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TRANSACTIONS.

A few words more on BENJAMIN MARTIN. By JOHN WILLIAMS, Assistant-Secretary.

(Read Oct. 8th, 1862.)

IN the introduction to my description of the Martin microscope, read at one of the meetings of the Society during the last session, I gave some particulars of the life of Benjamin Martin, the constructor of that beautiful instrument. I was, however, unable to give any account of his early life. Since that time I have met with some additional information respecting that remarkable man which, although very scanty, may still be considered of interest by the Society, as supplying a deficiency in the former account. I have, therefore, with your permission, to call your attention to "A few words more on Benjamin Martin."

Since my last communication I have ascertained that Benjamin Martin was born of poor but well-conducted parents, at Worplesdon, a small town or village between Guildford and Woking, in Surrey, in the year 1704. He commenced his career in that neighbourhood at a very early age, as a ploughboy. Having a strong desire to acquire knowledge, and being gifted with extraordinary perseverance, he succeeded, by unremitting application, in teaching himself reading, writing, and arithmetic, and acquired such proficiency that he was able to undertake the instruction of others in those useful and necessary arts. Having also a strong inclination towards mathematical and philosophical speculations, after a while he abandoned husbandry, and, devoting himself to more congenial pursuits, persevered in such a course of reading and study as, in a great measure, compensated for the want of original education. How he supported himself during this time is not clear, but it was possibly by teaching, and he appears to have first employed himself in this way at Guildford. About 1735 he settled, as a schoolmaster, at Chichester; and there, about 1740, as appears from the advertisement quoted in my former account, he constructed his pocket reflecting microscope.

His first literary production was the 'Philosophical Grammar,' published without date, before 1735, which was succeeded by a number of useful introductory works, at the time they were published of great value to the student. He appears also, in one part of his career, to have read lectures in London on various branches of natural and experimental philosophy, which are said to have been well attended, and to have given much satisfaction.

I have taken some pains to ascertain the various works published by Martin, and have appended to this account as complete a list as I could make out. In the course of the necessary investigations for that purpose I have met with several curious particulars connected with them, and relating either to the author or to their publication, which may, perhaps, be of some interest. They are chiefly from incidental notices or advertisements in the works themselves. Thus, in the 'Young Man's Memorial Book,' published in 1736, at the end are two separate announcements of "Books published for J. Noon." In the first of these, which is of an earlier date than that of the book it is appended to, we read, "Just published, the 'Philosophical Grammar,' &c., &c. By Benjamin Martin." This was his first work. This announcement is succeeded by the following:—"November 20, 1735. Next week will be published, 'A New and Complete System or Body of Decimal Arithmetic,' &c., &c. By Benjamin Martin," thus giving almost the very day of the publication of that work, and also proving that the 'Philosophical Grammar' had not long preceded that date, viz., 1735. In the second announcement, which is evidently of the date 1736 (that of the work in which it occurs), we find, "In the press, and next February will be published, in two volumes, 'The Young Trigonometer's Complete Guide,' &c., &c. By Benjamin Martin." In the 'Description of both the Globes,' &c. (without date, but evidently published after Martin had opened his shop in London), we find an advertisement or notice, to which I call attention, as showing how widely spread was the renown that Martin had acquired as an optician. It is as follows:—"N.B.—Whereas the Jews, pedlars, &c., in all parts of England, sell visual glasses with the initials of my name (B. M.) upon them, and pretend on that account that they are of my make and were bought of me, I thought it necessary to undeceive the public, by assuring them that I never sold any to those who hawk goods about the country, they dealing in a sort of glass too bad for any but themselves to recommend, or for any one to buy who knows anything of optical glass, or has more regard to the safety of his eyes and the preservation of his sight than the saving of his money."

In the same work is given "A Catalogne of Philosophical, Optical, and Mathematical Instruments, made and sold by Benjamin Martin, at his shop, the sign of Hadley's Quadrant and Visual Glasses, near Crown Court, Fleet Street." The prices are mentioned, and among them we find, "Large parlour compound microscope, £3 13s. 6d.; ditto, in brass, £5 5s.; solar microscope, £5 5s.; Wilson's ditto, with apparatus, £2 12s. 6d.; ditto, small, £1 7s.; Dr. Lieberkuhn's opaque microscope, £2 12s. 6d.; ditto ditto, £3 13s. 6d.; aquatic microscope, £2 12s. 6d.; universal compound microscope, £5 5s.; pocket compound ditto, £2 2s." This list is curious, as showing the cost of various microscopes at that time.

Martin also published a few prints, of which a list is given: They were—'Synopsis of Celestial Science,' 1s. 6d.; 'Orbit of Comet of 1682 and 1759,' 1s. 6d.; 'Wonders of Cometary World Displayed,' 2s. 6d.; 'New Map of the World,' 1s. 6d.; 'Map of 460 Miles round London,' 6d.; 'Map of 20 Miles round London,' 6d.; Transit of Venus over the Sun, January 6th, 1761,' 1s. 6d.

In conclusion, I append a list of works published by Martin between 1733 and 1773, a period of forty years, which I have endeavoured to render as complete as possible. They amount to forty, and are:—'Philosophical Grammar' (the first of his works); 'Elements of Geometry,' 1733; 'Spelling-Book of the Arts and Sciences, for the use of Schools;' 'Decimal Arithmetic,' 1735; 'Young Student's Memorial Book,' 1735; 'Description of the Globes,' 2 vols., 1736; 'Memoirs of the Academy of Paris,' 1740; 'Panegyric of the Newtonian Philosophy,' 1734; 'On the New Construction of the Globes,' 1755; 'System of the Newtonian Philosophy,' 1759; 'New Elements of Optics,' 1759; 'Mathematical Institutes,' 1759-64; 'The Natural History of England,' 1759; 'Biographia Philosophica,' 1764; 'Introduction to the Newtonian Philosophy,' 1765; 'Institutions of Astronomical Calculations,' 1765; 'Description and Use of the Air-pump,' 1766; 'Description of the Torricellian Barometer,' 1760; 'Appendix to Description of the Globes,' 1766; 'Philosophia Britannica,' 3 vols., 1773; 'Philosophical Magazine and Miscellaneous Correspondence,' 14 vols.; 'New Principles of Geography and Navigation,' 1758; 'Familiar Introduction to Experimental Philosophy;' 'The Transit of Venus Explained;'

'The Theory and Use of Hadley's Quadrant Explained;' 'The Nature and Construction of Solar Eclipses;' 'Optical Essays on Curious Subjects;' 'The New Art of Surveying by the Goniometer;' 'The Principles of Pumpwork Explained;' 'The Young Gentleman and Lady's Philosophy,' 1759; 'A New Treatise on Perspective;' 'System of Optics,' 1740; 'Logarithmologia,' 1740; 'Philology and Philosophical Geography,' 1759; 'Philological Library;' 'Philological Grammar;' Description of both Globes, the Armillary Sphere,' &c.; 'Description of his newly invented Pocket Reflecting Microscope;' 'Bibliotheca Technologica.'

This list is taken partly from the works themselves, in which there are frequent advertisements of his publications, and partly from summaries in various biographical accounts of Benjamin Martin.

On CLEANING *and* PREPARING DIATOMS.
By J. A. TULK.

BELIEVING that a short description of the method of "Cleaning and Preparing Diatoms for Preservation," which I have found advantageous, may be of some service to those who are unacquainted with and about to commence the practice of that art, I am induced to record it; and if it be found to lighten their labours, and to produce the satisfactory results I anticipate, my object will have been accomplished. It is unnecessary to state where to look for diatoms, as that has been sufficiently pointed out by Professor Smith, in his work on the 'British Diatomaceæ,' by Dr. Arthur S. Donkin, in the sixth volume, 'Trans. Mic. Soc.;' by the editors of the 'Micrographic Dictionary;' by Mr. Ralph, in the fourth edition of 'Prichard's Infusoria;' by Mr. Roper, in the 'Trans. Mic. Soc.,' vol. ii; by Mr. Tomkins, in 'Recreative Science,' vol. ii; by Mr. Tuffen West, in 'Recreative Science,' vol. i; and by many other experienced writers, who, together with the above-mentioned gentlemen, have nearly exhausted the subject.

I will, therefore, commence with describing, as briefly as I am able, a plan for collecting, cleaning, and mounting a fresh-water gathering, taken from off the mud of a road-side ditch; and I may remark that any other description of gathering, guanoes and fossil deposits, may be cleaned and mounted in the same manner, of course omitting such of the detailed operations as are evidently unnecessary.

Diatoms are readily collected from the mud when the latter has only a few inches or no water at all over it, provided only it is in a moist state; and the plan I adopt, and which was suggested to me by my friend Mr. Currie, of Addlestone, is gently and lightly to detach the diatomaceous stratum lying upon the surface of the mud by the aid of a small, thin, old, silver salt-spoon, having its bowl-edge in the same plane as its shank; thus, the lighter and smaller the spoon is the more valuable it will be found to be. If carefully performed, by this operation a small portion of the diatomaceous stratum, in some cases entirely, in others almost entirely, free from siliceous particles, will be lifted, and may be transferred into the collecting bottle. It is as well to have in the bottle some water, into which the spoon can be immersed, when the forms will readily diffuse themselves in the fluid. Or if the mud from which the collecting is to be made has no water over it, but yet is moist, another method of gathering the forms may be adopted, namely, to roll over the diatomaceous stratum a rather large camel-hair brush, when the frustules will become entangled in the hairs of the brush, and may be separated from them by immersion in the water in the collecting bottle. Having by either of these means obtained a sufficient quantity of the material, and suppose it to consist of forms not quite clean, the next operation is to strain it through a piece of thin silk gauze, by which means any large pieces of vegetable matter are got rid of. It should then be placed in a small, unglazed saucer, with about $\frac{1}{8}''$ of water above it, and exposed for a few hours to the influence of the sunlight, which in many instances will cause the diatoms, which may be known by their brown colour, to rise to the surface of the impurities; and they may then be separated by means of a camel-hair brush rolled over them in the manner already described. Also in this case the diatoms may frequently be obtained absolutely pure, and requiring no further preparation than boiling in nitric acid and washing in clean water. However, it may be found that they have not risen to the surface of the impurities, or if they have, they cannot be collected by the brush free from silica, in either of which cases the whole of the gathering in the saucer may be transferred into a large, wide-mouthed bottle, six inches high and two and a quarter inches diameter inside, a few drops of nitric acid added to kill the forms, and the bottle two thirds filled with clean, it need not be distilled, water, and the whole well shaken. The mass is then allowed to subside, and the discoloured water poured off. This washing operation ought to be successively performed until the supernatant water remains colourless, for by this means a great deal of very minute matter is advantageously got rid of.

If it is thought advisable, the washed mass may now be subjected to the action of boiling sulphuric acid and chlorate of potash, according to the method described by Mr. Arthur M. Edward, in 'Jour. Mic. Soc.,' vol. vii; or if not, it may at once be transferred, if of considerable bulk, into a Florence flask; but if of only small amount, into a test-tube six inches long and one inch diameter, allowed to settle—the supernatant water being poured off as close as possible—covered by a quantity of strong nitric acid, sp. gr. 1·5, equal to its own bulk, and boiled for five or ten minutes. It is then poured into the large six-inch bottle, which should be about one half filled with clean water, with which it is well shaken, allowed to settle for twelve hours, when the acid water is poured from off it, and a similar amount of clean water again added to it. Again the fluid is violently shaken for upwards of five minutes, for the purpose of breaking down and getting rid of the flocculent siliceous matter or mucus with which the diatomaceous frustules are generally connected, and from which they can be completely separated by no other means that I am acquainted with, and for the knowledge of which fact I am indebted to the kindness of Dr. Greville, who communicated it to me.

The mass is again allowed to settle, until the superincumbent water appears tinged only with a slight milkiness; the water is then poured off. This operation of washing is successively repeated until the water, after standing for half an hour above the settlings and examined under a microscope, is seen to contain in suspension no very minute siliceous particles. Any larger particles which may be present will have subsided along with the forms, and will be got rid of in the next, the most important, operation.

The mass is now placed in a small, thin, flat-bottomed, porcelain evaporating basin, say of two and three-quarter inches diameter and half an inch deep, with so much water as will half fill the basin; the latter is put upon a table, and its contents allowed to subside, but not quietly, for during the subsidence a very gentle whirling or gyrating action is given to the water, similar to that by which the gold-washer separates the gold from the gravel in his round, iron washing-vessel. The diatomaceous frustules being comparatively light and of large superficial area, are more readily acted upon by the moving water than the solid, small masses of siliceous matter are, which, in proportion to their weight, are of small superficial area; the consequence is, if the whirling motion is gradually reduced in force until it is altogether discontinued, it will be found that the mass has arranged itself about the centre of the basin, the siliceous particles being below, and the diatoms lying as a stratum upon them. The latter may now easily be separated.

Again the slight whirling motion is given to the vessel, when immediately a cloud of diatoms is seen to rise up from the mass into the centre of the water. Into this cloud the capillary end of a small dipping-tube, three and a half inches long and a quarter inch diameter inside, is inserted, at an inclined angle, when at once a portion of the pure diatoms will enter it, and from this they may be blown into a small bottle. By successively performing this operation a very large proportion of the diatoms may be obtained in a pure state, and fit for mounting. However, there are certain heavy, compact forms, which will not readily rise in the whirling process, such, for example, as *Amphitetras antediluviana, Triceratium Favus, Biddulphia turgida,* &c., &c., which will be found at the bottom of the vessel along with the silica. These may be advantageously picked out with a fine needle under a simple microscope.

By a little practice and dexterity in the whirling process, so as to produce a less or greater amount of motion of the water, the lighter forms may be collected separate from those more dense, for the former will rise on a very gentle action being given, whilst the latter will require rather more motion to stir them.

The forms thus collected may then be washed in the small bottle two or three times with distilled water, when they will be in a satisfactory state for mounting.

It is requisite so to apportion the water in the bottle to the quantity of forms, as that when the latter are laid on the cover they appear to be neither too abundant nor too scant.

The slide and the cover about to be used should be made scrupulously clean, and this is best done by placing on them a small quantity of a solution of Ward's washing powder (a packet of which can be procured at any grocer's shop for one penny, and which will be found most useful for removing balsam or grease from slides), well rubbing them with the finger, and drying them with a clean cloth. Any filaments from the cloth should be picked off with a needle under the microscope.

The cover should then be made to adhere to a slide, by first breathing on the latter, and then pressing the cover down upon it with a needle-point.

The bottle containing the forms is now well shaken, and the small dipping-tube is immersed into the fluid to such a point that the liquid ascends into the tube about half an inch. The capillary opening of the tube is then made to touch the middle of the cover, when at once the liquid will diffuse itself over the latter, but will not overflow its edges. It is then dried very slowly under a large glass shade, otherwise the forms will segregate together, after which it is ready for mounting, either dry or in balsam. I will describe how the latter operation should be performed.

A drop of Canada balsam, taken out of the balsam bottle on the head of a common pin which has been immersed into it, is transferred to the centre of the slide, and the cover, one end of which has first been made to rest on the slide, gently laid over it, when, by capillary attraction, the balsam will diffuse itself through the forms and under the whole of the cover, and yet without extending beyond its limits. There are these advantages attending this plan: the forms being next to the glass cover, no considerable thickness of balsam has to be looked through when they are seen under the microscope, and by the use of the pin's head the quantity of balsam used may be so gauged as to necessitate no after-cleaning of the slide from superfluous balsam. The slide is then placed on its edge half an hour or an hour, when any air-bubbles which may have been entangled by the forms will have found their way out of the fluid balsam by the edges of the cover, after which the slide may be put aside to harden the balsam gradually, or it may be exposed to heat not greater than the finger can pleasantly bear, when the balsam will harden more rapidly.

The preservation of diatoms in a dry state is performed in the usual manner.

A ring of gold size is made on a slide by means of the whirling table, and over this a ring of asphalt when the former is dry. When the asphalt is dry, or nearly so, the slide is heated until the asphalt becomes soft, when the cover with the forms on it, as above described, is quickly placed upon it, and its edges pressed with a needle-point, so that they adhere to the asphalt at every part. The mounting may then be finished by placing another ring of asphalt round the edge of the cover. By this plan the asphalt will not run under the cover and spoil the preparation.

On the Photographic Delineation *of* Microscopic Objects.

By R. L. Maddox, M.D.

(Read Nov. 12th, 1862.)

On the construction of the microscope, its appendages and uses, much has been written; still it is to be marked, and with regret, that the page devoted to its conjoined application with photography bears so insignificant a proportion, when we see that the tendency of the present day is to employ each for the purpose of scientific observation and illustration. In a degree, this may have arisen from the trouble or difficulty peculiar to the study, and the paucity of attempts to reduce the art to a position calculated to advance its use. Doubtless, each individual has adopted methods peculiar to himself, which he has employed for some supposed, if not real, advantage; therefore, if only these, so far as they have been made known, were briefly enumerated, it would considerably guide others, and greatly tend to facilitate its use.

Yet it seems likely, without aid from opticians, that we shall be subject to perpetual vibrations, "without important additions;" nevertheless, it cannot be desired that we yield to our exigencies by assigning "a limit to the discoveries of future ages," prescribe to science her boundaries, restrain the active and insatiable curiosity of man within the circle of his present acquirements, and thus rather accommodate his wants to the narrow spirit of prejudice, neglect, and disappointment, than strive to participate in the common advancement of applied photography.

Unfortunately there is little encouragement given to advocate its use, even when its usefulness is acknowledged, and the common remark, that "its employment must be very limited, for, unless the object to be represented lies in one plane, you cannot, by the microscope, obtain definition over its entire surface," at once prejudices the question, and consigns us to still chiefly rely on woodcuts, with their errors, omissions, and the "distinct folds of their accustomed drapery." It should be remembered we are not in a position to limit its use, nor assign, without experiment or trial, the number of diameters an object, whether primarily or secondarily, can be enlarged, before the eye detects any offending error; rather would it be in harmony with the basis upon which the science of experiment has been reared to first acknowledge the want, then encourage the effort, and, no doubt, as in the parts now considered necessary appurtenances to the microscope, we should, ere long, find the deficiency supplied.

Again, much objection has been taken to the application of photography for obtaining drawings of microscopic objects, not simply, as stated, in an optical point of view, but also from the reason that we are accustomed to learn all we can of any object under observation by every means placed at our disposal, these being gathered, as it were, by the draughtsman, and combined by his skill to represent that which he has separately observed; whilst in the employment of photography we must rest content, if in one drawing, with what we consider the best general view of the object, or some particular part. Here, however, we have this advantage, there are no notable mistakes of relative magnitude, distance, or separation of parts, upon the strict correctness of which much in scientific observation depends; also, parts incapable of being easily, if at all, rendered by the hand can by its use be traced in more than mere outline; for it is possible, in very many cases, though needing considerable patience, to obtain some shadows and markings in objects which are commonly, if not entirely, ignored by the artist, even with the advantage of continued examination. Whatever may be his legitimate omissions, all must admire his great skill in beautiful delineation, and appreciate his work—work which will, no doubt, increase with the employment of photography for the purpose here advocated.

The general application of Mr. Wenham's excellent arrangement for giving sterecopicity to objects by means of the binocular microscope will, probably, tend to greatly alter the ordinary methods of rendering engravings or drawings of microscopic subjects, especially when viewed as opaque bodies, and we shall then, perhaps, be more ready to appreciate their photographic representation.

If we divide the advantages of photomicrography into their twofold character, we shall find the one derived from the facility with which an object can be rendered in its chief or general aspect, thus affording considerable assistance for its recognition by others, retaining in its freshness much intact, even in its minutiæ, which often becomes greatly altered when preserved in any of the usual media; whilst the other tends to an opposite direction, and points at once to the difficulty experienced when we attempt the photograph of portions or entire surfaces of minute objects with their details; the opprobrium and perplexity here combine.

The correctness of the position assumed will, I trust, be in part somewhat verified by the prints for your observation that accompany this paper. Untouched, unpressed, prepared with little care, they are simply intended to show the general and the partial application of photomicrography, and, however feebly they may represent either, the infancy of the art must be remembered, and the failings forgotten in the effort to render them more acceptable.

The midge, sand-hopper, Entomostraca, section of the pith of Hydrangea, of scalariform duct of Macca or Racca, the seaweeds, Fragilaria and Zygnema, will sufficiently illustrate its first application, and the prints of the several diatoms will show its employment in its second character; the former being casually mounted without preparation, the latter as commonly prepared by microscopists.

The apparatus may briefly be stated as a microscope attached by means of telescope tubes to an expanding camera, the whole fixed on a stout board, four feet six inches long, supported by double triangle legs; the illumination is either by a plane or concave mirror, or Abraham's achromatic prism, preference being given to the latter; the condensing lens, a Coddington of small angular aperture. Strong sunlight, if possible, is employed in all cases; a slow collodion, iron developer, and the ordinary means used to strengthen the negative, if, on examination by a lens, the details be seen sufficiently perfect. Slight obliquity of the light has generally been attempted, especially when the surface of the object was not flat. The long eye-piece has been occasionally used, and I think, gives what is commonly called "depth of focus," but certainly at a little loss of definition. The main difficulty lies, not in obtaining a negative, but one that, when nicely printed, gives something of the character of the object when seen by a weak, reflected light; for the prints may be said to scarcely resemble objects seen by transmitted light. In fact, we are hardly yet familiar with the representation of microscopic objects by its means, and therefore we rather at once unjustly revert to the illustration by engraving for a comparison. There is a considerable danger of producing a weak negative from over-exposure where the field is not well filled by the object, and especially if we seek to render the details when the object itself is coloured. Success appears to me much to rest, *cæteris paribus*, in the illumination of the object, in the plans for which there is a wide field, from ordinary daylight to concentrated sunlight, from the mirror to the prism, from the achromatic to the simple condenser, from direct to oblique transmitted light, from concentrated to obliquely reflected light, to which may be added polarized and artificial illumination and the employment of coloured media.

Finding how much the appearance of an object may be altered by the direction of the illuminating pencils, as will be recognised in some of the photographs of the Coscinodiscus, &c., where the focus remained unaltered, the plan of determining the constant focus for a certain objective and object has been seldom attended to, but in most cases trials have been repeated until the appearance of the negative seemed satisfactory, due regard being made for the common "over-correction" where necessary. As the objects are focussed in sunlight, it must be remembered there is a chance, without some care, of softening the cementing medium of the lenses of the object-glasses or of "firing" the object. The advantage of the prism was noticed more than three years since, and consists in the readiness with which the centring of the object-glass and condenser can be recognised on its surface, and a trifling alteration given to the course of the rays entering them.

A few stereophotographs have been taken by the plan suggested by Professor Wheatstone, also by the method proposed by Mr. Smith; the best negative was fractured by a fall, but its definition was barely satisfactory. That of the animal (parasite?) found on the Brittle Star was by the plan of masking the alternate half of the front lens of the objective, as also of the Brittle Star, seen by transmitted light. The print of the former appears rough, as the object was mounted without other preparation than gentle washing, its edges being covered by Diatomaceæ. No particular scale has been adopted as regards the magnitude of the image, it being generally preferred to render the object about the size usually chosen by microscopists; still many of the negatives will bear considerable amplification, if required.

However inadequately this subject is now placed before you, it possesses in itself a sufficient charm and interest to claim your attention to the extended variety of a "beauteous garniture" that can be made to unfold its exquisite tracery by the simple means advocated, enable us "to imitate, in some faint degree, and to admire, at least, where we cannot imitate, the perfection" that adorns even Creation's lowliest forms.

Descriptions *of* New *and* Rare Diatoms. Series VIII.

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

(Communicated by F. C. S. Roper, F.R.S.)

Plagiogramma.

Plagiogramma Robertsianum, n. sp., Grev.—Valve lanceolate, obtuse; costæ 2, centrical; striæ very fine, about 30 in ·001″. Length ·0018″ to ·0030″. (Pl. I, figs. 1, 2.)

Hab. Port Stephen, New South Wales; Dr. Roberts.

Unquestionably distinct, with finer striæ than in any species previously described. Indeed, under a moderately magnifying power, they are invisible. The frustules vary, to some extent, in shape and size; the more minute examples being somewhat elliptical, the larger ones narrower in proportion to their length, and, generally, slightly constricted below the apices, where a few very minute, raised points are situated. These come out most distinctly in the front view, but even then require careful adjustment.

Campylodiscus.

Campylodiscus ornatus, n. sp., Grev.—Valve nearly circular, much bent, with two bands of radiating canaliculi, the marginal one narrow, the inner one much broader, the canaliculi distant, with two rows of puncta between them; central space filled with faint, obscurely moniliform, radiating lines, and bordered with a row of oblong granules. Diameter ·0056″. (Fig. 3.)

Hab. On *Tridacna*, West Indies; F. Kitton, Esq.

An exquisitely beautiful diatom, having some relation to *Campylodiscus Horologium*, in its circular form, distant canaliculi, and intercanalicular puncta; but differing from it in the much-bent valve and in the double band of canaliculi, besides various minor points. In the inner band, which is about twice the breadth of the outer one, the long canaliculi alternate with very short, imperfect ones, while in the outer band they are all equal, and correspond in number with the perfect and imperfect canaliculi, taken together, of the inner band.

Campylodiscus Wallichianus, n. sp., Grev.—Valve circular, with a defined, broadly linear, central space; canaliculi about 48, concentric, with extremities very slender, and armed with minute spines. Diameter ·0040″. (Fig. 4.)

Hab. Dredged off St. Helena by Dr. Wallich, in from fifteen to forty fathoms. Harvey Bay, Queensland, and Port of France, New Caledonia, Dr. Roberts.

This most graceful species in some respects closely resembles my *Campylodiscus Normanianus.* The form of the central space is precisely similar, and the number of the canaliculi is about the same. It is, however, a much more delicate species. The canaliculi are far more slender; indeed, the sharpness and fineness of the lines are most striking at the first glance. Dr. Wallich correctly remarks, in his notes upon his St. Helena dredgings, which he has most kindly placed in my hands, that the canaliculi, when seen in a favorable point of view, exhibit themselves as the angular edge of elevated ridges. In an accurate sketch by him, now before me, the canaliculi pass quite across the central space, closely and very minutely beset with spinulæ; I have also seen a similar specimen from New Caledonia, but it is an exceptional case, as they rarely traverse more than a third of the distance, and often not so much. The irregularity, however, of the central markings in this genus are now too well known to have any influence over specific diagnosis.

Campylodiscus Robertsianus, n. sp., Grev.—Valve circular, with an oval central space and prominent radiating costæ of equal length, the ridge of which is composed of minute, oblong cellules, in pairs. Diameter ·0050″. (Fig. 5.)

Hab. Harvey Bay, Queensland; Dr. Roberts.

One of the most exquisite species of this charming genus. The valve is bent and concave. The costæ or canaliculi resemble sharply prominent ribs, along the crest of which are disposed longitudinally numerous minute, oblong cellules, in pairs, which in some lights might be hastily taken for short lines. The nearest ally of this remarkable species is unquestionably *C. diplostichus,* also a native of the Australian seas, where it was obtained from the stomachs of Ascidians by Dr. Macdonald. I am indebted to the kindness of Dr. Roberts, of Sydney, for a series of gatherings from the Southern Pacific, which, having very recently arrived, are mostly unexamined. I rejoice, however, in having an early opportunity of dedicating so well-marked a species to Dr. Roberts, who, from want of leisure, has been prevented from carrying out his intention of investigating the Diatomaceæ of the Southern Ocean.

Campylodiscus crebrecostatus, n. sp., Grev.—Valve nearly circular; canaliculi imperfectly radiating, very numerous, 6 in ·001″, forming a broad, marginal band, the outer portion being bent back, so as to form a ridge along the middle of the band; central space elliptical, closely filled with fine transverse costæ, interrupted by a narrow median line of blank space. Longest diameter ·0037″. (Fig. 6.)

Hab. Port Jackson, New South Wales; Dr. Roberts.

In a mounted slide presented to me by Dr. Roberts I find the beautiful *Campylodiscus* now described. In the dry preparation the valve is of a dark-blue colour. The canaliculi are fine and sharp, and the separation between the marginal band and the central space is marked by a very narrow blank line. The ridge which runs along the middle of the band of canaliculi is so prominent that, at first sight, there appears to be a solution in the continuity of the canaliculi, which, however, is not the case. The costæ in the centre are not in the slightest degree moniliform. It is a robust species for its size.

Navicula Lewisiana, n. sp., Grev.—Valve elongated, linear oblong; striæ very fine, parallel; median line terminating considerably within the apices in a linear, elongated nodule, the base of which rests in a socket. Length ·0076″ to ·0122″. (Fig. 7.)

Navicula, n. sp.? or sporangium of *N. rhomboides?* Lewis, 'Notes of Diatom. of the U.S. Seaboard,' p. 6, pl. ii, fig. 3.

Navicula, n. sp.? or sporangium of *N. rhomboides?* or *N. fossilis*, Ehr. Lewis, in 'Mic. Journ.,' n. ser., vol. ii, p. 161.

Hab. India (Sunderbunds); Dr. Wallich. Mud from oysters, St. Mary's River, U.S.; tidal mud from Savannah River, U.S.; marsh at Fernandina, Florida; Dr. F. W. Lewis. Mouth of the River Berbice; Dr. Abercrombie. Sierra Leone, in gathering communicated by Frederick Kitton, Esq.

Of this diatom Dr. Lewis remarks that "it is nearly allied to *Nav. rhomboides* and *crassinervia*, more particularly to var. β of the first named, and, perhaps, notwithstanding its marine habitat, ought to be regarded as a variety of one or other of these species." Dr. Lewis, however, at the same time registers it as a doubtful new species, and I am myself certainly disposed to consider it as really distinct. With regard to mere figure, the frustules of both *Nav. rhomboides* and *crassinervia* are decidedly lanceolate, whereas those of the diatom now before us have the sides nearly parallel at the middle, and although gradually narrowing as they approach the apex, are still, at that part, broadly rounded. And I am not aware that we have any authority for assuming that the sporangial condition would cause so radical a change in the frustular form. In the absence of any such evidence, it appears to be a safer proceeding to treat it as new. But the difference in form is, indeed, the least argument in favour of such a conclusion. The terminal nodules alone constitute an essential peculiarity. They are situated at a considerable distance from the apices, are elongated, apparently cylindrical, and are, besides, connected in so curious a manner with the median line, as to render an observation on that organ expedient before proceeding with my description. The term central or median line is, at present, used with great latitude, and seems to be held to include, not only the truly simple central line, which extends longitudinally throughout the valve, but also, in various instances, two additional lines which run close to and parallel with it. In the present case it becomes necessary to distinguish between them, and, until a better name be suggested, I shall call these additional lines the extra-median lines. In *N. Lewisiana* the true median line, which is very slender, passes to the base, and, as it were, supports the terminal nodule. The extra-median lines are very much stronger, incrassated, and somewhat convex opposite the central nodule, and on reaching the terminal nodules suddenly expand, increase in bulk, and embrace the lower part of the nodule exactly as a porte-crayon holds a pencil—a comparison which I perceive, from Dr. Wallich's notes, we have both made independently of each other. The frustule is diaphanous, even under considerable magnifying power, and the striæ strictly transverse and parallel, and so fine that they cannot be exhibited by the engraver. According to Dr. Lewis, they are 50 to 60 in ·001″, while Dr. Wallich makes them 85 in ·001″. I confess that I have been unable to estimate them satisfactorily. In the 'Microscopical Journal' (vol. ii, p. 155, n. ser.) is a partial reprint of Dr. Lewis's original pamphlet, in which this species is referred, with a question, to *N. fossilis*, Ehr., as well as to *N. rhomboides*, a suggestion which does not occur in the original pamphlet itself. That diatom, however, has, I believe, never been described, and we only know it by the figures in 'Mikrogeologie' (pl. 10 I, fig. 6). Judging from these figures, it is a minute species, with the striæ visible and highly oblique, a few radiating ones being very conspicuous opposite the central nodule. It seems quite clear, therefore, that it has no affinity with the very fine and curious diatom under consideration.

