—a very long fibre receiving a nervous supply at one single point only—I have been led to conclude that every muscular fibre is crossed by very delicate nerve-fibres, frequently, and at short intervals, the intervals varying much in different cases, but, I believe, never being of greater extent than the intervals between the capillary vessels." Dr. Beale's lecture will shortly be published separately, illustrated by his beautiful drawings.

"*On the Anatomy and Physiology of the Nematoids, Para-*

sitic and Free; with Observations on their Zoological Position and Affinities to the Echinoderms," is the title of an able memoir by Henry Charlton Bastian, M.A., M.B., F.L.S., communicated to the Royal Society on the 13th of June last. After commenting upon the many conflicting statements which have been made concerning the anatomy of these animals, the author alludes to the increased interest which has lately been thrown over this order by the discovery of so many new species of the non-parasitic forms, marine, land, and fresh water. He has entered fully into the description of the tegumentary organs, and has recognised a distinct cellulo-granular layer intervening between the great longitudinal muscles and the external chitinous portion of the integument. He confirms Dr. Schneider's conclusions as to the nature of the transverse fibres attached to the median lines, and also with regard to the form of the nervous system. That which Mr. Bastian has to say about the water-vascular system is interesting in connection with the paper of Mr. Macalister which we have noticed above. Mr. Bastian considers the water-vascular system of Trematoda and Tæniada, as well as Nematoda, a purely excretory glandular apparatus, there being little or no provision for the oxidating portion of the process of respiration, and thinks that this deficiency may be compensated by a greatly increased activity of glandular *eliminating* organs. The author also brings forward some interesting facts with regard to the "tenacity of life" of some of the free Nematoids, and their power of recovery after prolonged periods of desiccation. He concludes by pointing out some resemblances between these animals and the Echinoderms, particularly in the nervous system and integumental pores, and states that he would regard the order Nematoda as an aberrant division of the class Echinodermata, to which expression of opinion but few zoologists will feel inclined at present to consent.

Dr. Wilson Fox, of University College, has a paper on the "*Development of Striated Muscular Fibre,*" on which subject it may be remembered that we published a memoir some time since, by Mr. Lockhart Clarke.

"*Researches on the Structure, Physiology, and Development of Antedon* (*Comatula*, Lamk.) *rosaceus,*" is the title of an important memoir by Dr. Carpenter, on a subject in which he has been for some time engaged. The gradual series of changes by which the plates of the calyx of the young pentacrinoid larva become converted into the skeleton of the adult are fully and carefully traced. In the adult the oral and anal plates have completely disappeared, and no part of the primordial calyx of the pentacrinoid larva is traceable in it until the adherent pieces which form its base are separated, and the minute rosette-like plate is discovered, which is formed by the metamorphosis of the *basals*, and was first made known by Dr. Carpenter. The anatomy and physiology of the viscera, &c., will form the subject of a future memoir.

Mr. J. W. Hulke has contributed a paper on the "*Chameleon's Retina*,' of which a short abstract appears in the 'Proceedings' of the Society, of June 15th.

Miscellaneous.—The meetings of Section D at the British Association gathering, which has just terminated at Birmingham, were not very rich in papers on subjects in the investigation of which the microscope had been used. It is a somewhat difficult thing to know whether such papers as those of Mr. Spence Bate "*On Praniza and Anceus*," of Mr. Norman "*On Marine Invertebrata dredged off Guernsey*," &c., come rightly within our domain. Assuredly these gentlemen have had to use their pocket glasses, and not unfrequently their microscopes, in the identification of the forms obtained; and hence we may claim to bring their researches before our readers' notice, and hope to be able to obtain abstracts of these communications for our next Chronicle. Sir John Lubbock's paper, "*On the Development of the Larva of Chlæon* (*Ephemera*)," was one of very great interest, and will be published in the Linnæan Society's 'Transactions,' in which a former part of the same series of observations has already appeared. There can be no possible excuse for an idle microscopist when such charming and invaluable investigations as these are to be made on the commonest of water-animals. Why is not a large body of observers found ready to join in this field of research—to sit down patiently and intelligently to watch the changes of some of our most common insects and other invertebrates from the egg to maturity? English microscopists, as a rule, are too fond of *playing* with their instruments, when they might turn them to the highest possible purpose—the investigation of truth.

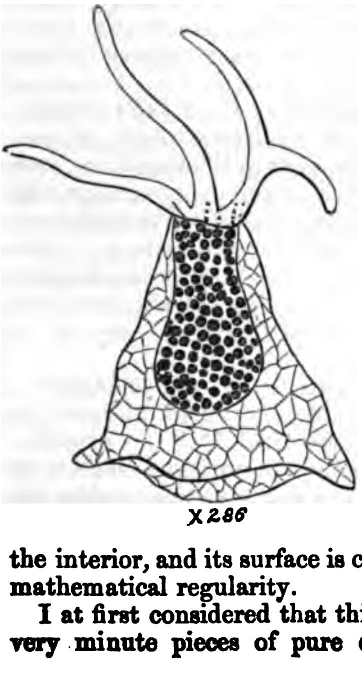
In Sub-section D a lively discussion on cell theories took place, in which Drs. Lionel Beale and Hughes Bennett, Mr. Turner and Mr. Jordan, took part.

Dr. Rolleston, the Professor of Physiology in the University of Oxford, brought forward an admirable paper "*On Certain Points in the Anatomy of Lumbricus terrestris*," in which he added some interesting discoveries of his own on this subject to the details already recorded in Mr. Ray Lankester's essays published in this Journal. They referred principally to the muscular system and the salivary organs.

[redacted]

NOTES AND CORRESPONDENCE.

A New Difflugia.—I have lately met with an undescribed species of Difflugia; at least, I cannot find it either mentioned or figured in any published account of this genus. There can be no doubt that it is a distinct and and peculiar species. The carapace, instead of being more or less spherical, globose, or pyriform, is almost flat and triangular, one of its apices being truncated to form an orifice for the emission of the pseudopodia. It is so remarkably transparent that the animal is seen, as through a glass case, freely suspended in



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the interior, and its surface is covered with markings of almost mathematical regularity.

I at first considered that this carapace was constructed of very minute pieces of pure diaphanous silica cemented to gether; but as, on drying it and subjecting it to the flame of a spirit lamp, it becomes more or less distorted, and the markings are almost obliterated, I have come to the conclusion that it is more likely of a membranous nature.

When the animal, moving through the water, presents the edge of its shell to the spectator, this is seen to have scarcely any depth, and looks like a cocked hat turned edgeways.

I have found it in tolerable abundance associated with *Difflugia spiralis, D. proteiformis*, &c.; but as it is much smaller and extremely diaphanous, it may be easily overlooked.

The accompanying drawings of two separate specimens found in the same drop of water, though not artistic, are faithful representations of the creature and its house, having been carefully made under the microscope with the aid of the camera lucida.

If this *is* a new species, I think it may be appropriately named "*triangulata*."—Fred. H. Lang, Reading.

Arachnoidiscus.—In the 'Quarterly Journal of Microscopical Science' for April of the present year, pp. 132 and 167, an account is given of an Arachnoidiscus found on the Irish coast, and it is there stated to be the second occurrence of the genus on the British coasts.

I have in my cabinet a specimen of *Odonthalia dentata* covered with Archnoidiscus, probably Ehrenbergii; it was given me in 1857 by Charles Johnson, Esq., Botanical Lecturer at Guy's Hospital, among whose collection of seaweeds it had been for about thirty years, and was originally obtained from the late James Sowerby, author of 'English Botany.' The specimen of Odonthalia is British, although the exact locality is not stated on the specimen from which the fragment was taken.—W. T. Suffolk, Camberwell.

Maltwood's Finder.—Your correspondent "A." very properly directs attention to the importance of a uniform method of using Maltwood's finder, and suggests various modes of determining the exact position occupied by any object on a slide.

Permit me to place before your readers a description of the method which I adopt, and which I find admirably adapted to the ready re-discovery of any object, even with the highest powers. Suppose, for example, I have a diatom under the microscope; I, in the first instance, place it in the centre of the field, and, on introducing the finder, I observe the following figures and lines, $\left|\frac{18}{28}\right|$; I then register the position of the object thus, $\frac{18\cdot}{28}$ with a point (·) on the exact position which indicates the centre of the field where the object will be found; if the figures and lines seen on the finder be thus, $\left|\frac{29\cdot}{20}\right|$ I again with a point indicate the exact position of the object. Should two or three objects be registered for one field, I mark their position thus, $\left|\frac{17\cdot}{\cdot 24\cdot}\right|$. If the field of the finder be divided thus, $\frac{26}{2\cdot 5}\Big|\frac{2}{2}$, I again indicate the exact position by a dot (·). In Newcastle-on-Tyne the mode of using the slide is to place the label to the left hand against the stop.—T. P. Barkas, Newcastle-on-Tyne.

Nervous System of Lumbricus.—I beg to draw your attention to the fact that I have been misled in my paper on the earthworm, in attributing the discovery of the pharyngeal portion of the nervous system to Mr. Lockhart Clarke. It was briefly described and admirably figured by M. de Quatrefages in Cuvier's 'Règne Animal,' in the year 1847, whilst Mr. Clarke's memoir was not published until the year 1856. I am anxious that the merit of the discovery should be given, however small, to its rightful claimant.—E. Ray Lankester, Down. Coll., Camb.

Beck's Treatise on the Microscope.—A note from Mr. Lang, published in the last number of the 'Microscopical Journal,' calling in question some statements on my 'Treatise on the Microscope,' requires a reply from me.

It will, perhaps, be most straightforward to state that one or two private communications have passed between us, and I am now at liberty to mention that Mr. Lang is quite convinced of the necessity for some fixed standard when estima' magnifying powers. If it were attempted to calcul many times an object were magnified by comparing i scale invariably held on the same level as the object when on the stage, but not always at the same distance from the eye, we should have some astonishing results; for instance, by doubling the length of the body the magnifying power would also apparently be doubled; but this we know to be impossible.

As regards the illumination of the podura scale from above, when under an $\frac{1}{8}$th object-glass, I have had the pleasure of sending Mr. Lang a specimen suited for such examination, and he has told me since that he can confirm my representations as to the appearances; at the same time I must confess that I have not explicitly stated in my description the fact of having made allowance for the image being reversed by the microscope, and consequently Mr. Lang was perfectly justified in presuming that I had overlooked this essential point.

Respecting the conclusions which I have ventured to draw from those appearances, which are now confirmed by another observer, I merely leave them for the further criticism of those who may be interested in the subject.—Richard Beck, Lister Works, Upper Holloway.

PROCEEDINGS OF SOCIETIES.

MICROSCOPICAL SOCIETY.

June 14*th*, 1865.

JAMES GLAISHER, Esq., F.R.S., in the Chair.

THE CHAIRMAN announced that the Council had taken into consideration the question whether they should endeavour to obtain a Charter of Incorporation for the Society, with a view to improving its status and position. A Committee had been appointed to inquire into the probable expense of effecting this object, and a "Charter Fund" would probably be established, which the Members would be invited to support by guarantees or subscriptions.

A paper "On the Anatomy of the Generative Organs in certain Pulmo-gasteropoda" was read by ALFRED SANDERS, Esq., M.R.C.S., F.L.S., &c. (See 'Trans.,' p. 89.) The thanks of the Members were awarded to Mr. Sanders.

Mr. BROWNING then read the following paper on "The Application of the Spectroscope to the Microscope." (See 'Trans.,' p. 107.) Mr. Browning added—This arrangement answers equally well, whether applied below the stage or in place of the eye-piece. Of course each method would have its advantages for different classes of objects. Direct-vision prisms, such as he had used in a spectroscope made for Mr. Gassiot, had been pointed out both by Mr. Slack and himself as especially adapted for this purpose. They also would be applied either above the eye-piece or below the stage; indeed, Mr. Sorby had devised special contrivances for using them both ways.

After some remarks from the CHAIRMAN on the great results which might be expected to follow from Mr. Sorby's and Mr. Browning's joint labours, and the importance of new discoveries and applications being from time to time brought before the Society,

Mr. WENHAM said—I have only to remark that Mr. Browning seems to be working in the right direction in making the application serve two purposes. I may point out that there is a wide difference between the uses of the two instruments—Mr. Sorby's original instrument represents the application of the microscope to the spectroscope; on the other hand, fig. 7 is the application of the spectroscope to the microscope. In the first case we produce a spectrum of very small size, and magnify it up again, and we are necessarily limited to low powers; but, according to my experience with the instrument represented by fig. 7, the higher the power the better the result.

Mr. BROWNING.—That is so.

Mr. WENHAM.—I should like to ask Mr. Browning the width of the jaws under the slit. As far as I have observed, it has always seemed desirable to get rather a wide slit, because in having it close to the prism we get it narrow, and the loss of light from dust and other irregularities on the edges of the jaws are detrimental to the effect. Mr. Wenham then asked Mr. Browning if he had observed the actual width of the slit.

Mr. BROWNING said he had not. He thought it must be somewhere between $\frac{3}{1000}$ and $\frac{5}{1000}$ of an inch wide. He might add that Mr. Sorby was quite of Mr. Wenham's opinion, that the spectroscope should be applied to the eye-piece of the microscope.

Mr. WENHAM said that as thus adapted it showed indications which could not be seen in the ordinary way. With the former instrument it was not difficult to analyse a fluid of any thickness; but if an apparatus could be combined with the opposite plan, they would be able to examine individual cells containing blood or chlorophyll.

Mr. SLACK referred to some experiments which he had made with Mr. Browning's instrument, and said that the prism found best for observation of the bands might be inapplicable to many purposes for which microscopists would like to use the apparatus. He felt sure that Mr. Browning's arrangement would prove a valuable one; but the question of expense was one of some importance. Mr. Slack added, as soon as Mr. Browning had given him the opportunity of trying the prisms made for Mr. Gassiot's electrical experiments, it had occurred to him that there was the very thing that was wanted, and the application of it that had been made seemed to warrant that idea.

The CHAIRMAN asked Mr. Browning to state the price at which the spectroscope could be applied to the microscope, and whether it was equally available for transparent and opaque objects.

Mr. BROWNING said that Mr. Sorby's object and his own had always been to produce the most perfect kind of instrument at the lowest possible price, and he felt confident that when the instrument was made as perfect as it could be made its cost would not exceed £4 or £5.

Mr. BECK said it appeared to him that no definite result had been produced, and that Mr. Sorby had not yet obtained a prism which gave what was actually required. The one he tried was not convenient in use, and the other did not give sufficient dispersion. He had examined a spot of blood with the former, but without obtaining a satisfactory result. He had seen nothing except Mr.

Sorby's diagrams, but he did not perceive what progress had really been made in the instrument, and he thought that the matter stood just where it was left by Mr. Sorby in his paper in the 'Quarterly Journal.' How far he would be able to work out a direct-vision prism remained to be seen; but what was required was some actual result.

Mr. Browning stated he had received four letters from Mr. Sorby, in which that gentleman said that a direct-vision prism with which he had been supplied gave him all he required. With reference to what Mr. Beck had said, he would remark that if they tried to examine a spot of blood on the microscope with an instrument which could only be used for transparent objects, a successful result would, of course, not be likely to be obtained.

Mr. Brooke.—I do not understand by what means Mr. Sorby's original apparatus can be applied to opaque objects.

Mr. Beck.—That is precisely the tendency of the remark I made.

Mr. Browning.—Mr. Sorby is now engaged with the direct-vision prism examining opaque objects.

Mr. Brooke.—But, as far as I understand, the production of spectra from that spot of blood is a result obtained, and one which could not have been obtained from Mr. Sorby's original apparatus. I should like to ask Mr. Browning if as good definition could be obtained by the compound prism as by an ordinary train of prisms placed in the usual way.

Mr. Browning.—Where low powers are used, and the spectra are small, I believe equally so. I cannot distinguish between them. This instrument, which contains only a simple prism, placed at the angle of deviation in the ordinary way, does not give superior results.

Mr. Brooke.—I was only judging from the spectroscopes which I saw about three years ago in the Exhibition, and which were not so good in definition as the ordinary instrument.

Mr. Browning.—That arose from using prisms with too obtuse angles. Hoffman uses prisms with angles of 90°. Nearly all the prisms are made of flint-glass, with masses of veins in it. Dr. Miller, who was in the room just now, gave me one of Hoffman's to adapt to his microscope, and we found it so veiny that we could not use it for the purpose at all. The lines were not sharp enough. Mr. Slack has seen the action of Mr. Gassiot's prism. It is a direct-vision prism, such as is shown there, for getting the spectra of metals. Mr. Huggins has used it, but he had no fault to find with it, and, indeed, liked its performance very much.