I have attempted in vain to render the frustule of *N. Lewisiana* stationary under examination, in order to obtain a drawing of the front view. That, however, given by Dr. Lewis, "linear and slightly inflated," appears to be correct. In one or two immaterial points this species is subject to irregularity. The terminal nodules vary in length, and the forceps-like receptacle is sometimes closed upon the nodule, while at others it slightly expands. The size of the frustule is also uncertain. The specimens from Sierra Leone are the largest I have seen, one in my possession being nearly a third longer than the individual figured. Those kindly communicated by my friend, Dr. Abercrombie, of Cheltenham, from Berbice, are generally small, and occur along with fine varieties of *N. permagna* of Bailey, which I hope to illustrate in a future paper. In the same gathering is also a long *Pleurosigma,* apparently intermediate between *P. Balticum* and *P. longinum.* (Brightwell, 'Mic. Journ.,' vol. vii, p. 180, plate ix, fig. 7.)

Navicula Johnsoniana, n. sp., Grev.—Valve somewhat convex, elliptical-oblong, with slightly produced, obtuse extremities, and a transversely rounded, stauros-like blank space in the centre; striæ very oblique, conspicuously lineato-punctate. Length ·0034″ to ·0040″. (Fig. 8.)

Hab. New Zealand; C. Johnson, Esq. Harvey Bay, Queensland, in a dredging communicated by Dr. Roberts.

Again I have the pleasure of recording one of the many discoveries of my esteemed and venerable friend, Mr. Johnson, of Lancaster. It is only recently that he detected the present diatom in his New Zealand slides, and kindly presented me with one containing several specimens. I had, however, scarcely prepared my description before I recognised the same thing in an Australian dredging transmitted by Dr. Roberts, in which it appears to be exceedingly rare. It is a somewhat remarkable species, being intermediate between the genera *Navicula* and *Stauroneis,* and I have been mainly induced to place it in the former, on account of the nodule being sufficiently definite apart from the rounded blank space into which it expands on each side, and because this blank space is unequal, being always larger on one side than the other, as in many *Pinnulariæ.* The most striking feature in the valve is the conspicuous, remote, oblong puncta, and the very oblique striæ into which they are disposed. The median line is prominent, and there is a straight parallel row of puncta on each side. A difference exists between the New Zealand and the Australian examples. In the former the frustules are oblong, the puncta larger, and the striæ 16 in ·001.″ In the latter the frustules are elliptical-oblong, the puncta much smaller, and the striæ 22 in ·001″. This is certainly a considerable discrepancy, but the recent study of these wonderful little vegetables has led to the conclusion that far too much importance was formerly attached to number in the markings, and that it would be desirable to establish characters, if possible, upon other grounds. I had prepared drawings of both forms; but not having room in the plate for both, I have given the Australian, on account of the more highly developed central-nodular blank space. In the New Zealand frustules it is very considerably smaller.

Navicula notabilis, n. sp., Grev.—Valve oval, with extra-median lines, and near them a parallel uninterrupted line of minute granules on each side, and with a band of marginal granules, composed of three or four longitudinal contiguous series, the intermediate wide blank space obscurely striated. Length ·0020″ to ·0030″. (Fig. 9.)

Hab. Cook's Reef, Torres Straits; G. Norman, Esq.

A singularly rich and delicate species, totally distinct from all that I am acquainted with. The whole valve seems to be made up of microscopic strings of beads. Even the extra-median lines which run close to the true median line are very minutely punctate. Then comes another straight line of fine granules on each side, scarcely more distant from the extra-median lines than they are from each other, not contracted in the slightest degree opposite the central nodule, and converging just before reaching the ends. Between these lines and the margin the space is divided into two equal parts, the one being blank, or at least only obscurely transversely striated, the other filled up with about four rows of granules, following the curve of the margin. The two inner of these rows are distinctly defined; the others are more or less confluent. The only variation I have observed is in size and in the tendency of the smaller specimens to approach a circular form.

Navicula luxuriosa, n. sp., Grev.—Valve elliptical, somewhat obtuse; striæ composed of distinct oblong puncta, so arranged as to form longitudinal lines contracted opposite the nodule; the margin, as well as an intra-marginal line or ridge, also composed of close puncta. Length ·0030″ to ·0038.″ (Figs. 10, 11.)

Hab. Port Stephen, New South Wales, in a dredging communicated by Dr. Roberts.

It is utterly impossible for the pencil to convey any idea of the exceeding beauty of this little object. Under a moderately magnifying power the delicate striation is scarcely perceived; but the intra-marginal line at once strikes the eye, as well as the indication of wavy longitudinal lines. Under a higher power the surface of the valve is seen to be undulated; the intra-marginal line, especially, forming a prominent ridge, leaving a sort of channel between it and the margin. The median is accompanied by parallel extra-median lines, straight at the sides and converging towards the ends. Then follow three longitudinal, convex lines of puncta, contracted opposite the nodule, at which point they occupy a space of about half the distance from the nodule to the margin. The only species which appears by description to approach this diatom is *N. costata;* but on consulting the figure given by Kützing ('Bacill.,' plate iii, fig. 56), it is evident that there is no connection whatever between them. The latter has no extra-median lines, and although the valve is said to be "longitudinaliter punctato-costata," the punctate character arises, not from puncta in the direction of the transverse striation, but from circular puncta arranged at intervals along either one or two longitudinal lines. The remarkable intra-marginal line of puncta so conspicuous in *N. luxuriosa* is wholly wanting.

Navicula? Cistella, n. sp., Grev.—Valve quadrangular, about twice as long as broad, the angles rounded and somewhat dilated; surface marked with delicately punctate, longitudinal lines; transverse striæ very fine, parallel. Length, ·0015″ to ·0025″. (Figs. 12—14.)

Cocconeis? quadrata; Roper, MS.

Hab. Dredged off Lyme Regis, in eight fathoms' water by the Rev. J. Guillemard, 1855; F. C. S. Roper, Esq. Harvey Bay, Queensland, in a dredging communicated by Dr. Roberts, of Sydney; not unfrequent.

It is not a little interesting that after I had described this ambiguous, minute diatom from the antipodes, I should be informed by my most obliging friend, Mr. Roper, that it was actually discovered some years ago on our own shores. The very accurate drawings made by himself in 1855, and now lying before me, leave no doubt to be entertained on this point. But the real nature of the frustule seems to have been doubtful from the first. Mr. Roper regarded it as possibly a *Cocconeis.* The late Professor Smith, to whom specimens were submitted, could make nothing of it, and would not venture to refer it to any genus. In now publishing it as a doubtful *Navicula,* my object is to attract such attention towards it as may lead to its generic settlement. Looking at the side view, it is certainly as much like a *Cocconeis* as a *Navicula;* but the front view, which Mr. Roper had not seen, seems to point more towards the latter. After all, that acute diatomist may be correct in his conjecture (*in litt.*), that it may belong to an unknown filamentous form. And, indeed, before I had communicated with him, I had myself remarked in my MS.,—"So little, indeed, does the frustule resemble a *Navicula,* that in hastily passing the slide across the field of view it might be taken to belong to one of the *Melosireæ.*" It must be understood, therefore, that its present position is simply provisional. The valve is somewhat opaque, and varies considerably in size and in relative length and breadth; the ends are very slightly convex, rounded and inflated at the corners, and the sides generally more or less convex opposite the central nodule, very rarely straight. The longitudinal lines are curved outwards opposite the nodule, in number about 21 in ·001″, and most exquisitely punctate. The transverse striæ are fine, and require careful manipulation for their resolution. The front view has straight sides and ends, the angles rounded. The whole frustule is very solid and compact.

AMPHIPRORA.

Amphiprora oblonga, n. sp., Grev.—Large; front view oblong; wings not deeply constricted; greatest breadth at a point about half way between the constriction and the ends; curve of the lateral plates reaching the constriction. Length ·0060″ to ·0085″. (Fig. 15.)

Hab. Harvey Bay, Queensland; Dr. Roberts.

Here is a large *Amphiprora*, which I cannot refer to any described species, and yet it may be found eventually to be merely an extreme aberrant form. Unfortunately, although I have seen many examples, I have been unable to fix upon any side view as indubitably identified with it. If I knew any described species to which I could trace it, even as a remote variety, I would gladly do so; but the very circumstance of this perplexity renders a figure desirable, and I give it a provisional name, which may be cancelled whenever its relations shall have been conclusively established. Specimens occur much larger than the one figured, and, consequently, greatly exceeding in size *A. maxima* of Gregory, with which I was at first induced to compare it. But that diatom is very much more broadly truncate, the widest part being near the ends and the constriction very deep, whereas, in the present species, the widest part is halfway between the end and the constriction, and the latter comparatively quite shallow. The character of the marginal curve in the two species appears to me to be essentially distinct. It would require a careful examination, however, of a long series of examples of the different species in order to ascertain finally how much dependence may be placed on the character to be derived from the curve of the lobes. My own impression is that a peculiarity exists in the curve of most of the species, especially when taken in connection with the constriction, which may be recognised throughout all the variations of each species. This, however, is only an impression produced on my own mind after, it must be confessed, a too limited suite of observations. I find that Dr. Wallich obtained an *Amphiprora* at St. Helena, which he also compared with *A. maxima;* but he remarks in his notes, written at the time (accompanied by a very careful sketch), that the curve of the lobes is different. They appear, indeed, to differ both from those of *A. maxima* and the subject of the present notice.

TRANSACTIONS.

MICROSCOPICAL SOCIETY.

ANNUAL MEETING.

Report of Council.

According to custom the Council have to make their annual report on the progress and state of the Society during the past year.

The number of members reported at the last anniversary was 317. During the past year 31 members have been elected, making a total of 348. This, however, must be reduced by 11 resigned, making a final total of 337. It is with much satisfaction the Council have to state that no deaths have been reported during the past year.

The reports of the auditors, and of the library, the cabinet, and instrument committees, will give the necessary information as regards the finances, the additions to the library and cabinet, and the state of the instruments at present belonging to the Society.

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

Report of Committee for investigating the condition and performance of the Society's Microscopes.

We have to state that the object-glasses belonging to the Society are all in serviceable condition, and the best of their date. Their performance is equally creditable to their respective makers. But as such improvements have since been made that they must be considered inferior to what most of the members are now in the habit of employing—these improvements consisting of increased aperture, more perfect flatness of field, and superior definition—we recommend that a set of object-glasses, up to $\frac{1}{4}$ inclusive, be purchased by the Society for the instruments now in their possession by the respective makers, and also achromatic condensers; those belonging to the Society being very imperfect.

In addition to this there is great need for a parabolic condenser, or some approved form of dark field illumination.

Mr. Ross has made a most munificent offer through Mr. Reade, stating that, on returning his old instrument, now in our possession, he will present the Society with a new one, having the binocular arrangement and all accessories, with a set of new objectives up to $\frac{1}{8}$th. We have accepted this offer on behalf of the Society.

Names of Committee,

C. Brooke.
E. G. Lobb.
Dr. Miller.
Rev. J. B. Reade.
F. H. Wenham.

Report of the Library Committee to the Council of the Microscopical Society.

The large additions made to the Library in 1861 have rendered unnecessary any purchases during the past year, but your Committee have to report an accession of thirteen volumes and seventy-nine pamphlets, &c., presented to the Library since our last anniversary—the number of works lately acquired being more than the present book-case can well accommodate. Your Committee, with the sanction of the Council, are about to procure another, which they trust will make the entire Library more available for the members. They also wish again to draw the attention of the members to the fact, that the three volumes of 'Original Transactions,' with many interesting plates, may still be had at the reduced price of One Guinea.

Jno. Millar.
F. W. Roper.

AUDITORS' REPORT.

RECEIPTS.

	£	s.	d.	£	s.	d.
By Balance from previous year				33	1	1
Admission Fees of 29 new Members				30	9	0
Compositions				94	10	0
Dividends on £652 12s. 8d. Consols				18	16	10
Annual Subscription—						
For the year 1858	1	1	0			
„ „ 1859	2	2	0			
„ „ 1860	8	8	0			
„ „ 1861	30	9	0			
„ „ 1862	170	2	0			
„ „ 1863	47	5	0			
				259	7	0
				£436	3	11

PAYMENTS.

	£	s.	d.	£	s.	d.
To Salary of Assistant Secretary				21	0	0
„ Curator				8	0	0
Editors of the 'Microscopical Journal'	145	19	0			
Postage and Delivery to ditto	10	19	6			
				156	18	6
Rent				25	0	0
Expenses of Soirée, viz.—						
Fittings and Gas	4	17	10			
Refreshments	19	15	0			
				24	12	10
Printing, Stationery, &c.—						
Printing	12	2	0			
Books	2	11	0			
				14	13	0
Subsription Ray Society				2	2	0
Commission on Collection of Subscriptions				19	6	0
Assistant Secretary for Petty Expenses				6	4	7
Lamp Oil, &c.				4	13	0
Balance in hands of Treasurer				153	14	0
				£436	3	11

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 £652 12*s.* 8*d.*, and the balance in favour of the Society being £153 14*s.*

W. HISLOP.
RICHARD BECK.

The President then delivered the following Address:

The President's Address *for the year* 1863.

By R. J. Farrants, Esq.

Gentlemen,—This is the twenty-third anniversary of the Society. In the usual retrospect of our affairs for the past year, the subject which, on this occasion, properly has precedence is the *proceedings* (and their result) *of the Committee* appointed at the last annual meeting to confer with the Council on "the publication of our 'Transactions,' and the supply to the members of the 'Quarterly Journal of Microscopical Science.'" Your Committee, having inquired into the matter referred to them, made a report to the Council, which led to a conference between that Committee and a Committee of the Council appointed for the purpose. The whole subject was fully considered at the conference, and a course of action recommended to the Council, in conformity to which they resolved to rescind the agreement then in force. This having been done, proposals were offered by the editors of the 'Journal,' to which the Council assented, and a new arrangement was settled, to take effect from the commencement of the present year. This arrangement the Council believe to be a fair one, and trust it will be mutually advantageous to the parties interested in it. While it continues in force the members of the Society will be supplied with a copy of the 'Journal,' together with the 'Transactions,' as has been usual of late years, and our finances be considerably benefited.

The reports which have been read show a satisfactory state both as regards members and finances. It is gratifying to find that the number of members suffers no diminution, notwithstanding the establishment of numerous provincial societies with similar objects to our own. The existence, in full activity, of the Microscopical Societies of Bradford, Hull, Manchester, Newcastle-on-Tyne, and Southampton, is known to us by their proceedings published in the 'Microscopical Journal.' I hope, however, the Metropolitan Society will still continue a centre of union to many, if not to all engaged in microscopical observations. That this hope is not groundless is proved by the steady increase of the number of members shown by the annual reports of the last ten years.

In 1853	the total number	of members was	207
„ 1854	„	„	228
„ 1856	„	„	241
„ 1858	„	„	267
„ 1860	„	„	285
„ 1862	„	„	317

We now have 337 members contributing to our funds, many of them contributing also to our 'Transactions,' and, still more, regularly attending our meetings, and taking part in the proceedings. This increase is not accidental, it is continuous and regular, and may be fairly referred to the operation of a cause connected with the constitution and character of the Society.

Happily there are no obituary notices; at least, I am not aware of the death of any member during the year.

I am pleased at being able to speak favorably of the progress made in the improvement of our collection of objects, so long an opprobrium to us.

In 1858 the cabinet contained only .	351	slides.
„ 1860 the number had increased to	663	„
„ 1862 the number was	882	„

And now, by presentations during the year, and some purchases which, for the first time, the Council have been able to make from the Society's funds, the number is raised to 1100.

I am also now able to tell you that the Council have determined to appropriate a portion of the balance at their command to improving the microscopes of the Society. A committee has been appointed to examine the instruments, objectives, &c., to settle what is most urgently required, and to advise the Council as to the best mode of procedure. The deficiencies at present are confessedly very great, but we hope soon to have sets of objectives of the best construction, with the latest improvements, of the eminent makers of the respective instruments, so that the glasses accompanying them may again be, what they originally were, the best attainable, and examples of what the science and skill of our leading opticians enable them to accomplish.

And now I have much pleasure in communicating to you a most generous act of Mr. Ross. When spoken to on this subject, he spontaneously, liberally offered to present to the Society one of his best microscopes, with objectives and apparatus complete, to replace the old but excellent instrument made for the Society in 1841 by the late Mr. A. Ross, his father. I am authorised to state that an instrument for this purpose is now in hand, and, when completed, will be presented to the Society.

Messrs. Powell and Lealand, and Messrs. Smith, Beck, and Beck will supply any objectives required of them, at prices which will leave them no gainers by the transaction, and will barely cover the cost of production. Messrs. Smith, Beck, and Beck also write me as follows:—"Having been informed that Mr. Ross has promised to present to the Society one of his best microscopes, complete in every respect, we have considered whether we should, on our part, make any gratuitous addition to the above offer (which refers to the liberal terms on which they will supply any glasses ordered from them); and we have determined not to do so at present. The existing arrangements of the Society admit of so few and of such short opportunities for the use of the microscopes by the members, that any increase in the present number of instruments would confer no real benefit in any way. Whenever the Society may provide fit accommodation for the proper use of good serviceable microscopes, as well as the means of frequent access to them, the gratuitous contributions then from most, if not from all of the makers, will, no doubt, be very considerable. We are quite prepared to do our part; but probably a present of more than one stand, or some arrangement of instruments adapted to the particular wants of the members generally, would be of more service to the Society than merely another complete microscope, many of the accessories to which would probably never be used. That the future of the Society may be so prosperous as to test this promise of ours to the utmost, and at no distant period, is the sincere wish of yours very truly, "SMITH, BECK, AND BECK."

Last year, on this occasion, I was fortunate in having to announce the gift to the Society, by Mr. Peters, of his instrument for microscopic writing. Soon after it was known that this instrument was in the possession of the Society, intimations were given to the Council that it would be an acceptable addition to the collection of wonderful objects then being prepared at South Kensington. The Council were led to believe they would not be justified in withholding from public inspection an instrument so ingeniously contrived, and by the use of which such marvellous results had been attained. Finally, the Council determined on sending it to the International Exhibition. It was admitted to the building on Monday, May 5th; on Wednesday, 7th, a notice of it appeared in the 'Times,' which at once directed public attention to it; and it continued to excite much interest during the whole of the time the Exhibition was open to the public. The simplicity and completeness of its arrangements were highly commended by those, foreigners or countrymen, best able to appreciate the difficulties to be overcome, and the admirable manner in which the task was accomplished. I have much satisfaction in adding that a medal was awarded to Mr. Peters, as the award states, for ingenuity of construction. The instrument is now, by permission of the Council of King's College, in their museum.

The International Exhibition afforded an opportunity of comparing the microscope stands and glasses of English and foreign makers. In this competitive examination the English opticians fully maintained the supremacy which, by general repute, was assigned to them; indeed, anything nearer to perfection than a first-class microscope, as supplied by the principal London houses engaged in the manufacture of these instruments, can scarcely be expected. The makers, however, are not content to remain without striving still further to improve both stand and glasses.

Messrs. Powel and Lealand now regularly supply a $\frac{1}{25}''$ objective, remarkable for clearness of definition, of large but not extravagant aperture. The demand for these glasses, I am informed, far exceeds the expectations of the makers: this I believe is, in great measure, owing to the fact that the combination allows sufficient space between it and the covering glass to render its use comparatively easy and agreeable, instead of merely possible.

Mr. Ross has greatly improved his microscope stand by various additions and alterations. The rotating stage is now only one third of its former thickness, and being well chamfered on its under side, there is a large increase of working room for all the illuminating apparatus used beneath the stage; the mechanical stage has been also reduced one third of its former thickness. By the use of the same diameter of tube as that adopted by Messrs. Smith, Beck, and Beck, the whole of the sub-stage, with the apparatus fitting into it, has been very much diminished in bulk. This is also one more step towards uniformity of size in the fittings of first-class microscopes by the various English makers. Both the circular part of the main stage and also that of the sub-stage are graduated; the former enables the instrument to be used as a goniometer, and the latter will be found very useful in investigations with polarized light.

To the mirror has been added a double arm, for the more efficient resolution of lined objects by simple oblique light.

The whole instrument has been reduced more than one third in weight, and as this has been accomplished by a simplification of the construction, and reduction of unnecessary thickness in the upper and moving parts, its steadiness has thereby not been impaired.

Such is a description of the instrument intended for the Society, which, by the kindness of Mr. Ross, I have had an opportunity of inspecting and examining.

Mr. Ross has also constructed a new achromatic condenser, giving a large field with great intensity, intended for use with both high and low powers: it adapts to the diaphragm plate of the microscope, for the modification of the illuminating pencil, and, in combination with the polarizing prism, will be found a great advantage, as in polarization one half of the light is thrown away.

The "Kelner's Orthoscopic Eyepieces," though not new, have this year met with a very greatly increased demand, due to the recognition of the advantage which their very extended field gives for purposes of exhibition.

An improved compressor consists of a base plate, across which is fitted a dovetailed slide, carrying the lower glass. At one end of the base plate is another short, vertical, dovetailed slide, moved by a milled head and screw; and again on to this, parallel to the base plate, a frame, which holds the upper glass. Both glasses can be removed for cleaning with great facility; the pressure applied is completely under control, and as the glasses remain parallel whatever the separation, the object under manipulation is not slid about by unequal pressure.

Messrs. Smith, Beck, and Beck remark, "The most noticeable feature of the past year has been, that microscopists are returning to the use of object-glasses of moderate aperture, but with the corrections made as perfect as possible." This they think "may be attributable to the introduction of the binocular principle, which opens up a new field of observation amongst general objects which mostly require illumination from above." Very few of the better class of instruments, I am told, are now made with a single body, and great numbers have been returned to the makers, to have binocular adaptation.

From memoranda kindly furnished by the three firms above-mentioned, I am able to state that the demand for microscopes has continued to increase, "in spite of the bad state of trade generally, and the entire stoppage of any supply to America." The number of microscopes sold by these three houses during the year is considerably above 600; "the sale of instruments of the very highest class maintains its full proportion of increase;" the number exceeds 100. One of these houses alone has supplied to the public during the last year 360 object-glasses of the very highest character.

The demand for mounted objects for the microscope is, I learn, proportionate to the demand for instruments; so great indeed is it, that it is with difficulty the supply keeps pace with it.

We have had the usual number of ordinary meetings, with the usual annual *soirée*, the full attendance at which may be accepted as additional evidence of the interest taken by a large portion of the public in microscopical pursuits.

Our members have not failed to furnish material for consideration and discussion at the ordinary meetings. On one evening only the Council were not provided with a written communication to submit to the meeting, and on that occasion the unusual and unexpected deficiency was amply compensated by the valuable observations and interesting discussion elicited on subjects extemporally introduced by the Rev. J. B. Reade and Mr. H. Deane, which I shall presently have to notice.

We have had several communications on methods of preparing objects for examination with the microscope:—

1. The first of these was "On the Preservation and Mounting of Microscopic Objects in Minute Tubes." By Dr. Guy. (Read March 12th; published in 'Trans. Mic. Soc.' vol. x, N. S., p. 77.)

The mode of preparing the tube, introducing the object, and securing it, by sealing both ends of the tube, are fully and clearly explained, and the classes of objects to which the method is especially adapted are indicated. Such are chemical sublimates, as of arsenious acid, antimony; some volatile chemical substances, as camphor, iodine, sulphur, &c.; small seeds, pollen, and starch, and small "cylindrical objects, as the antennæ of insects, and the stamens and pistils of most plants." Minute insects, also, may be well preserved in this way. The advantages of the plan, when appropriate, are, the objects are preserved from pressure or distortion, and the necessity of using any preservative medium is superseded, as the exclusion of air and moisture, by sealing the tubes at both ends, answers every purpose of preservation. Specimens of objects thus mounted were exhibited. One particularly remarkable was a stamen of the rhododendron, which had been enclosed in the tube more than nine months, and was then as fresh and clear as when first introduced.

2. "On a Revolving Disc-holder for Opaque Objects." By Mr. Richard Beck. (Read June 11th; published in 'Trans. Mic. Soc.,' vol. x, N. S., p. 101).

The author gave a short description of the apparatus which is designed to facilitate the examination of objects under

Lieberkuhn illumination, and the instrument was exhibited. It affords ready means of bringing into view any part of the object under examination: it has many advantages over the usual forceps attached to the stage, for which it is a convenient substitute. The author states that, by the use of this little instrument, he has "ascertained many facts which he never could satisfactorily determine before."

A. 3. A paper "On Cleaning and Preparing Diatoms," by J. A. Tulk," communicated by Dr. Millar, was read October 8th., published 'Trans. Mic. Soc.,' vol. xi, N. S., p. 4.

The author gives directions for collecting the diatoms, so that from the first the gathering may be as free as possible from foreign admixture. He then explains how all inpurities unavoidably present may be removed. Finally, he gives full details of the manner of mounting the prepared specimens either in Canada balsam, or in the dry way. Many a microscopist, without doubt, will gratefully acknowledge his obligations to the author for these practical hints.

At our last meeting, when there was no paper, the Rev. J. B. Reade communicated a method of separating Desmidiæ, which he had practised with great success. It consists in taking advantage of the endowments of the living organisms, whence it results that they become firmly attached to appropriate surfaces, while any impurities that may be mixed with them may be readily diffused through the water which contains them.

Putting the gathering into a wide shallow vessel, as a common soup plate, and covering it completely with water, the whole is set aside for ten or twelve hours, by which time the living organisms will have become fixed to the surface of the plate; then, by slightly tilting the plate, and gently agitating the water, the foreign substances will be diffused through the liquid, and by pouring off the water, will be removed with it; this may be repeated, if necessary, without detaching the Desmids. Finally, having added a little clean water, the Desmids may be gently separated and easily transferred to the receiving bottle perfectly clean and free from all foreign matter.

Two papers were read "On the Application of Photography to the representation of Microscopic Objects as seen through the Microscope."

4. The first of these, "On Micro-Stereography," by Mr. J. Smith, was read May 14th.

The plan adopted by the author to obtain match pictures was to cover in succession the right and left half of the objective, and to take a picture in each state. By this method he succeeded in getting pairs, which, combined, gave good stereoscopic effects.

5. The second of these papers, "On the Photographic Delineation of Microscopic Objects," by R. L. Maddox, M.D., was communicated by Mr. Shadbolt. (Read November 12th; published 'Trans. Mic. Soc.,' vol xi, N. S., p. 9.)

The author, admitting the difficulties attending the attempt to produce well-defined and useful representations of objects as seen through the microscope, and that pictures so obtained can at best only give a general view of an object or of some particular part, still regards the process as advantageous, because in the pictures there can be "no notable mistakes of relative magnitude, distance, or separation of parts, upon the strict correctness of which much in scientific observation depends; also parts incapable of being easily, if at all, rendered by the hand can by its use be traced in more than mere outline." Strong sunlight, if possible, is used on all occasions, though this is attended with the risk of softening the cementing medium of the lenses of the object-glass. In the discussion which followed the reading of the paper, the Rev. J. B. Reade remarked, that the injury of the object-glass might be avoided by the dispersion of the heat rays, which could be effected by an arrangement he had long ago used for that purpose; and Mr Highley suggested that the heat rays could be intercepted if the illuminating pencil were made to pass through a solution of alum.

6. A paper "On the Scales of some Species of thysanoura," by Mr. Richard Beck, was read March 12; pub. in 'Trans. Mic. Soc.,' vol x, N. S., p. 83.

The author considers the scales of some of these insects as test objects of great value, as affording the means of determining the exact condition of a combination as to the centring of its component lenses, and its corrections for aberration and dispersion. The proper scales (known generally as Podura scales) are really obtained from a species of Lepidocyrtus; but the precise species is not yet certainly determined. The author mentions the difficulty of finding the insects, gives the results of his experience in searching for them, adds instructions for capturing them when their haunts are ascertained, and for transferring their scales to the glass which thenceforth is to bear them. He tells us there is danger of the insects hopping away and effecting their escape before the transfer is completed, but assures us this may be secured by a moderate dose of chloroform, which he administers by dropping a little near them upon the paper which has been used to receive them. The vexed question of the structure of the scales is fully considered, particularly whether the wedge-shaped markings possess individuality as little scales, or are mere inequalities on the surface of the membrane. The opinion of the author is that the markings are more or less elevations or corrugations on the surface, which answer the simple purpose of giving strength to a very delicate membrane. Seven slides illustrating the paper were presented as an addition to the Society's collection of objects.

7. "A Description of a New Parasite in the Heart of the Edible Turtle," by Dr. A. Leared, was read May 14, and is pub. in 'Quar. Jour. Mic. Soc.,' vol. ii, N. S., p. 168.

This parasite, an undescribed species of Distoma, which the author provisionally names constrictum, was found in great numbers in the cavities of the heart of the turtle. The development and migrations of the Entozoa is a subject of great interest which has not received in this country the attention it deserves.

The parasites met with by Dr. Leared were undoubtedly immature animals; their larval condition and the situation where they were found, in the full current of the blood, suggest the idea that they were in the act of migrating, for we can hardly suppose the cavities of the heart to have been their permanent abode. If this conjecture be correct, it is the only instance (as far as I am aware) where the animals have been caught on their journey to the place where they were ultimately to be developed.

8. A paper "On the Generation of Acari in a Nitrate of Silver Bath," by R. L. Maddox, M.D., communicated by Mr. Shadbolt, was read May 14, pub. in 'Trans. Mic. Soc.,' vol. x, N.S., p. 96.

The facts narrated I think scarcely support the title. All that is clearly made out is, that the insects were found in considerable numbers on the surface of the solution.

9. A second paper on the same subject, also communicated by Mr. Shadbolt, was read Nov. 11. In this it is stated that the insects were covered with a secretion which appeared to protect them from the action of the nitrate of silver. How the insects obtained admission under the circumstances mentioned is not easy to understand; but remembering how extensively these little animals are diffused, and the difficulty of finding any situation entirely free from them, we can scarcely infer, in the absence of all evidence as to their origin, that they were propagated and developed in the solution on the surface of which they were found.

10. "Descriptions of New and Rare Diatoms" (series vi). By R. K. Greville, LL.D. (Communicated by Mr. Roper, was read May 14th; published in 'Trans. Mic. Soc.,' vol. x, N. S., p. 89).