The Chairman said—The paper Mr. Browning has read was promised last month. I am now very glad that I did not press for it. The letter quoted by Mr. Beck, in which Mr. Sorby states that direct-vision prisms do not perform satisfactorily, was written on the 22nd of last month; the letters Mr. Browning has just alluded to have been written by Mr. Sorby this month, one so late as the day before yesterday; in them he states that such improvements have been made in that short space of time that their performance is now everything that could be desired. See what we have gained by waiting a month longer! This strikingly illustrates the remark I made before this discussion commenced, on the importance of one being made acquainted with the most recent improvements. I have now merely to ask Mr. Browning to let me see Mr. Sorby's recent letters to which he has referred.

Mr. BECK then read a paper "On a New Form of Live-Trap and Parabolic Reflector." (See 'Trans.,' p. 113.)

A paper "On New and Rare Diatoms" was read from Dr. Greville. (See 'Trans.,' p. 97.)

Mr. WENHAM read a paper "On the Fracture of Polished Glass Surfaces." (See 'Trans.,' p. 105.)

Mr. BROWNING asked Mr. Wenham if he had tried the effect of a screw on the surface of glass. The subject was an interesting one, and the more so because the microscope and polariscope could be used to detect the change effected.

Mr. WENHAM said the polariscope afforded an excellent indication of the condition of glass when under a strain. If it was under the compression of a screw, the polariscope would show colours in the vicinity.

Mr. BROWNING said he had tried that, and always carried a polariscope with him for the purpose, but he should like to know whether the effect was permanent.

Mr. WENHAM.—It requires this peculiar burnishing action to produce a permanent result. I may here mention, in reference to a remark just made to me by Mr. Beck, that when a glass tube breaks, in consequence of a metal wire having been passed through it in contact with the surface, it gives a loud sound, like the report of a pistol. Some imagine that if the wire is merely passed down without touching the tube it will have the effect I have described; but I have never found this to be the case, although I have always found a simple touch to be sufficient.

Mr. BECK.—I am no barometer-maker myself, but I understand that the makers never touch a tube with a piece of metal, as the tube would in that case certainly break. I apprehend Mr. Wenham could not pass a wire along a long barometer-tube without touching it in some way.

The CHAIRMAN then declared the meeting adjourned to the 11th October.

The following are Extracts from Mr. Sorby's letters forwarded to the President, and published by his permission.

June 7th, 1863.—"I have not attempted much work with the new plan, being anxious to wait until I had got all the apparatus finished; but I have tried enough to see that it will be a very great improvement on my original method. I applied it yesterday to a very curious, most rare kind of crystal, in a meteorite, which gave a spectrum unlike any I have yet seen, and perhaps may lead to some interesting results. It was a case in which the old plan would not have answered at all."

June 9th.—"I spent the whole of yesterday and to-day in most carefully going over all sorts of test-objects with the new prisms, making, and trying, a great variety of schemes. On the whole, the improvement we have effected is most striking. Unless you had worked with the original arrangement I think you would hardly believe the advantages of using the prism over the eye-piece. One can in this manner overcome the effect of partial opacity. I have contrived a slit to put into the eye-piece, which can be made broad, so that the object can be distinctly seen, and then narrow for use; and also arranged it so that the length of the slit can be made either the whole width of the field or very narrow. This is a great advantage in looking at small objects in large sections of rocks, &c., for one can see before putting on the prism that only the object under examination is behind the open part of the slit."

June 12th.—"The best tests are—1st, that the absorption-bands in blood can be seen when they are very faint; 2nd, to well divide the bands in a very dilute solution of permanganate of potash; and 3rd, to see distinctly the very fine line given in the red by a very pale blue solution of chloride of cobalt, in a concentrated solution of chloride of calcium. This is so fine that it looks like a Fraunhofer's line. A dispersive power that will show all these well is about all that one could wish. The combined prisms do this."

PRESENTATIONS TO THE MICROSCOPICAL SOCIETY.

May 10th, 1865.

	Presented by
On the Parasitic Origin of Pleuro-pneumonia in Cattle. By Thomas Shearman Ralph, Esq., M.R.C.S.	The Author.
Sidereal Chromatics; being a Reprint from the "Bedford Cycle of Celestial Objects," and its "Hartwell Continuation" on the Colours of Multiple Stars. By Admiral W. H. Smyth, R.S.F., &c. &c.	Ditto.
Hämatologische Studien. Von Dr. Alex. Schmidt	Ditto.
Quarterly Journal of the Geological Society, No. 82	The Society.
Transactions of the Linnean Society, Vol. 24	Ditto.
Proceedings of the Academy of Natural Sciences of Philadelphia, Nos. 1 to 5	Ditto.
Popular Science Review, No. 15	The Editor.
Intellectual Observer, No. 39	Ditto.
The Annals and Magazine of Natural History, Nos. 88 and 89	Purchased.
Eight Slides of the oldest known Fossil, *Eozoon canadensis*	Dr. W. B. Carpenter.

June 14*th*.

De vero Telescopii inventore, Accessit etiam centuria observationum Microscopicarum. By Petro Borello, 1655	F.C.S. Roper, Esq.
A Collection of the Minute and Rare Shells lately discovered in the Sand of the Sea-shore near Sandwich. By Wm. Boys, Esq., F.S.A., and Geo. Walker, Esq.	Ditto.
List of Diatomaceæ occurring in the Neighbourhood of Hull. By G. Norman, Esq.	The Author.
A Treatise on the Construction, Proper Use, and Capabilities of Smith, Beck, and Beck's Achromatic Microscopes. By Richard Beck, Esq.	Ditto.
Photograph of a small Glass Tumbler	R. Beck, Esq.
Proceedings of the Literary and Philosophical Society of Liverpool, No. 18	The Society.
Intellectual Observer, No. 40	The Editor.
The Annals and Magazine of Natural History, No. 90	Purchased.
The Quarterly Journal of Microscopical Science, Nos. 4 to 33 inclusive, Old Series	H. Rutt, Esq.
Ditto, Nos. 1 to 16 inclusive, New Series	Ditto.

W. G. SEARSON, *Curator*.

NATURAL HISTORY SOCIETY OF DUBLIN.

On the OCCURRENCE *of* SPIRAL VESSELS *in the* THALLUS *of* EVERNIA PRUNASTRI (Ach.; Linn., sp.). By ADMIRAL T. JONES, F.L.S., F.G.S.

WHILST examining the thallus of *Evernia prunastri*, gathered at Curraghmore, my object being to ascertain whether certain dark spots on it were parasitic, fungoid, or of insect origin, I was surprised to find bundles of spiral vessels. The portion under examination on the table of the microscope was necessarily very minute. I satisfied myself that the dark spots were occasioned by insects; but, after repeated attempts, I did not succeed in again finding spirals. It is, however, desired to record this occurrence of spirals, and Mr. Archer has very kindly made a sketch of them, which accompanies this paper. I have always taken the greatest pains to perfectly clean the glasses I use in microscopic examinations, and I do not believe any error has been occasioned by neglect of this necessary precaution; but as I failed in my attempt to find these spiral vessels a second time, I think it prudent merely to record their occurrence.

Dr. David Moore, F.L.S., considered the society should feel itself much indebted to Amiral Jones for making it the medium by which he made public so remarkable an observation. He had himself seen the specimen, and believed that not only did the sketch convey a correct representation of what he had seen, but that the vascular bundles had not intruded from some other source during the manipulation. Spiral cells have been found in certain fungi, and analogy would possibly lead one to expect their being met with belonging to a lichen. He thought that some of the cells he had seen in the preparation shown to him by Admiral Jones, presented somewhat of a "scalariform" appearance, and this present record, especially if hereafter confirmed, would be extremely valuable.

Admiral Jones exhibited the original specimen of *Evernia prunastri*, bearing the black dots, within the substance of one of which he had found the remarkable spiral vessels forming the subject of the present communication.

Mr. Archer, who had to thank Admiral Jones for having kindly afforded him an early opportuniry to examine the singular preparation obtained from the lichen in question, believed that the drawings thereof, which he had endeavoured to make, conveyed at least a correct idea of the vascular bundles themselves thus found in a plant so unexpected. He did not consider these "vessels" were any of them "scalariform," or "annular," but were strictly "spiral." After examining the specimen very carefully, he was in very few instances able to see the ends of these spiral vessels, owing to their being, without injuring the preparation, so inextricably immersed in the brown cellular mass, mixed with fragments of coarse pellucid fibres, which together seemed to form the substance or tissue producing the dark dots apparent on the surface of the lichen, and which had first attracted Admiral Jones's attention. Mr. Archer stated, however, that where he had been able to see the extremities of the vessels he had found that they gradually tapered; and he drew attention to one instance depicted in the sketch, in which one had been broken off by the pressure, and the fibre uncoiled—thus proving its strictly spiral character. These vessels, indeed, by mutual contact, sometimes acquired somewhat flattened surfaces for a considerable length, and the fibres, following the angles thus produced, assumed sometimes an apparently transverse ("annular"), or, when the angle of the vessel rendered itself especially evident, a sub-scalariform appearance; but he thought, nevertheless, that the fibres were throughout actually spiral. Mr. Archer adverted to what appeared to him to be a singularity of the vessels forming these vascular bundles. This was, that not infrequently certain (sometimes several) vessels, running up and down, parallel with the other vessels of the bundle, upon meeting, did not overlap, but suddenly diverged at right angles from the rest, and were prolonged concurrently in a direction vertical to them, and parallel and juxtaposed to one another, the entire bundle thus forming somewhat the figure of a T. This seemed to be something different from the bundles merely giving off what might be called branches, or simply divaricating. He ventured on this observation for information's sake, and would leave to those acquainted with the histology of the higher plants the decision as to whether this was a circumstance of special singularity or weight. He thought, then, that this seemingly unusual arrangement, coupled with the apparent completeness and intimacy with which these vascular bundles were immersed in the brown, indefinite, cellular mass, whatever may have been its origin, seemed to point to the conclusion that they actually belonged thereto, or at least were found in it, and were not accidental foreign intruders during the manipulation, which latter assumption, indeed, Admiral Jones's well-known scrupulous care would *à priori* forbid. This assumed, then, notwithstanding that Admiral Jones's researches had not disclosed any more of these spiral vessels, the observation thus recorded seemed of very great interest, and, as far at least as it went, noteworthy in a very high degree.

Dr. Grimshaw coincided with Mr. Archer that the circumstance of the vessels forming the bundles standing out at right angles from the rest, in the manner which had been drawn attention to, was singular, and he was not aware of a similar instance.

Description of a New Species *of* Docidium (Bréb.), from Hong-Kong. By William Archer.

Family Desmidiaceæ, *Genus* Docidium (*Bréb.*)

Docidium Kayei (sp. nov.).

Plate VII, Fig. 2.

Specific characters.—Frond stout, about five times longer than broad; segments with four whorls of prominent, short, stout, hyaline, quadripartite spines, and a terminal whorl of hyaline simple spines; ends truncate.

Locality.—Kowloon, on the mainland, opposite Hong-Kong.

General description.—Frond about five times longer than broad, stout; suture forming a somewhat prominent rim; segments about two and a half times longer than broad, slightly and gradually tapering, with four prominent transverse whorls of short, stout, hyaline, quadripartite spines, their points divergent and subacute, and with a fifth whorl, just under the ends, of short, stout, subacute, simple spines; ends broad, truncate. The margin of the body of the segments presents an undulate outline, (including the terminal) forming five prominences and four intervening depressions. It is, of course, only the marginal prominences which impart this undulate outline—they really form whorls (Mr. Kaye informs me ten in each whorl), and on their summits are seated the hyaline quadripartite spines, forming gradual continuations of the prominences, and which are here so characteristic. The basal undulation, as is usual in this genus, is somewhat larger than the others which very slightly and gradually diminish upwards. The termina, clear space in the endochrome large, circular, well defined; active granules very numerous.

Measurements.—"Length of frond $\frac{1}{117}$, breadth $\frac{1}{400}$ of an inch" (Kaye, in litt.).

Affinities and differences.—The whorls of hyaline quadripartite spines abundantly separate this beautiful species from every other belonging to this genus, or to Triploceras (Bailey). In outline of frond, indeed, it seems much to resemble *Docidium nodosum* (Bailey), but that species is quite destitute of spines. There is no other species, taking even the general form of the frond merely into account, and irrespective of the spines, with which, so far as I can see, there is the least necessity to contrast this form. The spines seem to me to be quite similar in structure to those of *Xanthidium armatum* (Brèb.). The extremities are not at all lobed, but are abruptly truncate; and hence this species cannot be referred to the genus Triploceras (Bailey).

Mr. Kaye having kindly placed at my disposal, accompanied by his valuable remarks, the very graphic drawing (executed by his friend Dr. Lauder), from which the figure is taken, it affords me very great pleasure indeed to avail myself of the opportunity to call this beautiful and very distinct species after his name, as a humble mark of esteem, and in reminiscence of some pleasant hours.

Manchester Literary and Philosophical Society.

Microscopical Section.

February 26th, 1865.

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

Dr. Alcock showed mounted specimens of the carapaces of Entomostraca, picked from shore-sand from the coast of Galway. They included *Cythere alba-maculata*, *angustata*, *variabilis*, *flavida*, *convexa*, *impressa*, *pellucida*, and *quadridentata*; besides about thirty other species of Cythere and Cythereis which are not described in Dr. Baird's monograph.

Professor Williamson said that the further we extend our observations of the lower forms of animal life, the greater become our difficulties in determining specific distinctions; and in the present case it must be remembered that we have only the shell or carapace for examination, and this outer skin is of less value for distinctive characters than the internal parts. Then, again, it is known that some of the Entomostraca undergo several metamorphoses similar to those passed through by the higher Crustacea before they become adult, so that he should not be at all surprised if some ten or twenty of these different forms turned out to belong to one and the same species. There still remained a third difficulty, the greatest of all, namely, the doubtfulness of what a species is; and in the lower forms of life the variability is so great that he doubted if specific distinctions could be made with any certainty. The same remark is applicable to the lowest forms of the higher divisions of animals, and the Entomostraca, standing low in the articulate class are probably subject to similar variability.

Specimens of Hydra with *Paramœcium aurelia* and *Trichodina pediculus* parasitic upon them were shown by Mr. A. Brothers.

February 27th, 1865.

The PRESIDENT in the Chair.

Mr. G. E. Hunt read the following "Notes on Mosses":—*Campylopus setifolius*, Wilts.—This species was described by Wilson in his 'Bryologia Britannica,' from specimens collected by the late Dr. Taylor on Carrig Mountain, Ireland. Since then it has been observed by Dr. Moore, of Dublin, in county Wicklow, and on Cromaglaun; by myself, in great abundance, at Cromaglaun and Gap of Dunloe, Killarney. In these stations it is the female plant that we find. In August, 1863, however, I met the male plant on the moors of the Isle of Skye, this being the only recorded occurrence of the male plant, and the only occasion of the species being found out of Ireland. It is at once distinguished from every other Campylopus by the large auricles of the base of the leaf, which are composed of perfectly colourless, diaphanous cells, and by the large red quadrate cells above this base.

In *Dicranodontium longirostre*, which presents some characters similar to this species, the large quadrate cells above the base are green. Specimens were exhibited of both the above species; also Scotch ones of *Dicranodontium aristatum*.

At Southport, in November last, I observed a new species of Brachythecium, intermediate between *campestre* and *rutabulum*, differing from the former in its less plicate leaves and very rough setæ, and from the latter in its slightly plicate leaves, lanceolate, gradually tapering from a wide base to a very acute point, not at all acuminate, shining; inflorescence, as in these species, monoicous. If a variety, it must be united with *Brachythecium campestre*, which has not yet been certainly identified in Britain. Specimens were exhibited.

March 20th, 1865.

J. SIDEBOTHAM, Esq., President of the Section, in the Chair.

A paper entitled "Remarks on the Microscopical Appearance of Cotton Hair during Dissolution in the Ammoniacal Solution of Copper," was read by J. B. Dancer, F.R.A.S.

The structure of cotton hairs has occasionally furnished an interesting topic of conversation at the meetings of our microscopical section.

Two of our members, Mr. Charles O'Neill and Mr. Heys, have given considerable time and attention to this subject. Mr. Walter Crum, F.R.S., communicated to the Chemical Society a memoir "On the Cotton Fibre," and the manner in which it unites with colouring matter. His paper is illustrated with some beautifully executed drawings of the microscopical appearances of cotton in the natural state, and when mordanted, mercerised, and treated with various dyes; the paper is well worthy the attention of those interested in this branch of inquiry. Mr. Crum has presented a copy of his memoir to this society. His description of the ordinary appearance of the cotton fibre agrees so nearly with what I believe it to be, that I will take the liberty of referring to his printed paper at page 5. To Mr. Crum's description I may add, that many specimens of cotton, especially on the cylindrical portions of the hairs, show transverse markings. At times these appear at tolerably regular intervals; they have been claimed as evidences of spiral structure; when, however, they are examined with magnifying powers of 1000 to 1200 diameters they proved to be cracks in the external membrane. Other portions of cotton exhibit longitudinal furrows, irregular in length and direction—having a shrivelled appearance something like the bark of an aged tree. In gun-cotton the transverse cracks are very numerous. From an examination of transverse sections of cotton I incline to the opinion that there is an external membrane distinct from the true cell-wall or cellulose matter;* inside the cellulose there is an irregular cavity; this, in some specimens (when viewed longitudinally), appears to contain granules, probably the remains of the organizing fluid contents of the cell, the mucous matter which is seen in growing cotton as mentioned by Captain Mitchell, in his letter to Mr. Hurst, read at this society, March 22nd, 1864.