11. "Description of New and rare Diatoms" (series viii). By Dr. Greville. (Also communicated by Mr. Roper, was read Nov. 10th; published in 'Trans. Mic. Soc.,' vol. xi, N. S., p. 13.)

Note.—No. vii of this series was not communicated to this Society. It is published in 'Quart. Journ. Mic. Soc.,' vol. ii, N. S., p. 231.

12. "On some New Species of Diatomaceæ." By J. Staunton, Esq. (Read June 11th.) Twelve slides illustrating the paper were at the same time presented, and are added to the collection of objects.

13. "On Fungus Destruction of Lozenges in a dry Atmosphere." By F. M. Rimmington, was communicated by Mr. Tuffen West. (Read June 11th; published in 'Trans. Mic. Soc.,' vol. x, N. S., p. 103.)

The point of interest, as remarked by Mr. West, is the great amount of deliquescence caused by the fungus in a perfectly dry atmosphere.

B. *Vibrio Tritici.*—Some interesting facts in connection with these animals were mentioned to the Society at the last meeting, by Mr. H. Deane. The long time they maintain their vitality is well known; how long is not determined. Mr. Deane has had some diseased wheat for ten years, in which, when last examined, a year ago, the animals were found alive and in full activity. He also mentioned a remarkable fact known to him, viz., that on a particular piece of land, whenever wheat is grown, it is always infested with vibrio, no matter what the length of time since the previous wheat crop, or what crops have been grown in the meantime.

Having completed this retrospect of the year, and given a short account of the thirteen papers which have been read at our ordinary meetings, it only remains for me to congratulate you on the present state of the Society, and its prospects for the future, and to thank you for the kind support and assistance uniformly afforded me during the two years I have occupied the chair I am shortly to resign to the gentleman appointed to succeed me,—one whose thorough acquaintance with the mechanical and optical properties of the microscope, whose familiarity with all the details of microscopical investigation, and whose scientific and general attainments, eminently fit him for the office of President.

A Monograph *of the genus* Auliscus. By R. K. Greville, LL.D., F.R.S.E., &c.

(Communicated by F. C. S. Roper, F.L.S., &c., and read March 11th.)

It is impossible to be engaged in the study of natural science at the present time, and especially in the more practical departments, without being perpetually involved in the *quæstio vexata,* What is a species? Even in working out the following monograph of the small genus *Auliscus,* I have found myself beset with difficulties; and without doubt some of my conclusions will be challenged by labourers in the same field, who hold (with perfect right) what they assume to be the most orthodox views. But who is to decide between conflicting opinions? And so the question again recurs, What is a species? It is singular that what appears at first sight to be so clear in theory, should be found practically in the direst confusion. Naturalists of the greatest reputation are not agreed on even the first step. Thus, Professor J. G. Agardh, in his 'Theoria Systematis Plantarum,' after quoting various eminent naturalists, remarks — "Ex his, quæ breviter attulimus, satis, credo, apparet, tres nostræ ætatis vel excellentissimos naturæ investigatores in illa, quam proposuimus, quæstione dijudicanda, inter se dissentire. Schleidenius sola individua, Lindley species, Friesius species et genera a natura vult constituta, majores omnes ordines ab arte inventos esse."

"A *species,*" says Professor Walker-Arnott, "in the Linnean sense of the word . . . . is formed by our Maker, as essentially distinct from all other species, as man is from the brute creation: 'Species tot numeramus, quot diversæ formæ *in principio* sunt creatæ,' *Linn.* It ought neither for convenience to be united with others, nor be split into several on account of newly detected diversities of form; but the difficulty is to ascertain what is such a primitive or natural species, and how to characterise it so as to include those numerous varieties and individuals now existing on the surface of the globe which have sprung from it, but of which none may bear greater resemblance to the original or typical form than they now do to each other."* This is sufficiently disheartening; and Bentham, than whom a higher authority can scarcely be quoted, is not more encouraging. "The *species,*" he remarks, "in the ordinary traditional accepta-

* 'British Flora,' "Introduction."

tion of the word, designates the whole of the individuals supposed to be descended from one original plant or pair of plants. But this definition is practically useless; for we have no means of ascertaining the hereditary history of individual plants. . . . Believing, however, as I do, that there exist in nature a certain number of groups of individuals the limits to whose powers of variation are, under present circumstances, fixed and permanent, I have been in the habit of practically defining the species as *the whole of the individual plants which resemble each other sufficiently to make us conclude that they are all,* or MAY HAVE BEEN *all, descended from a common parent.*"* Here, it will be perceived, everything ultimately depends upon the judgment of the observer.

Agassiz speaks with the utmost confidence, and apparently sees no difficulties at all. "It was a great step," he says, "in the progress of science, when it was ascertained that species have fixed characters, and that they do not change in the course of time. . . . . Geology only shows that at different periods there have existed different species; but no transition from those of a preceding into those of the following epoch has ever been noticed anywhere . . . . nothing furnishes the slightest argument in favour of their mutability. On the contrary, every modern investigation has gone only to confirm the results first obtained by Cuvier, and his views, that species are fixed."†

In amusing contrast to Agassiz, we have the astounding deductions of Mr. Darwin, who writes—"I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists entertain, and which I formerly entertained, namely, that each species has been independently created, is erroneous. I am fully convinced that species are not immutable. . . . I believe that all animals have descended from at most only four or five progenitors, and plants from an equal or lesser number. . . . Probably all the organic beings which have ever lived on the earth have descended from some one primordial form, into which life was at first breathed." Alas! for the fixity of species! The shades of Linnæus and Cuvier are not to rest in peace.

Dr. Joseph Hooker, in his most valuable and interesting "Introductory Essay" to the 'Flora of New Zealand,' adheres to what may be called the popular view of the question, in assuming that "all the individuals of a species (as I attempt to confine the term) have proceeded from one parent (or

* 'Nat. Hist. Review,' vol. i, p. 133.

† 'Essay on Classification,' pp. 75—78.

pair), and that they retain their distinctive (specific) characters." And he also assumes that "species vary more than is generally admitted to be the case."*

In adopting these assumptions, for they express my own convictions, we still have to acquire a practical insight into the laws which govern the limitation of species and the range of variation. So involved in obscurity are those laws, that one of the most cautious and philosophical naturalists in America does not hesitate to say—"It is by no means difficult to believe that varieties are incipient or possible species, when we see what trouble naturalists, especially botanists, have to distinguish between them,—one regarding as a true species what another regards as a variety, when the progress of knowledge continually increases rather than diminishes the number of doubtful instances; and when there is less agreement than ever among naturalists as to what is the basis in nature upon which our idea of species reposes, or how the word is to be defined."† This is strikingly illustrated in the most recent works devoted to the Flora of our own country. Scarcely two of our leading botanists take the same view of what constitutes (in practice) a rigid diagnosis. In five of the British genera of flowering plants (admittedly difficult and testing examples), the following differences occur in two Floras. According to Professor Babington there are 24 species of *Ranunculus,* 45 of *Rubus,* 17 of *Rosa,* 32 of *Hieracium,* and 70 of *Carex.* According to Mr. Bentham there are 13 species of *Ranunculus,* 5 of *Rubus,* 5 of *Rosa,* 7 of *Hieracium,* and 47 of *Carex;* being a difference in only five genera of one hundred and eleven species. This extraordinary contrast might possibly be attributed to certain extreme views entertained by the authors of these Floras. This may be the case, and parties who differ from them both will no doubt say so; but who is to decide? The matter is infinitely complicated by other and equally distinguished botanists holding not exactly an immediate position, but oscillating in a most irregular manner between the extremes. Sir W. J. Hooker and Professor Walker-Arnott describe in their British Flora 4 species of *Ranunculus* fewer than Babington, and 7 more than Bentham; of *Rubus,* 34 species fewer than Babington, and 6 more than Bentham; of *Rosa,* 2 more than Babington, and 14 more than Bentham; of *Hieracium,* the same number as Babington (32—one extreme being here reached), and 25 more than Bentham; of *Carex,*

* 'Flora of New Zealand,' "Introductory Essay," p. viii.

† Professor Asa Gray, 'Nat. Selection not inconsistent with Nat. Theology,' p. 5.

3 fewer than Babington, and 20 more than Bentham! Well may the humble student fall back upon the old proverb, "Who shall decide when doctors disagree?" On the one side is a war-cry against too many species; on the other an alleged tendency in the opposite direction. "The time may ere long arrive," says Professor Walker-Arnott, "when what are now called genera or subgenera will alone be considered species, and another Linnæus be requisite to reduce the chaos to order."*

If such difficulties beset the botanist among the higher orders of vegetation, we need not be surprised to find them multiplied when we descend to the more obscure and simple forms of organized life. Dr. Carpenter has been unable to discover anything approaching to fixity of species among the *Foraminifera.* "The impracticability," he remarks, "of applying the ordinary method of definition to the *genera* of *Foraminifera* becomes an absolute impossibility in regard to *species.* For whether or not there really exist in this group generic assemblages capable of being strictly limited by well-marked boundaries, it may be affirmed with certainty that, among the forms of which such assemblages are composed, it is the exception, not the rule, to find one which is so isolated from the rest by any constant and definite peculiarity, as to have the least claim to rank as a *natural* species."†

The *Diatomaceæ,* while not, perhaps, in quite so hopeless a predicament, are in a very unsatisfactory state, notwithstanding the labours of Ehrenberg, Kützing, Smith, Ralfs, and others. With regard especially to the determination of species and limits of variation the greatest uncertainty prevails. A few years ago I remarked in another place—"In the present state of our knowledge it would appear that scarcely any one character taken by itself is to be relied on, and that even a combination of characters which may be sufficient for the determination of species in one genus may be unsatisfactory in another; and where groups or sections happen to be what is called exceedingly natural, the difficulty is greatly increased. Indeed, it often becomes a question whether it is best to leave a doubtful-variety to embarrass the diagnosis, or to separate it under a provisional character. No law can be laid down on this subject which shall practically be a clear and unerring guide. Among the *Diatomaceæ,* the process of self-division, by means of which any deviation from the normal condition of a species becomes stereotyped and perpetuated with inconceivable rapidity, complicates the

* 'Brit. Flora,' "Introduction."

† 'Introduction to the Study of the *Foraminifera,*' p. 56.

idea of a species to an extent unknown among the higher orders of vegetables. For example, let A represent a species of diatom. By some unknown cause one of its progeny, B, becomes so changed as to constitute a well-marked variety. Another of its progeny, C, undergoes a different but equally decided change; and possibly the same thing may occur in others. Now these varieties or aberrations from the typical condition may be propagated, according to the late Professor Smith's calculation, at the rate of a thousand millions in a single month. Then, as there is no reason why B and C should not also have an indefinite number of nonconformist children, all removed in one character or another a *second stage* from the type, and producing duplicates by thousands of millions, it is manifestly impossible to say where the confusion is to end. But this is not all. By the process of conjugation, what Mr. Thwaites calls 'sporangial frustules,' are produced, which are very much larger than the ordinary size of the parents; and these, it is presumed, multiply equally freely by self-division, and are equally liable, from accidental causes, to have their deviation from the normal type perpetuated. Such is the theory; and to arrive at anything like fixed specific distinctions would seem to be almost a hopeless endeavour. Nevertheless, by correcting processes unknown to us, we cannot doubt that the typical characters of real species are preserved."*

There is, besides, another element to be taken into account connected with the process of conjugation above referred to. Professor Smith remarks, "Cases have fallen under my notice which seem to indicate that the further process of reproduction consists in the resolution of the contents of the sporangium into a 'brood' of diatoms having the same form and specific characters as the original frustules which originated the sporangia."† And he adds, in speaking of *Cocconema Cistula,* "forms of every size intermediate between the minutest frustule in the cyst and the ordinary frustules engaged in the conjugating process were easily to be detected; and the conclusion was inevitable, that the cysts and their contents were sporangia of the species with which they were associated, and indicated the several stages of the reproductive process." Every diatomist must be familiar with similar "broods" of *Cocconeides,* looking just like broods of young spiders. Now, the chief point of interest here is, what becomes of these broods? How do they increase in size? Minute as the individuals are compared with the parents,

* 'Edin New Phil. Jour.,' vol. x, new series, p. 26.
† 'Brit. Diat.,' vol. ii, p. 15.

they are enveloped in a siliceous case. It cannot be by self-division, as they would then be stationary. We are accustomed to hear of the unsatisfactory state of certain frustules, being attributed to their probably young condition. This may be very convenient, but what is meant by it? Is a frustule which has arrived (by some process or other) at its ordinary size supposed to become more perfect by successive self-division? It is evident that all this uncertainty adds greatly to the labour of determining both species and the range of variation.

In addition to all that has been said, the following excellent observations of Professor Asa Gray must not be omitted: "Everywhere," he says, "we may perceive that Nature secures her ends and makes her distinctions on the whole manifest and real, but everywhere without abrupt breaks. We need not wonder, therefore, that gradations between species and varieties should occur. . . . . From the nature of the case, the classifications of the naturalist abruptly define where Nature more or less blends. Our systems are nothing, if not definite. They are intended to express differences, and perhaps some of the coarser gradations. But this evinces not their perfection, but their imperfection. Even the best of them are to the system of Nature what consecutive patches of the seven colours are to the rainbow."* Among the *Diatomaceæ* particularly, the maxim *Natura non agit saltatim* applies with far greater force than among more highly organized vegetables, rendering the lines of specific separation very hard to find. So that in the very imperfect state of our knowledge of these microscopic forms, it would be rash in the extreme to dogmatise on the subject of species. What is therefore most required is, a more extensive acquaintance with the forms of diatomic life. Materials must be accumulated before they can be reduced to order; and, as in all similar cases, this can only be accomplished at the risk of encumbering both genera and species more or less with a provisional nomenclature. This has been the inevitable history of every department of progressive science. Some parties, in their wholesome horror of doubtful species, seem disposed to assume that every discovery must be an old friend with a new face; and to maintain that all new species or supposed new species, should be kept *in retentis* until every doubtful point in their history and structure is cleared up. This would be to lock up indefinitely a large number of interesting discoveries, and to retard the progress of science in this particular department, which can scarcely be compared with any other. It appears

* 'Nat. Selection not inconsistent with Nat. Theology,' p. 25.

to me that the time has not yet arrived when the introduction of a doubtful species is to be regarded as so serious an intrusion. Besides, as I have already observed, it requires almost as much caution to call a new form a questionable *variety* of some known species, as to put it down at once a questionable *species*. A series of doubtful varieties is exceedingly inconvenient by weakening the original definition, especially when we are only groping our way to what really constitutes specific difference, and consequently a reliable diagnosis in this very peculiar tribe.

AULISCUS, Ehr., Bail.

Frustules cylindrical or discoid; valve circular or oval, undulated, with two (three, or four?) opposite circular, flattened, submarginal processes, and four groups of lines radiating from the centre; two of them converging towards the processes, and two expanding towards the margin.

It is remarkable how much uncertainty appears to exist with reference to the species of this small genus. This has been owing partly to our ignorance in not knowing what part of the structure furnished the most trustworthy characters, and partly to the very small number of examples in collections. So little are the American species of my late lamented correspondent, Professor Bailey, understood, viz., *A. radiatus, pruinosus, punctatus,* and *cælatus*, that Dr. Lewis remarks—"They vary much in their markings, and occasionally approach so near each other in general character as to make it very doubtful whether they ought to be kept apart." This want of confidence in Professor Bailey's species has induced me to reproduce figures of the whole of them, as those which accompany his original descriptions are extremely vague and deficient in detail. It is true, however, that some of the *Aulisci* do sometimes resemble each other so closely as to render the task of discrimination exceedingly difficult. Until recently the number of processes was regarded generically as two. *A. pruinosus*, indeed, not unfrequently occurs with three. Within the last two months, however, not only has another species been discovered with three, but two species with four processes; one of these will be found described as *A. Johnsonianus;* the other is not in a sufficiently perfect state for description, although several valves of it have been seen, all of them showing tolerably distinctly the alternate processes of the subjacent valve; so that the disc is ornamented with a circle of eight visible processes. It seems doubtful, therefore, whether some species may not actually possess three or four processes.

* Radiating lines costate (not punctate). Valve mostly oval, or slightly oval; in the first three species occasionally circular.

Auliscus sculptus (Smith), Ralfs; valve circular or inclining to oval, with indistinct umbilicus, and two lateral rounded depressions; costæ in four sets, radiating from the centre, two of them converging to the processes, and, along with the rounded depressions, forming a well-defined 4-lobed figure or quatrefoil; the costæ within the depressions strong, few, unequal, quite smooth (no apiculi), and appearing to terminate abruptly within the edge of the cavity; marginal costæ strong, distant; diameter ·0020″ to ·0035″. (Pls. II & III, figs. 1—3.)

Auliscus sculptus, Ralfs in Pritch. Inf., 1861, p. 845, pl. vi, fig. 3.

Enpodiscus sculptus, 'Sm. Brit. Diat.,' vol. i, p. 25, pl. iv, fig. 42; 'Mic. Dict.,' pl. xii, fig. 31.

Hab. Poole Bay, 1851; Professor Smith; Barking Creek, on the Thames, F. C. S. Roper, Esq.; Ipswich, F. Kitton, Esq.; Penzance, J. Ralfs, Esq.; Westport Bay, Ireland, G. M. Browne, Esq.

I have been quite unable to discover any strongly definitive character between this, the earliest known species, and the one immediately following; and those naturalists who are influenced by what has been called a "righteous horror" of uncertain species would, no doubt, be in favour of their union; but in that case we should have fig. 1 at one end of the series, and fig. 6 at the other, which would surely be an extreme view. The single desire to study these two species, and the singular deficiency of materials, has alone caused a twelvemonth's delay in the preparation of this small monograph. I have at length, however, in addition to an ample series of *A. cælatus,* had an opportunity, through the kindness of Mr. T. G. Rylands, and other friends, of examining a considerable number of the present species; and the result is, on the whole, satisfactory to my own mind, although it may not be equally so to others who have not had the same opportunity of tracing minute differences. It will be at once perceived that there is no difficulty in referring specimens, as they ordinarily occur, to their respective places. It is only where exceptional frustules approach each other that any embarrasment is experienced. The principal features in *A. sculp-*

tus, as compared with *A. cælatus,* are as follow :—1. The form is *usually* circular, while in *A. cælatus* it generally tends to oval. 2. The lateral depressions are deeper. 3. The costæ within the depressions are strong, unequal, not radiating symmetrically, like a fan, but generally pointing in different directions, and apparently terminating abruptly before reaching the outer curved edge of the depressions. 4. A much greater tendency in the costæ of the depressions to anastomose. 5. The entire absence of apiculi. This character, although a minute one, seems to be of importance. I have examined very many examples of *A. cælatus,* and never found apiculi wanting, excepting in one instance, which I have given at fig. 7. Occasionally there are, in *A. sculptus,* a few narrow, transverse cellules, formed by anastomosis, just beneath the outer curve of the depressions; and sometimes a transverse costa is visible, following the line of the ridge below its summit, from which branch off at right angles the strong costæ which proceed to the margin. This transverse costa is probably always present, concealed within the margin of the cavity, as the marginal costæ are certainly not (all of them, at least) continuations of those within the depressions. Mr. Ralfs, under *A. ovalis,* in Pritchard, remarks—"The truncated processes do not, in general, correspond exactly with the longer diameter of the valve, but are placed a little on one side in opposite directions." This I have ascertained to be the case in all those species which deviate from the circle. If a straight line be drawn through the middle of the valve in its longest diameter, the two processes will invariably be seen more or less on the opposite sides of the line; and such is the rule with our present species itself, whenever it assumes a slightly oval form.

Auliscus cælatus, Bail.—Valve slightly inclining to oval (most rarely circular), with indistinct umbilicus; radiating costæ next the margin, strong, distant; central area 4-lobed, 2 of the lobes composed of finer costæ converging to the processes; the intermediate lobes depressed, containing radiating, often more or less anastomosing lines, and studded with minute apiculi, which are sometimes confined to the outer edge of the lobes. Diameter ·0022″ to ·0065″. (Figs. 4—7.)

Auliscus cælatus, Bail.—'Notes on New Species of Mic. Organ.' ('Smithson. Contrib.,' vol. vii), p. 6, figs. 3, 4; Ralfs, in Pritch., 1861, p. 845.

Hab. In sand washed from West India sponge, and in soundings from Mobile Bay, U.S.; Prof. Bailey. Mud from New London Harbour; Delaware River mud, rare, U.S.; Dr. Lewis. Californian and Ichaboe guanos, C. Johnson, Esq.,

R. K. G. Bolivian guano and Monterey stone, G. M. Browne, Esq. Bass' Straits, C. Johnson, Esq.; New Zealand, G. M. Browne, Esq.; Harvey Bay, Queensland, New Caledonia, and Woodlark Island, in dredgings communicated by Dr. Roberts; R. K. G.; Brodick Bay, Island of Arran, R. K. G.

Having already referred to this species under the previous article, I am not called upon to enter into many additional details. The most essential character, perhaps, resides in the apiculi, which are sometimes so numerous as to render the whole area of the depressions quite rough, surrounding even the umbilical space; while, in other cases, they are few and scattered, or occur only on the ridge or outer curve of the depressions. Typical specimens seem to exhibit two or three minute apiculi or tubercles on the costæ, following exactly the curve of the depression. In the Arran example (fig. 4), which much resembles *A. sculptus,* there are very few apiculi, and they are so situated; but, in addition to this character, the radiating costæ of the depressions are continued to the margin. The range of size is extraordinary. Those from Ichaboe guano, obtained, I believe, only by Mr. G. M. Browne and myself, are so far beyond the average dimensions, that it is probable they may be sporangial. I am not disposed to place any reliance on the presence or absence of anastomosing lines among the costæ of the depressions, as they appear to be sometimes nearly, if not quite absent. A few may be occasionally perceived in the neighbourhood of the umbilical space; while they are sometimes so numerous as almost to amount to reticulation, only being too irregular to deserve that name. Not unfrequently the depressions, instead of forming semicircular lobes, unite with the umbilical space, and resemble an oblong bar stretched across the valve, scarcely dilated at each end, and rough with apiculi. The depressions are considerably more shallow than in the preceding species, or, in other words, the undulation of the surface is less prominent. No character of any value can be obtained from the marginal costæ, which, although generally distant, are sometimes double the ordinary number. A very fine valve, kindly communicated by Mr. Brightwell, and obtained from sponge sand, without any specified locality, and named *A. sculptus,* I take to be the present species. There are, indeed, no apiculi, but the costæ within the depressions pass into a perfect anastomosing network, unlike anything I have seen in *A. sculptus;* and the marginal costæ are very numerous.

Auliscus elegans, n. sp., Grev.—Valve circular, with a small, round umbilical space; radiating costæ proceeding to the processes, widely converging and forming obcordate groups; centrical spaces between the umbilicus and the marginal costæ, more or less minutely reticulated. Diameter ·0032″. (Fig. 8.)

Hab. Patos Island guano, C. Johnson, Esq.; R. K. G.

Surface of the valve much undulated. Processes large, with a broad border. The sets of costæ leading to the processes suddenly converging. The space between the umbilicus and the costæ of the margin, extending so as to partially enclose the converging sets, being filled up with a network of minutely anastomosing lines. Marginal costæ less robust than in either of the preceding species. The umbilical space is distinctly defined; but there is no conspicuous quatrefoil.

Auliscus racemosus, n. sp., Ralfs, MS.—Valve nearly circular, with definite umbilicus and row of marginal puncta; costæ converging to the processes delicate, terminating in little clusters of minute granules on each side of and below the processes. Diameter ·0024″. (Fig. 9.)

Hab. Barbadoes deposit, Cambridge estate, C. Johnson, Esq. Communicated by J. Ralfs, Esq.; R. K. G.

An interesting little species, of which several specimens exist. It is not improbable that a larger number of examples would show some difference in the amount of the punctation; for there are indications of puncta within the marginal circle, and the lateral sets of radiating lines which, in the specimens before me, terminately shortly in faint granules, may, in other cases, be more fully developed. But the character derived from the clusters of granules terminating the costæ, is so distinct and remarkable, as to leave no doubt regarding the validity of the species.

Auliscus reticulatus, n. sp., Grev.—Valve broadly oval, with indistinct umbilicus; marginal radiating costæ forming a rather narrow border, within which the whole area is divided into 4 lobes; the lateral ones very large, and filled with a reticulation of anastomosing lines; converging lines also often anastomosing. Diameter ·0035″. (Fig. 10.)

Hab. Cape of Good Hope, G. M. Browne, Esq. From *Melobesia*, on *Haliotis tuberculata*, Peru, F. C. S. Roper, Esq.

In the large proportion which the internal 4-lobed space bears, to the entire valve this species differs from all the preceding, and in the very large comparative size of the lateral lobes, it differs most remarkably from its nearest allies, certain extreme varieties of *A. cœlatus*. The marginal costæ form a narrow band, often narrower than in the individual represented in the plate; and the line of separation between this band and the depressed lateral lobes is sharply defined; the transition from the strong, simple, somewhat distant costæ to the network of anastomosing lines being quite abrupt. The processes are small, and situated very near to the margin. In a frustule from the Cape of Good Hope the reticulation is confined to the side lobes of the quatrefoil; but in the beautiful Peruvian specimen figured, which belongs to my friend Mr. Roper's cabinet, it extends to the lobes connected with the processes, in which, however, the converging costæ preserve their distinctness; the reticulation being produced by sharp lines anastomosing transversely at different angles.

Auliscus mirabilis, n. sp., Grev.—Valve broadly oval, with large, definite umbilical space, and marginal border of oblong cellules, each cellule penetrated at the base by a short line; area within the border, with the exception of the converging costæ, more or less filled with a reticulation of anastomosing lines. Diameter ·0040″. (Fig. 11.)

Hab. Monterey stone; G. Norman, Esq., G. M. Browne, Esq., R. K. G.

An exquisitely beautiful diatom, and rare as beautiful. It was first brought under my notice by Mr. Norman, but his specimen had unfortunately sustained some superficial injury. That subsequently supplied by Mr. Browne leaves nothing to be desired. My own specimen is a fragment. The general effect of the ornamentation of the valve is exceedingly rich, and resembles a lace pattern; indeed the whole might be transferred with little modification to lace manufacture. The processes are large, very conspicuous, irregularly circular, with a very broad unequal border. The umbilical space defined, and oval in the direction of the processes. The costæ which converge to the processes very clear and sharp; those which radiate towards the margin anastomosing, so as to fill the lateral space even to the sides of the processes with an irregular network. The structure immediately within the margin is quite peculiar, being composed of a close row of large oblong cellules, penetrated by a small line or spine, which reaches past the middle of each cellule.

Auliscus ovalis, Arn.—Valve oblong-oval; costæ all delicate, several of the lateral ones opposite the umbilicus crested near the margin with minute apiculi. Long diameter ·0040″. (Fig. 12.)

Auliscus ovalis, Arn.—Ralfs, in Pritch. Inf., 1861, p. 846.

Hab. Algoa Bay and Peruvian guanos; Ralfs, F. Kitton, Esq., Prof. Walker-Arnott, G. Norman, Esq., R. K. G.

The form of this species is alone sufficient to distinguish it from all others. The radiating costæ are all slender and somewhat faint; those passing from the umbilicus to the processes widely converging; some of the lateral ones rough for a short distance from the margin, with very minute apiculi. Umbilicus rather indistinct. Processes generally very large, not truly circular, but often tending to a very obtusely triangular figure, sometimes very broadly ovate.

** Radiating lines punctate or scabrous. Valve strictly circular (except in *A. punctatus*, which is nearly so).

Auliscus pruinosus, Bail.—Valve circular, with a large, smooth umbilicus; radiating lines all minutely scabrous, becoming close and numerous towards the margin. Diameter ·0055″. (Fig. 13.)

Auliscus pruinosus, Bail.—'Notes on New Sp. of Mic. Organ.' ('Smithson. Contrib.,' vol. vii), p. 5, figs. 5—8. Ralfs, in Pritch. Inf., 1861, p. 845. (Pl. vi, fig. 1.) (Bad.)

Hab. In estuaries, &c., from Massachusetts to the Gulf of Mexico; Prof. Bailey. At Black Rock, Long Island; Dr. Lewis. Var. with three processes in Savannah River mud; Dr. Lewis. Georgia; F. Kitton, Esq.

A most charming diatom, scarcely to be recognised by the published figures. In none of the specimens which I have seen is there any trace of the bevelled edge described by Professor Bailey, and which in his figure has the appearance of a broad border. Nor are the processes so very remote from the margin; but this I apprehend to be a variable character in several of the species. The most graphic idea I can give of the general appearance of the valve, arising from the numerous plumose, rough lines, is that conveyed by the term *frosted*—a disc of the most exquisite and symmetrical frost-work. The umbilicus is a clear, circular, blank space, from which the lines radiate, at first rather widely, but soon approximating from the addition of intermediate lines, like the lamellæ in many *Agarici*, become fine and extremely numerous as they approach the margin. When closely examined they are seen not to be punctate, but rather resemble delicate scratches on glass, the roughness of the edges causing the frosted appearance. The processes are large and handsome, with a broad border. I have availed myself of Mr. Kitton's kindness, and given a representation of the three-process variety from a splendid example in his cabinet.

Auliscus radiatus, Bail. ?—Valve circular, with obsolete umbilicus, and striated marginal border; lines all regularly and conspicuously punctate, those converging to the processes forming a narrow, obovate group, those radiating to the margin straight. Diameter ·0045″. (Fig. 14.)

Auliscus radiatus, Bail.? 'Notes on New Sp. of Mic. Organ.' ('Smithson. Contrib.,' vol. vii), p. 6, fig. 13?

Hab. In mud, New York harbour, and in the mud of the Hudson River at West Point; Rockaway, Long Island, U.S.; Prof. Bailey. Fossil at Kaighu's Point, New Jersey; New London harbour, U.S.; dredged, Dr. Lewis.

The diatom described under this name by Professor Bailey is, he says, "a minute species, presenting the characteristic mastoid processes of the genus Auliscus, but having no distinct umbilicus, and having only slight indications of the peculiar curved lines of the preceding species" (*A. cœlatus*). His figure is also that of a minute species, and exhibits not the very slightest indication of any curved lines at all. It will be perceived, from the specimen which I have figured from Mr. Kitton's cabinet, that it is anything but minute; that the lines which converge to the processes are quite evident and well-defined, and that there is a remarkably conspicuous border, which does not appear in Bailey's figure, nor is it referred to in his description. Under these circumstances I should, perhaps, be justified in regarding our present diatom as distinct. Mr. Kitton, however, is decidedly of opinion that they form one species, and I therefore leave the question undecided until some information be obtained of Prof. Bailey's species. In the event of the one before me being ascertained to be truly different, I wish it to bear the name of *Baileyi*. In Mr. Kitton's specimens there is no distinct umbilicus, but an indefinite space, irregularly filled up with puncta. All the lines are composed of a single row of minute puncta, the lateral ones not plumose, but straight. The border is very striking, being composed of an inner line, and the space between it and the margin crossed with rather distant striæ. It seems scarcely credible that if such a border existed in the examples which Prof. Bailey obtained from three localities, he should have overlooked it.