On the 21st of April, 1863, Mr. Charles O'Neill made a communication to this section, "On the Appearance of Cotton Fibre during Solution and Disintegration;" these experiments referred to the application of Schweizer's solution of copper and ammonia. Under the action of this solvent Mr. O'Neill considers that cotton exhibits spiral vessels situated either inside or outside the external membrane. In a paper read by the same gentleman, on the 18th of May, 1863, it is stated that spiral vessels are seen

* See Mr. O'Neill's paper, April 25th, 1863.

during the solution of gun-cotton in ether and alcohol. On the 21st of December, 1863, Mr. Heys read a paper before this section, in which he refers to spiral vessels in cotton whichhairs seem to prevent the collapse of the tubes. The announcement of the discovery of spiral vessels excited my curiosity. Having often examined varieties of cotton under the microscope without suspecting any such structure, I was naturally desirous of witnessing its appearance during dissolution. A careful examination of cotton in the copper solvent, with powers varying from 50 to 1200 diameters, showed me the appearances described by Mr. O'Neill. I could not, however endorse his interpretations of them. On the 16th of January, 1865, I sent a letter to the chairman of the microscopical section, stating my belief that the spiral appearances could be clearly traced to a mechanical action which the solvent exerted on the vegetable cell, and that at some future time I hoped to illustrate this to the members of the section. Since December last I have subjected cotton during microscopical examination to a variety of influences in acids, alkalies, metallic solutions, iodine, and also gun-cotton in varied proportions of ether and alcohol. Repeated experiments tend to confirm my disbelief in the existence of spiral vessels, properly so called, either inside or outside cotton hairs. It would be difficult to explain, by means of drawings, how these pseudo-spirals are created, and I have, therefore, supplied a number of microscopes for the purpose of showing, at the close of the meeting, the actual appearances. Some of the gentlemen present have witnessed these experiments, but, for the benefit of those who have not, I shall attempt a brief explanation to enable them to comprehend more readily what they will see under the microscopes. In order to observe the action of the copper solvent on cotton, place a few hairs about a quarter of an inch in length on a glass plate, and cover them with thin glass; it is useful to rub a little beeswax on the glass plate, in such a manner as will just support the covering glass, to prevent too great a pressure on the cotton; then arrange the cotton under the microscope with a power of not less than 200 diameters. The solvent should be applied by a glass pipette to the edge of the covering glass whilst the observer is looking through the microscope (this is important) If the solvent is very strong the action is too rapid for the eye to follow, if of moderate strength it will be seen that as soon as the solvent comes into contact with the cotton in the field of view a rapid rotation or twisting of the hairs takes place. In my opinion it is this rotating action which brings about the appearances which have been mistaken for spiral vessels. The explanation which I have to offer for the phenomenon is this—first, we have the external membrane of the cotton, then the cellulose and primordial utricle, and finally, the dried contents in the cell, which I take to be the remains of the organizing fluid. Observation shows that the external membrane is not elastic, and only partially soluble. The cellulose is exceedingly elastic and soluble, and expands to a remarkable degree in the act of dissolution. The contents of the cell behave in a similar manner to that of the external membrane; it is neither elastic nor very soluble. The most successful experiment is made by allowing the copper solvent to come at once into contact with some length of the cotton hair. The solvent permeates some parts of the external membrane more easily than others, and causes a rapid expansion of the cellulose, which bursts the external membrane, and as this action is taking place at various portions of the same hair, a tangential force is exerted which twists and contorts the cotton in the direction of its length, and thus a spiral appearance is given to the whole structure of the cell. The non-elastic external covering is twisted round the expanded cellulose, sometimes as a single band, at others like a bundle of fibres. In those parts where the external covering has given way all round the hair the cellulose expands into a bulb, pushing back the external membrane into a series of folds, which form a ligature, and resists the expansive force of the cellulose. A number of these ligatures cause the expanded cellulose to assume the appearance of a string of beads. The lateral expansion of the cellulose contracts the length of the hair, and this causes the contents in the cavity of the cell to assume a corrugated appearance; this corrugation has also been subjected to the twisting power along with the other parts of the cell, and thus its spiral appearance is produced. What becomes of the primordial utricle I cannot state with certainty. After the disappearance of the cellulose there is an envelope left, which surrounds the contents of the cavity; this may be the primordial utricle, or the film left by the drying up of the protoplasmic or organizing fluid. If the solvent is made to come into contact with the ends of recently cut cotton, a beautiful trumpet-mouth is produced—the exposed surface of cellulose has expanded and pushed back the external coverings into folds—the contents of the cell may, in this case, be seen projecting from the mouth of the trumpet form. Long after the complete dissolution of the cellulose has taken place the external membrane remains just as the rotations or twistings had left it, some portions in the form of rings, which had been the ligatures between the bulbous expansions, other portions as irregular spirals. The cell contents also remain as twisted corrugations. From the observed difference in solubility between the cellulose and the external and internal matter, I should imagine a difference in constitution. A few experiments have led me to suspect that some of the spiral appearances observed in hemp and flax fibres during dissolution may possibly be caused by the mechanical action of the solvent employed.

P.S.—In making the cupric oxide with ammonia, the oxide of copper requires a thorough washing before dissolving in the ammonia. The presence of any salt of ammonia, even in very small quantities, interferes with its power in dissolving cotton.

M. Heys, in proposing a vote of thanks, said that he was gratified to find that the important subject of the structure of cotton, in which he had himself for some time felt an interest, was now being taken up in a manner likely to clear away all doubts.

Mr. Dancer also read a paper "On Pseudoscopic Vision through Prisms."

If we look with both eyes at an object, such as the flat top of a table, for example, and then interpose a prism between one eye and the object, we discover, after a short time, that the portion of the surface to which the sight is particularly directed has apparently changed its distance. If, in trying the experiment, the thin edge of the prism is turned inwards to the nose, the flat surface will appear concave; if, on the contrary, the base or thick angle is turned towards the nose, the surface will appear convex. The full effect of this alteration in the appearance of the object is not realised immediately; some persons see it perfectly in a few seconds, others require some moments of steady gazing before it becomes evident to them.

The character of the surface to which the vision is directed exercises some influence in producing the effect. A circular table covered with a cloth of bright pattern, having a few articles disposed towards the edges, exhibits this fallacious vision in a marked degree.

The angle of the prisms for showing these experiments should be about 15°; if less than this, the elevation or depression of surface is not sufficient to produce a good effect; if the angle is much greater than 15°, many persons are unable to unite the refracted image of the prism with the real image seen by the other eye.

Achromatic prisms are much to be preferred in these experiments to those which are uncorrected for colour. Experiments with these prisms have shown that the power of converging the optic axes differ very considerably in individuals.

Oculists occasionally recommend prismatic lenses, mounted in spectacles, to assist persons who suffer from insufficiency of the recti interni muscles; it would be interesting to know if those, so assisted, have noticed the fallacious appearances which the healthy eye can appreciate. The pseudoscopic effects are exaggerated by using a prism to each eye, but in most persons this produces a painful sensation.

The explanation of these phenomena, which I offer with some hesitation, is based upon the supposition that in binocular vision we estimate the distance of an object by the degree of convergence of the optic axes. In these experiments, when a flat surface appears concave by the interposition of the prism, the optic axes are made to converge on a point situated behind the real surface, and the imagination gradually removes the object to this apparent distance.

When the base of the prism is towards the nose then the fla surface becomes convex; in this case the optic axes cross in front of the real surface, and the imagination raises the object to that point. A diagram of the convergence of the optic axes on an object, before and after the interposition of the prism, will show that when the thin edge of the prism is turned towards the nose the effort made to unite the real and the refracted image is the same as if the vision was directed to a point more distant than the real object. The opposite to this takes place when the base of the prism is turned towards the nose. It is very possible that the pseudoscopic vision through prisms may have been noticed by others, but I have not been able to discover any description of such in the works to which I have access.

Mr. Heys said he had been asked by Mr. Dale to introduce to the notice of members a preparation of Canada balsam for mounting, which has the property of hardening in a very short time. It consisted of balsam first made perfectly solid by evaporation, and then dissolved in bisulphide of carbon. He found the smell a strong objection to its use, but the results were very satisfactory, the balsam on a slide becoming perfectly hard in a few hours. He thought, however, the dry balsam might prove to be the more important element in the preparation, and that its solution in chloroform would probably be found to answer all practical purposes.

Mr. Dancer exhibited many beautiful photographs of microscopic objects by Dr. Maddox.

March 27th, 1865.

JOHN PARRY, Esq., in the Chair.

Sections of various shells were exhibited by Mr. Parry.

An apparatus for applying pressure to the cover-glasses of objects freshly mounted in Canada balsam. It consisted of a dozen small upright pistons placed in a frame, and each furnished with a spiral spring coiled around the rod and pressing against the upper horizontal bar of the frame.

Dr. Alcock exhibited a second time his specimens of shells of marine Entomostraca from the coast of Galway. He said that renewed examination of them and the collection of many more specimens had strengthened his belief that, however numerous their forms, they are entitled to be considered as so many distinct species, and he did not think that the general arguments used by Professor Williamson in support of an opposite opinion, at the meeting of February 26th, had any application to their particular case. In the first place, it was stated that the outer skin or shells of these creatures is of less value for distinction than the internal parts; but Dr. Baird had described nine out of his fifteen species from living specimens, and yet in these his specific distinctions are mainly derived from the shells. Again, we were reminded that some of the Entomostraca are known to undergo metamorphoses, and that this might probably be the case with the genera Cythere and Cythereis; but Cypris, which approaches very nearly in character to Cythere, does not undergo these changes, and might furnish some ground for the supposition that these marine Entomostraca also do not; but it would be sufficient for the present purpose to state that there is no support for the supposition that they do, on the general ground that some kinds of Entomostraca are known to undergo these changes, because it is also well known that other kinds do not.

But a further objection was that low forms of animal life are liable to extreme variability, and that the same remark is applicable to the lower groups in the higher divisions of animals, the argument being that in these cases the variability may be so great as to render specific distinction of little or no value. He felt compelled to state that he did not admit this excessive variability as a certain fact, even in the lowest forms of animal life, until it could be actually proved to be true by most careful observation, and even then he would apply it no further than to the particular cases in which it had been proved; but as to making it a general rule with the lowest groups of the higher divisions of animals, he saw not the slightest reason for doing so, and here, more than in the former case, the diversity of character in the different groups would render it extremely unlikely that what might apply to one would also be found to apply to another. Even among low forms of animal life, such as the Foraminifera, he had searched in vain for examples of that extreme variability which must necessarily confound specific distinctions, and he was sure that every young working naturalist, at all events, would agree with him that a conclusion so discouraging to exact observations as that suggested by Professor Williamson, ought to be accepted by no one unless he became convinced of its truth by his own painful experience. With regard to the Foraminifera, he had no hesitation in saying that, with only a few exceptions, the extraordinary uniformity of character in individuals of the same type was a fact that must strike every observer. In the cases of Miliolina and Polymorphina he would admit there is difficulty, but an examination of many of their numerous forms did not suggest to his mind that a great tendency to variation, in the ordinary sense of the term, would explain their diversity. Knowing, however, from his own observations, what is meant by the statement that the Foraminifera are liable to great variation, he was prepared to say that the shells of the marine Entomostraca do not at all show this liability; the forms are clearly defined, and distinct from one another, and intermediate forms blending the characters of two others rarely, if ever, occur.

Then, as to the last objection which was brought forward, namely, the difficulty of defining what a species is, he believed that practically it might be put aside altogether; for the fact was that any creature whatever which could be shown to be clearly distinct from all others that had been described must be admitted as a species, and must remain a species until it could be proved to be unworthy of this distinction. In conclusion, he would say that he had no strong opinion as to whether this question of what a species is could or could not be answered, but he felt sure that to take Professor Williamson's suggestion, and merge some ten or twenty of these forms of marine Entomostraca into one species would be to make it impossible to form even a conjecture of what is meant by that term.

THE QUEKETT MICROSCOPICAL CLUB.

Under this name a new club has started in London. The following manifesto of the nature and objects of this new Society has been issued:

"This club has been established for the purpose of affording to microscopists, in and around the metropolis, opportunities for meeting and exchanging ideas without that diffidence and constraint which an amateur naturally feels when discussing scientific subjects in the presence of professional men.

"The increased study of natural history during late years has created a large class of observers, who, although with limited leisure for such pursuits, possess notwithstanding earnestness of purpose, and ability to render good service in the cause of microscopical investigation.

"The want of such a club as the present has long been felt, wherein microscopists and students with kindred tastes might meet at stated periods to hold cheerful converse with each other, exhibit and exchange specimens, read papers on topics of interest, discuss doubtful points, compare notes of progress, and gossip over those special subjects in which they are more or less interested; where, in fact, each member would be solicited to bring his own individual experience, be it ever so small, and cast it into the treasury for the general good. Such are some of the objects which the present club seeks to attain. In addition thereto it hopes to organize occasional field excursions, at proper seasons, for the collection of living specimens, to acquire a library of such books of reference as will be most useful to inquiring students; and, trusting to the proverbial liberality of microscopists, to add thereto a comprehensive cabinet of objects. By these, and similar means, the Quekett Microscopical Club seeks to merit the support of all earnest men who may be devoted to such pursuits; and, by fostering and encouraging a love for microscopical studies, to deserve the approval of men of science and more learned societies.

"The ordinary meetings of the club will be held on the fourth Friday of every month, at 8 o'clock in the evening, at No. 32, Sackville Street, Piccadilly.

"In order to place the advantages of this club within the reach of all, the annual subscription has been limited to ten shillings, payable in advance, on the 1st of July in every year.

"Gentlemen desirous of becoming members are informed that *no entrance fee* is demanded, and that the Secretary will furnish them with all further particulars which they may require, upon application by letter, addressed to No. 192, Piccadilly, W."

Dr. Lankester has been elected President, and Mr. W. M. Bywater Secretary. The first meeting was held on the 25th of August, when Dr. Lankester delivered an address on the history and uses of the microscope. He said, as an old President of the Microscopical Society of London, he welcomed the new club as a school and a nursery for that society. He hoped even that the fact of the existence of a junior body would stimulate the parent society to greater activity, and thus promote the great object which all true lovers of science had at heart—the advancement of human knowledge.

The second meeting was held on Friday, the 22nd of September.

TRANSACTIONS.

DESCRIPTIONS *of* NEW *and* RARE DIATOMS. SERIES XIV.
By R. K. GREVILLE, LL.D., F.R.S.E., &c.

(Read Nov. 9th, 1864.)

(Plates I & II.)

PLAGIOGRAMMA.

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

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

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

PYXILLA, n. gen., Grev.

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

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

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

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

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

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

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

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

CRESSWELLIA.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

LIRADISCUS, n. gen., Grev.

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

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

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

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

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

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

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

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

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

AULISCUS.

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

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

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

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

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

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

BIDDULPHIA.

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

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

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

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

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

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

TRICERA[illegible]

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[illegible] Barbadoes deposit, Cambridge estate; in slides [illegible]icated by C. Johnson, Esq.

[illegible]gh the sides of the valve are nearly straight, there [illegible]ible approach towards convexity. The pseudo- [illegible] transversely roundish-oval, and somewhat re- [illegible]stoid process of an *Auliscus*. Distance between [illegible]″.

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

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

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

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

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

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

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

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

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

TRANSACTIONS.

NOTES *on the* VINEGAR PLANT.

By HENRY J. SLACK, F.G.S.

(Read January 11th, 1865.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

MICROSCOPICAL SOCIETY.

ANNUAL MEETING,

FEBRUARY 6th, 1865.

Report of Council.

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

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

Honorary Associates	4
Compounders	60
Annual Subscribers	284
Total	348

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

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

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

Report on the Cabinet of Objects during the past year.

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

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

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

84

Ellis G. Lobb.

January 11, 1865.

AUDITORS' REPORT.

RECEIPTS.

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

PAYMENTS.