Auliscus punctatus, Bail.—Valve nearly circular, with subdistinct umbilicus; whole surface more or less punctate, but generally so irregularly that it is difficult to trace the radiating lines. Diameter ·0030″. (Figs. 15, 16.)

Auliscus punctatus. Bail.—'Notes on New Sp. of Mic. Organ.' ('Smithson. Contrib.,' vol. vii), p. 5, fig. 9. Ralfs, in Pritch. Inf., 1861, p. 845.

Hab. "Often associated with *A. pruinosus* in the stations given for that species," Prof. Bailey. Rice-field mud, Savannah river, rare; Dr. Lewis. Patos Island guano; C. Johnson, Esq. Monterey Stone; F. Kitton, Esq.

This species is in a very unsatisfactory state, and it may be doubted whether specimens have been seen in a really perfect condition. Having myself had no opportunity of examining many individuals, I can say but little regarding it. In one example now before me, the puncta are so disposed over the entire surface that not the very slightest trace of a line of any kind can be perceived. In one specimen figured, the radiating lines are partially visible. In a valve I have from Virginia there are comparatively few puncta, and the characteristic lineation is of course conspicuous. The late Professor Bailey compared *A. punctatus* with *A. pruinosus*, and supposed that it might prove to be a variety of that species. He remarks, however, that "the sparsely punctate basis of the one (*pruinosus*) with the closely punctate surface of the other (*punctatus*) appear to offer a sufficient distinction between them." I apprehend that if these two species are to be compared at all with each other, a better criterion exists in the totally different character of the punctation.

Auliscus Peruvianus (Kitton), Grev.—Valve circular, with close radiating lines of very minute puncta, and a row of marginal apiculi; processes very small, each surrounded by a circlet of minute apiculi. Diameter about ·0039″. (Fig. 17.)

Auliscus Peruvianus, Grev.—'Trans. Mic. Soc.,' vol. x, p. 25, pl. ii, fig. 6 (very coarsely engraved).

Eupodiscus? Peruvianus; Kitton, MS., Ralfs, in Pritch. Inf., 1861, p. 938.

Hab. Peruvian and Californian guanos; F. Kitton, Esq., Dr. Macrae, C. Johnson, Esq., R. K. G.

As I have already mentioned in the tenth volume of the Society's 'Transactions,' Mr. Ralfs first indicated the resemblance of this diatom in certain of its characters to an *Auliscus*. At first sight it has far more the aspect of a *Eupodiscus*, under which genus it was published. The very small processes, the total absence of any umbilical space, and the equal manner in which the surface is filled up with what appears to be uniform straight lines of puncta, all tend to convey the impression of a *Eupodiscus*. It is not until the radiating lines are carefully examined that some of them are seen to follow the usual curved and converging course to the processes. In other respects the species is distinguished by well-marked characters, the most conspicuous one being a rather close series of marginal apiculi. A small, irregular circlet of more minute apiculi also surrounds each of the processes, and, what I believe has hitherto escaped observation, there is on one side of each process a tubercle larger than the apiculi, and at about the same distance. Minute apiculi are likewise remotely scattered over the surface of the valve, which, in certain lights, resemble diaphamous points, and are very liable to be passed over. Specimens, however, sometimes occur in which these raised points are very numerous and visible, and towards the margin especially, give quite a rough appearance to the valve.

*** Radiating lines, exceedingly fine and crowded, and sometimes more or less very minutely granulose. Valve strictly circular.

Auliscus Macræanus, n. sp., Grev.—Valve circular, with a thick, prominent margin, and small, indistinct umbilicus; radiating lines all exceedingly fine; minute intra-marginal puncta scattered between the large, broadly-oval processes. Diameter ·0040″. (Fig. 18.)

Hab. Ceylon; Dr. Macrae.

One of the finest of Dr. Macrae's discoveries in the Indian seas, and strikingly distinct. The processes are very large, and touch the margin, which is highly raised. A row of minute puncta is situated immediately within the margin, and halfway between the processes additional puncta form an irregular belt, while two little clusters on each side are found midway between the margin and the centre.

Auliscus elaboratus, n. sp., Ralfs, MS.—Valve circular; centre minutely granular, giving off numerous very fine converging lines, which, as they approach the processes, are interrupted by a circular ridge, surrounding at some distance each process; whole surface more or less minutely granular. Diameter ·0044″. (Fig. 19.)

Hab. Barbadoes deposit (Cambridgc estate); kindly communicated by Mr. Ralfs.

A most peculiar species. The radiating lines excessively fine; the centre completely filled up with a minute granulation. Processes in the specimens now before me three; each surrounded by a circular ridge, which encloses a space about as broad as the diameter of the processes themselves; and the fine lines passing over the ridge catch the light, or produce a slight shadow, and thus cause the appearance of a sort of halo round each process.

Auliscus Johnsonianus, n. sp., Grev.—Valve circular, with minutely granular centre, and very fine, obscure, converging lines; processes (4) with striated border. Diameter ·0034″. (Fig. 20.)

Hab. Barbadoes deposit (Cambridge estate); C. Johnson, Esq.

The striated border of the processes is of itself sufficient to mark this species; but it is also distinguished (if the character be permanent) by the presence of four processes. One other species belonging to this marvellous deposit has occurred both to Mr. Ralfs and myself with the same number; and as those of the subjacent valve are nearly as visible as the four in the upper valve, there is the singular effect of a circle of eight processes. Our specimens of this latter species are all unfortunately more or less injured in the superficial sculpture. The plumose lines in *A. Johnsonianus* are even finer than in *A. elaboratus,* but are otherwise very similar, and have also the same very minute granular character.

**** Whole surface of valve widely reticulated.

Auliscus Ralfsianus, n. sp., Grev.—Valve circular, with the whole surface covered with a wide and lax network, the spaces within the interstices showing minute puncta, arranged in radiating and converging lines. Diameter ·0045″. (Fig. 21.)

Hab. Barbadoes deposit (Cambridge estate); C. Johnson, Esq.

Perhaps this may be considered as the most extraordinary species in the whole genus, and I have the greatest pleasure in dedicating it to my highly valued friend and fellow-labourer, Mr. Ralfs. In all the rest the prominent superficial sculpture is characteristic of the group; the radiating or plumose arrangement of the lines, especially those which curve and converge from the centre to the processes, being more or less evident. But in the present case the observer is startled by, at first sight, perceiving nothing but a loose, wide, brown network enveloping the whole valve, with the exception of the processes. An attentive examination, however, shows that within the reticulations there are puncta or minute cellules, arranged in the manner common to the genus. The processes are almost marginal, nearly circular, and very large.

The following species are unknown to me, and cannot be established without additional information:

Auliscus Americanus, Ehr.—It is impossible to say what this may be from Ehrenberg's figure (Microg. pl. xxxviii (14), fig. 2), which is doubtless incorrect, as no space is left for any converging lines between the centre and the processes.

A. gigas, Ehr., Microg., pl. xix, fig. 63. A fragment too small and imperfect.

A. cylindricus, Ehr.—No figure published.

A. polystigma (*Coscinodiscus*), Ehr., Bericht Berl. Akad., 1844, p. 78. No figure published.

At fig. 22 I have given a figure of a specimen observed by Mr. G. Norman in shell cleanings from Japan. I do not venture, on the strength of a single specimen, to describe it as a distinct species. It comes nearest to *A. cœlatus,* but differs in the sharp and diffused character of the punctation, and especially in the presence of puncta on the converging lines.

On the genus LICMOPHORA (Agardh).

By F. C. S. ROPER, F.L.S., &c.

(Read March 11th, 1863.)

THE microscopic forms of Algæ of the order Diatomaceæ, although slightly alluded to in the works of Dillwyn in 1809, and, with respect to a few genera, more carefully investigated by Dr. Greville, in the 'Scott. Crypt. Flora' and 'British Flora,' and since then in the papers of Messrs. Ralfs and Thwaites in the 'Ann. Nat. Hist.,' had not been made the subject of any special work in this country, until the liberal guarantee offered by Messrs. Smith and Beck induced the late Professor Smith to publish the result of his labours in that hitherto neglected branch of science; as although in the earlier editions of Pritchard's 'Infusoria,' a portion of Ehrenberg's descriptions of the Diatomaceæ, with copies of his figures, were given, these were so imperfect and meagre, and included so many foreign forms, that they were of little use to elucidate our British species.

Our native microscopists, although universally admitted to have the best instruments, and therefore the best means of investigation in their hands, had treated the siliceous epiderms of the Diatomaceæ more as objects for testing the powers of their respective instruments than with any endeavour to arrive at a satisfactory conclusion as to their relative habits, modes of growth, or position in the scale of nature. The labour of reducing to anything like a system the varied and often widely discordant opinions on these minute forms of the vegetable kingdom was thus left almost entirely in the hands of continental observers, and the works of Agardh, Kützing, Ehrenberg, Nitzsch, De Brebisson, and others, show the patience with which—with the imperfect instruments at their command—they reduced the chaos previously existing to something like order. But the difficulty of giving accurate, or, at least, generally recognisable descriptions of such minute forms is so great, that though the voluminous works of Kützing and Ehrenberg are invaluable in determining those species which present constant and strongly marked peculiarities, a vast number of the forms included in their genera, in the absence of authentic specimens, are now quite unknown, and can neither be determined by their specific characters or figures. The difficulty thus presented to the English observer may be estimated by the fact stated in the preface to Professor Smith's 'Synopsis,' that, out of the 224 species included in his first sub-tribe, not more than twenty had been previously recorded by native observers, and of the remainder a very large proportion are only doubtfully to be referred to the outline figures of Ehrenberg and Kützing. The appearance of Professor Smith's researches at once obviated the great difficulty the English diatomist had to contend with; and affording a sure foundation to start from, brought a host of observers into the field, attracted by the great beauty of the hitherto neglected frustules of the tribe, by the abundance with which they are found in almost every locality, and especially to the field thus offered by a more careful examination of marine and foreign collections for the description of new species or varieties of those already known.

The great advantage Professor Smith's work offers over that of all his predecessors, consists in the determination he formed, and to which, except in a few cases, he adhered, not to admit species unless he had an abundant supply of material for investigation; in the beauty and accuracy of Mr. Tuffen West's illustrations; but chiefly to his own authentic slides being made available to the public for nearly all the species described in the 'Synopsis.' The value of his work, therefore, as a basis for further observation, is far greater than that of any of his predecessors; and though, had his life been spared, he would doubtless have availed himself, in another edition, of the extended researches he originated, to modify some of his species, and probably also some parts of his classification—still, the greater part of those species he has included in the 'Synopsis' are well authenticated, can be readily recognised, and will form a sure ground work for any future writer on the subject.

That in a first attempt to describe our native species of these minute and lowly organized forms of life, so few errors should have occurred is truly remarkable, when it is remembered how little was known of the variations arising from habitat; of the influence of the temperature of the water, and the effect of salt, brackish, or fresh water on the form and marking of the frustules; of the astonishing rapidity with which slight structural peculiarities might be perpetuated by the process of self-division; and that, except in a few genera, no observations had been published as to the laws of development and the propagation of the plant.

It is not at all surprising, therefore, that in attempting to avail himself of the meagre specific characters and mere outline figures of his predecessors, in the endeavour to reduce as far as possible the overloaded nomenclature and synonymy of the tribe, some errors should have crept in, which at the present day can be to a certain extent cleared up; and I propose on the present occasion to show that in the genus *Licmophora,* though the author of the 'Synopsis' appears to have referred to what are, or what he supposed to be, authentic specimens for the determination of the species, yet by some oversight, not readily accounted for, the names of the only two species included in the genus are reversed. The *Licmophora splendida* of the 'Synopsis' is in fact the *L. flabellata* of all previous writers, whilst what is referred to as *L. flabellata,* Ag., is the true *L. splendida,* Grev. It is also perfectly evident to any one who will carefully examine the allied genera *Podosphenia* and *Rhipidophora,* and compares the species and synonymy of the 'Synopsis' with the works of Kützing, Ehrenberg, and Agardh, that great confusion exists as to the limits and specific characters of those enumerated by Professor Smith; and though I have been unable at present to obtain a sufficient series of authentic specimens to arrive at any satisfactory conclusion on the doubtful points in these genera, I hope on a future occasion to be able to elucidate them and lay them before the Society.

With the genus *Licmophora,* however, the case is different, for by the kind assistance of Dr. Walker-Arnott, who first directed my attention to the point, and also of Dr. Greville, I have been able to study a variety of gatherings, including authentic specimens both from Agardh and Kützing. Dr. Hooker has also permitted me to examine the original MSS. of Capt. Carmichael, and the specimen of his *Echinella ventilabrum,* on which Greville's species of *L. splendida* was I believe originally founded;* and as I had in my own collection

* That this is the case is tolerably certain, from the fact that in 1827 Dr. Greville, in the 'Scot. Cryp. Fl.,' only describes the *Exillaria flabellata* from Capt. Carmichael's specimens; in 1833, in the 'Brit. Fl.,' he includes this under Agardh's name of *Licmophora flabellata,* and also describes a new species as *L. splendida,* the only specimens mentioned being those of Capt. Carmichael. Now, as Capt. Carmichael in his herbarium has only two species, which he called *Echinella flabellata* and *E. ventilabrum* (the latter having broadly cuneate valves, as in Dr. Greville's *L. splendida*), there can be little doubt that they are identical, and I hear from Dr. Greville that he has no doubt the reason for his adopting a new name for the species was, that, though the specimens came into his possession, he had not the manuscript descriptions to refer to, and, therefore, did not adopt Carmichael's

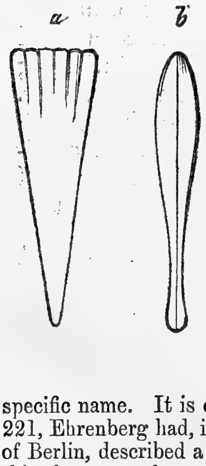
authentic slides of Professor Smith's of both species, I have been enabled to satisfy myself, and I trust any one who will investigate the subject, of the peculiarities which are the true characteristics of each.

As I have had no opportunity of examining any living specimens, I am unable to determine, with any degree of certainty, whether there ought to be two or only one species in the genus, though this is a point which is open to much doubt. Kützing divides it into five, but his *L. fulgens* is the *Synedra fulgens* of Smith, and his *L. divisa* I believe identical with *Rhipidophora Dalmatica*, and *L. flabellata* and *Meneghiniana* are evidently the same species; so that in fact he has really only two, *L. flabellata* and *L. radians.*

Professor Smith states that he only gives, "in accordance with the authority of his predecessors, two species of the present genus; but he is far from satisfied that they are truly distinct."* In all the gatherings I have examined, I can detect no structural peculiarity that is not common to both, and certainly there is no difference in the form which will allow the F.V. of one to be called "rounded at the upper extremity," while the other is said to be "truncate;" nor are the valves of one "attenuate at the larger extremity" whilst the others are "rounded," as stated in the specific characters by Professor Smith, and illustrated by the figures 233 and 234, in t. xxxii, vol. ii of the 'Synopsis.'

The only real difference that can be detected in dried or prepared specimens is, that certainly some gatherings consist of frustules broadly cuneate on the S.V., and widely club-shaped on the F.V. (fig. 1, *a, b*); and at the same time, as far as our present evidence goes, this is combined with comparatively short valves, a shorter and less dichotomously branched stipes, and, perhaps, some difference in the arrangement of the endochrome, as shown in fig. 234, t. xxvi, vol. i of the 'Synopsis.'

Fig. 1.



This last peculiarity, however, may arise from the time of year in which the specimen was gathered, as the ocelli or

specific name. It is curious that, according to the 'Infusionsthierchen,' p. 221, Ehrenberg had, in 1828, and again in 1831, in the 'Abhandl. der Akad.' of Berlin, described a small form under the name of "*Echin. splendida*," but this also was unknown at the time to Dr. Greville, and I have only included it in the synonomy of his species with much doubt.

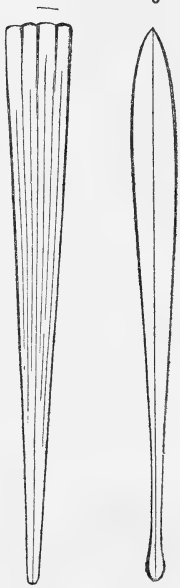
* 'Syn. B. Diat.,' vol. i, p. 85.

circular bodies which are seen in the contracted endochrome of some gatherings appear more as if they were the commencement of the reproductive process than merely a simple contraction of the endochrome itself. The fact has been noticed by other writers, but it is a point on which I place little reliance as a specific character, and can only be cleared up by a careful comparison of living specimens.

In contradistinction to these decidedly cuneate valves, there are others, and from the number of gatherings I have, and also from its being the first recorded, I should imagine by far the most widely distributed, with valves narrow, linear-cuneate on the S.V., club-shaped but attenuate on the F.V. (fig. 2, *a*, *b*), almost invariably and sometimes considerably longer than those of the cuneate form, with a long and much branched stipes, and altogether a larger and more robust plant than the other.

Fig. 2.

a *b*



Now, if these peculiarities are permanent, and not the result of habitat or local influences, there is considerable probability that they ought to rank as distinct species, or, at all events, as well-marked varieties; and as far as my present information extends, I am inclined to think that the latter is the most correct classification; but this is a point that can only be cleared up by a more extended examination of living specimens, and for the present I shall merely give the best specific characters I can to the two species of Agardh and Greville, with the synonymy as far as I have been able to trace it satisfactorily, with a few remarks on the gatherings on which my conclusions are founded.

Genus. Licmophora, Ag.

Frustules cuneate, stipitate, flabellate at the summits of the stipes; stipes dichotomously branched; incrassate, valves convex, elongated, and traversed by a longitudinal median line.

1. *Licmophora flabellata,* Ag.

Frustules linear-cuneate, truncate; F. V. club-shaped, but attenuate, stipes much branched; tufts usually three to four lines in height.

Marine on Zostera and small Algæ.

Syn. *Licmophora flabellata,* Ag., Consp., 1830, p. 41.
„ „ Hooker's Br. Fl., 1833, p. 408.
„ „ Wyatt's Fl. Danm., vol. v, No. 234.
„ „ Har., Br. Alg., 1841, p. 206.
„ „ Kütz., Bac., 1844, t. 12, f. 1, 2, 3, 4.
„ „ „ Sp. Alg., 1849, p. 113.
„ „ „ Phy. Ger., 1845, p. 108.
Exillaria flabellata, Grev., Sc. Cryp. Fl., 1827, t. 289.
Echinella flabellata, Carm. MSS., 1826.
„ „ Ehr., Infus., 1838, t. 19, f. 1.
„ „ Bail., Sil. Jour., 1842, vol. xliii, t. 5, f. 8.
Licmophora Meneghiniana, Kütz., Bac., 1844, p. 123.
„ *argentescens,* Ag., Consp., 1830, p. 41.
„ „ Ag., Ic. Alg. Eur., 1835, t. 2.
„ *splendida,* W. Smith, Syn., 1853, t. 26, f. 233.
„ „ Ralfs in Pritch. Inf., 1861, p. 771.
Meridion radians, Ag., Sys. Alg., 1824, p. 3 (in part).
Gomphonema flabellatum, Kütz., Linnea, 1833, p. 571.
„ *argentescens,* Kütz., Lin., 1833, p. 571.

This is decidedly the most common and best known of the two species or varieties of which the genus is composed, and is generally noticed as the larger plant. Agardh, in 1824, in the earliest notice of it, under the name of *Meridion radians,* describes it as "frustulis lineari-cuneatis," and in the 'Conspectus,' in 1830, as "Plantula magnifica." Dr. Greville, in the 'Scot. Cryp. Fl.,' vol v, No. 289 (in describing *Exillaria flabellata*), and in Hooker's 'Brit. Fl.,' p. 408, states the frustules to be linear-wedge-shaped, and stems from one third to half an inch in height. Captain Carmichael, in the MSS. 'Algæ Appinensis.' in Sir W. Hooker's library at Kew, describes the frustules as "linearis-cuneatis," and calls it the "largest and most beautiful of the tribe." Professor Harvey, in the 'Brit. Algæ,' appears simply to follow Dr. Greville's description in Hooker's 'Brit. Fl.' Ehrenberg, in the 'Infusionsthierchen,' states the frustules to be "lineari-cuneatis truncatis," and Kützing, in the 'Bacillarien,' says, "bacillis gracilibus lineari-cuneatis." Ralfs, in the last edition of Pritchard's 'Infusoria,' evidently follows Professor Smith in naming the species, but in describing his *L. splendida,* he states it to "differ from the other species of the genus by its longer and narrower frustules. I, at one time, thought that Agardh's *L. argentescens* of the 'Consp. Crit. Diat,' p. 41, was identical with Dr. Greville's *splendida,* as he states the valves to have "frustula cuneata;" but, at the same time, he says, "the plant is three to six lines in height," and from authentic specimens I have had kindly sent me by Dr. Greville, I find it is certainly the same as *flabellata,* and it was probably only separated, as suggested by Mr. Ralfs, for its silvery lustre when dried. Looking at all these previous authorities, it is surprising to find Professor Smith applying Agardh's name of *flabellata* to the cuneate variety, and uniting in the synonymy, the *L. radians* of Kütz., which is the true *L. splendida* of Greville, with the species described by Ag. in the 'Conspectus,' p. 41, and the *Exillaria flabellata* of Greville, which are identical with the form to which he gives the name of *splendida.* There appears to be the same confusion in the localities given, as the Torbay specimen of Mrs. Griffiths, and those of Salcombe of Mr. Ralfs, have the linear-cuneate form, which is the true *flabellata*, Ag., not the *L. splendida* of Smith.

2. *Licmophora splendida*, Grev.

Frustules cuneate, truncate; F.V. broadly club-shaped; stipes branched; tufts usually one to three lines in height.

Marine on Small Algæ and Zostera.

SYN. *Licmophora splendida*, Grev., Hooker's Br. Flor., 1833, p. 408.
" " Har., Brit. Alg., 1841, p. 206.
Echinella ventilabrum, Carm. MSS., 1829.
Licmophora radians, Kütz., Bac., 1844, t. 11, f. 4.
" " Kütz., Spec. Alg., 1849, p. 113.
" *flabellata*, W. Smith, Syn., 1853, t. 26, f. 234.
" " Ralfs in Pritch. Inf., 1861, p. 771.
Meridion radians, Ag., Sys. Alg., 1824, p. 3 (in part).
Echinella splendida ? Ehr., Inf., 1838, t. 19, f. 2.

This form, whether it be a different species, or merely a variety, does not seem to be so well known as that previously described, but it appears to have been separated by all writers on the genus since the time of Agardh from its smaller size and the decidedly cuneate form of its frustules. Dr. Greville, in the 'Brit. Flor.,' p. 408, says it is "nearly allied to *flabellata*, but smaller and less divided, and frustules more broadly wedge-shaped; tufts two or three lines in height." Captain Carmichael describes the frustules as having "terminali latissimi," and notices the peculiar arrangement of the endochrome as having the appearance of "bars or ocelli," which occurs in some of the gatherings I have, and is shown in tab. xxvi, fig. 234 of the 'Synopsis.' Kütz. describes *L. radians* as with frustules "cuneatis, basi acutis, apice latioribus." Mr. Ralfs copies Professor Smith, but is doubtful if both ought not to be referred to one species; and yet, with these characters by the earliest observers of the form, Professor Smith has applied the name of *splendida* to the linear-cuneate and large variety, and mixed up the true *Licmophora flabellata* of Kütz. and *Echinella flabellata* of Ehr. in his synonymy with the *L. splendida* of the 'British Flora.'

That in many cases there is great difficulty in clearly ascertaining the species really described by the earlier writers, I am quite ready to admit, as we are almost dependent on short descriptions and imperfectly drawn figures; and even specimens named by Kütz. and Agardh I have found to be erroneous. I have seen a gathering named *Rhipidophora grandis,* by Kützing, which is the true *L. flabellata* of Agardh, and of two gatherings by Agardh of *L. argentescens;* one was *L. flabellata,* the other a mixture of a large Synedra with a Rhipidophora. That Professor Smith's transposition of the names in this genus has arisen from some similar cause I have little doubt, and that, without looking with sufficient care into the synonymy, he has depended on specimens which have been erroneously named, or of which the names had been transposed. It is hardly possible that so careful an observer as Dr. Greville, after his description of *Exillaria flabellata* in the 'Scot. Cryp. Flora,' and his subsequent account of it as *L. flabellata* in the 'Brit. Flora,' could have intentionally sent the small and widely cuneate form of which he made the species *splendida* to Professor Smith, as stated in the 'Synopsis,' as the true *flabellata* of Agardh. But I am still more at a loss to understand how in the 'Synopsis' the locality, "Saltcoats, Dr. Landsborough, from Dr. Greville's 'Herbarium,'" could be placed under the *splendida,* as described by Professor Smith, as I have had an opportunity of examining Dr. Landsborough's gathering, which has the widely cuneate valves of the true *splendida* of the 'Brit. Flora,' and is synonymous with the *L. radians* of Kützing. Dr. Landsborough, in speaking of this gathering in 1851, two years prior to the appearance of the 'Synopsis,' says, "This plant has not been found by any since its discovery at Appin by Captain Carmichael, till it was got in considerable abundance by D. Landsborough, junr., in September, 1848, at low water-mark, in a creek formed by trap-dykes in the parish of Ardrossan. Hoping it was the *L. splendida* I sent it to Dr. Greville, and was gratified by his pronouncing it that rare plant. The fans were spread out, in many cases, so as to form more than a semicircle, the rays numbering ten to twenty-six. Each ray or frustule was wedge-shaped and a little denticulated at the top; the upper part was amber-coloured, and each ray had a lighter-coloured dot in the middle of this portion. These bright dots formed a crescent of sea gems. Under this amber-coloured portion there was a pellucid band, the lower part of the fan being amber-coloured, like the upper."*

With respect to Captain Carmichael's specimens from Appin, as far as I can gather from his MSS., the *L. flabellata,* Ag., was described in 1826, and has the long, linear-cuneate frustules of the true *flabellata,* not the cuneate form, as would be imagined by the statement of the 'Synopsis;' whereas the *Echinella ventilabrum,* which was, I believe, the foundation of the *L. splendida* of Greville, and has the broadly cuneate valves, appears to have been described in 1829, which accounts for its non-appearance in the 'Scott. Cryp. Flora' of Dr. Greville, which appeared in 1827.

With respect to the size of the valves given in the 'Synopsis,' there is the same discrepancy as in the other points noticed, and I should imagine they were both taken from a mixture of the two forms. Professor Smith gives ·0033 to ·0078 as the length of his *splendida,* and ·0033 to ·0058 as the length of his *flabellata,* or ·0055 and ·0045 as the average length of each. I have carefully measured fifteen gatherings of the linear-cuneate variety, from Appin, Cumbrae, and Ayrshire, in Scotland; Neyland, in South Wales; Torbay, in the south of England; Bantry Bay, in Ireland; from the north and south of France, and Venice; and find they range from ·006 to ·011. And in nine gatherings of the broad cuneate variety, from Appin, Cumbrae, and Saltcoats, in Scotland; Paignton, Exmouth, and Salcombe, in the south of England; the north of France, and Venice, the valves range from ·0035 to ·0051. The average of all the gatherings of each variety being respectively ·0073 for the linear frustules and ·0048 for the cuneate forms, showing a considerable difference from those before quoted from the 'Synopsis.' The frustules in the same gathering are generally very persistent in size, but I have one gathering from Dunbar, named *L. flabellata* by Dr. Landsborough, in which the stipes is gone and most of the valves separated. This contains a mixture of the cuneate and linear-cuneate varieties, but the former all range from ·0045 to ·0050, the latter from ·0065 to ·0070, and there is no evidence to show that they are from the same plant.

From a careful consideration of the foregoing particulars I can only arrive at the conclusion, that Professor Smith, in describing the species of *Licmophora,* by some intermixture of, or examination of wrongly-named specimens, has reversed the true names of the species in the 'Synopsis;' and that both in the measurements, synonymy, and localities given to

* Lands. 'Pop. Brit. Seaweeds,' p. 337.

each, some belong to one and some to the other species; and that the *Licmophora splendida* of the 'Synopsis' is the true *L. flabellata* of Agardh, and the *L. flabellata* the true *L. splendida* of Greville.

It is also, I think, clearly proved that the only ground for considering them as true species is that they differ in the size and comparative breadth of the frustule and (on the evidence of several observers) in the size of the plant, but that there is no decided structural peculiarity. As it is highly probable that a more extended examination of living specimens may show that this is owing to habitat and the nature of the plant on which they grow—the larger forms growing on those that offer a firm and decided support to the stipes, whilst the smaller may be confined to the weaker and more filiform algæ—I consider that, as far as we at present know, they ought to be considered rather as varieties than true species, and that both ought to be classed under the name of *Licmophora flabellata*, Ag.

TRANSACTIONS.

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

(Communicated by F. C. S. Roper, F.R.S.)
(Read May 13th, 1863.)

(Pl. IV and V.)

The species described in this paper were obtained from a sample of Barbadoes earth (Cambridge estate), communicated a few months ago to my veteran friend in diatomic research, Mr. Johnson, of Lancaster. Extensively as this remarkable deposit had been examined, it is most extraordinary that in the small sample referred to, a host of new things—genera as well as species, should have been discovered; while it is equally curious that many forms common in previously examined portions of the same deposit should here be absent. Some of the most singular as well as beautiful of these diatoms are in the hand of my friend and acute fellow-labourer, Mr. Ralfs, and will enrich the supplement to Pritchard's 'History of Infusoria,' upon which he is at present engaged.

Porodiscus, nov. gen., Grev.

Frustules free, disciform, composed of two discs, united by an intermediate, ring-like zone; discs very convex, minutely radiato-cellulate or punctate, with a conspicuous central pseudo-opening or pore.

This genus is evidently closely allied to *Coscinodiscus*, differing chiefly in the remarkable pore-like pseudo-opening, which is not a mere blank circular space produced by the absence of cellulation at the apex, but a well-defined, concave, apparent orifice, provided with a thickened margin. All the species hitherto discovered—and they are confined to the Barbadoes deposit—are very convex, with a minute structure of distinctly radiating puncta (cellules under a sufficiently magnifying power). In nearly all the species certain of the radiating lines are continued from the margin to the apex, and divide the disc into faint but perceptible compartments. The surface is either plain or armed with variously arranged, minute spines. The first and last of the following species occurred to myself some years ago, when I was engaged upon the examination of Barbadoes earth, in working out the remarkable *Asterolampræ* contained in that deposit; but no others had been observed, until my friend, Mr. Johnson, commenced the investigation of the sample of the deposit from Cambridge estate, which has yielded so prolific a harvest of beautiful and curious new diatoms. The species of the present genus not described in this paper will be published by Mr. Ralfs, along with many other new and remarkable objects, in the forthcoming supplement to Pritchard's valuable work on the 'Infusoria.'

Porodiscus elegans, n. sp., Grev.—Disc very convex, unarmed, divided into compartments by pairs of the radiating lines of very minute puncta, extending from the margin to the centre. Diameter ·0020″ to ·0033″. (Pl. IV, fig. 1.)

Barbadoes deposit, from Cambridge and other localities; C. Johnson, Esq., R.K.G.