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

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

P. H. LEALAND

The President then delivered the following Address:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

This triumph of optical skill has been constructed for Dr. Beale, and as I have not myself had the opportunity of more than a casual inspection of it, it may not be inappropriate to quote from the 'Proceedings of the Royal Society,' vol. xiv, p. 35, Dr. Beale's own account of its performance:—"The $\frac{1}{50}$th is even better than the $\frac{1}{25}$th, which is now made instead of the $\frac{1}{20}$th. Plenty of light for illuminating the objects to be examined is obtained by the use of a condenser provided with a thin cap, having an opening not more than $\frac{1}{50}$th-inch diameter. The preparation may be covered with the thinnest glass made by Messrs. Chance, or with mica; and there is plenty of room for focusing to the lower surface of thin specimens, which can alone be examined by high powers transparent objects.

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

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

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

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

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

3. An educational microscope at three guineas.

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

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

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

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

DESCRIPTIONS *of* NEW *and* RARE DIATOMS. SERIES XV.

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

(Plates III & IV.)

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

CLAVULARIA, n. gen., Grev.

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

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

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

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

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

SYNEDRA.

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

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

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

COSCINODISCUS.

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

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

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

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

AULACODISCUS.

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

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

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

HEMIAULUS.

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

HEMIAULIDÆ, fam. nov., Heiberg.

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

TRIBE I. *Hemiaulidæ genuinæ.*

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

Gen. 1. *Hemiaulus*, Ehr.

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

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

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

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

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

TRIBE II. *Hemiaulidæ cuneatæ.*

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TRICERATIUM.

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

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

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

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

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

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

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

ENTOGONIA.

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

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

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

COCCONEIS.

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

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

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

PHOTOMICROGRAPHY, *its* APPLICATION *and* RESULTS.

By R. L. MADDOX, M.D.

(Read March 8th, 1865.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[redacted]

TRANSACTIONS.

Descriptions *of* New *and* Rare Diatoms. Series XVI.

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

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

(Plates V & VI.)

Skeletonema, n. gen., Grev.

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

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

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

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

Strangulonema, n. gen., Grev.

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

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

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

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

COSCINODISCUS.

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

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

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

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

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

Hab. Indian ocean; Dr. Macrae.

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

PORODISCUS.

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

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

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

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

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

LIRADISCUS.

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

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

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

ARACHNOIDISCUS.

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

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

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

CESTODISCUS, n. gen., Grev.

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

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

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

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

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

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

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

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

BIDDULPHIA.

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

Hab. Bardadoes deposit, Cambridge estate; extremely rare.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PORPEIA.

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

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

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

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

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

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

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

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

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

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

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

HEMIAULUS.

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

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

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

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

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

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

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

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

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

TRICERATIUM.

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

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

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

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

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

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

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

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

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

DICLADIA.

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

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

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

GONIOTHECIUM.

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

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

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

PINNULARIA.

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

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

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

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

On the STRUCTURE *and* AFFINITIES *of the* POLYCYSTINA. By G. C. WALLICH, M.D., F.L.S., &c.

(Read May 10th, 1865.)

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

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

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

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

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

Rhizopoda Radiaria seu Radiolaria.

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

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

As I shall have occasion to state my views regarding the expediency or otherwise of accepting variations in the characters of the pseudopodia as distinctive of the Orders into which the Rhizopods are divisible, I would merely observe, at present, that, under the system thus constructed, the *Polycystina* which have no nucleus, are associated with two families which possess this organ in a highly developed degree. And further, that, in consequence of the unguarded manner in which the term "*nucleus*" has been employed, in Müller's work, to signify a portion of the structure totally distinct from that to which it usually, or indeed legitimately, applies, not only has his classification been impaired, but, on his authority, has an error been promulgated by other writers, the importance of which can hardly be over-estimated. For, if it be admitted, as I presume is the case, that physiological advance is deducible from the gradually increasing complexity of a creature's organization, the presence or absence of such an appendage as the nucleus must necessarily be regarded as of higher significance than the degree of frequency with which the pseudopodia coalesce, or the form these processes assume when projected beyond the general mass of sarcode.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

RHIZOPODA.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Order I.—HERPNEMATA.

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

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

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

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

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

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

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

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

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

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

Order II.—PROTODERMATA.

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

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

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

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

[redacted]

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

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

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

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

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

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

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

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

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

† Ἀκανθ, and στυπος, a stem or stock.

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

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

Order III.—PROTEINA.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Family

POLYCYSTINA.

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

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

On a WIRE SPRING CLIP.

By R. J. MADDOX, M.D.

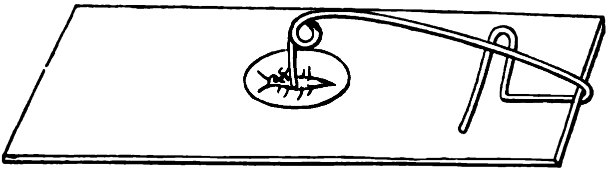
(Read May 10th, 1865.)

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

To make the clip, take a straight piece of [illegible] nd three quarter inches in length, turn [illegible]

[redacted]

eighths of an inch with a pair of *wire* pliers at right angles; this second portion, at half an inch, again bend at right



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

Note *on the* Prismatic Examination *of* Microscopic Objects. By William Huggins, F.R.S.

(Read May 10th, 1865.)

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

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

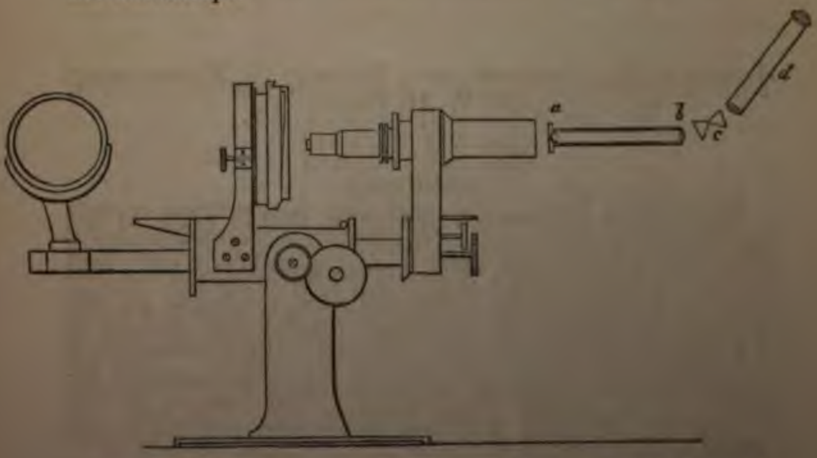
By means of the apparatus described below, the spectrum of any part of a microscopic object can be examined apart, and also can be compared with the spectra of the adjoining portions of the object.

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

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

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

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



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

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

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

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

PARAFFIN OILS: *their* RELATIVE VALUE *to the* MICROSCOPIST.

By W. H. HALL.

(Read May 10th, 1865.)

(*Abstract.*)

THE author commenced by stating, that in order to test the relative value of certain condensers, he was desirous of trying their powers by a good and similar light, and was thus induced to compare the purity and relative value to the microscopical observer of the three paraffin oils, known as "Young's Paraffin," "Price's Belmontine," and a "Diamond Crystal Oil from America," as being always easily obtainable from any respectable dealer in these oils. The table annexed gives the result of two series of experiments, made with three lamps of similar construction, with flat wicks cut from the same piece of cotton, and with an equal quantity of oil in each lamp. The first experiment was made by placing the

lamp before a concave reflector, and the light being then passed through a narrow slit in a sheet of cardboard, in front of which was a prism, the prismatic ray was received on a sheet of white paper, and the purity and breadth of colour between the red and blue rays noted as shown in the table. The second was by removing the lamp from the microscope after a bee's tongue and a micrometer were brought into focus with a one-fourth objective and a B eye-piece, and measuring the distance when it became impossible to count the rings of the first, or the lines of the second. The remaining lines of the table give the length of carbonized wick after each period of burning, the quantity of oil consumed in each trial, the temperature of the room, the specific gravity of each sample of oil, and the temperature at which it permanently ignited on water, the total result showing that "Young's Paraffin" is the best material for a microscopical lamp of the three oils examined.

	Young's Paraffin.		Price's Belmontine.		Diamond Crystal Oil.	
	1st Trial.	2nd Trial.	1st Trial.	2nd Trial.	1st Trial.	2nd Trial.
Character of light with prism, and width of band between the red and blue	Clear and bright	$\frac{3}{16}$ inch	Very dirty and dull	$\frac{2}{16}$ inch	Not so dull as the last.	$\frac{1}{16}$ inch
Distance at which a microscopical object became indistinct by direct light	After 6 *hours*	After $1\frac{1}{2}$ *hour*	After 6 *hours*	After $1\frac{1}{2}$ *hour*	After 6 *hours*	After $1\frac{1}{2}$ *hour*
Bee's tongue	20 feet	22 feet	8 feet	8f. 6in.	10 feet	11 feet
Micrometer 1000 inch...	—	8ft.3in.	—	3ft.6in.	—	5 feet
Carbonized (black) length of wick..................	6 *hours* $\frac{4}{20}$ inch	$2\frac{1}{2}$ *hours* $\frac{4}{20}$ inch	6 *hours* $\frac{7}{20}$ inch	$2\frac{1}{2}$ *hours* $\frac{7}{20}$ inch	6 *hours* $\frac{6}{20}$ inch	2 *hours* $\frac{5}{20}$ inch
Quantity consumed......	$3\frac{3}{8}$ oz.	$1\frac{3}{8}$ oz.	$3\frac{1}{4}$ oz.	$1\frac{3}{8}$ oz.	$4\frac{1}{4}$ oz.	$1\frac{7}{8}$ oz.
Temperature of room ...	55°	58°	55°	58°	55°	58°
Specific gravity (hydrometer graduated for 60°)	826	823	816	815	810	810
Temperature of permanent ignition on water	—	165°	—	160°	—	124°

[redacted]

TRANSACTIONS.

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

(Read June 14, 1865.)

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

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

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

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

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

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

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

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

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

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

The oviduct commences by an enlarged extremity; for $\frac{3}{16}''$ of its length it is so intimately united to the vas deferens as to require rather delicate dissection to separate them, and, were it not for the difference in colour, they would give the observer, at first sight, the idea that they were one and the same duct; the walls then acquire greater thickness, and become semi-transparent, containing large gelatinous cells; this part appears to secrete the cement by which the eggs are attached to stones after they are hatched; soon after this thickened portion the oviduct contracts in diameter and terminates externally in front of the opening of the lung on the left side of the body; immediately before its external opening it receives the duct of the spermatheca.

The vas deferens commences as a separate duct at the enlarged head of the oviduct; the prostate gland pours its secretion into it at $\frac{4}{16}''$ from its commencement. The prostate is a compact gland, made up of follicles closely pressed together; these follicles are all ciliated, and pour their secre[illegible] into a widened part of the vas deferens, which then ac[illegible] muscular parietes, and, after passing for a short distance through the parietes of the body, terminates in the penis. The penis consists of an external bag, which forms a sort of prepuce, which contains a solid rod-like prolongation of the vas deferens; this body, which recalls by its situation the glans penis, is grooved on one side and attached to the prepuce by the other, and terminates by two projecting lips; at the base of the groove is the opening of the vas deferens, surrounded by a projecting margin; the prepuce is attached to the walls of the body by two retractor muscles, and opens externally just behind the left tentacle.

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

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

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

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

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

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

* Op. cit. † Op. cit.

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

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

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

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

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

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

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

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

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

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

Plates VIII & IX.

Cladogramma.

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

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

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

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

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

Thaumatonema.

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

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

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

DICLADIA.

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

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

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

STICTODISCUS.

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

Hab. Monterey deposit; L. Hardman, Esq.

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

LIRADISCUS.

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

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

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

ASTEROLAMPRA.

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

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

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

BIDDULPHIA.

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

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

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

PORPEIA.

Porpeia quadriceps? Bail.—(Fig. 13.)

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

HEIBERGIA, n. gen., Grev.

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

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

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

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

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

HEMIAULUS.

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

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

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

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

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

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

TRICERATIUM.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Hab. Greece (fossil); Moron deposit (fossil); Red S[illegible] dredgings, L. Hardman, Esq.

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

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

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

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

AMPHITETRAS.

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

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

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

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

By F. H. WENHAM.

(Read June 14, 1865.)

THE short communication which I submit to your notice rcely merits consideration as a discovery; but as the roscope has in this case immediately detected the cause well-known phenomenon, I bring it forward as an ex- of the use of the instrument in practical investigations. s a fact known to the philosophical instrument makers, f a metal wire be drawn through a glass tube, a few fterwards the tube will burst into fragments. The annealed glass tubes used for the water-gauges of steam-boilers are sometimes destroyed in this way, after the act of forcing a piece of cotton waste through them with a wire for the purpose of cleaning the bore. This will not happen if a piece of soft wood is employed.

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

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

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

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

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

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

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

(Read June 14, 1865.)

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

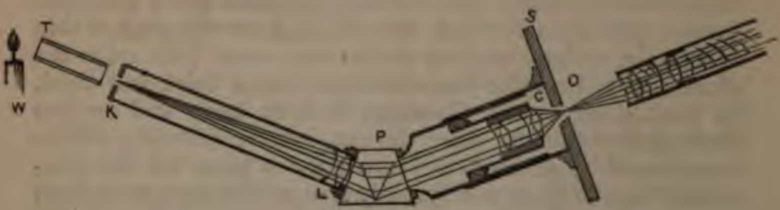
Fig. 1 represents the kind of apparatus, together with the optical arrangement, which I had found give the best results. It seems to me to possess some advantages over Mr. Sorby's original contrivance.

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

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

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

Fig. 1.



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

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

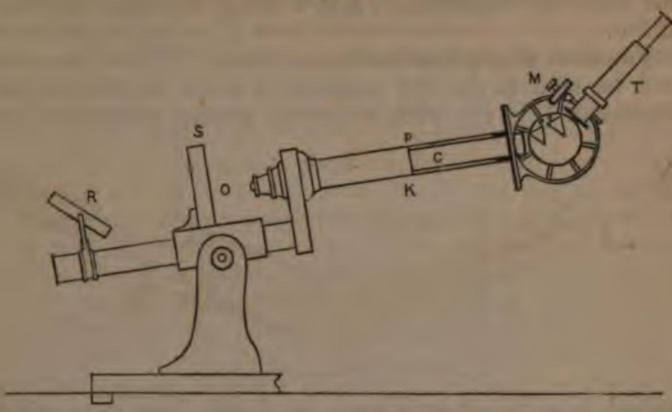
For simplicity and economy this arrangement will probably be preferred to any of the other contrivances which have been proposed, and to which I shall presently refer.

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

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

The apparatus Mr. Huggins has used for the [illegible] sists of a star spectroscope, which I made for h[illegible] the collimating tube was inserted in the body [illegible] scope instead of an eye-piece. With this con[illegible] succeeded in obtaining a spectrum showing the absorption-bands from a mere fragment of a single blood-disc, when mounted transparent.

Fig. 2.



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

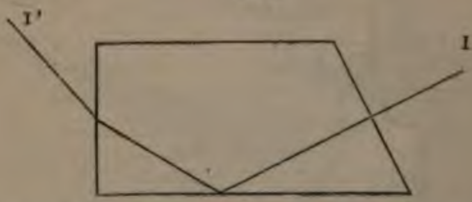
Mr. Huggins also suggested that the apparatus could be used to examine opaque objects, but the great drawback to its extended use is that it is rather inconvenient and expensive. Other investigations have, unfortunately, prevented Mr. Huggins from pursuing this subject further himself at present, but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

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

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

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

Fig. 3.



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

Mr. Sorby has informed me that for liquids or transparent

Fig. 4.

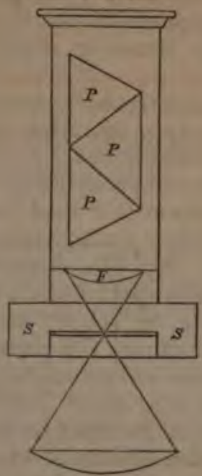
objects nothing could work better than this contrivan[illegible] it is, of course, not applicable to opaque objects.

Conversing with our President and Mr. Slack, [illegible] last meeting, I mentioned that I believed that so[illegible] direct-vision prisms, applied in the body of the [illegible] would prove the best arrangement to answer both[illegible] and Mr. Slack expressed the same opinion.

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

Fig. 5.

Fig. 6.



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

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

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

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

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

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

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

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

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

It is very desirable that others should also give their at- tion to this matter, each choosing different subj[illegible] tigation. The recent important discoveries [illegible] Jones, F.R.S., and Dr. Dupré, on the detecti[illegible] the eyeball a few hours after its administrati[illegible] vantageously carried further in this manner; [illegible] which has attended the researches of Professor Stokes and Mr. Sorby would lead us to believe that any time bestowed on the subject, either by the chemist, physiologist, or mineralogist, would meet with an ample reward.

Description *of a* new form *of* Live-trap, *and* Parabolic Reflector. By Richard Beck.

(Read June 14, 1865.)

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

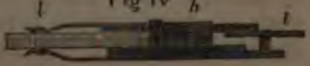
Fig. I.

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

Fig. II.

Fig III

Fig IV



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

Fig V

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

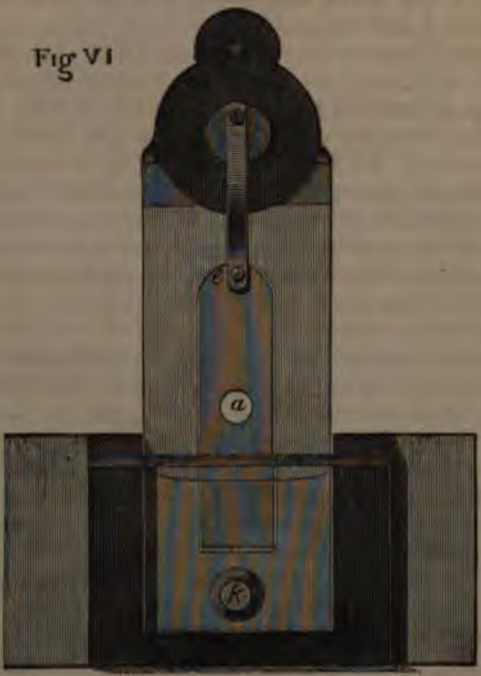
The piece of brass with the springs (Figs. III and IV) is clamped to the glass plate by first screwing down the larger milled head (*h*) until it just comes in contact with the glass, and then by screwing up the smaller milled head (*i*) against the under side of the larger one, which is thus pressed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

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

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

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

Fig VI



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

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

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

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

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

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

Fig VII.

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

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

Fig. VIII.

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

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

Fig IX

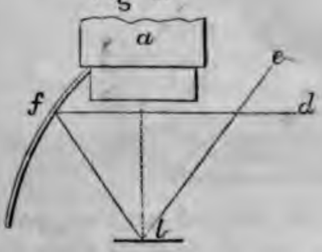
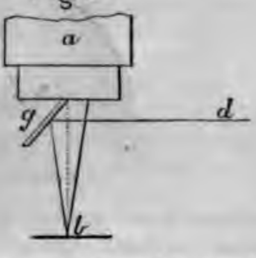


Fig X



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

JOURNAL OF MICROSCOPICAL SCIENCE.

DESCRIPTION OF PLATE I,

Illustrating Dr. Herapath's paper on Photographs from the Anchors and Plates of various Synaptæ.

Fig.

1.—Whole animal, *Synapta Duvernæa*, copied from Quatrefages, very like *S. Sarniensis;* but the latter has one pair of pinnæ extra on each tentacle.

2.—Anchors and plates of *S. Duvernæa*, from Quatrefages, showing the armed or spinous character of the anchor at its convex border, and the plate with six holes surrounding the central aperture, as in *inhærens;* but the thick plain borders distinguish it.

3.—Plate, compounded of the various published figures of Synapta—Hogg, Carpenter, 'Micrographic Dictionary,' Quatrefages. The whole animal is Hogg's figure of Chirodota from Forbes, called Synapta by Hogg; the oral tentacles are imaginary developments of *S. digitata.*

C, in this figure, is an anchor-plate of *S. Sarniensis*, for comparison.

4.—Anchors and plates of *S. inhærens*, given by Professor Wyville Thompson in the 'Microscopical Quarterly Journal.' (Compare with fig. 7.)

5.—Photograph of anchors and plates of *Synapta digitata*, as prepared from a specimen sent by Professor Wyville Thompson, as obtained from Antrim.

6.—Anchors and plates of *Synapta vittata;* six holes surrounding the central aperture; well-formed arch at articulating extremity. (Suez.)

7.—Anchors and plates of *S. inhærens*, as prepared from a specimen forwarded to the author by Professor Thompson, of Belfast; six holes surrounding the central aperture; margin of plate smooth; apertures crenated.

8.—Anchors and plates *in situ* skin of *Synapta bi-dentata*, obtained from China. Anchor-head bifid at each extremity; plate, six holes around central aperture; apertures oval; margins smooth.

9.—Anchors and plates of *S. Sarniensis*, seen by reflected light; the well-formed arch apparent; the cup-shaped appearance of plate; the reflected arms of the anchors; the seven holes around the central aperture; rounded holes, crenated edges, and margin.

10.—Photographs taken by the Rev. J. Whiting, of Clifton, also from *S. Sarniensis;* some plates monstrous in this slide; seven holes are central in the normal.

11.—Various plates and anchors from *Synapta Sarniensis*, by transparent light; seven holes around central aperture; margins crenated; apertures roundish; margin of plate crenated; arch dimly seen.

C and *d*, two plates of *S. inhærens* occurring by accident in the slide. The animal found in the same bed with *S. Sarniensis.*

JOURNAL OF MICROSCOPICAL SCIENCE.

DESCRIPTION OF PLATES II & III,

Illustrating Mr. E. Ray Lankester's paper on the Earthworm.

PLATE II.

Fig.

1.—Genitalia of *Lumbricus terrestris*, much enlarged.
2.—Portion of ciliated canal or segment organ of Lumbricus.
a. Granular tissue. *b*. Cilia. *c*. Capillary.
3.—Testes, seminal vesicles, and vasa deferentia, of the right side, seen posteriorly.
4.—Ciliated canal or segment organ from posterior of body.
5.—Fibrous tissue of testis.
6.—Nucleated epithelium of ciliated receptacle.
7—11.—Development of zoosperms.
12.—Commencement of the seminal duct, or vas deferens.

PLATE III.

1.—Segment organs, and their modifications, in the 8—15 segments of Lumbricus.
a. Normal canal. } Segment organs ?
b. Sperm-reservoir.
c. Vas deferens.
d. Oviduct.
e. Capsulogenous gland.
2.—Oviduct, magnified.
3.—Ovary, more highly magnified.
4.—Papillæ of cingulum.
5.—Typical segment of an Oligochete.
6.—Pores of the first sixteen segments.
7.—Cingulum.
8.—Dermal canals.

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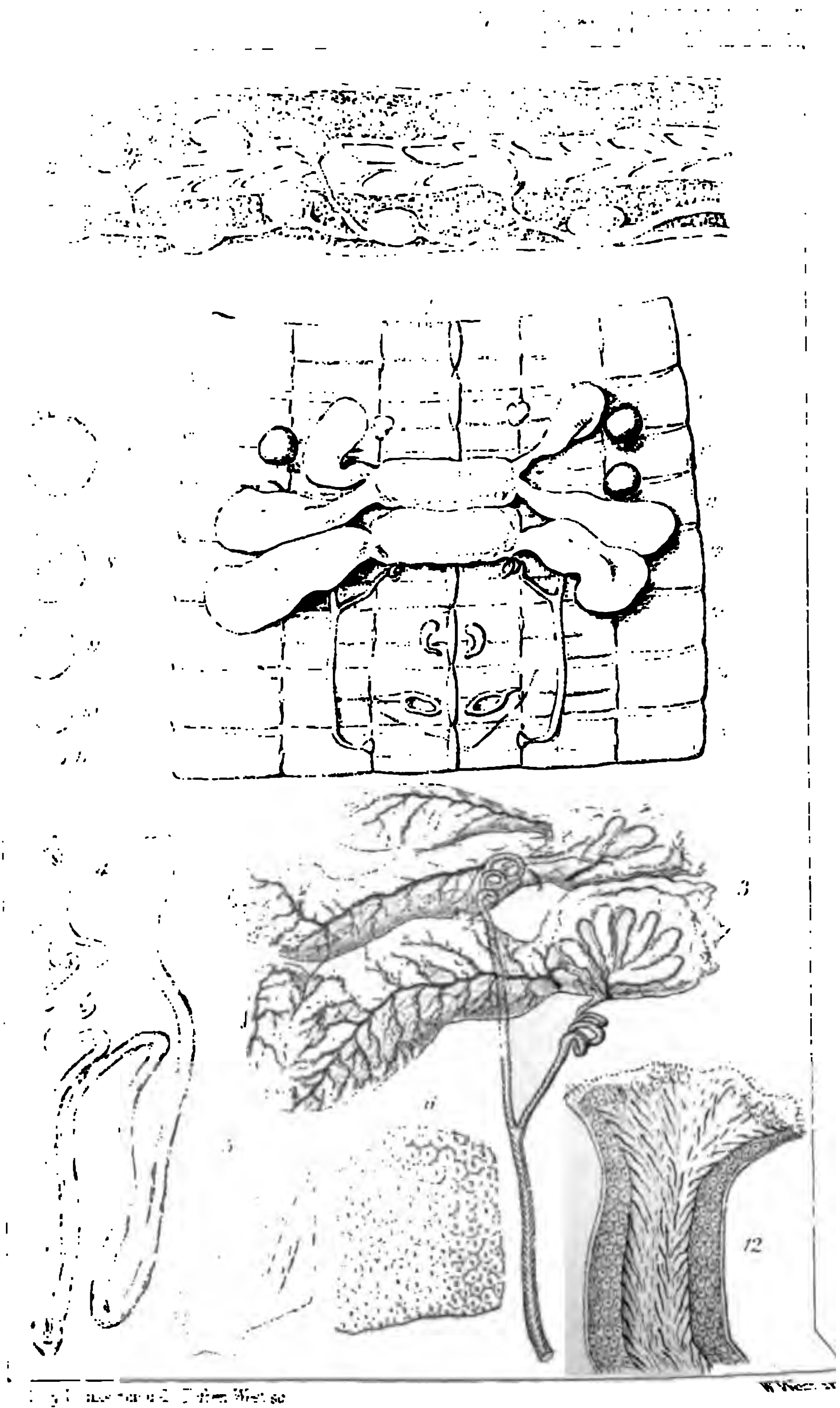

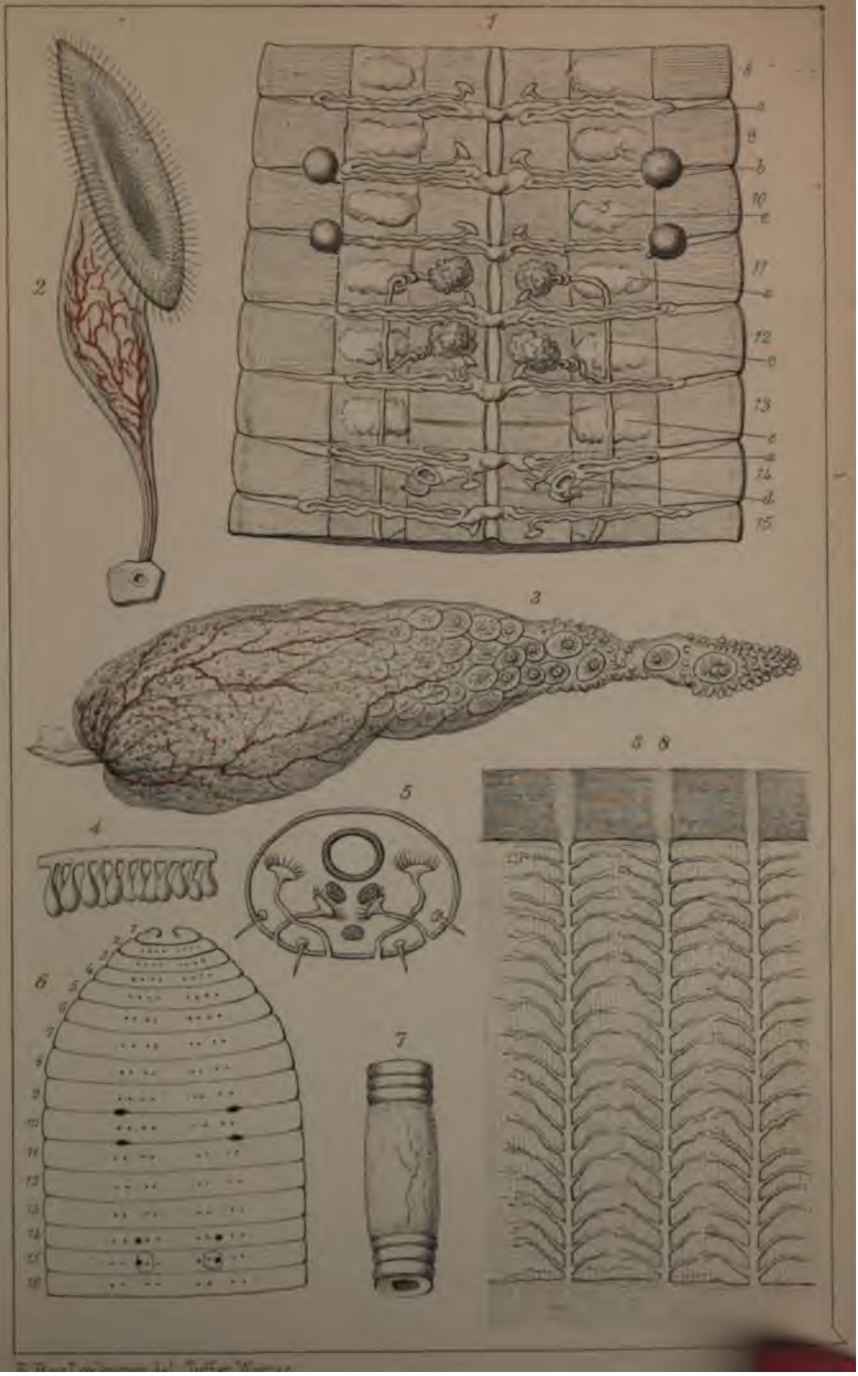

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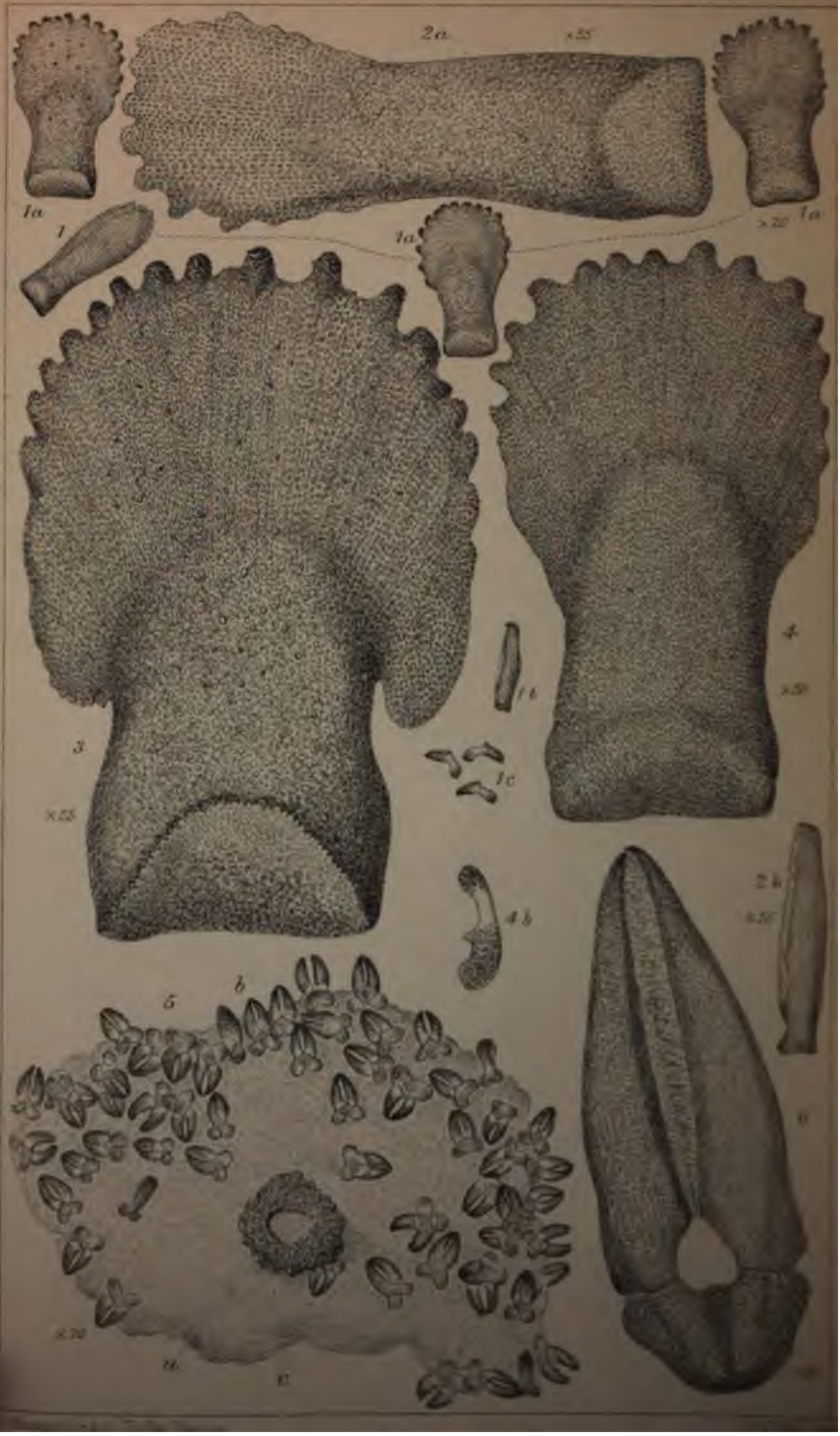
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DESCRIPTION OF PLATES IV & V,

Illustrating Dr. Herapath's paper on the Pedicellariæ of the Echinodermata.