This species is distinguished by the disc being divided into numerous compartments, by pairs of radiating lines of puncta, very distinctly seen under a moderately magnifying power, and at the same time being quite destitute of spines. It is the most frequent species, three or four valves sometimes occurring in a single slide. The connecting zone is rarely seen *in situ*.

Porodiscus major, n. sp., Grev.—Disc with a very large pseudo-opening; the radiating puncta very minute, irregular, and interrupted for some distance round the opening, afterwards becoming regular, with faint, equidistant rays, formed by pairs of the longest lines. Diameter of pseudo-opening ·0006″. (Fig. 2.)

Hab. Barbadoes deposit from Cambridge estate, in a slide communicated by C. Johnson, Esq.

I have not seen an entire valve of this species, but from what remains in the specimen before me it is probably not less than ·0040″ or ·0050″ in diameter. The margin of the pseudo-opening is somewhat crenate or plicate, in consequence of the lines of puncta being somewhat thickened at their termination. From its large size, it is easily seen that there is no real perforation; and that it is simply concave, and closed by a diaphragm. For a space round the pseudo-opening equal to the diameter of the opening itself the puncta are exceedingly irregular; many of the radiating lines are interrupted, and here and there the puncta are either altogether wanting or look as if they had been shaken out of their places. At present it is impossible to say whether this centrical irregularity is accidental or otherwise.

Porodiscus conicus, n. sp., Grev.—Small; disc conical, unarmed, with an obtusely truncate apex; radiating lines of puncta extremely minute. Diameter ·0014″. (Fig. 3.)

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

The smallest of the species hitherto discovered, and occurring not unfrequently in perfect frustules. The length of the connecting zone is considerable, and that of the entire frustule, when both valves are symmetrical, about ·0040″. The valve is decidedly conical, but obtusely truncate at the top when seen in profile. It hardly ever happens that the valves are equal in the same specimen; indeed I do not think that I have seen a single example perfectly symmetrical, one valve being almost always considerably shorter than the other. The length of the connecting zone gives the frustule a cylindrical appearance.

Porodiscus nitidus, n. sp., Grev.—Disc convex, unarmed, the longest lines of puncta single (not in pairs), alternating with two or three series of shorter ones; puncta distinct, all of them becoming much more minute towards the margin. Diameter ·0026″. (Fig. 4.)

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

Disc much less crowded than in the three preceding species, and the puncta larger and more distinct. A certain number of the lines reach from the margin to the centre; a second series very nearly so; a third are considerably shorter, and the last extend but little beyond the margin. It is a scarce species.

Porodiscus oblongus, n. sp., Grev.—Disc elliptical-oblong; pseudo-opening large. Long diameter about ·0028″. (Fig. 5.)

Hab. Barbadoes deposit.

A species by no means rare in some specimens of the deposit which I investigated a few years ago, but it does not seem to occur in those which have recently been so carefully examined from Cambridge estate. The form alone is sufficient to identify it. The pseudo-opening is very large, the radiating lines of granules are less crowded, and the granules themselves larger than in any of the preceding species.

HETERODICTYON, nov. gen., Grev.

Frustules free, disciform; disc with radiate or scattered cellules or puncta in the middle portion, and a circle of large intra-marginal cellules.

This genus is allied on the one hand to *Coscinodiscus*, on the other to *Brightwellia*. From the former it differs in the circle of very large cellules, from the latter in the absence of the spiral arrangement of the central cellulation. Besides this distinction, the circle of large cellules seems to be more associated with the marginal structure than in *Brightwellia*, at least such is very decidedly the case in one of our species. In the other there is an approach towards the last-mentioned genus, the circle being further removed from the margin. Perhaps the best character will be found to consist (taken in conjunction with the circle of large cellules) in the absence of the beautiful curved or spiral cellulation which marks the three known species of *Brightwellia*.

Heterodictyon Rylandsianum, n. sp., Grev.—Disc with minute radiating puncta, and a circle of very large, linear-oblong, marginal cellules. Diameter ·0050″. (Fig. 6.)

Hab. Barbadoes deposit, from Cambridge estate, in a slide communicated by C. Johnson, Esq.

An exquisitely beautiful disc, and so well marked as to require no extended description. Viewed apart from the circle of large cellules which occupy nearly a fifth part of the radius, there is no character to distinguish it from *Coscinodiscus*, and the resemblance to various species of that genus is rendered more striking by the presence of a little central cluster of cellules considerably larger than the puncta which radiate from them. The large cellules of the margin are parallel with each other, somewhat arched at their inner extremity, and arranged in groups of three, the middle one being the longest. A narrow band of puncta is situated between the base of these cellules and the margin.

Heterodictyon splendidum, n. sp., Grev.—Disc small, the central portion occupied with remotely scattered, large, round cellules, and surrounded with a circle of large hexagonal cellules, having an exterior border of coarse, moniliform striæ. Diameter ·0023″. (Fig. 7.)

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

A remarkable, ornamental species, and illustrative of the generic name, as no fewer than three conspicuous structures unite in its composition. The central and larger space has round cellules, so remotely and irregularly disposed as to render it unlike a diatomic structure. Then comes the characteristic circle of large, equal, hexagonal cellules, which exhibit the singular peculiarity that the marginal angles of the hexagons are not quite completed. Lastly, between the large cellular circle and the margin the space (equal in breadth to the diameter of the large cellules) is filled up with radiating, robust, moniliform striæ, which take the place of the narrow marginal band of puncta seen in the preceding species. It must be confessed that in general appearance the two species differ exceedingly, and it is by no means improbable that the present one may be ultimately separated.

FENESTRELLA, nov. gen., Grev.

Frustules free, disciform; disc with a minute, radiant cellulation, interrupted in the middle by linear bands, composed of parallel lines of cellules, each band terminating in a flat ocellus.

This genus is composed for the reception of a solitary but most curious diatom, the relations of which it is not easy to define. The groundwork of the disc is very much that of *Coscinodiscus*, being composed of radiating lines of cellules, with a marginal row of puncta. But a couple of circular ocelli, at little more than half the radius from the centre, although not conspicuous, are sufficiently evident, and show that we must look for affinities elsewhere. These ocelli are not processes, but definite blank spaces in the cellulation, and have therefore no connection with *Eupodiscus* or *Aulacodiscus*. Another peculiarity is a broad, linear-oblong band passing across the middle of the disc, and composed of about eight rows of cellules; or perhaps it would be more correct to say that two opposite sets of rows of cellules meet at their bases in the centre, and at the other extremity converge as they terminate in the occelli, with which they are evidently connected. There is no umbilicus, the band of cellules intercepting, as it were, the meeting of the radiating lines, the only indication of the central point being a slight interruption in the continuity of the cellules, not sufficiently definite to constitute a character. The convergence of these lines of cellules towards the ocelli seems to point to some alliance with *Auliscus*, but, on the other hand, there is none between the mastoid processes of that genus and the ocelli of the present one.

Fenestrella Barbadensis, n. sp., Grev. (Fig. 8.)

Hab. Barbadoes deposit, from Cambridge estate, in a slide communicated by C. Johnson, Esq.

The diameter of the disc is ·0040″. Parallel lines leading to the ocelli, 8 in ·001″. The most remarkable feature in the disc, composed, as it is, of a radiating cellulation, is the absence of a central point, there being neither umbilicus nor centre of radiation, the band above described lying like a bar across it.

Craspedoporus, nov. gen., Grev.

Frustules free, disciform; disc divided into radiating segments, the alternate ones dilated towards the margin, and bearing an intra-marginal ocellus or pseudo-opening.

In one species of this most curious genus the structure is distinctly cellulate, but so irregularly as to bear no resemblance in this respect to *Actinoptychus* (Ehr.) and its allies, the walls of the cellules being thin and cobwebby. In the other species the structure is more dense and opaque, and scarcely any approach to cellulation can be perceived. There are no septa, but the radiating segments or compartments are defined by an undulation, or, perhaps, a slight fold, the ocelliferous segments being very slightly raised above the plane of the intervening spaces. The ocelli or pseudo-openings are large and conspicuous, and appear to be concave or foveate, with a somewhat prominent border, especially on the side next the margin of the valve. In general character, the genus would take its place among the *Coscinodisci*, but the thickened and somewhat raised border of the ocelli shows more affinity with the *Eupodisceæ*.

Craspedoporus Ralfsianus, n. sp., Grev.—Valve cellulate; ocelliferous compartments numerous, narrow and linear next the central space, becoming spoon-shaped towards the margin; ocelli suborbicular. Diameter ·0045″. (Fig. 9.)

Hab. Barbadoes earth, from Cambridge estate; John Ralfs, Esq. A fragment, in a slide communicated by C. Johnson, Esq.

Structure an irregular network. Central space about a fourth of the diameter of the disc, and somewhat more dense. Ocelliferous rays eight, nearly linear for half their length, then dilating into a spoon-like extremity, in which the pseudo-opening is situated near the margin. The ocelli have a distinct border, which is sometimes so much raised next the margin as to cause it to resemble a little pocket. The fragment in my own cabinet (half a disc) had, when perfect, nine ocelliferous rays.

Craspedoporus Johnsonianus, n. sp., Grev.—Valve not visibly cellulate, with five ocelliferous compartments; ocelli or pseudo-openings large, transversely oval, close to the margin. Diameter ·0025″. (Fig. 10.)

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

In this species the compartments into which the disc is divided are more equal, and it consequently bears some general resemblance to *Actinoptychus* (Ehr.). There is, nevertheless, a great difference. In both species of our present genus there is a sort of central nucleus, of considerable size. No fine, decussating striation is perceptible; and the whole structure is quite unlike the hexagonal cellulation of *Actinoptychus.*

ACTINODISCUS, nov. gen., Grev.

Frustules free, disciform; valve granulose, with a central nucleus and numerous broadly linear rays extending from it to the margin.

This is distinguished from the last genus by the total absence of ocelli. The rays are not in the least degree wedge-shaped, but are linear, about half the radius in length, and resemble the spokes of a wheel. The structure is dense, not showing any approach towards cellulation in any part.

Actinodiscus Barbadensis, n. sp., Grev. (Fig. 11.)

Hab. Barbadoes deposit, from Cambridge estate, in a slide communicated by C. Johnson, Esq.

The most conspicuous feature in this disc are the numerous rays, fifteen in number; they are slightly dilated at the ends, and apparently somewhat thickened, but have not the slightest indication of an opening. Diameter ·0038″.

AULACODISCUS.

Aulacodiscus inflatus, n. sp., Grev.—Disc bullate beneath the processes, the bullation causing a dark line of shadow just within the margin; processes 4, submarginal, long, cylindrical; furrow defined by parallel lines of granules reaching nearly to the centre, where the granules are arranged irregularly round a somewhat quadrate blank space; lines of granules in the spaces between the inflations about 8 in ·001″. Diameter about ·0035″. (Fig. 12.)

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

The section containing those species which have the processes seated on an inflated portion of the disc is so limited that there can be no hesitation in considering the one now before us as new. It is more frequent than any other in the particular sample of the deposit which has furnished so many novelties. There are also at least three other *Aulacodisci* about the same size with which it is associated, and which are inflated beneath the processes. One of them is the species next described. In another the inflations are further removed from the margin, and are extended in an oblong form nearer to the centre. In the third the inflations are more or less rough with tubercles or apiculi, as in *A. Petersii,* and the margin is besides distinguished by a circle of gland-like tubercles.

Aulacodiscus mammosus, n. sp., Grev.—Disc very prominently bullate beneath the processes, the bullations close to the margin and forming elevated cones; processes long, cylindrical; furrows open, composed of two parallel rows of granules reaching the umbilical blank space. Diameter ·0038″. (Fig. 13.)

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

This species may be known at once by the cone-like inflations, which are so elevated as to be completely out of focus when any other part of the disc is examined; and they rise so suddenly, and the sides are so steep, that it is impossible, in a vertical view, to see the structure. Having been so fortunate as to discover a valve exhibiting a front view, I am able to give the height of the bullation above the surface of the disc, which is about ·0010″, and, including the long cylindrical processes, ·0012″! Indeed, they may be not unaptly compared to thimbles. The ridges on which the furrows are situated commence near the centre with two parallel lines of granules, and gradually dilate, so that, including the bullation (as viewed vertically), the whole resembles in outline a child's wooden battledore. On each side of the ridge the granules are so arranged as to appear like a fringe of diverging lines, while those on each side of the bullations become widely radiating.

Aulacodiscus Kilkellyanus, n. sp., Grev.—Disc with (3) spherical, sub-marginal processes, and distant radiating lines of minute granules, 7 or 8 in ·001″, many of the lines not reaching more than half way towards the centre; intra-marginal striæ 31 in ·001″. Diameter about ·0040″. (Fig. 14.)

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

A remarkably distinct and beautiful species, conspicuous at first sight for the open character of the disc, arising from the distance between the radiating lines, which, in regard to length, are divided into several series, like the gills in an Agaric. This is more or less the case in many of the species, but here it attracts attention on account of the comparatively small number of lines rendering the arrangement more visible. The processes appear to the eye to extend as far as the margin. There is no bullation, and the connecting furrows are so similar to the other interlinear spaces that they do not form a prominent character.

I have great pleasure, in accordance with the wish of my highly valued friend, Mr. Johnson, in bestowing upon this exquisitely beautiful diatom the name of — Kilkelly, Esq., of Barbadoes, to whose kindness Mr. Johnson was indebted for the material which has proved so rich in new genera and species, and which has enabled us to extend so considerably our knowledge of diatomic forms.

Aulacodiscus angulatus, n. sp., Grev.—Valve elevated in the middle, and somewhat prismatic; the centre depressed, with a blank umbilicus; processes (5 or 6) without inflations, submarginal; connecting furrows very narrow, on prominent ridges. Diameter about ·0040″. (Fig. 15.)

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

The most characteristic feature in this species is the elevated and somewhat angular form of the middle of the valve. The centre is flattened or depressed, and surrounded by a raised shoulder, from which the prominent furrow-bearing ridges radiate to the processes. The prismatic form of the disc will be best understood from the fact that when the glass is adjusted for the shoulder and ridges the intermediate compartments are quite out of focus. An additional angularity is also imparted in consequence of the portion of the raised shoulder which is left between the radiating ridges being carried in a straight line between ridge and ridge, a pentagonal or hexagonal effect (as the case may be) being thus produced. The furrows are very narrow, the space being often less than the diameter of the granules themselves, except as they approach the processes. In the specimens which I have examined, the processes seem to have been all broken away, the roundish, blank spaces being quite flat.

Aulacodiscus spectabilis, n. sp., Grev.—Valve convex, with the centre depressed, and a blank umbilicus; processes (5) without inflations, submarginal; furrows open, on slightly convex ridges, regularly fringed on each side with short, granular lines. Diameter about ·0050″. (Fig. 16.)

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

Not prismatically elevated in the middle, as in the preceding species, but the centre is depressed, and the granules irregularly disposed round the umbilicus, some of them, at least occasionally, partially concentric. The connecting furrows form a conspicuous feature, being twice as wide as the diameter of the granules. From the two lines of granules which define the furrows spring the fringe of short lines, given off at right angles so regularly as to be pectinate, and which increase in length near the processes and margin, like the feathers on a bantam's legs and feet.

Aulacodiscus pallidus, n. sp., Grev.—Valve pale, with numerous (10) processes at some distance from the margin, and radiating lines of minute puncta; connecting furrows defined by two rows of puncta. Diameter ·0035″. (Fig. 17.)

Hab. Barbadoes deposit, from Cambridge, estate in a slide communicated by C. Johnson, Esq.

At first sight the present species appears to be very unlike an *Aulacodiscus,* but the connecting furrows are sufficient to establish its position. There is no umbilical vacancy; the radiating puncta commence at the very centre, and just before reaching the circle of processes appear to sink down at an obtuse angle to the margin, while the furrows are continued, at a slight elevation, to the processes. The latter may have been all broken off, as I can perceive merely the oval vacant space, and a tubercle within it.

Aulacodiscus? paradoxus, n. sp., Grev.—Valve divided by radiating undulations into six compartments, filled with decussating lines of distinct granules, each alternate compartment being in a higher plane than the rest, and provided with an intra-marginal, short process. Diameter ·0040″. (Fig. 18.)

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

I have only seen two specimens of this most remarkable diatom, but they are in so good a state as to render their examination perfectly satisfactory. The general structure is sufficiently characteristic of the genus, but in several points of view the valve is anomalous. The equal division into six compartments is more like *Actinoptychus* (Ehr.) and its allies, and the resemblance is rendered more striking in consequence of the alternate compartments lying in a different plane.

There is also something very unusual in the situation of the processes. They are not placed at the termination of the ridge-like folds which separate the compartments where we should naturally look for them, but in the middle of each compartment, next the margin; an arrangement which reminds us rather of the spine in *Omphalopelta*. Again, there is no true connecting furrow. The usual law is a linear channel, bounded on each side by a row of granules; or if the channel or furrow be nearly obsolete, still the radiating lines of granules run parallel with the obsolete furrow. There is nothing like this in *A. ? paradoxus*. The lines of granules, which are beautifully arranged quincunx fashion, come down obliquely from the ridge on each side, to meet in the middle at an acute angle; and as the meeting of the two opposite sets of lines is not exact, the end of one line often overlaps the ends of another, and produces an irregularity which attracts the eye, since it constitutes an obscure sort of line, bearing, however, no resemblance to a furrow. The processes themselves do not resemble those of the genus, being, as far as I can make them out, mere oblong or linear-oblong tubercles, in the middle of an elliptical blank space, and not presenting the usual dilated base. In the centre of the valve is a rather large umbilical space. This diatom will probably form a distinct genus.

EUPODISCUS.

Eupodiscus punctulatus, n. sp., Grev.—Pale; disc slightly convex, minutely and somewhat concentrically punctate; puncta smaller in the centre, then becoming equal throughout; processes (4) marginal. Diameter ·0032″. (Fig. 19.)

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

Clearly characterised by its minute, uniform punctation, arranged somewhat in the manner of an engine-turned pattern, there being no radiation in any part of the disc. The four processes are rather small, circular, close to the margin, and prominent when seen in profile.

Eupodiscus simplex, n. sp., Grev.—Disc slightly convex, filled up with small, uniform, hexagonal cellules; processes (2) large, circular, or broadly oval, at some distance from the margin, within which is a row of very minute puncta. Diameter about ·0030″. (Fig. 20.)

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

A most beautiful species, easily known by its regular network of hexagonal cellules, which are about 7 in ·001″. I scarcely know what is the true form of the processes, as in half the specimens I have seen they are not truly circular, but tending to broadly oval.

AULISCUS.

Auliscus nebulosus, n. sp., Grev.—Valve circular (with 4 processes); no definite umbilicus; radiating lines all uniform, extremely fine; minute puncta, forming irregular clusters beneath and between the processes. Diameter ·0030″. (Fig. 21.)

Hab. Barbadoes deposit, from Cambridge estate; C. Johnson, Esq., G. M. Browne, Esq.; very rare.

Of this beautiful species various examples have occurred to Mr. Johnson, Mr. Ralfs, and myself, but always with the surface so abraded as to prevent description. Perfect specimens have, however, been recently discovered. Nearly all the frustules which have been seen present the singular appearance of eight processes, the four of the subjacent valve alternating with those of the upper, and being almost equally conspicuous. In my figure I have represented the four belonging to the upper valve, in order to prevent confusion in the engraving. As all the discs hitherto observed possess this number, it is probably the normal one. The species belongs to the group characterised by very fine and crowded radiating lines; but in the clusters of minute puncta, in the neighbourhood of the processes, it is also allied to *A. racemosus*. It wants, however, the circle of marginal puncta. The processes are circular, and large for the size of the disc.

Auliscus parvulus, n. sp., Grev.—Very small; valve circular, with 4 processes; structure obscure. Diameter ·0015″. (Fig. 22.)

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

I have been unable to make out any striation in the specimens of this species which I have examined. It apparently belongs to the same group as *A. elaboratus* and *Johnsonianus*, having the same pale, semi-opaque, somewhat dense appearance. I cannot refer it to any described species; and, indeed, it is so many degrees smaller than any one hitherto discovered, that there is good reason to regard it as distinct. It presents another example of valves with four processes.

Auliscus ambiguus, n. sp., Grev.—Valve broadly oval, the whole surface filled up with a minute cellulation (no trace of converging or radiating lines); cellules 11 or 12 in ·001″. Longest diameter ·0022″. (Fig. 23.)

Hab. Barbadoes deposit, from Cambridge estate, communicated by C. Johnson, Esq.

This is one of those anomalous forms which disturb the natural habit of genera. In *A. Ralfsianus* we have a similar instance, but in that case the indications of converging lines could be perceived by an attentive observer in the direction of the puncta within the meshes of the network. Here, however, we have a very minute cellulation covering the entire valve (with the exception of the processes), without any indication of converging lines at all. At the same time the diatom is evidently an *Auliscus*, the processes being unmistakable, and, as in all the other non-circular species, they are placed, not in the exact line of the longest diameter, but on each side of it. I have examined two specimens and the fragment of a third, all of which are precisely alike.

TRICERATIUM.

Triceratium lineatum, n. sp., Grev.—Valve with a dense, obscurely radiating structure, nearly straight sides, subacute angles, and prominent pseudo-nodules; within each angle three remote lines, sub-concentric with the angles. Distance between the angles about ·0040″. (Fig. 24.)

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

One of the most distinct species in the whole genus. The remarkable lines within each angle include the greater part of the surface. The structure is more or less opaque, exhibiting an obscure radiation in the centre and an exceedingly fine striation between the curved lines. The pseudonodules are not large, but very conspicuous.

PEPONIA, nov. gen., Grev.

Valves sub-circular, conspicuously cellulate, suddenly contracted, above and below, into a triangular apiculus; cellules round.

The definition of this genus must be regarded as provisional until the front view of the frustules can be obtained. Of the valve I have seen a very considerable number of specimens, and in several instances the opposite valve partially displaced, as shown in the figure, which shows that the connecting zone must be narrow. The apiculus has sometimes a distinct appearance of being furnished with a nodule or short process, but I have not been able to satisfy myself on this point. This diatom is so exceedingly peculiar that, notwithstanding the deficiency of the front view, and, consequently, our ignorance of its precise place in the system, I do not hesitate to make it known.

Peponia Barbadensis, n. sp., Grev. (Fig. 25.)

Hab. Barbadoes deposit, from Cambridge estate (not unfrequent); C. Johnson, Esq.

Valve yellowish, more or less circular, the transverse diameter being often the longest, suddenly contracted at the opposite ends into a triangular, subacute apiculus. Whole surface filled up with rounded cellules, largest in the middle. In size the valves vary greatly, from ·0020″ to upwards of ·0030″ in diameter. Between the body of the disc and the apiculus there is the appearance of a septum. The apiculus itself is generally, but not always, destitute of cellules. The individual figured is the finest I have seen.

THAUMATONEMA, nov. gen., Grev.

Frustules united into a filament; valves disciform, each producing a central, forked process, which is articulated at the apices with that of the opposite valve.

From the front-view position of the frustule it is difficult to ascertain precisely the nature of the structure of the discoid portion of the valve, but it appears to consist of radiating lines of minute puncta. The genus, I presume, must be placed among the *Melosireæ*.

Thaumatonema Barbadense, n. sp., Grev. (Fig. 26.)

Hab. Barbadoes deposit, from Cambridge estate, in a slide communicated by C. Johnson, Esq.

An extraordinary diatom, unlke anything previously described. If the valves of *Melosira Westii*, instead of being joined by their narrow, truncated ends, were each provided with a central process widely forked, the apices of the forks somewhat dilated and articulated with the forks of the opposite valve, a tolerably accurate idea would be conveyed of this singular production. Length of two valves, with processes *in situ*, ·0038″. Breadth of valve, and also of the space between the articulations of the forks, ·0017″. Length of process, including the fork, the one being about equal to the other, ·0013″.

On the Nerves *of the* Cornea, *and of their* Distribution *in the* Corneal Tissue *of* Man *and* Animals. By J. V. Ciaccio, M.D., of Naples.

(Read May 13th, 1863.)

(Pl. VI and VII.)

Since Schlemm's discovery of the nerves of the cornea up to the present time nearly all observers who have investigated the subject agree that these nerves, after dividing and subdividing, terminate in a wide network, composed of non-medullated or pale nerve-fibres. The ultimate arrangement of this network has not yet, however, been fully pointed out, neither has any one proved whether it exhibits the same arrangement in different animals as in man. With the hope of throwing some light upon a subject at present so little known, I have made many observations on the cornea of the sparrow, eel, frog, mouse, and man, and the conclusions which I have arrived at will be detailed in the paper which I have the honour to bring before the notice of the members of this Society.

The great importance of the present inquiry, I imagine, will be generally admitted. The cornea is endowed only with common sensibility, so that when we have established with certainty the manner in which the nerves terminate in it, we may, with some reason, infer the mode of ending of the nerves in the other parts possessing the same kind of sensibility. By comparing, then, these results with those hitherto obtained by observers, in reference to the ending of motor nerves, the debated question about the terminal distribution of these two kinds of nerves, perhaps, will be finally settled. But this inquiry is as difficult as it is important. Of the many difficulties which I have met with, I shall only now allude to those which seem to me to be the greatest.

1. The first is, that the nerves of the cornea in all their course continually change the plane and direction of their distribution, so that in making very thin sections for microscopical investigation, not only is the relative position of nerves and the adjacent tissues altered, but those nerve-fibres which we observe in the thin sections very often exhibit such appearances that they are hardly recognised by the most experienced eye as nerve-fibres.

2. The second difficulty consists in this, that the optical properties of the nerves and other elementary parts of the cornea are such that, without the aid of some chemical

agents, it is impossible for the nerves to be seen. But by the use of chemical agents the natural aspect of the nerves is always altered, and if we are not very careful in using them, we may destroy the finest fibres.

3. The third difficulty arises from the peculiar structure of the cornea itself, which contains a very large number of corpuscles, with many anastomosing processes. This undoubtedly causes much difficulty in tracing the ultimate nerve-fibres running through its lamellated structure; and if we do not use much diligence in observing, we may mistake the processes of the cornea-corpuscles for the finest nerve-fibres, and draw the erroneous conclusion that there exists an intimate connexion between the nerve-fibres and the cornea-corpuscles.

It seems to me that these three difficulties which I have mentioned, if not totally, can at least in part be surmounted. In fact, if we select for the microscopical investigation those animals in which the cornea is not thick, we shall find that the first difficulty decreases in proportion as the thickness of the cornea which we have to examine diminishes. Hence the cornea of small birds, of the frog, mouse, and so on, are more suitable for investigation than that of man or the larger animals. I have found by experience that in the sparrow's cornea the nerves can be easily seen and traced for a very long distance, because in this little bird the distribution of nerves is more simple than in the mouse and frog, and the thickness of its cornea is such that by only dividing it transversely we are enabled to examine it with high powers. We cannot, in my opinion, completely overcome the second difficulty in the present state of our knowledge; but the only thing we can do is to moderate, in some way, the chemical action of those agents which we are obliged to employ for bringing out the nerves, which lie hidden among the proper fibrous tissue of the cornea. In such a case the best way is to employ only a small quantity of the reagent, because, if required, we can always add more; while, on the contrary, we can never remedy the harm produced by a large quantity. The third difficulty can only be avoided if we are careful in observing. The processes of the cornea-corpuscles generally exhibit such an appearance that they are with great difficulty distinguished from the finest nerve-fibres. Like the nerve-fibres, they become granular by the action of acetic acid. How much this increases the difficulty it is hardly necessary to say. In no other way, therefore, we can distinguish the processes of the cornea-corpuscles from the finest nerve-fibres, but by following both to their respective origins, viz., the former to the cornea-corpuscles, and the latter to the branches, from which they are derived. I say, candidly, that when I commenced this inquiry, I had fallen into the error of believing that, if not all, at least some of the finest nerve-fibres distributed to the cornea, really terminated in its corpuscles; but a rigid and exact investigation has since convinced me that I was greatly mistaken. I have often succeeded in tracing beyond the cornea-corpuscles some nerve-fibres which, at first, seemed to end in them. The truth is, that sometimes some of the finest nerve-fibres, which could be followed as far as the cornea-corpuscles, could not be traced further on, so that they appeared really to terminate there. But I think this appearance depends on the continuation of the fibre being destroyed either by the pressure of the thin glass, or by the action of the chemical agents which we are obliged to employ. Because if it were not so, the above-mentioned appearance would be more frequently observed.

After these brief remarks upon the great importance and the difficulties of the present inquiry, I shall proceed to state what my observations have shown with regard to the distribution and termination of the nerves of the cornea; and I shall divide, but only for the sake of a clear and methodic arrangement, the whole subject into two parts. In the first part the nerves, with all their peculiarities, will be considered; and in the second, the manner in which they end will be described in detail.

I.—OF THE PLACE WHERE THE NERVES ENTER INTO THE CORNEA—OF THEIR NUMBER AND SIZE.

The nerves of the cornea derived from the ciliary nerves pass from the sclerotica into the laminated structure of the cornea, rather nearer the posterior than the anterior surface. They are seen at its margin in the form of several fine trunks, which, as they pass in different directions from their entrance, form with the border of the cornea various angles. I have observed that, when the cornea of some small animals, namely, frog, eel, mouse, and sparrow, is transversely divided into two parts, at the microscopical examination, most of the fine trunks divided across their course are found in the section corresponding to the posterior part of the cornea, while the network formed by them is found in the anterior part. The conclusion from this observation is, that the nerves, in entering the cornea towards its posterior surface, after dividing and subdividing, reach the anterior surface, where they end in a very composite network or plexus.

The number of the nerves of the cornea varies very much in different animals. This number can be determined with some certainty only in small animals, because in the larger ones the cornea is so thick that in order to examine it with high powers, it is necessary to make very thin sections, in which we very often fail to find any nervous trunks, or not more than one or two. In small animals, on the contrary, the cornea is thin enough to be examined microscopically, either entire, or only divided transversely into two parts. According to my observations, in the cornea of the sparrow there are thirty-one nerve-trunks; in that of the mouse twenty-six, and in that of the frog about thirty. I say *about thirty,* because, in a sixth part of the cornea of this animal, I have seen nearly five trunks. Supposing, then, that in each of the remaining parts were the same number, the total sum will be as above. But this supposition is not quite correct, for in the cornea the nerve-trunks are not at equal distances from one another, so that in one part the number of the nerve-trunks may be greater than in another part. In the cornea of the frog, therefore, the nervous trunks may be more or less than thirty.

Some observers have asserted that the nerves of the cornea in man are from twenty-four to thirty-six; but every one who considers the difference between twenty-four and thirty-six, will at once see that this is only a mere assertion, and nothing else. In man, as in other large animals, I believe it is very difficult to ascertain the precise number of the nerves of the cornea. I must say that, in calculating the nerve-trunks distributed to the cornea of the animals above mentioned, I have not taken the slightest notice of those very fine trunklets which, together with the large ones, enter the cornea at various depths.

The corneal nerves also vary much in size. Not only is there a great difference in the size of the various trunks in the same animal, but between those of different animals when compared the one with the other. From my observations, I am led to the conclusion that the nerves in the cornea of the mouse are larger than those in the cornea of the eel, frog, and sparrow.