PLATE IV.

Uraster rubens.

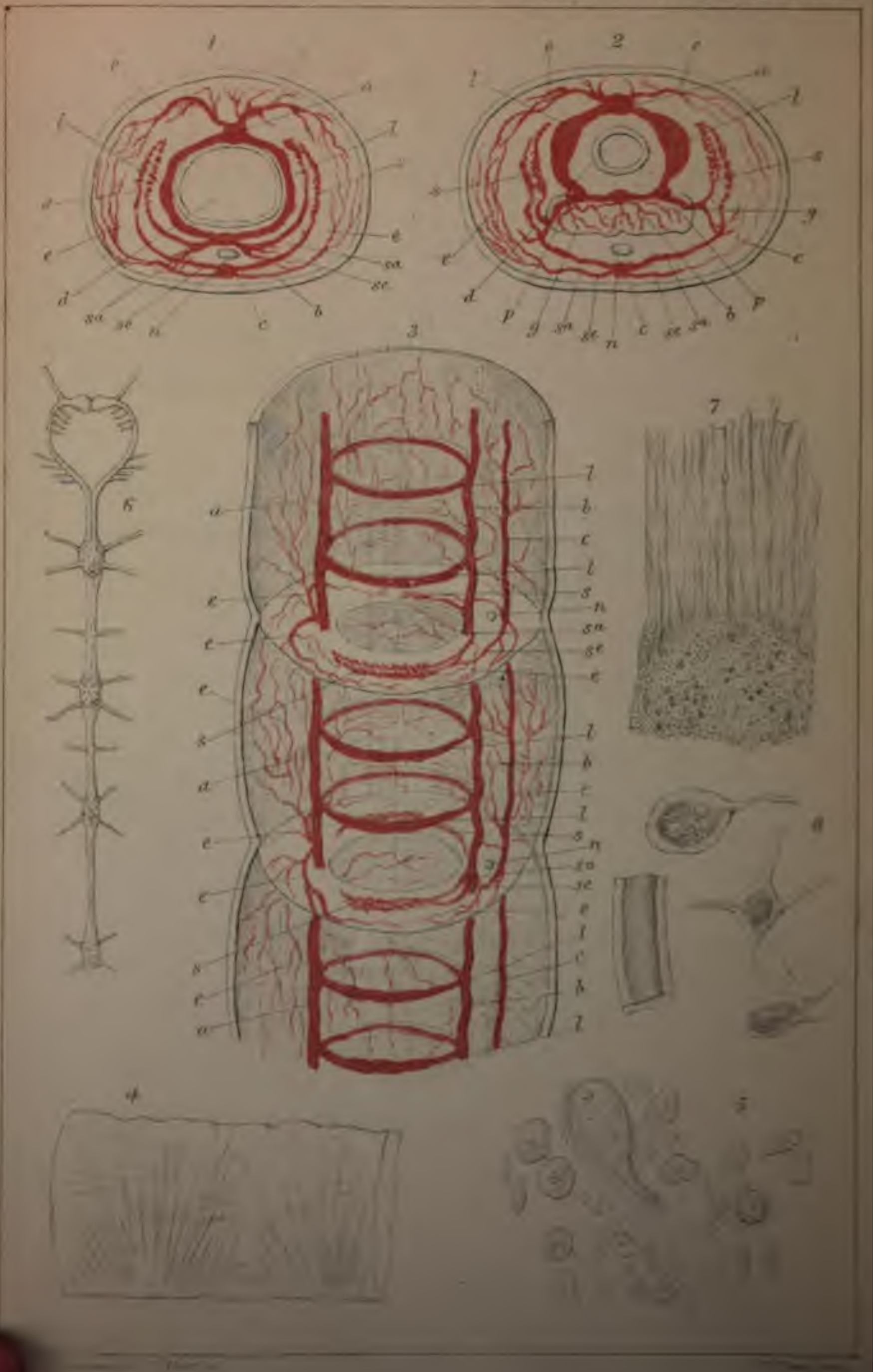
Fig.
1.—*a*, Two pair of pedicellariæ forcepiformæ in conjunction.
b, Pedicellariæ mandibulatæ in conjunction, and separated by the process of boiling.
c, Basal joint of p. forficiformæ.
d, Two valves of p. forficiformæ, side view.
e, Basal joints of p. mandibulatæ.
f, Separated valves of p. forcepiformæ.
g, Upper ring of the sand-tube of *Uraster rubens.*
2.—*a*, Valves of p. forcepiformæ.
b, Two valves, separated, of pedicellariæ forficiformæ.
c, Valve of p. mandibulatæ.
d, Basal joint of p. mandibulatæ.
3.—*a*, Conjoined p. mandibulatæ.
b, Separate valves of the same.
c, Separate valves of p. forficiformæ.
e, Front view of single valve of p. forcepiformæ.
f, Basal joint of p. forficiformæ.
4.—Portion of external integument of *raster Urubens*, containing the pedicillariæ.
a, Solitary pedunculated pedicellariæ forcepiformæ.
b, Aggregated pedicellariæ forcepiformæ, surrounded by their fleshy covering.
c, Pair of p. mandibulatæ.
5.—Portion of skeleton of *Uraster rubens*, dried and mounted in balsam.
a, Opaque calcareous skeleton, forming bars of fenestral spaces.
b, Membrane filling up fenestral apertures.
c, Pedicillariæ mandibulatæ, attached to membrane of fenestra.
6.—One of the spines from ambulacral grooves, with pedicellariæ attached. Forficiformæ.

Uraster glacialis.

7.—Two valves of p. maxillæforæ, separated from basal joint.
8.—*a*, Three pairs of p. forcepiformæ, in various positions.
b, Single valve of p. maxillæformæ.
9.—Two valves of p. mandibulatæ.
10.—Basal joint of p. forficiformæ. That of p. maxillæformæ is similar in form, but much larger.

PLATE V.—*Uraster glacialis.*

1.—*a*, Four valves of p. maxillæformæ. 1. Partially developed.
b, One valve of p. mandibulatæ.
c, Various separate valves of p. forcepiformæ.
2.—*a*, Single valve of p. maxillæformæ.
b, Single valve of p. mandibulatæ.
3.—One valve of p. maxillæformæ, rather different from usual, the maxillary portion having alæ.
4.—*a*, P. maxillæformæ.
b, Valve of p. forcepiformæ, dorsal view.
5.—Portion of glacial-looking mass surrounding dorsal spines of *U. glacialis.*
a, Spine cut through as transverse section.
b, Aggregated p. forcepiformæ.
c, Membranous expansion, containing muscles, &c., for moving the calcareous blades.
6.—P. forficiformæ, side view,



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DESCRIPTION OF PLATE VI,

Illustrating Mr. E. Ray Lankester's paper on the Earthworm.

Fig.

1.—Diagrammatic view of the circulation in an ordinary segment (20th).

2.—Ditto in a generative segment (10th—14th).

3.—Lateral ditto in three ordinary segments; the letters refer to the same parts in all three.

- *a.* Dorsal vessel.
- *b.* Sub-intestinal vessel.
- *c.* Ventral vessel.
- *d.* Alimentary canal.
- *e.* Cutaneous or peripheral vessels.
- *g.* Generative organs.
- *l.* Deep commissural vessels.
- *n.* Subventral chain of ganglia.
- *p.* Extra-vessels parallel to the sub-intestinal vessel.
- *s.* Excretorial plexus.
- *sa.* Afferent trunk of ditto.
- *se.* Efferent „

4.—Muscular fibre in blood-vessel.

5.—Corpuscles of the colourless or perivisceral fluid.

- *a.* Form of *Monocystis Lumbricorum.*
- *b.* Spermatic particles.

6.—Cephalic ganglion and subventral chain of ganglia of *L. terrestris.*

7.—General structure of subventral chain.

8.—Ultimate constituents of ganglia and branches.

DESCRIPTION OF PLATE VII,

Illustrating Mr. Archer's papers on *Docidium pristidæ*, Hobson; on a new species of Docidium, from Hong-Kong; on Stephanosphæra; and Admiral Jones' on spiral vessels detected in *Evernia prunastri*.

Fig.

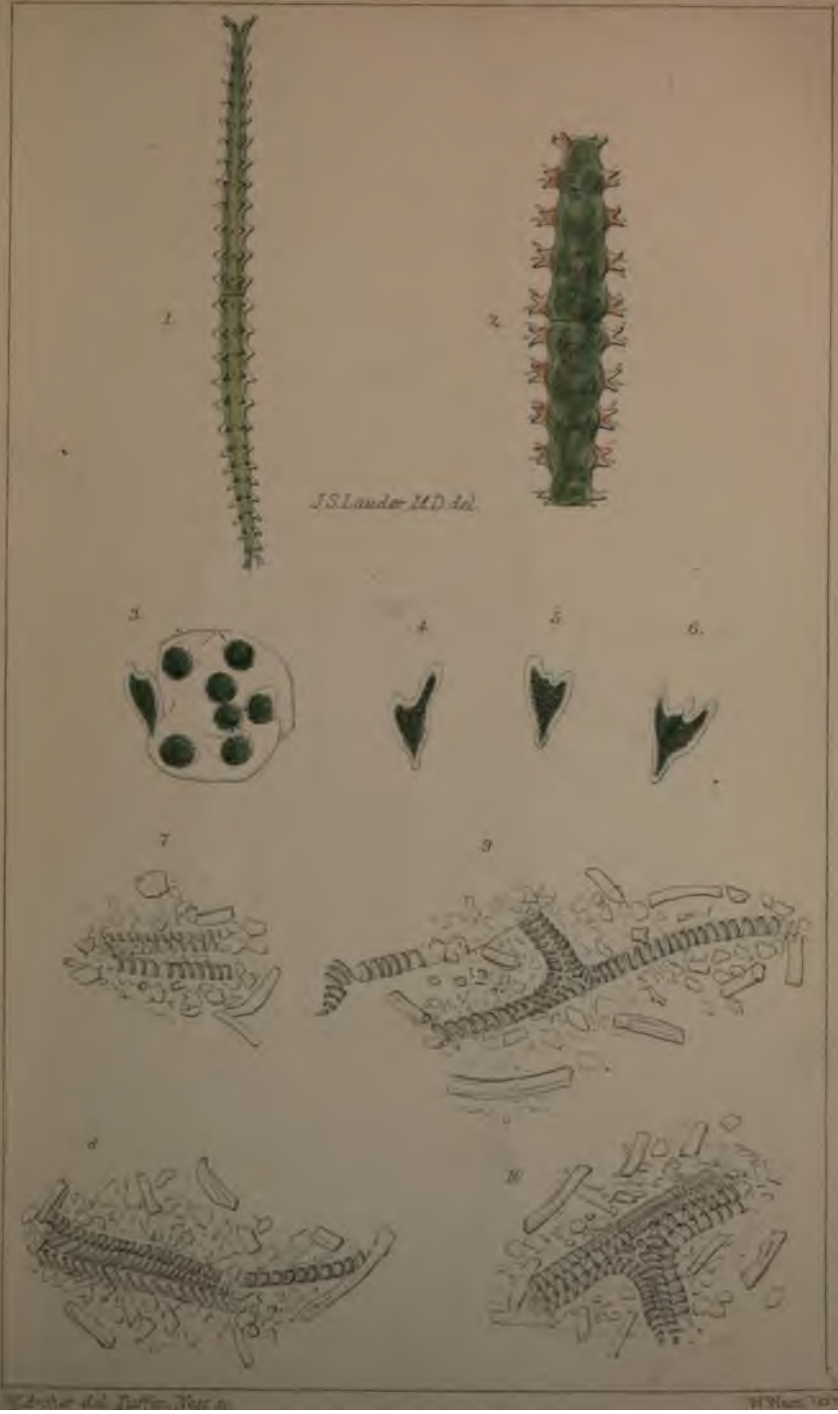
1.—*Triploceras gracile*, Bailey (= *Docidium pristidæ*, Hobson).

2.—*Docidium Kayei*, Arch. (sp. nov.)

3.—*Stephanosphæra pluvialis*, Cohn, showing the primordial cells assuming an amœboid state; one, to the left, about to make its exit from the old envelope-cell.

4, 5, 6.—Various appearances of the now reptant and freely moving primordial cells of the Stephanosphæra, having become completely amœboid.

7, 8, 9, & 10.—Spiral vessels detected by Admiral Jones, F.L.S., enclosed in certain dark dots in the thallus of *Evernia prunastri*, Ach.



W. Archer del. Tuffen West sc.

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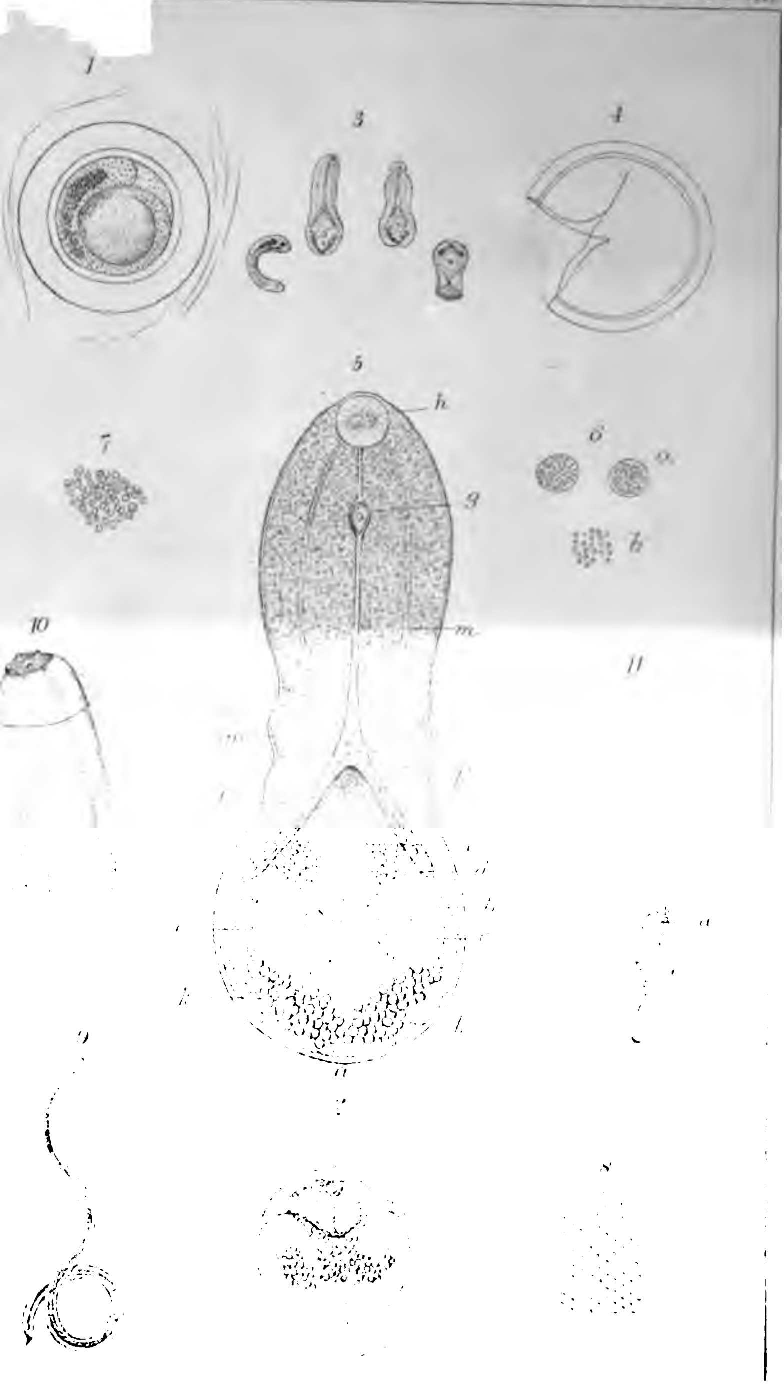
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DESCRIPTION OF PLATE VIII,

Illustrating Dr. McIntosh's paper on the Trematode Larva and Ascaris of the *Carcinus mœnas.*

Fig.

1.—Lateral view of the embryo, showing its coiled condition in the egg. ×180 diam.

2.—Front view of the embryo in the egg. ×180 diam.

3.—Various specimens of the extruded larva in different postures. Magnified by the high power of a dissecting lens.

4.—Egg-capsule after rupture. A delicate outer investment is in this case seen stretching across the rent.

5.—The trematode larva, ×180 diam. *a*, Pore at the posterior margin; *b*, ventral sucker; *c c*, large granular bodies; *d*, one of the circular granular masses anterior to the former; *e*, clear globule in front of ventral sucker; *f f*, alimentary cæca; *g*, dilatation of œsophagus (pharyngeal bulb?); *h*, oral sucker; *k k*, groups of large compound cells; *m m*, excretory (?) tubes.

6.—Portion of the investing tissue of the larva, showing the spikes. ×280 diam.

7.—The ascaris from liver of *Carcinus mœnas*. Magnified by high power of dissecting lens.

8.—The anterior extremity of the foregoing. ×80 diam.

9.—Posterior extremity of the same, ×80 diam. *a*. The granular rounded body most clearly observed.

DESCRIPTION OF PLATE IX,

Illustrating Dr. E. Perceval Wright's paper on Hartea.

Fig.

1.—*Hartea elegans*, fully expanded and greatly enlarged; '*a*', basal portion, thickly studded with spicula (*vide* fig. 4); '*b*', the swollen bases of the tentacles, crowded with elongated spicula (*vide* fig. 3).

2.—The same, twice the size of life, tentacles contracted.

3.—Spiculum from base of tentacle.

4.—Spiculum from base of the polype.

N.B.—The shell represented in fig. 1 is drawn from the imagination of the artist, as, in the examination of the specimens, they became detached from the *Cardium Norvegicum*.


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JOURNAL OF MICROSCOPICAL SCIENCE.

DESCRIPTION OF PLATES X & XI,

Illustrating Mr. Hepworth's paper on the Structure of the Horse's Foot.

PLATE X.

Fig.

1.—Vertical section of horse's foot.

- *a* Coffin-bone.
- *b.* Portion of coronet-bone.
- *c.* Navicular bone.
- *d.* Wall of hoof.
- *e* Laminæ.
- *f.* Coronary substance, its—
- *g.* Villi penetrating wall.
- *h.* Frog.
- *i.* Coronary frog-band.

2.—Horse's foot, with hoof removed.

- 1. Situation of coronary frog-band.
- 2. Coronary substance.
- 3. Vascular laminæ.
- 4. Villi of sole.

PLATE XI.

1.—Horizontal section of wall of hoof, the vascular laminæ being shrunk, and leaving openings, except at the points, where they unite the horny laminæ.

- *a.* Orifices in the wall, into which the villi of the coronary substance pass, surrounded by—
- *b.* Pigment-cells.
- *c.* Horny laminæ.
- *d, d.* Laminellæ (of Fleming).

2.—Injected vessels of villi of coronary substance.

3.—Ditto of vascular laminæ, two in the centre having coalesced, and slightly shrunk in drying.

4.—Vertical section of coronary frog-band.

- *e.* Cuticle.
- *f.* Hair.
- *g.* Capillaries of sebaceous glands.
- *h.* Villi penetrating its semi-horny substance.

5.—Vertical section of wall, including a portion of horny laminæ, into which the pigment-cells are seen to enter freely.

- *i.* Horny laminæ.
- *j.* Tubes for villi.

6.—Cribriform plate at the superior interior part of the wall of the hoof, on which the coronary substance rests, with its orifices for the passage of the villi.

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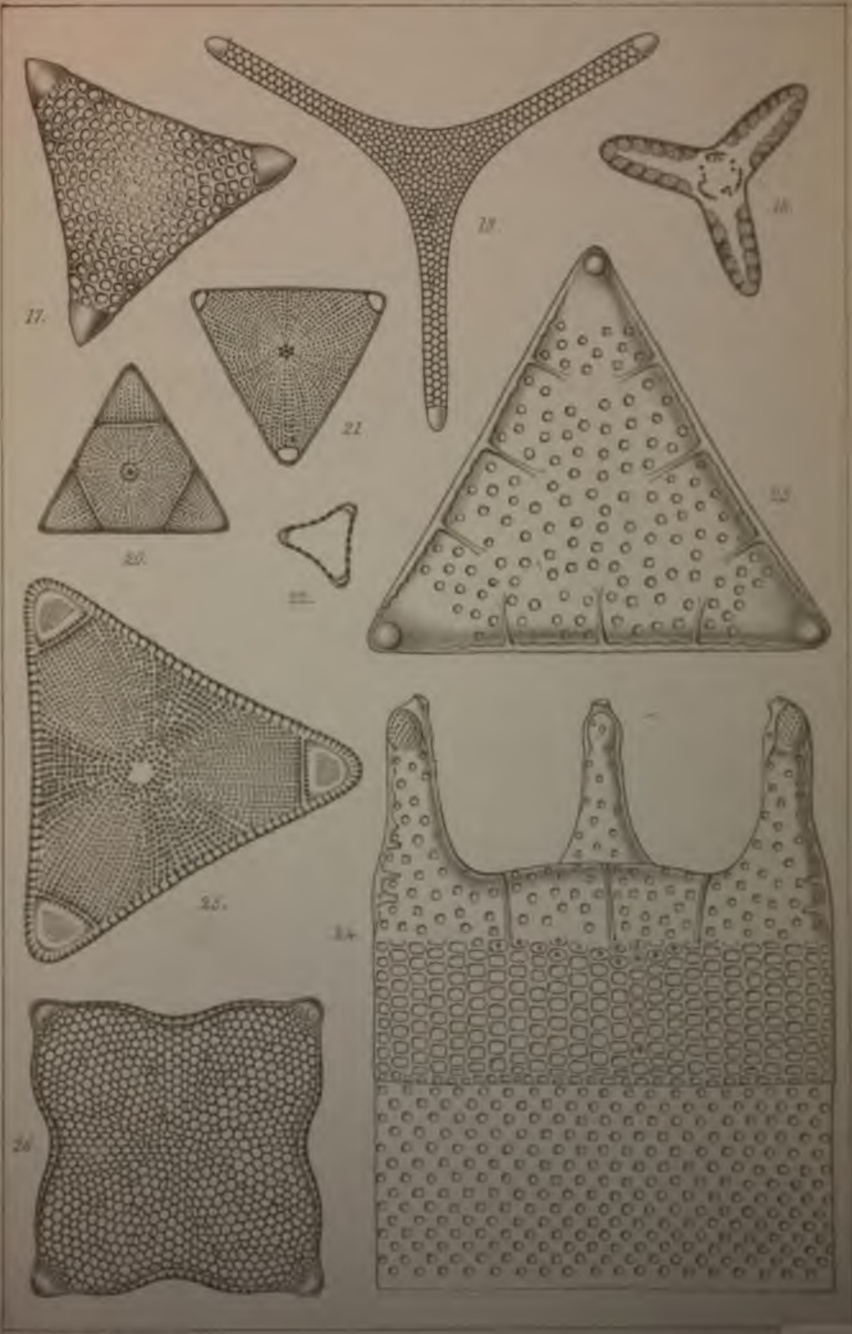
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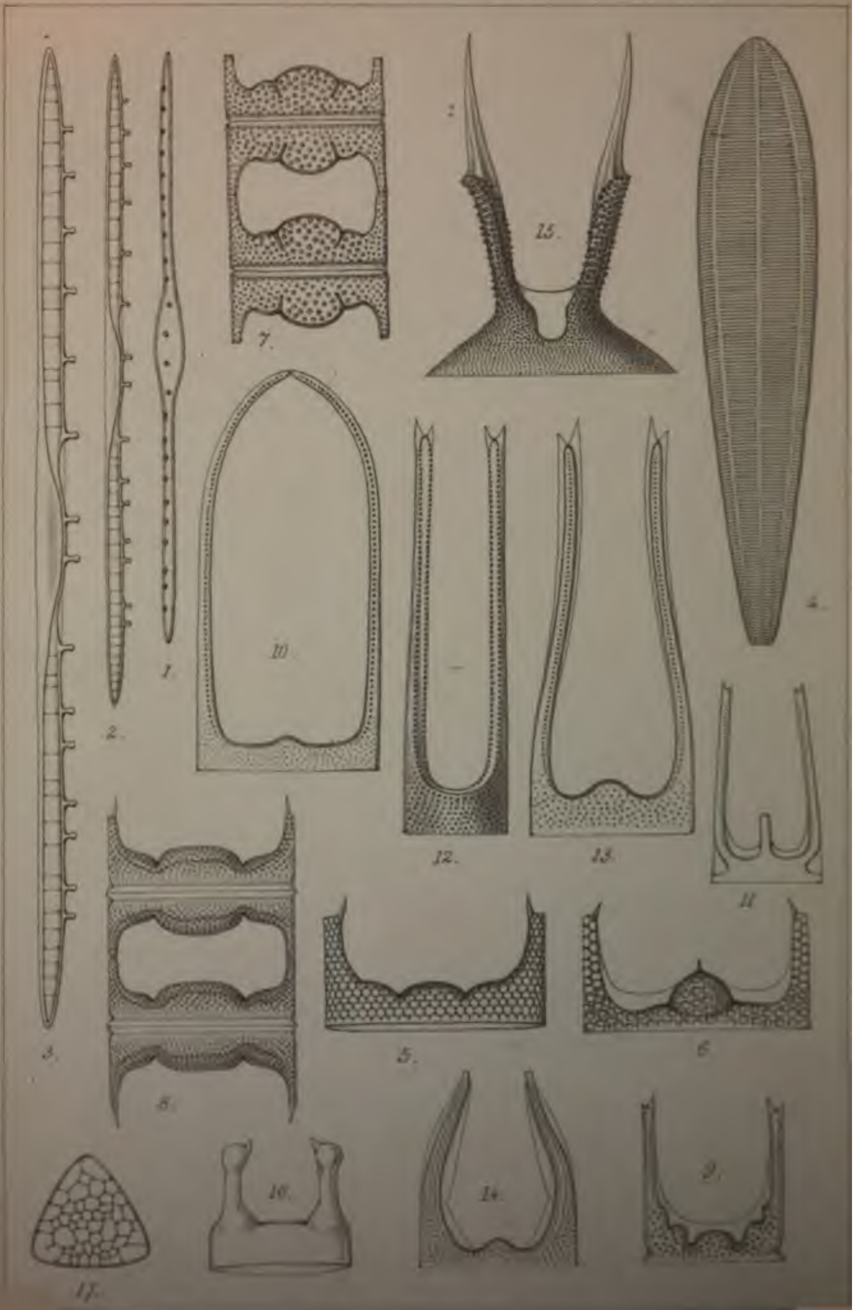
DESCRIPTION OF PLATES I & II,

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

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

All the figures are × 400 diameters.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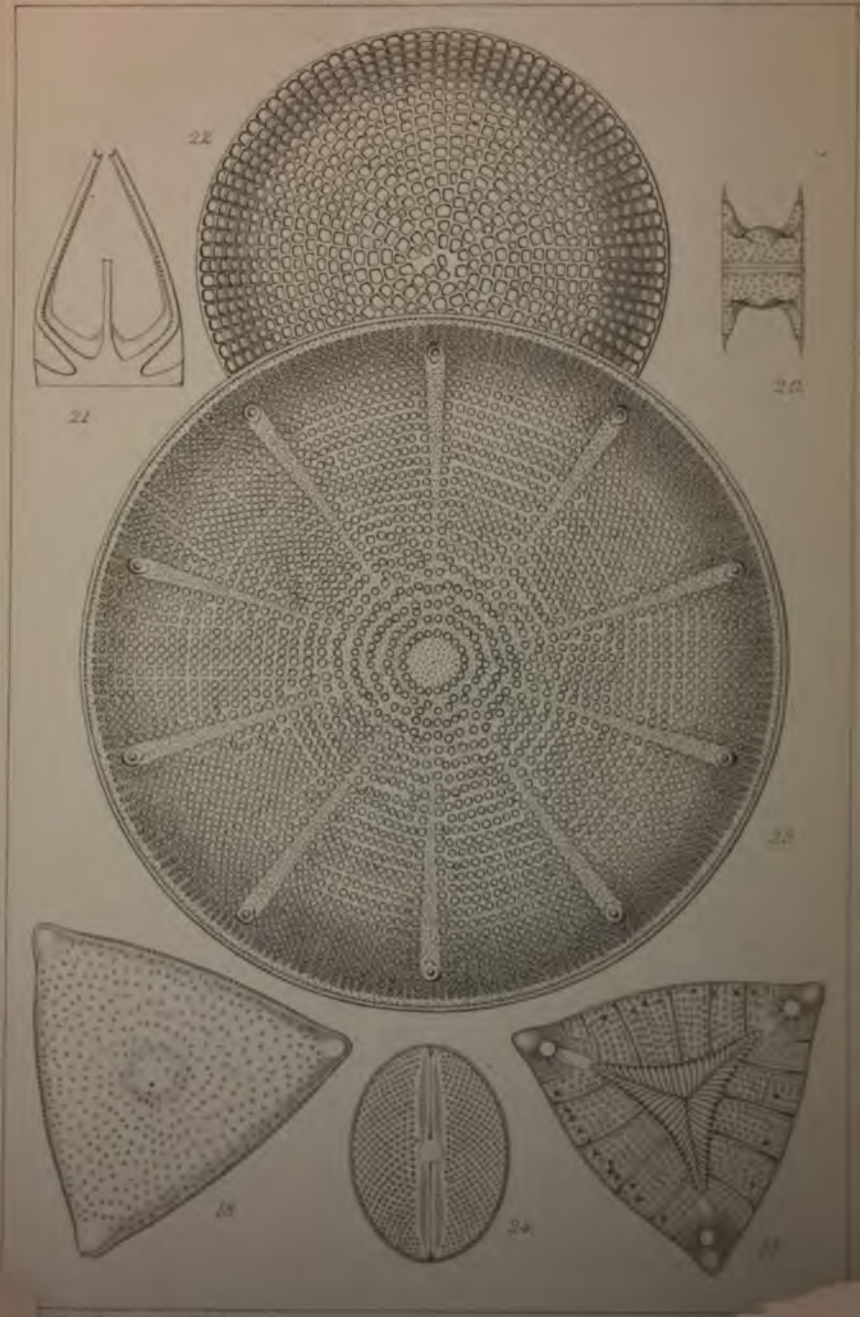
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TRANSACTIONS OF MICROSCOPICAL SOCIETY.

DESCRIPTION OF PLATES III & IV,

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

Fig.

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

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

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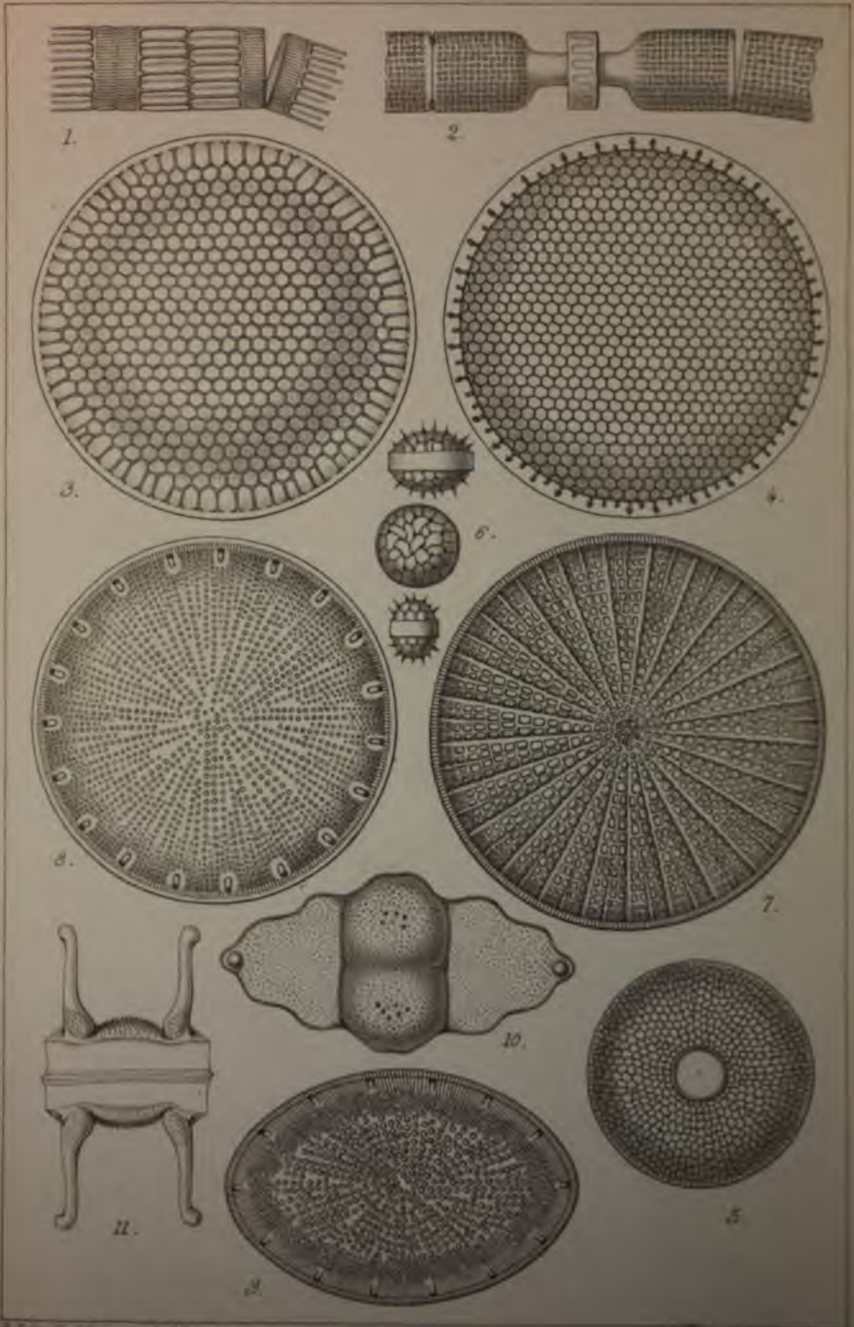