The manner in which the nerves of the cornea branch.

It is generally admitted that the mode of distribution of nerves to the cornea is effected by dichotomous division.

Undoubtedly this is the general rule, nevertheless, I have observed, although very rarely, in the cornea of the frog and sparrow, some large branches dividing into three or four smaller ones. There are, however, in the mode of branching of these nerves some points worthy of special note, which I shall presently allude to.

Not all the nerve-trunks of the cornea begin to divide at the same distance from its border. Some of them divide as soon as they enter, while others do so after running for some distance through its fibrous tissue. I have sometimes seen two distinct trunks in the sclerotica converging more and more as they approach towards the border of the cornea; but as soon as they arrive there they unite into a single trunk, which enters the cornea and divides in the same manner as the others. At other times I have observed a large trunk running through the sclerotica like a single trunk; but as soon as it reaches the margin of the cornea, it divides into branches, which, as two distinct trunks, penetrate into the cornea, and pass in different directions.

The division and subdivision of these trunks is generally effected at angles more or less acute. It is seldom that we observe a trunk or branch dividing at right angles. The distance from one to the other division varies greatly. In some cases, while from the first to the second division of a trunk there is a great distance, from the second to the third there is very little. As the nerves, however, approach their ultimate distribution, the distance among the divisions becomes less and less. All the branches resulting from these divisions are not of the same size. It sometimes happens that we observe two nerve-trunks of various sizes entering the cornea one close to the other, and while one divides into two branches, the other, without dividing, unites with the smaller branch, and the compound trunk thus formed runs on. It is also not unfrequently observed that, from a trunk before its regular division, a bundle of fibres separates at a very acute angle, which, after a more or less circuitous course, unites with one of the other branches of the same trunk, or with that from another trunk.

The nuclei in connection with the nerves of the cornea.

Dr. Beale, from his numerous investigations upon the peripheric distribution of nerves, has been led to the conclusion that, in connection with all nerve-fibres, there are little oval bodies, or nuclei, which form an integral part of each separate fibre, and increase in number as the nerves approach their ultimate distribution. This general conclusion of Dr. Beale cannot be accepted as regards the nerves of the cornea. The nuclei, as I have observed, are very numerous in the trunks and primary branches of the nerves of the cornea, but as the nerves reach their termination, these bodies gradually decrease in number. They are frequently seen in connection with single nerve-fibres, but sometimes more than one fibre is seen connected with a single nucleus. As to the number and size of these nuclei, there is much variety. I have found that in the nerves distributed to the cornea of man and the mouse, the nuclei are comparatively more numerous and broader than in the frog and sparrow.

Besides these nuclei connected with the nerve-fibres, I have seen, especially in the frog, another kind of nuclei, which lie on a more superficial plane than the former, and are spindle-shaped and sometimes so bent on themselves as to exhibit the form of the letter S. They are not arranged in the same linear direction as the nerve-fibres, but incline to them obliquely. I have been able to see these nuclei in the trunks of the nerves and the largest branches; and I hold strongly to the opinion that they are the special organs upon which depends the growth and repair of that clear transparent material in which the nerves at their peripheric distribution are imbedded.

I cannot say from my own observations whether the other nerves of common sensation have the same peculiar characteristic as those of the cornea. There are, however, some observations of Dr. Beale which satisfactorily clear up this point. This able observer has investigated and figured in a beautiful drawing the distribution of nerves in the mucous membrane covering the human epiglottis. Every one who attentively looks at this drawing will distinctly see branches of nerve-fibres in connection with triangular as well as with oval bodies. These bodies, however, in comparison with the large number of the nerve-fibres, are very few, and the greater part of the fibres represented in the drawing appear entirely destitute of nuclei. This is not the proper place to discuss whether the bodies alluded to are to be regarded as simple nuclei, or as peculiar organs. I need only remark for the present that the general appearance exhibited by the nerves, which are distributed to the mucous membrane of the human epiglottis, is, with some exceptions, the same as in the cornea. Now if we compare the before-mentioned drawing with those given by the same observer of the termination of nerves in the elementary fibres of striped muscles, we shall find a remarkable difference between them. The motor nerve-fibres delineated in these drawings are seen largely nucleated. The nuclei in connection with each individual fibre are often equal to the fibre itself in width, and at short distances from one another. Not one of those large oval or triangular bodies often found in connection with the terminal branches of the nerves of common sensation can be seen here. It appears to me, therefore, that upon this progressive increase of nuclei in motor nerves, as they approach their termination, and on the remarkable diminution of them in sensitive nerves, which, besides, are connected at their ultimate distribution with peculiar bodies, we can, with some degree of reason, establish a fundamental distinction between the terminal portions of motor and sensitive nerves. I cannot flatter myself that this conclusion will be accepted as an unquestionable fact by the generality of observers, because more numerous and accurate observations are required for establishing beyond any doubt its exactness. For the present it is enough for me to have made an attempt to point out some peculiarities which are found in motory and sensitive nerves respectively at the periphery. I firmly believe that when comparative investigations have been more advanced than they are at present, we shall find something peculiar not only in the termination of the nerves of motion and common sensation, but also in that of every nerve of special sensation.

The limiting investment of the nerves of the cornea.

The primitive fibres, of which the nerves of the cornea are composed, as it may be easily observed, are in more or less close apposition with one another. This depends upon the nerve-fibres being imbedded in a transparent homogenous substance, which forms not only a common covering to all fibres composing each separate nerve, but also a special one to each single fibre. The nerves in their ultimate ramifications are only separated from the adjacent parts by this material. According to Dr. Beale, the presence of this transparent substance is owing to the changes the nerves are continually undergoing during life, and undoubtedly he has brought forward a sufficient amount of evidence in favour of this view. Notwithstanding, I feel inclined to consider the above-mentioned material as a peculiar form of connective tissue, produced by a special kind of nuclei. Of these nuclei I have already spoken, and have stated the reasons why they are to be regarded as different from the nuclei connected with the nerve-fibres. I believe that this form of connective tissue has different degrees of firmness in the nerves of different animals, and that in the same nerve its firmness is gradually diminishing from the trunk to its terminal branches. If this supposition is not allowed, the facts which we are observing must remain either unaccounted for, or we must admit that the nerves at their termination lose the common investment, only retaining the special one to each separate fibre. Although the latter supposition has many degrees of probability in its favour, and explains very satisfactorily the continual change of position which the nerve-fibres undergo, as the trunks, dividing and subdividing, reach their ultimate distribution; yet there are some facts which positively demonstrate that, in some animals, the finest nerve-branches are provided with the same common covering as the trunks, from which they originate. Thus I have observed that, in the cornea of the sparrow, the individual nerve-fibres that compose the trunks and all the branches into which they divide, scarcely undergo any change of position. In this small bird the nerves of the cornea in the trunks, as well as in all the branches, exhibit the general appearance of large twigs, which, by dividing and subdividing, gradually diminish in size. So great is the firmness of the connective tissue which holds together the individual nerve-fibres, composing the nerves distributed to the cornea of this bird.

Number, size, and relative position of the primitive nerve-fibres composing the nerves of the cornea; their division and nature.

The number of the primitive fibres which compose the nerve-trunks of the cornea, is found to vary according to their size. But sometimes we observe in animals of different kinds nerve-trunks of the same size, containing various numbers of primitive fibres. This depends upon the different diameters of the nerve-fibres, as some of them are thicker than others. According to my observations in the mouse, the primitive nerve-fibres are larger than those of the frog and man; and in the sparrow they are much finer.

Before the nerve-trunks of the cornea begin to branch, the primitive fibres composing them undergo a very little change of position, but as soon as their branching begins the change of position takes place, and increases as the division of the nerve-trunks goes further on. In different animals this change of position does not occur to the same extent. Thus, for instance, in the frog and eel the nerve-fibres change their relative position very frequently and extensively, but less in the mouse. In the nerves distributed to the cornea of the sparrow scarcely any change in the relative position of the primitive nerve-fibres is observed. The change alluded to is effected in this manner:—A fibre running close by the side of another is seen to leave it and unite with a new one, with which, after proceeding for some distance, separates again and passes with another fibre or with its first companion.

Some observers have asserted that primitive nerve-fibres are seen dividing, although seldom, in the trunks of the nerves of the cornea, but such division never occurs in the network or plexus formed by them. This assertion is not supported by actual observation. When we consider the number of the primitive fibres contained in the trunks, and compare it with the numerous fibres into which they resolve themselves, we must come to the conclusion either that the fibres of which the nerve-trunks are composed divide and subdivide freely, as the trunks themselves divide and subdivide; or that what appears in the trunks to be a primitive fibre is not a single fibre, but a compound one. I have tried many times to follow some of these primitive fibres as far as I could, and I have always seen them gradually reduced into finer and finer fibres. I feel quite convinced, therefore, that the primitive fibres observed in the nerve-trunks of the cornea are not single fibres, as is generally believed, but compounded, of several finer fibres held together by that peculiar kind of connective tissue already spoken of. Dr. Beale has been led to conclusions of a similar kind from his observations upon the nerves distributed to the mucous membrane which covers the human epiglottis.

It is well known that the opinion generally received as regards the nature of these primitive nerve-fibres, is that the nerves of the cornea "contain fine dark-bordered primitive tubes only at the margin of the cornea, within a zone half a line to one line in average breadth, while in their further course they possess only non-medullated fibres, completely clear and transparent" (Kölliker). In my own specimens such distinction is not observed. All the nerves, from the entrance into the cornea to their ultimate distribution, do not appear to contain any fibre which could properly be called dark-bordered. All the fibres exhibit the same appearance and refract the light in the same way. I have, amongst many others, a specimen in which all the nerve-fibres, from the margin of the cornea to their termination, have been so acted upon by acetic acid as to display a very remarkable granular appearance. With the purpose of ascertaining the chemical nature of these granules I have treated some specimens which presented such appearance with ether, and have found that some of the granules were readily dissolved by the ether, while others resisted its action. The natural conclusion from this experiment is that the so-called non-medullated or pale nerve-fibres consists of fatty matter in combination with a protein compound. On being disintegrated by the action of acetic acid, both assume the granular form. Nevertheless it must be borne in mind that, although the pale nerve-fibres, by the action of acetic acid, pass through the change I have already mentioned, yet they never lose their outlines, which only become paler and indistinct.

An alteration precisely resembling that which has been described is also effected by acetic acid on the cornea-corpuscles and their branching processes; and the granules thus produced are acted upon by ether in the same way as those of the pale nerve-fibres. This I mention incidentally, because I am not sure whether it has been noted by those who have purposely studied the subject. I believe that a comparative study (histological as well as chemical) of the cornea-corpuscles would afford more positive information upon their nature than we now possess. Careful observations have shown that these corpuscles have not the same appearance and size in man, cat, and mouse, as in the frog, eel, and sparrow.

I must not omit to say, finally, that the nerves distributed to the cornea of different animals are not of the same degree of firmness. I have found that in the sparrow, frog, mouse, man, and fishes, the firmness of the nerve-fibres decreases in the order in which I have mentioned the animals. It is not so easy, therefore, to make out the nerves in the cornea of man and fishes, because the nerve-fibres being extremely soft are so altered by the chemical agents which we are obliged to employ, that it is more difficult to trace them among the other elements of the corneal tissue than in the other instances.

Channels which contain the nerves running through the cornea.

This question, as it seems to me, must be considered from two different points of view. If the term *channels* is here taken in the meaning of grooves or spaces excavated through the fibrous tissue of the cornea, where the nerves lie, the existence of such channels cannot be doubted. But if, on the contrary, the word is understood in the sense in which it is generally used, viz., as signifying tubes with distinct and proper walls, I strongly hold that, in this meaning, such channels do not exist at all in the cornea. I have never succeeded in seeing one of these channels, and I am convinced that the nerves distributed to the cornea are not separated from its fibrous elements by any other means but by that special transparent material in which they are imbedded.

II.

In the first part of this paper I have spoken of all those peculiarities which are found in the nerves of the cornea; I propose, in this second part, to explain the manner in which they terminate, and also their relation to the cornea-corpuscles.

I have studied this point with all possible attention, and I can state positively that the nerves of the cornea do not terminate in free extremities. I have often succeeded in tracing some of the nerves from their entrance into the cornea to their terminal distribution, and I have observed the union of the ultimate branches one with the other. But, if the nerves of the cornea do not end by free extremities, in what manner are they arranged in their ultimate distribution? The results of many investigations which I have made upon the cornea of several animals, have led me to conclude that the nerves of the cornea terminate in a network or plexus. I attach a different meaning to each of these two terms, which are generally employed almost synonymously. I understand by the arrangement of nerves in a *network,* when the different bands of fibres are not so interlaced with each other as to prevent us from recognising their respective origins; and by the term *plexus,* when such an intermingling of the bundles of nerve-fibres exists, that we cannot distinguish the point of their derivation.

Observation shows that sometimes the network seems to result from the close apposition or coalescence of one branch with another, without any visible interlacement of the primitive nerve-fibres which compose the uniting branches, and at other times from the intermixture of the fibres of one branch with those of another. Hence two varieties of network; the one, which may be called *network by the coalescence of nerve-branches with one another,* and the other *network by the intermixture of the nerve-fibres of one branch with those of another.* With regard to the plexus, as the meshes produced by the inextricable union of the various nerve-bundles may be either large or narrow, so two varieties could also be formed, and called the one *plexus with large,* and the other *with narrow meshes.*

Having advanced these short considerations on the manner in which the nerves of the cornea in their ultimate distribution are arranged, I pass on to say more particularly where I have found these distinctions existing.

1. *Network by the coalescence of nerve-branches with one another.*—I have observed this variety of network in the cornea of the sparrow. The trunks of the nerves, which enter the cornea of this little bird, are seen at different points from the corneal margin to divide and subdivide, and the immensely numerous branches which result from these repeated divisions are frequently observed to anastomose with each other. When a branch is uniting with another no interlacement of their fibres appears to take place; but they seem, so to speak, to fuse into a single larger branch. The branches generally unite themselves at angles more or less acute; sometimes, however, they appear to unite at regular right angles; and when such occurs, one of the branches forming the angle sends out a fibre on each side of the point of junction parallel with the other branch. Thus it would appear from such circumstances that the arrangement in the cornea of the sparrow is the most simple and regular.

2. *Network by the intermixture of the nerve-fibres of one branch with those of another.*—The second variety of network is found in the cornea of the frog and fishes. I have previously mentioned that, in the cornea of these animals, the different primitive fibres which compose the branches spread out and frequently change their relative position. Thence it happens that, when one branch unites with another, a very perceptible interlacement of their fibres takes place. I have often followed some trunks to their furthest branches, and observed that the disposition of these very fine branches is the same as with the larger, and that the anastomoses among them are of the same character as those between the main branches. I think I may safely argue from the above statements that the networks in the frog and fishes are more complicated in their formation than that of the sparrow.

3. *Plexus with wide meshes.*—The nerves which are distributed to the cornea of the mouse terminate in this variety of plexus. The ultimate branches of each trunk unite together in such a manner as to form meshes which have not all the same dimensions, but are in immediate continuation one with the other. The meshes generally assume an irre-

gular, pentagonal, or quadrilateral form, but sometimes they are seen exhibiting other shapes. The bundles of fibres, from the intermingling of which the meshes are produced, are of different sizes, and disposed in curved lines. Very often, from various parts of the meshes, fibres more or less fine are seen to arise, which cross the field of the meshes in different directions; and after a tortuous course, and continually change of plane, either unite with other fibres, which proceed from distant bundles, or with the bundles themselves. These fibres, which, from their thinness, would lead us to consider them as single, are never found in this state, but are made up of at least two fibres, and generally more.

4. *Plexus with narrow meshes.*—From what I have observed, I feel sure that the nerves distributed to the human cornea terminate in a very extensive plexus with narrow meshes. The plexus is not formed by single, separate nerve-fibres, but by bundles, which are in direct continuation with the smallest branches, into which the trunks, by repeated division, are reduced. In some of my specimens these branches may be seen crossing the corneal tissue in different directions, and may be followed for a long distance, before they are observed to divide into the bundles before mentioned. As the fibres which compose the bundles are extremely pale and transparent, and are also greatly softened and changed very soon after death, considerable difficulty exists in the investigation of this plexus, which can only be seen in good specimens prepared in a particular way.

These different kinds of networks and plexuses, which have been described, extend throughout the anterior part of the cornea, and gradually cease towards the posterior portion. It must be observed that the various bundles forming these networks and plexuses are frequently changing the planes and direction of their ramifications, so that each separate bundle during the whole of its course comes into contact with several other bundles. I have before stated that the principal trunks of nerves, on entering the cornea, are very near to its posterior surface, and pass in an oblique direction, repeatedly dividing, and at length reach the anterior surface. In this fact, which seems to me to admit of no further dispute, is found the explanation why, in the whole space over which the networks and plexuses extend, the different branches which enter into their formation are of unequal size, and the finest branches are found in that part of them which lies immediately beneath the anterior elastica lamina of the cornea.

In connection with the nerve-branches or bundles which compose both the networks and plexuses before mentioned, are observed several small bodies, triangular, or quadrangular, or even of an irregular shape. These small bodies are not all of the same size, and some of them appear of a uniform, granular structure, whilst in others I have found nuclei imbedded in the granular matter. These nuclei are prominently coloured by carmine, whereas the granular matter is not, or only very slightly affected by this substance. From these bodies bundles of fibres are seen to proceed in three, four, or more directions, while some other fibres pass close by them without being absolutely connected with the same. In the first variety of networks these bodies are few in number, and sometimes are found just at the point at which a branch is met by another; and in this case they are of a quadrangular form, and at others, at the point where a bundle of fibres bifurcates, and then present a triangular shape. In the second variety the small bodies are more numerous, and may exhibit an oval, triangular, or quite an irregular form, and are found either amongst the fibres which compose the large branches, or at the point of union of the bundles with each other or where they divide. Again, in the first variety of plexuses, the bodies alluded to are generally met with at the angles of the different meshes forming the plexus, and are usually either triangular or quadrangular. They contain granular matter, and sometimes a nucleus may distinctly be seen at their centre or at one of the angles. As to the second variety, I confess I have not succeeded in seeing any of the bodies I had found in the first variety of plexuses. I believe I have failed because the human corneæ which I could get for investigation were not so fresh as is requisite for carrying out successfully such delicate researches. I say, however, that in some specimens from man's cornea I have observed most distinctly very fine nerve-fibres connected with certain small bodies exhibiting a triangular or quadrangular form, but as the fibres ran for a long distance in straight directions, I cannot help doubting their nervous nature.

Now here arises the question: What is the nature of the bodies which have been described? Are they to be considered as special organs connected with the terminal portions of the nerves of common sensation? or are they not at all different from the nuclei which, as I have said before, are observed to be very numerous in connection with the individual fibres composing the trunks and the largest branches of the nerves of the cornea? It seems to me that Dr. Beale, who, so far as I know, was the first to point out the existence of these bodies in the terminal branches of the nerves distributed to the mucous membrane covering the human epiglottis, and who spoke of them, without any distinction whatever, as nuclei, could have thought them any way different from the ordinary nuclei which are generally found in connection with the nerve-fibres at their peripheral distribution. I regret I cannot agree with Dr. Beale on this point, because I find a remarkable difference between these bodies and the common nuclei. In fact, as observation shows, the nuclei connected with the nerve-fibres are always of an oval form, and equal in breadth to the fibre itself. Each single fibre contains several of them, separated from one another by little intervals, and arranged in linear series. They are seen varying greatly in number, according as the nerves are examined at an early period of development or in the adult state. On the contrary, the small bodies which are connected with the terminal branches of sensitive nerves are often triangular, quadrangular, or may exhibit some other form. As regards the fibres proceeding from them, these are very fine, and the relation they bear to the small bodies differs from that existing between the common nuclei and the nerve-fibres. Their number is not observed to vary according to the different periods of development of nerves, and they only appear to exist in greater number and to be more distinct in those animals in which there is reason to believe that the cornea is more sensitive. Besides, we must add, that the more the nerves approach the full development, the more perfect and complete the structure of these bodies appears to be. I think, therefore, that sufficient difference exists between these two kinds of small bodies to enable us to draw a marked distinction between them. Yet if we are not allowed to consider them as special organs of the terminal portion of the nerves of common sensation, it must still be admitted that they have something similar to those peculiar triangular nuclei which exist in connection with the nerves of special sensation at their ultimate distribution.

It is not my intention to enter into any deep physiological speculations with regard to the office of these special bodies, and the nuclei which are observed in the nerves distributed to the cornea. Yet I cannot forbear expressing my opinion on this subject. I believe that the nuclei are the agents which are concerned in the formation and repair of nerve-fibres which are continually undergoing change during life; while, on the other hand, I hold that the above-named small bodies take an active and important part in the phenomenon of sensation, and are the only organs by means of which the finest branches of sensitive nerves are brought into relation with the tissues in which they ramify. The opinion I have just expressed seems to me to be corroborated by this fact, that the nerve-fibres which proceed from the ganglion-cells are more or less nucleated. Now I ask, what is the office of these nuclei which are seen in connection with the fibres near their point of origin from the cells? It does not appear very probable that they are concerned in the formation and repair of the fibres while the cells are charged with a higher and more important office. If such a conclusion be not admitted, the function of these nuclei must remain unexplained.

Relation of the terminal branches of nerves to the cornea-corpuscles.

Scattered throughout the fibrous tissue of the cornea are an immense number of bodies which Virchow, who studied them carefully after their discovery by Toynbee, called *cornea-corpuscles.* From each of these corpuscles arise several branching processes, which freely anastomose with each other so as to form an admirable network, which extends over the whole so-called proper cornea. These corpuscles are intensely coloured by carmine, while their processes remain or are very slightly coloured. Now, it must be observed that the branches of the nerves which supply the cornea during their course, are in close contact with the cornea-corpuscles and their processes. I have often seen very fine nerve-fibres passing close by some of these corpuscles, and as their external appearance is the same as that of the processes, which are derived from them, it is difficult to distinguish the former from the latter. It appears to me, therefore, that between the nerve-fibres and the cornea-corpuscles there is no other relation but that of contiguity; because careful observations show that the nerve-fibres always maintain their individuality and never lose themselves in another tissue.

I shall conclude by only adding a few words about the preparations from whose careful examination are deduced all the facts contained in this paper. All my specimens have been prepared in the same way, and preserved as permanent objects in glycerine. In fact, the same process has been followed as that employed by Dr. Beale in his investigations on many of the simple tissues of the body. Most of the specimens have been examined by Dr. Beale, to whom I am greatly indebted for the kind assistance and warm encouragement he has afforded me in the present undertaking, in which I have spared neither time nor labour.

Some observers maintain that the sclerotica is entirely destitute of nerves, but I do unhesitatingly affirm the contrary. I have distinctly seen some very fine bundles of nerve-fibres distributed to this coat. These bundles, which arise from the nerves destined to supply the cornea, separate from them at different angles before they reach the corneal margin, and after passing backwards ramify in the fibrous tissue of the sclerotica, the bundles anastomosing with each other. I have a specimen from the mouse that evidently proves this fact.

TRANSACTIONS.

Of the Formation *of the so-called* Intercellular Substance *of* Cartilage, *and of its relation to the so-called* Cells; *with* Observations *upon the* Process *of* Ossification. By Lionel S. Beale, M.B., F.R.S., Professor of Physiology and of General and Morbid Anatomy in King's College, London; Physician to King's College Hospital.

(Plates VIII and IX.)

(Read March 1st, 1863.)

It is generally held that cartilage consists of cells, and a 'connective' or 'intercellular' substance or matrix. There is, however, much difference of opinion as to whether the cell-wall is a part of, or distinct from, the intercellular substance. Some observers maintain that, at least, in many forms of cartilage, the cell-wall exists as a distinct structure. Some hold, on the other hand, that the matrix itself corresponds to the cell-wall, and others state that the matrix is in part cell-wall and is in part composed of a cementing substance. There is the greatest difference of opinion as to the relative importance of these two structures, *cell* and *intercellular substance,* in the formation of the cartilage.

The cell-wall and matrix have been regarded in the light of excretions from the cell. It has been maintained that the cell exerts a direct influence upon the changes occurring during the formation of the intercellular substance, and, on the other hand, it has been considered to take part only in the process of reproduction. Intercellular substance, generally, is believed to possess formative power, by virtue of which (or, as Professor Huxley says, under the guidance of the 'vis essentialis') it becomes *differentiated* into the different forms of tissue with which we are familiar.

Those who accept this view regard the cell-wall and intercellular substance as of the highest importance, and the 'nucleus' as the less important anatomical element; for this, it is said, undergoes neither chemical nor morphological metamorphosis. Virchow considers that the nucleus is concerned mainly in the maintenance and multiplication of living parts; and while fulfilling its functions, he thinks that it remains itself unchanged, and he says it is the other contents of the cell, *not the membrane nor the nucleus,* which give rise to the physiological differences of tissues.

It seems to be a view generally entertained, that the intercellular substance of cartilage results from changes occurring in a plasma separated directly from the blood. Dr. Martyn, of Bristol, has, however, endeavoured to prove that the matrix of cartilage consists of the 'old dilated and blended capsules' of the cells ('Archives of Medicine,' vol. ii, p. 110). But Kölliker even ventures to assert that the fundamental substance of cartilage, bone, and teeth, arises *partly* as a secretion of the cells and *partly from the blood independently of them,* and then goes on to say that—"The occurrence of a solid, fundamental substance directly deposited from the blood, shows that all the solid parts of the body are not, without exception, formed from cells or in dependence upon them, as Schwann was disposed to assume." Kölliker here, as in many other instances, first makes an assertion, and then afterwards employs it as if it were an ascertained fact. Before such a statement can be used as an argument, it is obvious that Kölliker must define precisely what part of the matrix is formed independently of cells, but he has not advanced any facts which indicate that the smallest portion arises from the blood independently of the cells. There are, indeed, no facts which prove that any form of intercellular substance whatever is deposited directly from the blood.

The idea of this matrix being a cementing substance deposited between the cells, and uniting them, is very generally entertained. According to this view, the matter of the matrix must be deposited around the cells, and the process of 'cell-formation' and 'matrix formation' must be perfectly distinct processes.

I now pass on to the special subject of my paper, and I shall endeavour to show—

1. That the so-called intercellular substance of cartilage and other tissues is never formed independently of *cells,* or, more correctly, masses of living or germinal matter.

2. That the intercellular substance does not possess formative power, and that physical and chemical changes alone take place in it.

3. That in all cases the masses of germinal matter are continuous with the so-called intercellular substance, and that the latter was once in the state of germinal matter.

4. That in the development and growth of these tissues, the pabulum becomes (*a*) germinal matter; the germinal matter becomes (*b*) the formed material (intercellular substance), which accumulates, and gradually undergoes condensation.

I have endeavoured to show that at an early period of development the elementary parts of all tissues consist of—(1) matter in a *living,* active state; and (2) matter which *has lived,* and which has ceased to exhibit vital or formative power. The first I have called germinal matter, because it alone is concerned in growth, development, and formation, and gives origin to new elementary parts; and the second has been called formed material, because it results from changes which have occurred in the germinal matter. The germinal matter passes gradually into the formed material, so that, passing from without, inwards, we have (*a*) *formed material;* (*b*) *imperfectly developed formed material,* gradually passing into (*c*) *germinal matter;* and in the nutrition of an elementary part the inanimate pabulum first passes through the formed material, comes into contact with and is converted into (1) germinal matter. The oldest portions of germinal matter undergo change, and become (2) formed material. The formed material either accumulates outside the germinal matter as 'cell-contents,' 'cell-wall,' 'intercellular substance,' or becomes disintegrated and resolved into other compounds, which are removed in the form of 'secretions.'

If it could be shown that the intercellular substance of cartilage is deposited from the blood independently of the cells; or that 'intercellular substance' or 'cell-walls' are ever formed independently of germinal matter; or that the matter of which the 'cell-wall' consists is deposited layer *upon* layer, instead of layer *within* layer; or that the germinal matter is not, at any period of development, in bodily continuity with the formed material; or that the germinal matter is capable of exerting an influence upon matter situated at a distance from it, or that pabulum does not become germinal matter, but is merely changed or converted into new matter by some metabolic action exerted by the germinal matter, without coming into actual contact with it or becoming a part of it; or that cell-wall or intercellular substance possesses the power of selecting certain substances from the nutritive fluid, and converting these into matter like itself; nay, if it can grow in and form septa, as is described by almost all observers to take place in cartilage—if but one of these positions can be proved, my view must be greatly modified, if not entirely abandoned. So far, however, no observer has brought forward facts opposed to it, although some have expressed their dissent in general terms, which is not to be wondered at.

Now, cartilage is probably the tissue which an opponent would select as the one most likely to afford evidence against me; and I propose, therefore, to discuss the minute structure of this particular tissue, and shall endeavour to draw conclusions as to the manner in which it is developed and grows. The general structure of cartilage is represented in Pl. VIII, fig. 1, from the temporal bone of an adult frog prior to ossification.

Structure of Embryonic Cartilage.

All cartilage, at an early period of development, consists of masses of germinal matter imbedded in or surrounded with a soft-formed material. The masses of germinal matter, which are at first very close together, multiply by division. (Figs. 1, 5.) Now, as development advances, the masses of germinal matter become separated from each other by gradually increasing distances, or, as I would say, the formed material gradually accumulates between them as it continues to be produced, but more and more slowly, upon the surface of each mass. (Figs. 5, 6, 7, 8.)*

If the young cartilage be broken up, portions of the formed material are seen to be continuous with the germinal matter (fig. 2); and in specimens coloured with carmine we see, first, the smooth and very finely granular and transparent 'matrix' or 'formed material' colourless; next, a layer faintly coloured; and lastly, it is observed that the intensity of the colour increases as the matter situated more or less centrally is approached. From this I argue that there is a gradual growth and transformation proceeding from within outwards; and as it is a fact that my colouring matter passes through all the outer layers, and is deposited in greatest quantity in the central part which is at the greatest distance from the solution, it seems only reasonable to infer that pabulum takes the same course during life. These points are shown in figs. 1 and 2.

But the development of cartilage can be studied in the fully formed tissue as well as in the embryo, for up to a certain period of life many of the cartilages are continually growing. Indeed, if growth did not occur, the cartilage would diminish in extent, because, as age advances, the formed material

* Preparations illustrating the facts stated were passed round at the meeting.

shrinks and undergoes condensation. Near the surface, in many cartilages, a layer exists which could not be distinguished from embryonic cartilage, and here the changes occurring during development may be readily studied.

Of the Formation of the 'Cells within Cells.'

As growth continues in the higher forms of cartilage, the masses of germinal matter already separated from each other by a considerable thickness still continue to divide and subdivide, but more and more slowly, and at the same time condensation still proceeds in the matrix already formed. There are, therefore, collections of masses of germinal matter separated from each other by thick layers of formed material, and there are the individual masses constituting each collection separated from each other by a thin layer of formed material. Each of these may divide and be separated by a still thinner layer of formed material. Thus are formed the 'cells within cells.' The septa do not grow in, but the living germinal matter simply divides, and its outer part undergoes conversion into the formed material or matrix.