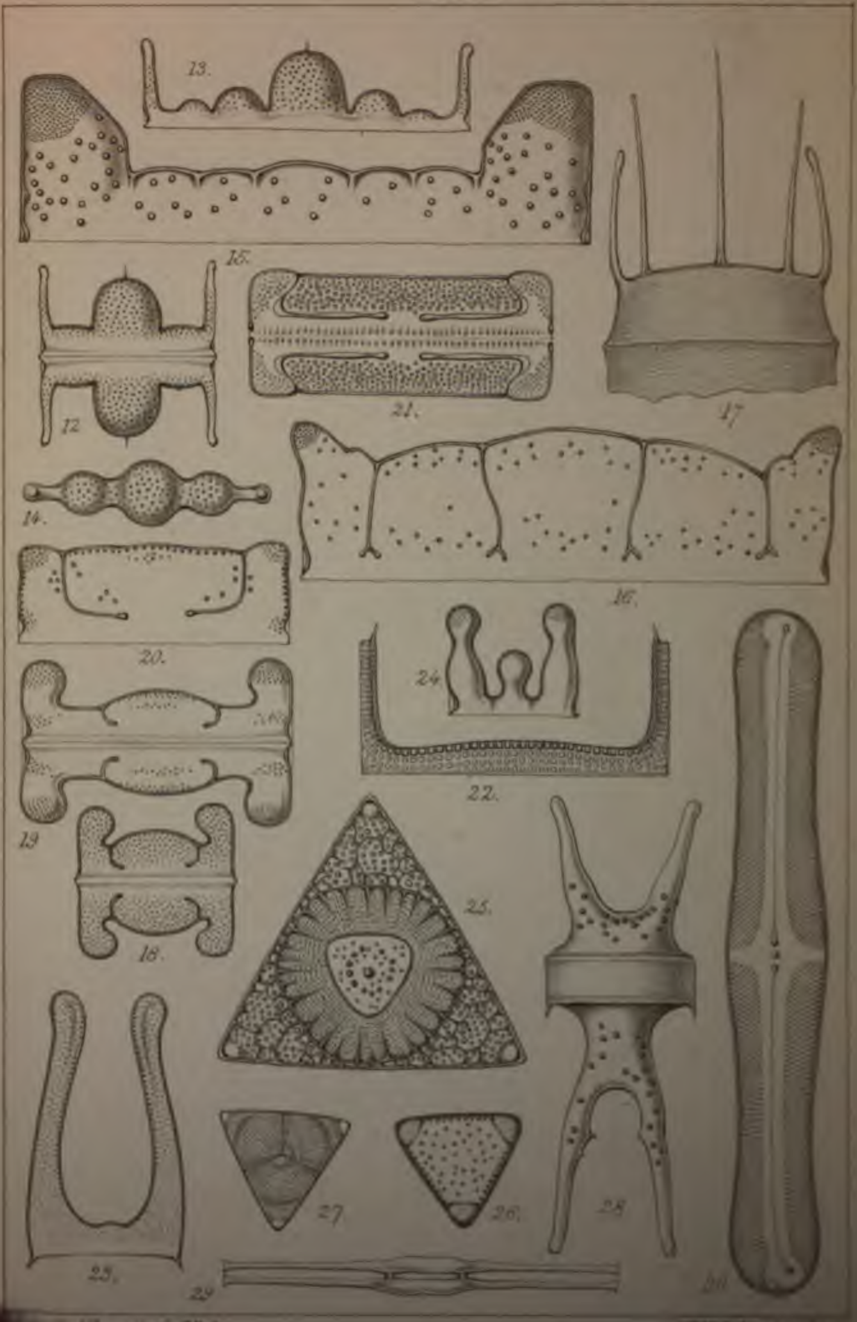
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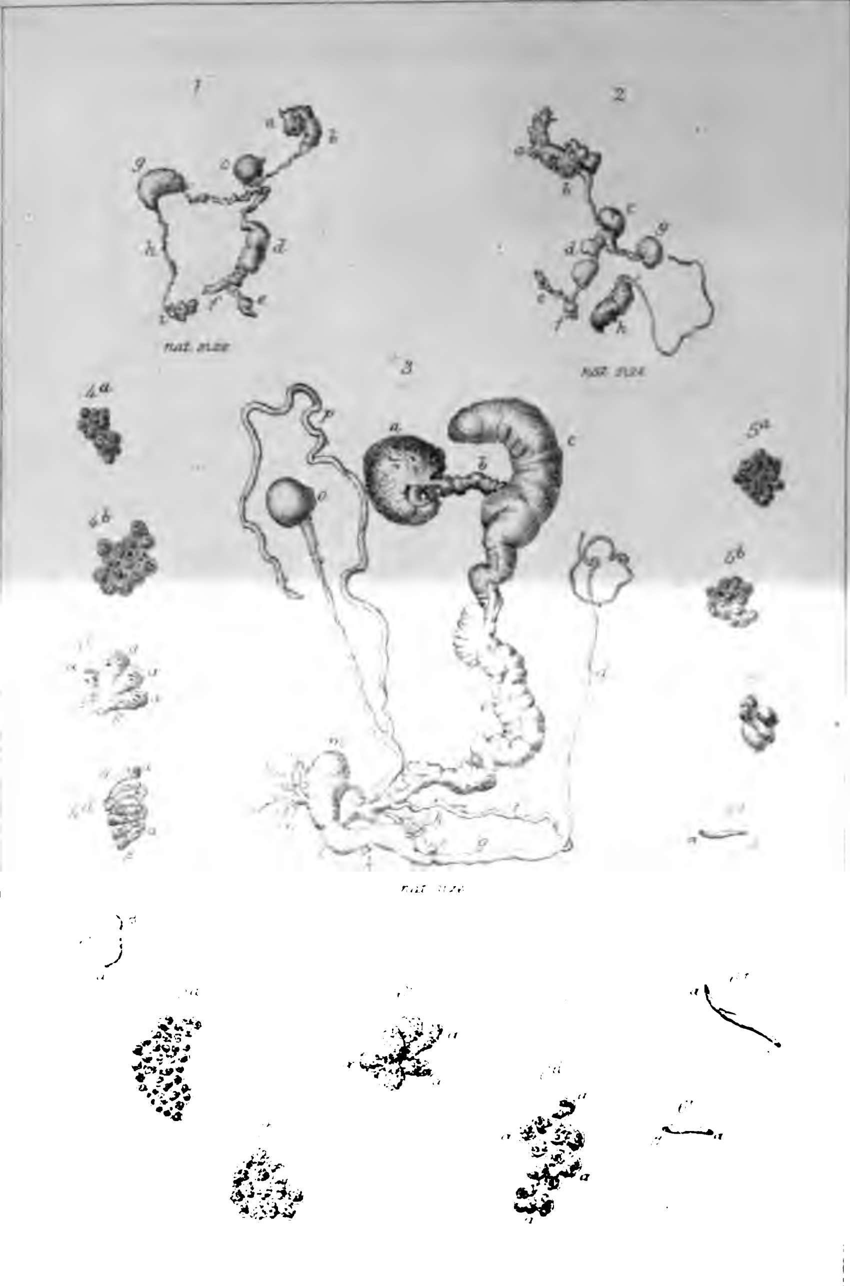
DESCRIPTION OF PLATES V & VI,

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

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

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



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DESCRIPTION OF PLATE VII,

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

Fig.

1.—Generative organs of *Planorbis corneus*, natural size.
- *a.* Dichogamic gland.
- *b.* Its enlarged duct.
- *c.* Albumeniparous gland.
- *d.* Oviduct, its enlarged portion.
- *e.* Spermatheca.
- *f.* Vagina.
- *g.* Prostate gland.
- *h*, *h*. Vas deferens.
- *i.* Penis.

2.—Generative organs of *Limnæus stagnalis*, natural size.
- *a.* Dichogamic gland.
- *b.* Its duct.
- *c.* Albumeniparous gland.
- *d.* Oviduct.
- *e.* Spermatheca.
- *f.* Vagina.
- *g.* Vas deferens; letter placed at its enlargement.
- *h.* Penis and its retractor muscle; letter placed on the muscle.

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

Planorbus corneus.

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

DESCRIPTION OF PLATE VII—*continued.*

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

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

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

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

Limnæus stagnalis.

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

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

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

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

Helix aspersa.

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

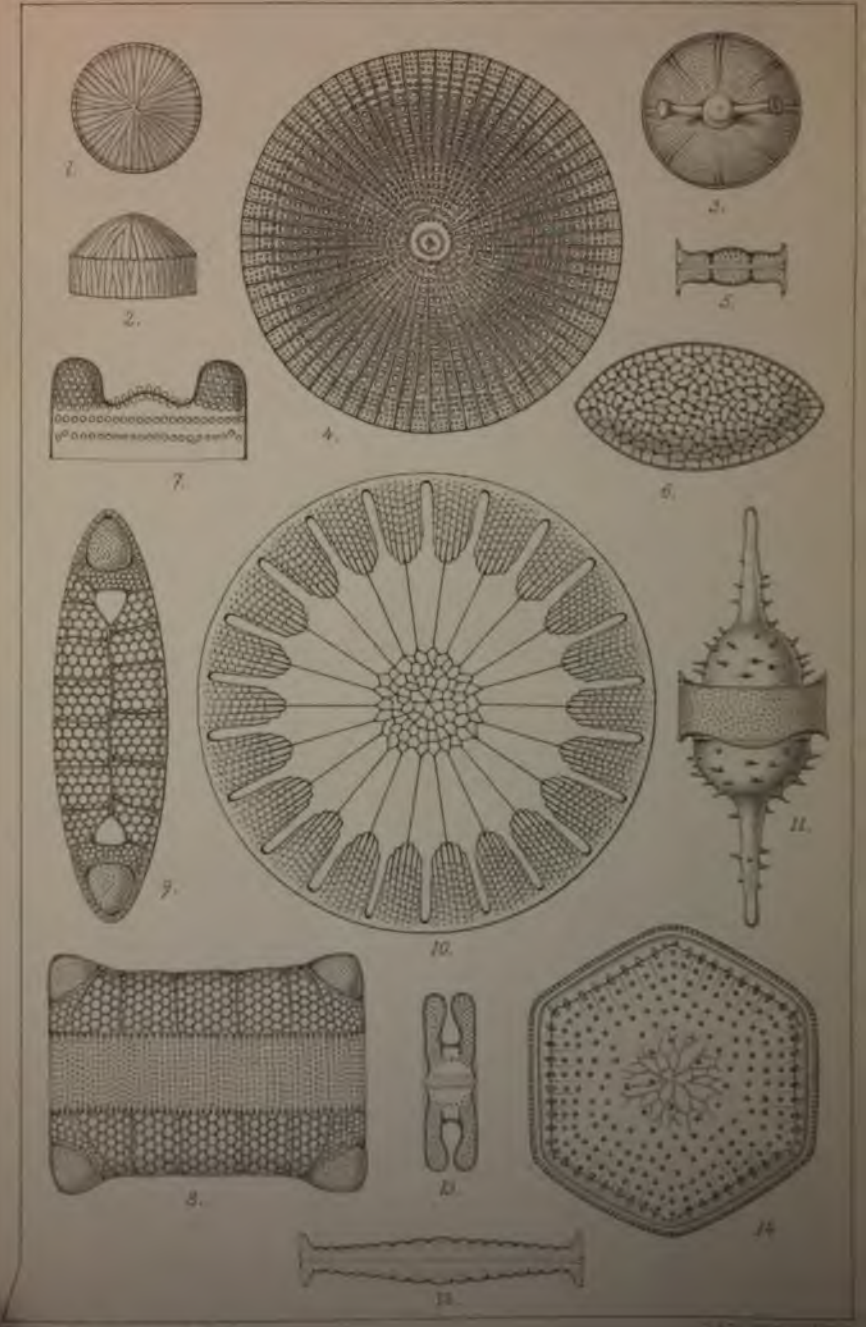
6*b*.—A group of older cells from same, measuring about ·0007″.

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

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

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

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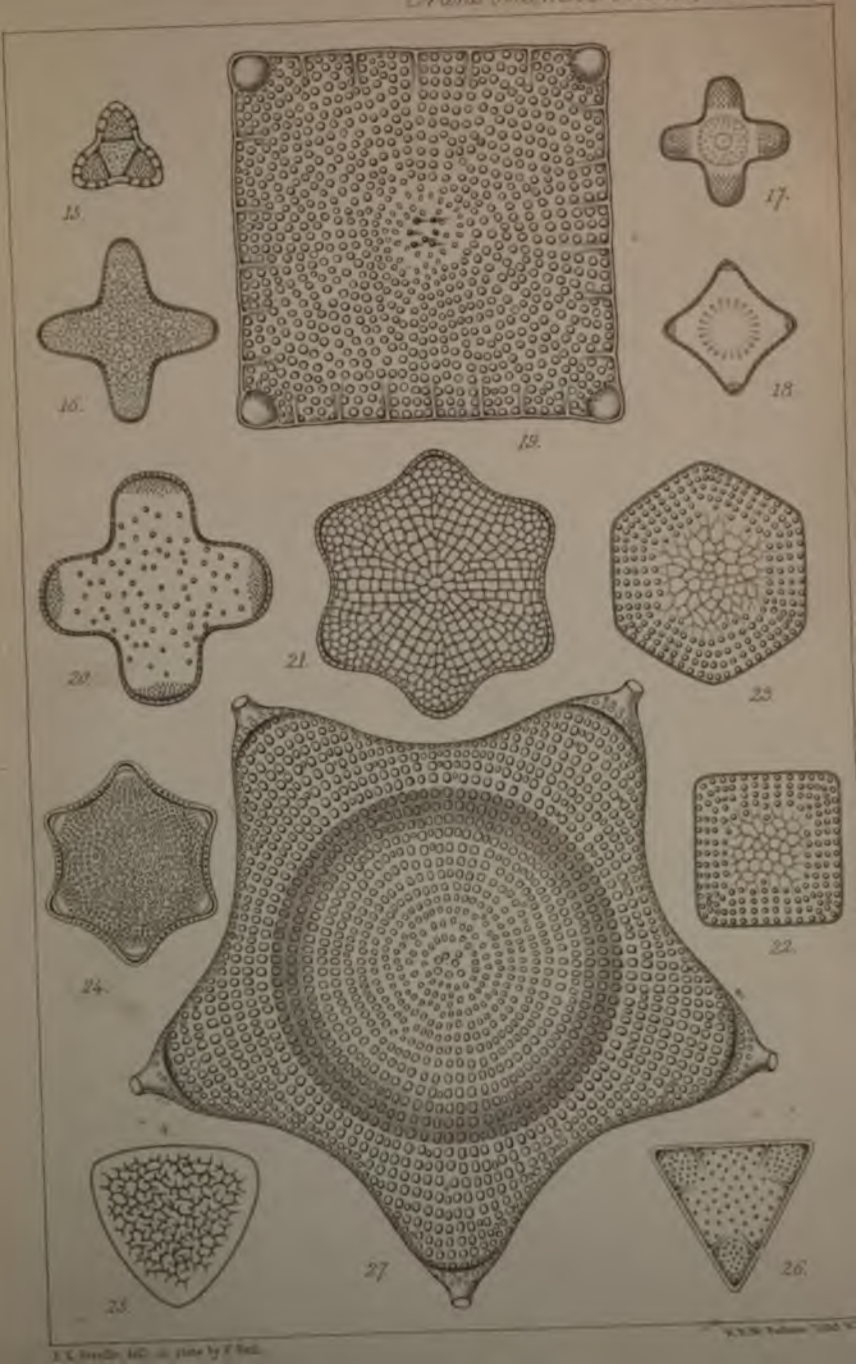
TRANSACTIONS OF MICROSCOPICAL SOCIETY.

DESCRIPTION OF PLATES VIII & IX,

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

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

All the figures are × 400 diameters.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