Of the Structure of a very simple form of Cartilage.

But in many cartilages of the frog the structure is not complicated by the formation of these secondary and tertiary formations (cells within cells). The cartilage in its fully formed state consists merely of germinal matter, which passes into imperfectly formed matrix, and this is continuous with the fully formed cartilaginous tissue. (Figs. 2, 3, 4.) Here the continuity of structure can be most distinctly demonstrated. If, however, the tissue be kept for a short time after death, and more especially if it be placed in water, a clear *interval* between the matrix and the so-called cell soon makes its appearance, and we observe the characters, so often represented in figures, which have led most observers to infer the existence of a cell-wall distinct and separate from the matrix. If cartilage be kept for a longer period, the germinal matter, and soft imperfectly developed formed material, break down and become liquefied, and then the cartilage appears as a matrix containing *numerous vacuoles or spaces*, an appearance which has led to the view that cartilage and many other tissues result from the '*vacuolation*' of a plasma or matrix. *But there are no 'vacuoles' during life.* These spaces were occupied by the living active matter, which was alone concerned in the formation and growth of the cartilage-tissue (matrix).

Of the Formation of the Matrix.

In the fresh cartilage of the frog the actual conversion of the germinal matter into formed material may be studied. In the preparation passed round (Prep. 4), magnified 700 diameters, numerous oval or spherical masses of a granular appearance will be noticed, but amongst them many of a half-moon shape may be observed, and others varying very much in shape, and with so ragged and irregular an outline that no one would be disposed to call them cells, or would maintain that they *possessed a cell-wall.* (Figs. 2, 3, 4, 5, 6, 7, 8.) At the edge of the specimen, where it is exceedingly thin, some of these angular masses, composed of granular matter, with the central part deeply coloured with carmine (nucleus), can be seen to shade *uninterruptedly into the matrix.* The granular, ragged edges gradually pass into, and are continuous with the clear, transparent matrix. Not only so, but in some of the oval masses, the formation of the clear, transparent matrix is seen to commence as a separate point *in the granular matter itself,* as well as to proceed upon its surface. In other parts of the specimen nothing but what would be termed the nucleus remains. It seems to be imbedded in the matrix of the cartilage, so that the whole of the outer part of the 'cell' has been *transformed into this structure* (matrix, intercellular substance), and the change has proceeded until of the germinal matter only a very small portion remained unchanged. This would soon die, and almost entirely disappear. A small space occupied by a few granules would remain in the substance of the cartilage, and this is all that would remain to mark the position of a cartilage-cell.

If I have interpreted these phenomena correctly, the history of the life of cartilage and allied structures is very simple, and easily understood. Masses of germinal matter appropriate pabulum, and having thereby increased in size, divide and subdivide, while those portions which are oldest and at the outer part of each mass gradually cease to manifest their active powers, and become resolved into soft-formed material, which gradually accumulates and undergoes condensation. *The formation of the matrix proceeds more and more slowly as the tissue advances in age, because the impediment offered to the access of pabulum to the germinal matter must become greater as the formed material around it increases in amount and undergoes condensation.*

It seems to me, therefore, that the *vital changes* occurring in this and other tissues are restricted to the granular structureless substance I have termed germinal matter. This alone can communicate to inanimate pabulum new and peculiar properties and powers. No cell-wall, no matrix or intercellular substance, no formed matters, as fat, starch, bile, and the like, are ever produced unless germinal matter be present. Without it a tissue may be changed, but it cannot change or alter by virtue of its own powers; it is a lifeless tissue that may be acted upon, but it is no longer a living tissue which can change, convert, or alter inanimate matter. All tissues and all elementary parts consist of germinal matter and formed material, and all formed material was once germinal matter, and the germinal matter itself was once pabulum. But pabulum could never have become germinal matter unless pre-existing germinal matter had been present to communicate to it its wonderful powers. The germinal matter does not secrete the formed material, but becomes resolved into it. The properties and composition of tissues and animal fluids depend upon the relations of the elements which enter into the composition of the germinal matter at the time while these are gradually passing from the *living* to the *formed and lifeless state.* Do not the elements assume these fixed and definite relations to each other in consequence of being influenced by a power, the nature of which we cannot understand, but which is very properly termed *vital?*

When the formed material has been *produced,* it may be the seat of physical and chemical changes. Of the nature of these changes there can be no doubt, as they may be imitated artificially; but the formed material itself, as, for example, the matrix of cartilage, cannot be produced artificially, nor can it be produced from any substance in the blood. Its formation is due to changes occurring in the matter when it was in a living state.

I think I am justified in the conclusion that physical and chemical, but not *vital,* changes occur in the matter of which the fully developed formed material is constituted, while vital changes take place in the germinal matter alone.* I would say that the matrix of cartilage is not living, but the germinal matter embedded in it is living, and the matrix itself was once in the condition or state of living germinal matter. The living matter is continuous with the matter that has lived.

* "An attempt to show that every living structure consists of matter which is the seat of *vital actions*, and matter in which *physical and chemical* changes alone take place."—British Association, 1862.

Mr. Rainey's Observations on the Process of Ossification.

Mr. Rainey has shown how globules of calcareous matter deposited in a viscid matrix gradually coalesce, and at length assume somewhat the appearance presented by tissues during the process of calcification. This observer goes so far as to attribute the entire formation, not only of such tissues as bone, teeth, shell, &c., but soft tissues (as, for example, the crystalline lens), to physical and chemical changes alone.

Now, no one has yet produced artificially a tissue that could be mistaken for bone or dentine, nor has the slightest approach ever been made towards the production of any soft tissue that exhibits any special anatomical characters. Nor has a particle of anything having the chemical composition and physical characters of the matrix of cartilage or any form of fibrous tissue ever been formed by artificial process. It is, therefore, somewhat premature to advance such a generalization as this, and I shall endeavour to show that the conclusions are not justified even as regards bone.

I regret to be compelled here to bring forward evidence against Mr. Rainey's conclusions; but as his statements are most positive, and have been accepted by some writers as evidence in favour of certain views, according to which the formation of tissues generally is ascribed to physical processes, as, for example, the attraction towards each other of molecules by gravitation, unfortunately the only course left is to give to conclusions resulting from observations which have been conclusively proved to be erroneous, the most distinct and positive contradiction. Mr. Rainey says that the production of bone takes place independently of cells or cell-germs, and that when cartilage ossifies, the globules and rings of calcareous matter deposited in the matrix have no definite relation to the cartilage-cells. Now, I submit a specimen of the cartilage of the temporal bone of the frog (Prep. 5) to the examination of the members of the Microscopical Society. Mr. Rainey's drawings, illustrating the process of ossification, as it occurs according to him, have been copied in figs. 9 and 10. He does not represent one single nucleus in either drawing.* I cannot but believe that when the specimens from which these drawings have been copied were part of the living frog, nuclei were present in great number. In the first a nucleus must have existed in every space left blank; Mr. Rainey exhibits ten

* 'On the Formation of Shells, &c.'

spaces, and there must have been at least ten distinct nuclei or masses of living germinal matter. There is a nucleus or mass of living germinal matter in *every single case* in, or about the centre of the ring of calcareous particles. The calcareous matter is always first deposited around and at a distance from the germinal matter, in fact, in the very part of the formed material which was first produced, and is, therefore, at the time of ossification, the oldest. I pass round a specimen where one or more masses of germinal matter may be seen with the ring of calcareous particles around them. (Prep. 6, Pl. IX, fig. 14.) Now, as long as these masses of germinal matter live in the normal condition, so long the deposition of calcareous matter proceeds in a direction from without inwards, or, as the fact would be generally stated, the lacuna becomes smaller as the tissue grows older. In every lacuna, even of fully formed *living bone,* a nucleus or mass of germinal matter exists. (Figs. 11, 12, 13.) If the lacuna is a real space, filled only with air or fluid, the bone is dead, and the lacuna could not become smaller.

Bone, therefore, cannot be formed independently of living or germinal matter.

The formation of the *matrix* of bone depends upon the changes taking place in germinal matter, and these changes must, at least, at present be referred to a force, power, or influence, the nature of which we do not understand—*vital power.* The matrix having been *formed,* the precipitation of calcareous matter takes place. This is merely due to a chemical change, the reaction of the oldest part of the matrix becoming alkaline; but it would seem that the currents flowing to and from the gradually diminishing mass of germinal matter determine the position in which the precipitation takes place, and so long as these masses are alive, the conversion of the outer part of each into matrix, and the deposition of calcareous matter in the matrix already formed, goes on in one definite direction from without inwards; so that in all cases the matrix exists for some time before it becomes impregnated with calcareous matter, the precipitation commencing in the oldest part of the matrix, and proceeding in the same direction as the formation of matrix itself—that is, from without inwards. When this mass of living matter dies these changes cease, and the corresponding portion of bone-tissue is dead. If, on the other hand, one of these nuclei or masses of living matter be too freely supplied with pabulum, it rapidly increases, divides, and subdivides. The tissue already formed around it becomes softened, disintegrated, and appropriated, and a soft mass composed of many separate spherical masses of living matter results. A space may thus be scooped out in the compact tissue of bone, and the process may go on until what is termed an abscess results. Very rapid growth is associated with the formation of a soft, spongy, and short-lived tissue; very slow growth with the production of a very hard and lasting structure. But in all cases the active changes are dependent upon the existence of living matter, that is, matter in which certain phenomena can be observed or proved to occur, which cannot, in the present state of science, be explained by physics or chemistry, and which never do occur except in matter derived from a living being.

DESCRIPTION OF PLATE I,

Illustrating Dr. Greville's paper on New Diatoms. Series VIII.

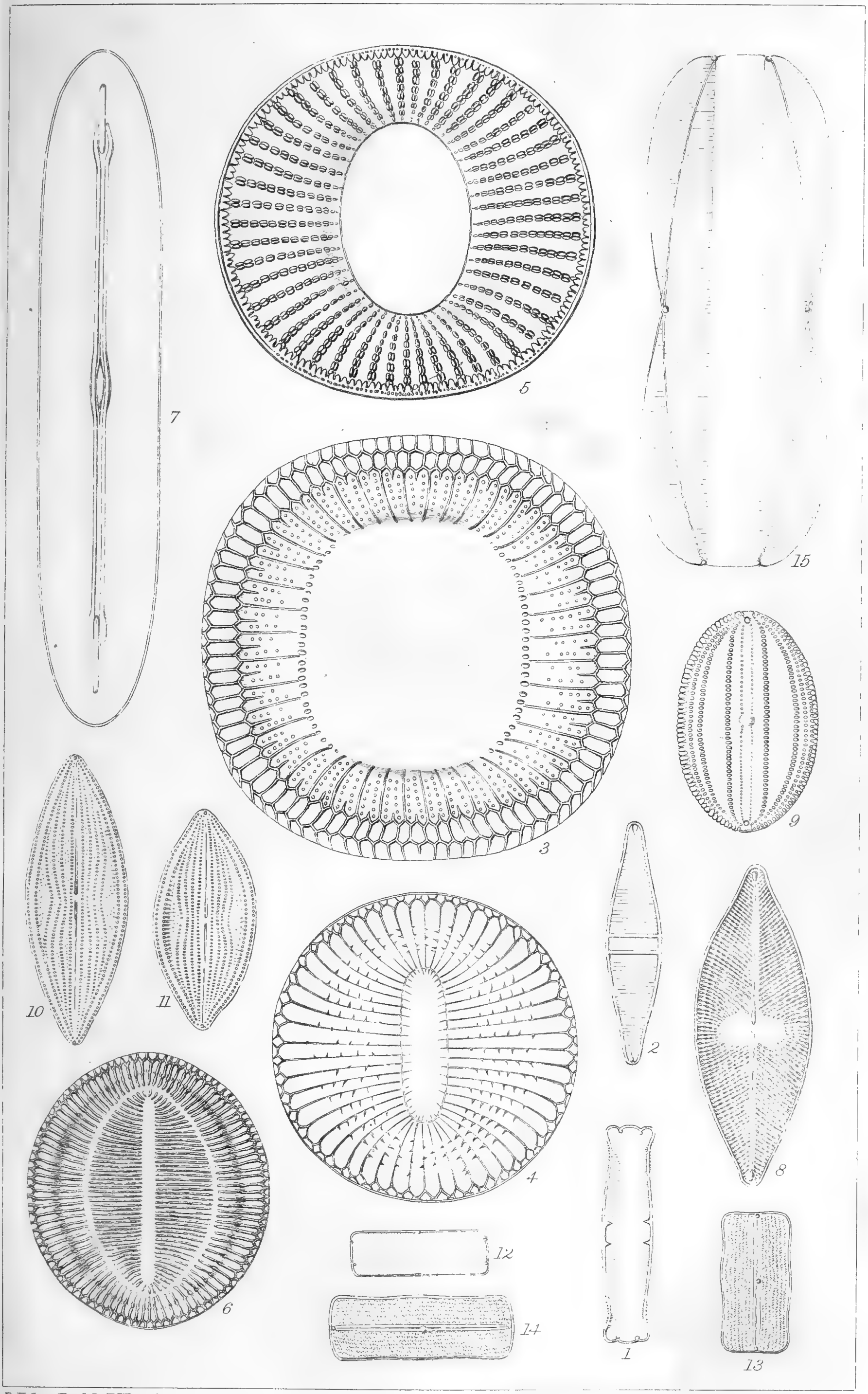
Fig.

1.—*Plagiogramma Robertsianum*, front view.
2.— ,, ,, side view.
3.—*Campylodiscus ornatus.*
4.— ,, *Wallichianus.*
5.— ,, *Robertsianus.*
6.— ,, *crebrecostatus.*
7.—*Navicula Lewisiana.*
8.— ,, *Johnsoniana.*
9.— ,, *notabilis.*
10, 11.— ,, *luxuriosa.*
12.— ,, ? *Cistella*, front view.
13, 14.— ,, ,, side view.
15.—*Amphiprora oblonga.*

All the figures are × 400 diameters.

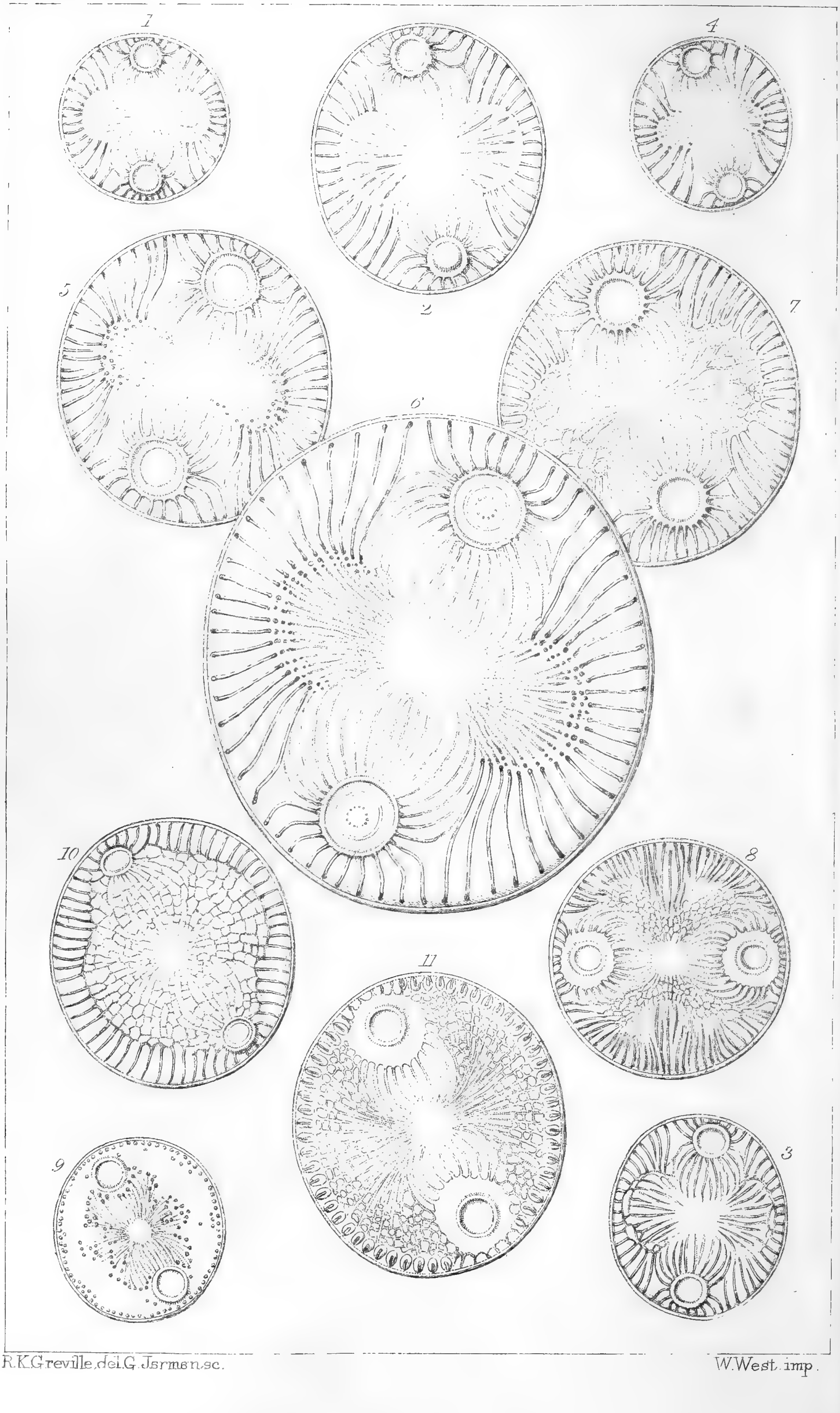
CORRIGENDUM IN SERIES VII.

The walls of the cellules in *Triceratium Davyanum* are unfortunately rendered much too thick by the engraver. The figure is, in other respects, faithfully executed.

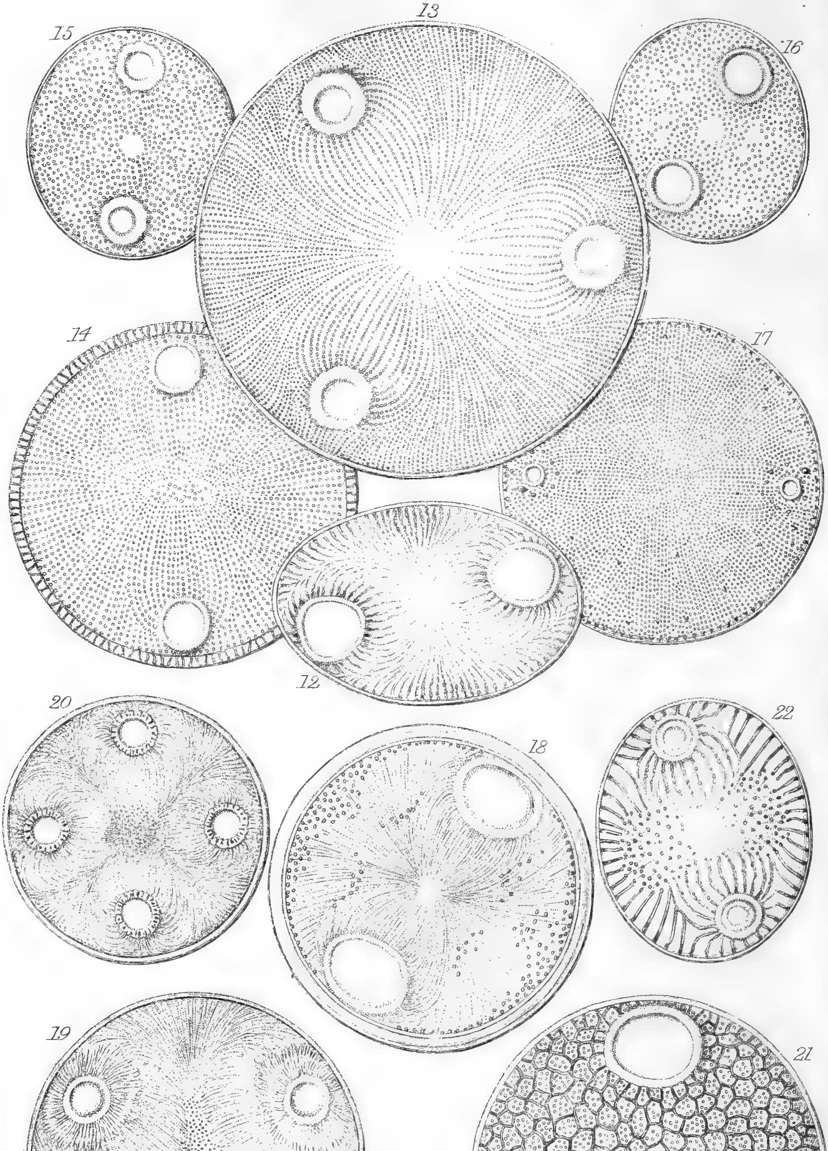


R. K. Greville, del. T. West. Sc.

W. West. imp.



R.K. Greville del. G. Jarman sc.   W. West imp.



R.K. Greville, del. G. Jarman, sc.

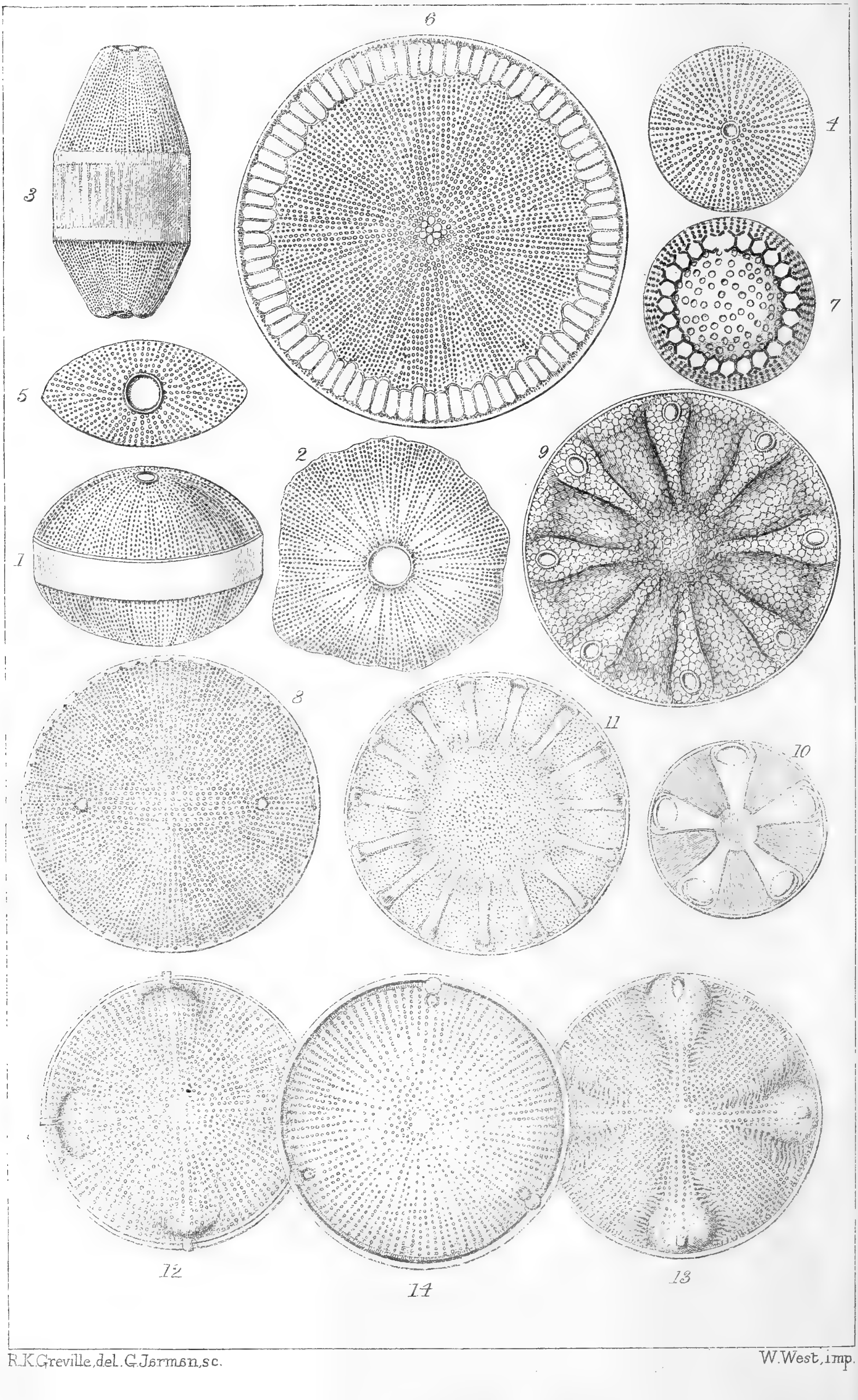
W. West, imp.

DESCRIPTION OF PLATES II & III,

Illustrating Dr. Greville's Monograph of the genus Auliscus.

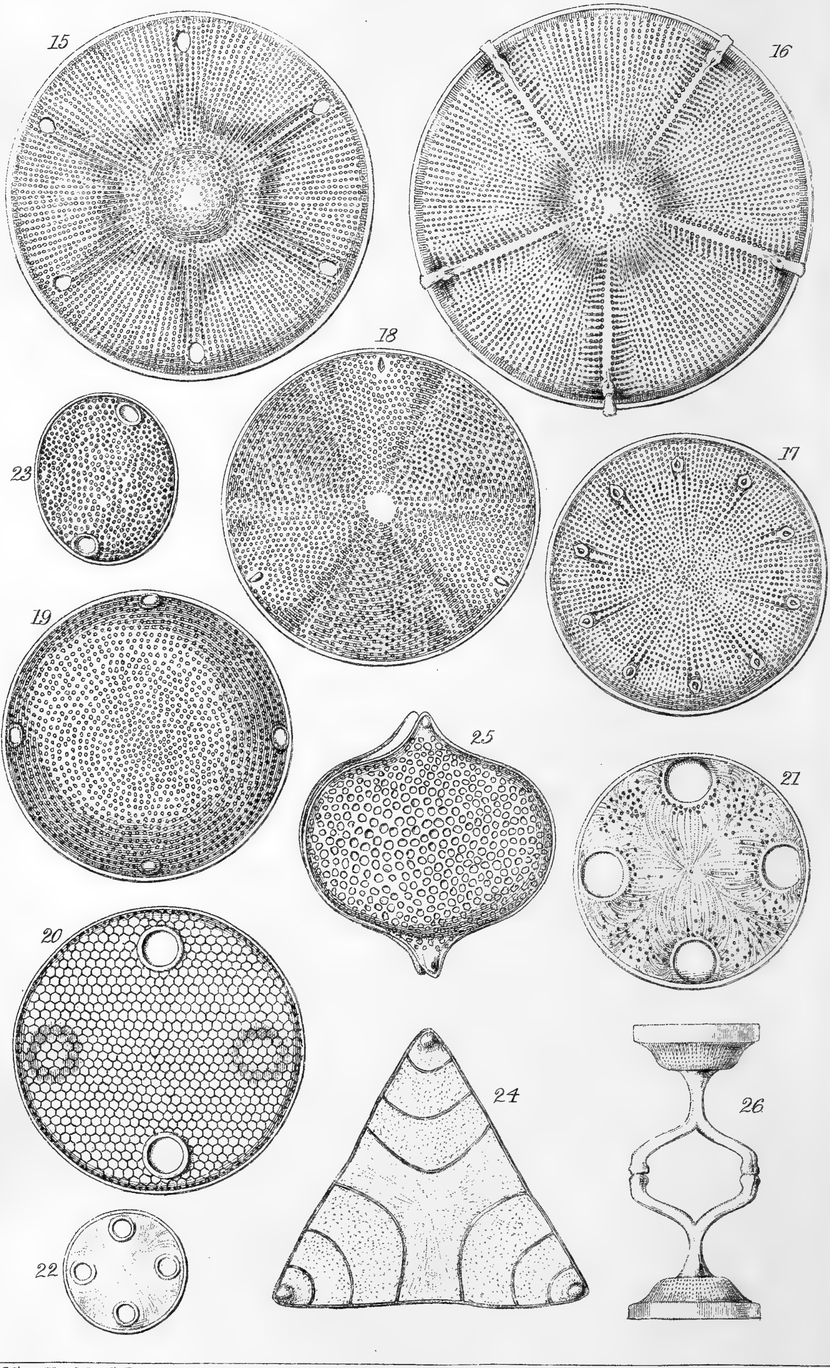
Fig.		
1—3.—	*Auliscus*	*sculptus.*
4—7.—	„	*cælatus.*
8.—	„	*elegans.*
9.—	„	*racemosus.*
10.—	„	*reticulatus.*
11.—	„	*mirabilis.*
12.—	„	*ovalis.*
13.—	„	*pruinosus.*
14.—	„	*radiatus.*
15, 16.—	„	*punctatus.*
17.—	„	*Peruvianus.*
18.—	„	*Macræanus.*
19.—	„	*elaboratus.*
20.—	„	*Johnsonianus.*
21.—	„	*Ralfsianus.*
22.—	„	n. sp. ? from Japan. Very imperfectly represented by the engraver.

All the figures are × 400 diameters.



R.K. Greville, del. G. Jarman, sc.

W. West, imp.



R. K. Greville, del. G. Jarman, sc.

W. West, imp.

DESCRIPTION OF PLATES IV & V,

Illustrating Dr. Greville's paper on New Diatoms, Series IX.

Fig.

1.—*Porodiscus elegans.*

2.— ,, *major.*

3.— ,, *conicus.*

4.— ,, *nitidus.*

5.— ,, *ovalis.*

6.—*Heterodictyon Rylandsianum.*

7.— ,, *splendidum.*

8.—*Fenestrella Barbadensis.*

9.—*Craspedoporus Ralfsianus.*

10.— ,, *Johnsonianus.*

11.—*Actinodiscus Barbadensis.*

12.—*Aulacodiscus inflatus.*

13.— ,, *mammosus.*

14.— ,, *Kilkellyanus.*

15.— ,, *angulatus.*

16.— ,, *spectabilis.*

17.— ,, *pallidus.*

18.— ,, *? paradoxus.*

19.—*Eupodiscus punctulatus.*

20.— ,, *simplex.*

21.—*Auliscus nebulosus.*

22.— ,, *parvulus.*

23.— ,, *ambiguus.*

24.—*Triceratium lineatum.*

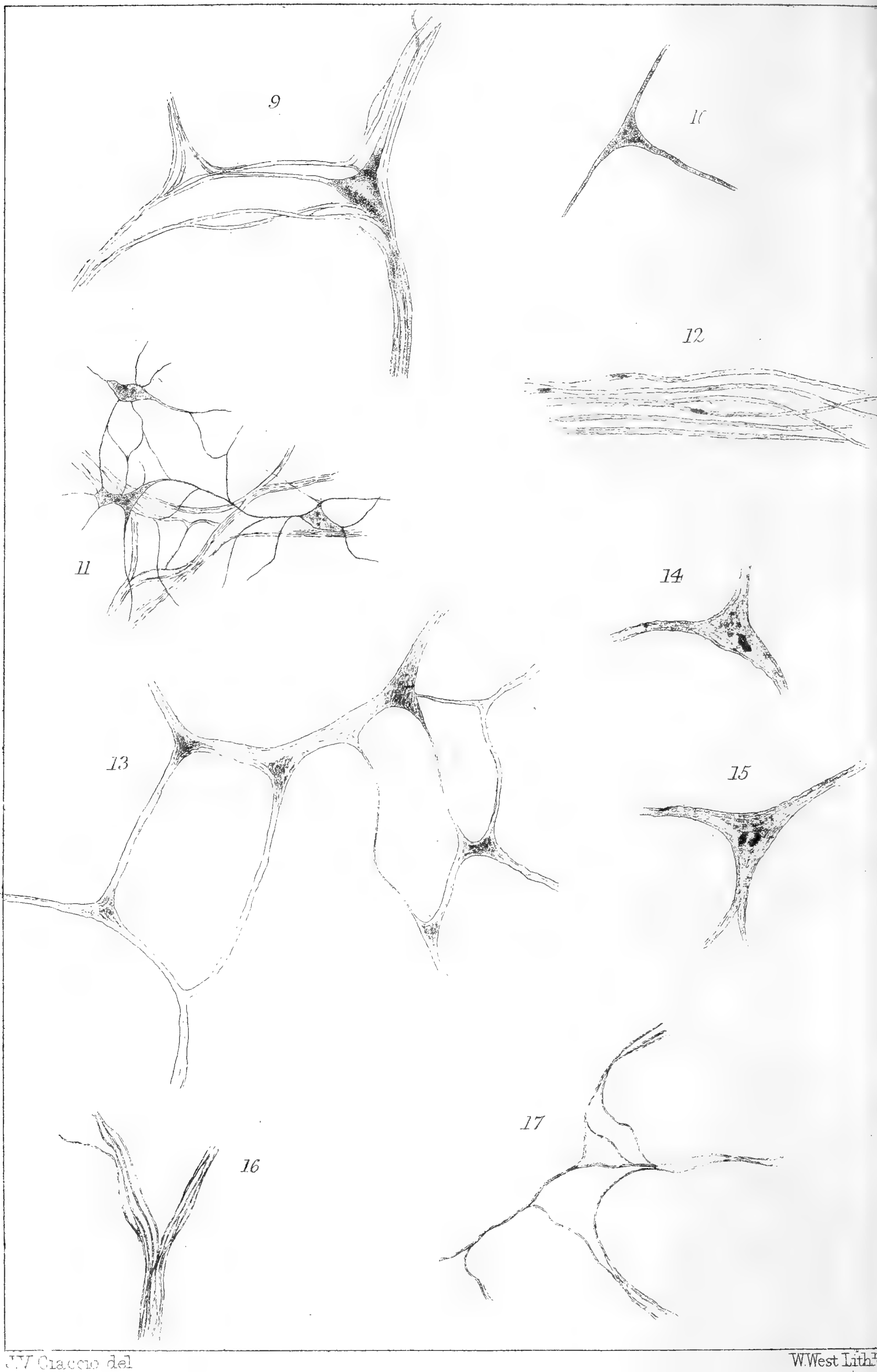
25.—*Peponia Barbadensis.*

26.—*Thaumatonema Barbadense.*

All the figures are × 400 diameters.

J.V. Ciaccio del.

W. West, Lith.



J. V. Ciaccio del.

W. West Lith.

DESCRIPTION OF PLATES VI & VII,

Illustrating Dr. Ciaccio's paper on the Nerves of the Cornea, and of their Distribution in the Corneal Tissue of Man and Animals.

Fig.

1.—One of the largest nerve-trunks from the cornea of the sparrow, showing the manner in which the nerves branch, the nuclei connected with the primitive nerve-fibres, and the relative position of the latter in the trunks as well as in the branches. × 150.

2.—Shows the manner in which the bundles of nerve-fibres are arranged in the formation of the network in the cornea of the sparrow. Two triangular bodies are also seen in connection with these bundles. × 700.

3.—One of the quadrangular bodies found in connection with the nerves distributed to the cornea of the sparrow. Bundles of nerve-fibres are observed to arise from it in four different directions. Some of the fibres, in passing from one bundle to another, flank one of the sides of the small body, while others seem to proceed directly from it. A nucleus and granular matter are also seen in the part within. × 750.

4.—From the cornea of the sparrow. A. Small, triangular body, with nucleus and granular matter, connected with bundles of nerve-fibres. B. A very small bundle of fibres, which, on meeting another bundle, nearly at a right angle to it, divides into two finer ones, which run in opposite directions, parallel with the other bundle. × 350.

5.—A rather large nerve-trunk, just at its entrance into the corneal tissue. The fibres, of which it is made up, are seen to be nucleated, but they have not the slightest appearance characteristic of dark-bordered fibres. On the contrary, the fibres bear a great resemblance to the so-called gray or gelatinous fibres of the sympathetic. From the cornea of the eel. × 250.

6.—Very small bundles of nerve-fibres forming networks. From the cornea of the eel. × 350.

7.—One of the branches resulting from the fourth division of a large nerve-trunk from the cornea of the frog. The course and continual change of the relative position of the nerve-fibres is well shown. Moreover, in the point where the branch undergoes division, is seen a fine fibre, which seemed to be a single fibre, but really divides into two finer ones, which go in opposite directions. This fact is very frequently observed in the distribution of nerves to the cornea of the frog. No nuclei are observed in connection with the fibres forming the branch. × 350.

Fig.

8.—A and B. Two ultimate branches of two different nerve-trunks, from the cornea of the frog, showing very distinctly the precise manner in which the one branch anastomoses with the other. The anastomoses are effected by the mutual change of the fibres. × 350.

9.—From the cornea of the frog. Bundles of nerve-fibres, forming networks. Connected with them may be seen a triangular body, from which fibres proceed in different directions. Some fibres of the bundles pass close to this body without any intimate connection with it. The triangular body contains granular matter, which appears to have collected in two places, assuming the appearance of two dark spots. × 350.

10.—Triangular body, from which fibres spring in three different directions. From the cornea of the frog. × 350.

11.—Network of pale nerve-fibres, and network of the branches of the cornea-corpuscles, from the cornea of the frog. These two kinds of networks lie on different planes, and the relation between them is well shown. × 350.

12.—Shows the course, size, and relative position of the primitive nerve-fibres in the branches of the nerves distributed to the cornea of the mouse. × 350.

13.—Nervous plexus in the cornea of the mouse. The general arrangement of the bundles of nerve-fibres in the formation of the plexus, and the special bodies connected with them, are well seen. × 250.

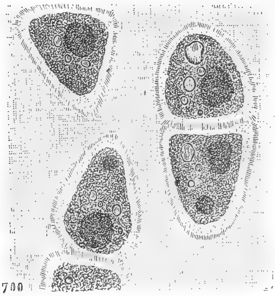
14.—One of those special bodies which are seen in connection with the nervous plexus of the cornea of the mouse. Besides a nucleus, it contains granular matter. Bundles of fibres proceed from it in three different directions. × 350.

15.—Another body of the same kind, in which the nucleus has undergone division. From the cornea of the mouse. × 350.

16.—From the cornea of man. Small nerve-branch, which divides into two smaller ones; and from the pressure to which the thin section of the cornea has been subjected, the nerve-fibres of one branch appear separated from one another. × 350.

17.—Shows the manner in which the fine bundles of nerve-fibres are arranged in the formation of the plexus existing in the human cornea. × 350.

Fig. 1.



×700

Fig. 2.

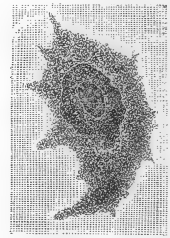


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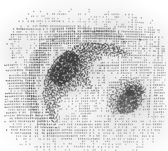
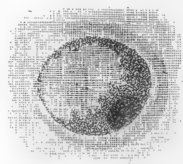
Fig. 3.



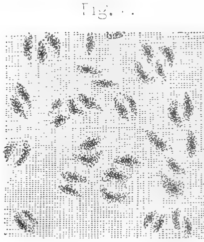
× 700.

Fig. 4.



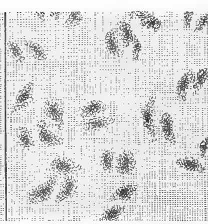
× 700.

Fig. 5.



× 215.

Fig. 6.

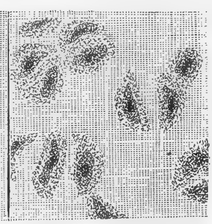


× 215.

Fig. 7.

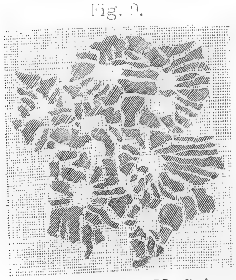
× 215.

Fig. 8.



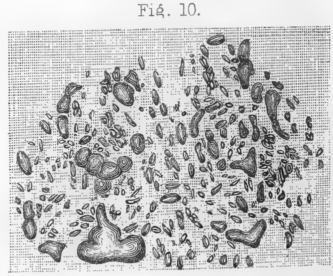
× 215.

Fig. 9.



After Mr. Rainey.

Fig. 10.



After Mr. Rainey.

SCALE.
$\frac{1}{1000}$ of an Inch ——————— × 700.
$\frac{1}{10,000}$ of an Inch —— × 1700.

L. S. B., ad nat.

DESCRIPTION OF PLATE VIII,

To illustrate Dr. Beale's observations on the Formation of the so-called Intercellular Substance of Cartilage. (*See* p. 96.)

Fig. 1.—Section of cartilage from the temporal bone of the common frog. The so-called "cell" is seen to consist of granular matter, in which small globules and a nucleus are embedded. Owing to change occurring after the removal of the cartilage, a slight interval appears to exist between the outer part of the granular matter and the matrix, but in the living state there is no such interval. The nucleus and the granular matter around constitute the author's "*germinal matter*." The oil-globules deposited in it correspond to secondary deposits. The matrix between the masses of germinal matter constitute the author's "*formed material*." Two of the masses of germinal matter are undergoing subdivision. The *septa* are not produced by the *growing-in* of the matrix, but the outermost part of the masses of germinal matter is converted into the matrix.

Fig. 2.—" Germinal matter" and surrounding formed material—costal cartilage—of a kitten at birth. The germinal matter exhibits zones, which are coloured with carmine, and exhibit different degrees of intensity as we pass from the outer one, which is faintly coloured, to the spot in the centre, which is intensely coloured. It is clear that these zones are all composed of material of the same general characters, so that it would be very unreasonable to call the outer zone " cell-contents," the next "nucleus," the next "nucleolus," and the spot in the centre "nucleolulus." The outermost zone is structurally continuous with the matrix, and is gradually being converted into matrix. The matter of which all these zones are composed is " germinal or living matter." The matrix around is *formed* and lifeless, but was once " germinal matter."

Figs. 3 and 4.—Cartilage from the frog, showing the germinal matter shading into and becoming gradually converted into " matrix " or formed material.

Figs. 5, 6, 7, and 8, represent sections of the cartilage of the ribs taken from corresponding spots. Kitten.—Fig. 5, at birth; fig. 6, at six weeks old; fig. 7, young but nearly full-grown cat; fig. 8, adult cat. These drawings show the gradual separation of the masses of germinal matter from each other as the matrix increases in the intervals between them, and the gradual increase in size of the masses until the tissue attains its adult condition.

Figs. 9 and 10.—Drawings copied from Mr. Rainey's work illustrating his views upon the mode of formation of lacunæ. He states that no nucleus or cell exists in any of the spaces represented in fig. 9, and that the calcareous particles are deposited in the matrix independently of the "cells" of the cartilage. No "nuclei" or "cells" (masses of germinal matter) are represented in either of these drawings, but the author maintains that when the sections were fresh several such bodies must have existed.

DESCRIPTION OF PLATE IX,

To illustrate Dr. Beale's views upon the Formation of Bone ('Transactions,' p. 103), the changes occurring in "Protoplasm" ('Mic. Journ.,' p. 260), and the Structure of the so-called "Unipolar Nerve-cells" from the Sympathetic Ganglia of the Frog ('Mic. Journ.,' p. 304).

Fig. 11.—Thin section of the frontal bone of the frog, showing the formation of four lacunæ.

Fig. 12.—Two lacunæ in a further stage of formation. The "canaliculi" commence at the intervals between the particles of calcareous matter deposited in matrix of the cartilage.

Fig. 13.—Two recently formed lacunæ from the frontal bone of the frog.

Fig. 14.—A diagram showing the mass of germinal matter with calcareous particles deposited in the matrix around it. The author considers that masses of germinal matter existed in each of the spaces left in Mr. Rainey's figure (Plate VIII, fig. 9).

Fig. 15.—Mucus-corpuscle from the mucus of the throat, showing the different forms it assumed within a minute. The nuclei are seen in the centre of the parent mass. Portions of this have moved away some distance, and two are detached. These would grow and form new mucus-corpuscles. Nuclei might arise in the portions detached. The movements observed seem to be independent of the nucleus. The nature of these movements has not yet been explained, but Dr. Beale calls them "vital" movements. (*See* 'Mic. Journ.,' vol. iii, N. S., p. 260.)

Fig. 16.—A so-called "unipolar" nerve-cell, with, 1st, a *straight*, and 2nd, a *spiral*, fibre emanating from it. The fibres continuous with these are seen to pursue opposite directions. The straight fibre is continuous with the central part of the material, of which the body of the "cell" is composed, and the spiral fibre with the peripheral part of the same. Both fibres are nucleated, and a large nucleus and nucleolus are seen in the upper part of the cell. The specimen from which this drawing was taken was coloured with carmine. The nucleolus was most intensely coloured, then the matter around this (nucleus). The matter around the nucleus was paler, and that portion at the lower part of the cell which is gradually undergoing conversion into the "spiral fibre" was not coloured at all. The nerve-fibres were not coloured, but all the nuclei embedded in these fibres were darkly coloured. (*See* 'Mic. Journ.,' vol. iii, N. S., p. 304.)

Fig. 11.

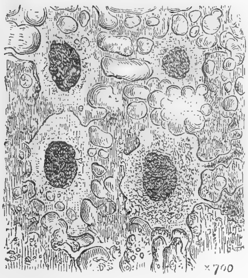


Fig. 12.

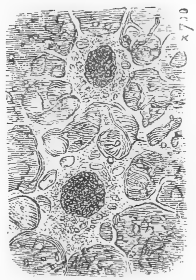


Fig. 13.

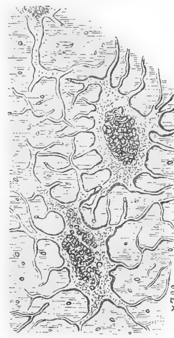


Fig. 14.

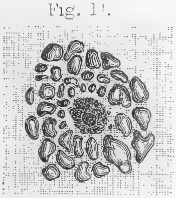
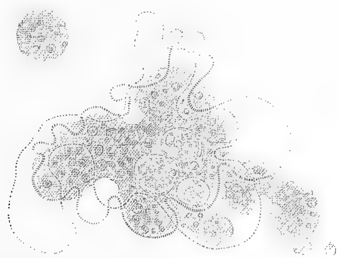
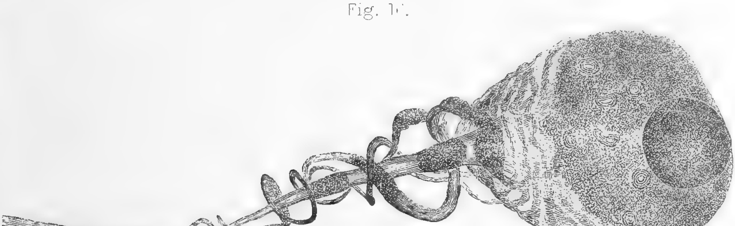


Fig. 15.



× 1700.

Fig. 16.



× 700.

SCALE. $\frac{1}{1000}$ of an Inch ———————— × 700.

$\frac{1}{10,000}$ of an Inch —— × 1700.

L. S. B., ad nat.

INDEX TO TRANSACTIONS.

VOLUME XI.

TRANSACTIONS

OF THE

MICROSCOPICAL SOCIETY

OF

LONDON.

NEW SERIES.

VOLUME XII.

LONDON:
JOHN CHURCHILL AND SONS, NEW BURLINGTON STREET.
1864.

TRANSACTIONS.

DESCRIPTION *of a* NEW STAND *for a* SINGLE MICROSCOPE, *with an arrangement for using the magnifiers with both eyes.* By RICHARD BECK.

(Read Oct. 14th, 1863.)

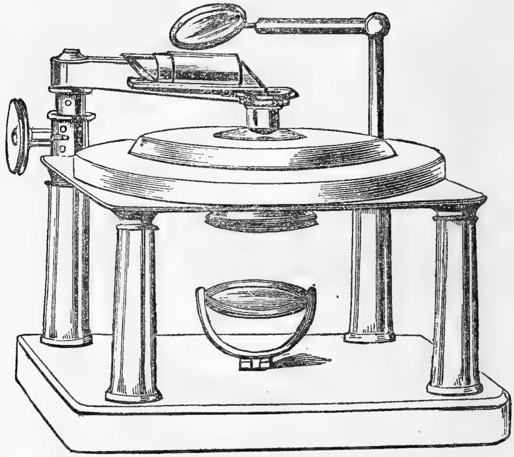
THE base of this instrument is a square block of mahogany (Figs. I and II), with the top edge and corners rounded off, and at the angles are four strong brass pillars, which support, at a height of four inches from the table, a brass plate six and a half inches square; above this are two circular brass plates: the first is the same diameter as the square plate, with a revolving fitting at the centre, and the means of tightening it down underneath by a large milled head; the second and top plate of all is much smaller, and is held down by springs, which allow it to be moved pleasantly over the lower plate to the extent of three quarters of an inch in any direction; this is equivalent to a space at the centre of one and a half inches diameter, and of this size the opening of the top stage is made for the reception of various glasses, troughs, or holders for dissection.

The magnifiers drop into the extremity of an arm, which comes in a diagonal direction from the left-hand back pillar; here it is fixed to a triangular bar, which can be moved up or down by a milled head, connected with rack and pinion for adjustment of focus; the arm can be turned on one side to the left, but in the other direction it stops, when central with the revolving fitting of the first circular brass plate already alluded to.

When light is required from below for transparent objects, a concave mirror, provided with a semicircle and other necessary fittings, can be turned up from a recess in the mahogany base, and a side condensing lens, with ball and socket and other movements, supplies all necessary illumination from above.

In most dissecting microscopes the magnifier is moved over the object, and consequently away from either condenser or

FIG. I.



mirror illumination. In this instrument the magnifying power is stationary, and not only does the illumination remain the same whilst the object is moved about in every direction, but any particular part that is being examined will remain in view whilst it is rotated by turning the large circular brass plate.

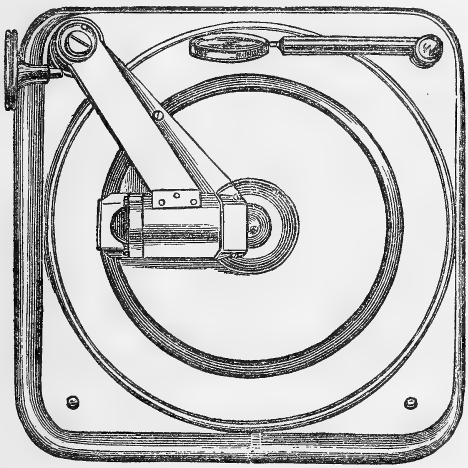
The following are the advantages of this construction:—The size, or as it might be termed spread of the microscope, gives great firmness, and also allows plenty of room on the top plates for the hands to rest upon during dissection.

The stand is comparatively low; for, in a single microscope it is necessary to allow some considerable open space beneath the lowest part of the stage, to admit of an illumination from below when the light in front is at a moderate elevation; but this unavoidable height is taken full advantage of by giving a range of three inches and six tenths to the rack of the triangular bar, and thus an object of considerable thickness may be placed on the instrument.

The different dissecting instruments and appliances to the stage are a selection from those recommended by various naturalists, and require no particular description; neither is there much to say respecting the magnifiers, which are either single lenses or Coddingtons, excepting a pair of achromatic powers, which may be used either separately or in combination, and in either case they admit a large pencil of light free from aberrations.

Nearly all the spare room in the case is made use of, first,

FIG. II.



by a good-sized box, which fits between the four pillars, for dissecting instruments and apparatus; and secondly, by a narrow strip of wood which occupies the top right-hand corner of the case and receives the magnifiers.

The binocular arrangement requires a few words of explanation. I find that in 1853 Professor J. L. Riddell, of New Orleans, described a form of binocular magnifier that could be made by using four reflecting prisms or pieces of silvered glass, and I believe a somewhat similar plan has been for some time adopted in France as an adjunct to the ophthalmoscope. But in these binocular arrangements there seems to have been the one idea that, if the rays passing through the lenses are to be divided, both halves must be similarly treated; this is now proved by Mr. Wenham's most successful construction of the binocular compound microscope, not only to be unnecessary, but really disadvantageous.

In the single microscope, when the object is in focus, the rays emerge parallel from the magnifier, and there is nothing to prevent the use of both eyes—one close to the lens and the other some distance off; the size of the object in each instance is the same, and the union of both images is perfect.

This arrangement is shown in Figs. I and II: half the aperture of the lens proceeds direct to one eye, and the other half is reflected by two ⌊ prisms to the other eye; the two fields of view are unequal, and the space included in a small circle only is stereoscopic: but this result is no worse than the ordinary disadvantage of smallness of field common to all binocular single microscopes of moderate power; whereas the advantages over the quadruple reflections are, much less loss of light, only half the cost, and great facility in turning the prisms out of the way when one eye only is used.

The mounting required by this binocular arrangement is as follows:—To a semi-cylindrical tube are attached two ∟ prisms; one is a fixture, but the other will slide in or out to suit the distances of different eyes; the two together are connected with a second arm, which fits immediately above the first arm, carrying the magnifier, and if both eyes are used the right-hand prism should exactly cover one half of the magnifying lens. The second arm is stopped when it reaches this position, but it can be turned out of the way to any extent in the other direction, and the fittings of the prisms allow of their easy removal when they require cleaning.

As to the value of binocular single magnifiers, I prefer quoting the words of Professor Riddell to giving any opinion of my own; he says, "I regard the binocular magnifier as supplying a great desideratum to large classes of persons pursuing a great diversity of calling. The effects, so often prejudicial to vision, of inordinately using one eye, are thus avoided, and a perfectly natural relief or definition of bodies in depth, as well as in extension, is thus attained."

Description *of* Two New Forms *of* Reversible Compressors. By Richard Beck.

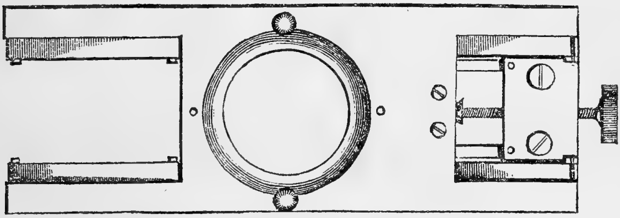
(Read Oct. 14th, 1863.)

Both these pieces of apparatus are contrived to meet the following wants:—A parallel and equal compression, with an immediate action up or down; the means of turning the compressor over, so as to see both sides of an object without disturbing it; the use of thin glass only, either at top or bottom; and, lastly, such restrictions in the thickness of the brass work as will permit the use of the achromatic condenser or the parabolic-reflector.

I am indebted to Mr. Slack for a suggestion which forms the basis of the construction in each case. He proposed that two oblong pieces of thin glass should each be secured to a brass plate by the heads of two screws; spaces were then to be made for the heads of these screws in each opposing plate, when the two pieces of thin glass could be brought close together. This simple plan has great advantages:—the pieces of glass are easily cut, as no great nicety of size is required, and they can be changed or replaced without difficulty and with little loss of time.

The following are the mechanical means by which I have endeavoured to fulfil the requirements already stated:—Fig. I shows two brass plates furnished with thin glass and

FIG. I.

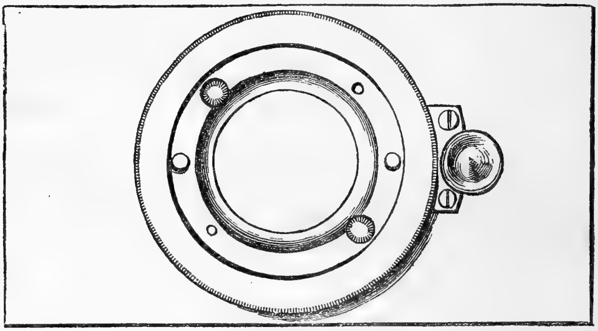


connected by four small rods; this is in fact the commonest parallel rule motion, and very nearly a vertical one, for when the plates are near together the position of the connecting rods is such as to cause no perceptible end movement. The plates, when about $\frac{1}{10}$th of an inch from each other, are kept apart by two springs, which supply the separating power, the compressing force being given by a small screw, with a conical end attached to one plate, working into a corresponding recess on the other plate; the first hold the point of the screw gets is at the bottom, so that the plates are drawn together as the screw advances. When the inner surfaces of the thin glasses want cleaning, or when the object or the glasses have to be changed, the screw must be brought quite back, and the plates will then separate to the extent of a full inch.

In the other compressor (Fig. II) the thin glasses are secured to two circular plates of brass; the one fits the ring, and the other the counter ring of a brass cell; when these are screwed together, the plates approach each other, and when unscrewed they are separated by springs. Two upright pins in a flat brass plate pass through both the circular brass plates to prevent their turning round whilst the cell is screwed or unscrewed, and a small milled head screwing against a push-piece holds the cell itself firmly in a sunken ring that it drops into.

Both these compressors supply the wants I commenced with enumerating: their defects, or their degrees of merit, I must leave to those who have had more experience than myself in the examination of objects under compression; but in

FIG. II.



my very limited observations I have frequently felt the want of some means of reversing the object quickly and easily whilst under pressure.

On NEW DIATOMS. By HENRY SCOTT LAUDER, Assistant-Surgeon Royal Navy, H.M.S. "Melville."

(Communicated by Dr. Lankester, F.R.S.)

Family CHACTOCENÆ.

Genus BACTERIASTRUM.

FILAMENTOUS; usually having about twenty frustules in the filament; connected together by the intimate apposition of the awns of contiguous cells for a part of their length; cylindrical; side view discoidal, with from five to thirty-two awns radiating from the margin of the disc; those of the cells at each extremity of the perfect filament are more or less simply curved, and their origin is slightly submarginal. The intermediate awns present the appearance of being bifurcated for about half their length. This appearance is caused by the awns of contiguous frustules being closely approximated, or, as it were, blended together for a certain distance from the margin of the cell, and for the remaining part of the awn to the extremity they separate into the two awns of which they are primarily composed, belonging to different frustules,

(Pl. III, fig. 1, perfect filament; fig. 2 *a*, 4, terminal cells; fig. 3 *a*, intermediate cell, composed of the contiguous halves of two separate frustules.)

For this reason it is that the awns at the extremities of the filament are always simple, having no other cell contiguous to assist in forming the compound bifurcated awn.

This process of blending and bifurcating in the awns, which takes place normally in Bacteriastrum, also very rarely happens as an accident or monstrosity in a species of Chactoceros (fig. 8)—an exception which serves to strengthen the rule with regard to Bacteriastrum.

From this it will be evident that *B. furcatum*, *B. curvatum*, and *B. nodulosum*, described in Pritchard's 'Infusoria' as distinct species, are in reality one and the same species, being different parts of the filament.

B. nodulosum is, I imagine, a terminal cell with the spirally arranged beads strongly marked.

The awns of the Hongkong species are always spirally beaded, most evident in the terminal cells; in the intermediate cells, the beading on the awns is aborted or very indistinct at that part when they blend together, appearing distinctly only on their free extremities (figs. 2 *b*, 3 *b*.)

The diameter of the disc varies from $\frac{1}{3000}$ to $\frac{1}{500}$; length of the awn is about four or five times the breadth of disc.

This diatom varies very much in size, and in the number and curvature of the awns, but there are no specific distinctions sufficiently well marked or constant to warrant its division into more than two species.

Multiplication and reproduction are carried on as in the other genera of Chactocereæ, by the lengthening of the connecting zone of the frustule, the division of the endochrome into two masses, and the sprouting of new awns from the middle of the frustule; so that each frustule consists of an old and a new valve (fig. 5).

At certain times, or under certain circumstances, the endochrome does not divide after the lengthening of the frustule, but secretes a siliceous envelope, and becomes a gonidium or sporangium (fig. 6), consisting of a cell with two rounded ends, and a connecting hoop, one end being smaller than the other. From the smaller end four or five slender spines proceed to the sides of the containing frustule, and serve as stays or props to keep the gonidial body in position; these bodies always lie with their similar ends towards each other throughout the filament. I may mention here that these sporangia (if one may call them so) of Bacteriastrum and Chactoceros are very variable in form and size, and from having been found in a free state in deposit or guano, have been very often mistaken for distinct species of diatoms by many observers; among these may be mentioned Dicladia, Eonisthecium, Hercotheca, &c. &c., all of which are the bodies formed within the frustules of diatoms belonging to Chactocereæ.

SPECIES 1.

Bacteriastrum varians (figs. 1 to 6). Breadth of frustule more commonly $\frac{1}{900}$; number of awns usually from ten to thirteen; those of terminal frustule slightly submarginal,* intermediate awns marginal. Very common, floating freely in Hongkong harbour.

SPECIES 2.

Bacteriastrum hyalinum (7 *a, b*) is distinguished from the former by being very hyaline, and having constantly thirty or thirty-two awns, *B. varians* never having more than twenty-four.

Body of frustule is short in front view, and is constantly $\frac{1}{900}$ in diameter; length of awn about twice and a half the diameter of the disc; found under the same circumstances as *B. varians*, but not so common.

DESCRIPTIONS *of* NEW *and* RARE DIATOMS. SERIES XI. By R. K. GREVILLE, LL.D., F.R.S.E., &c.

(Communicated by F. C. S. Roper, F.L.S.)

TEREBRARIA, nov. gen., Grev.

FRUSTULES in front view quadrangular, binately conjoined, with transverse rows of conspicuous pseudo-pores, and a longitudinal serrated suture. Valve elliptical, with transverse rows of similar pseudo-pores.

This highly curious fossil genus is conspicuous at first sight for the large, distinct pores, or pseudo-openings, arranged in rather distant rows, and, on a closer examination, for the sutural line being serrated, a character which, as far as I know, has not been observed in any other diatom. In the

* The terminal disc has a distinct central punctum.

frustular form it resembles *Dimeregramma* of Ralfs, but differs essentially in the absence of a longitudinal median line or interruption of the striæ in the valve. From *Plagiogramma, Denticula,* and *Odontidium,* it is separated by the absence of pervious costæ, as well as by its own peculiar characters.

Terebraria Barbadensis, n. sp. Grev. (Pl. II, figs. 12, 13).

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

Of this species I have met with several examples, all binately conjoined. The frustules are ·0027″ in length, sharply quadrangular, contracted below the ends, convex in the middle. The pores, or rather pseudo-pores, for these are not actual perforations, are large, circular, distinct, about three on each side of the serrated suture; while the number of the transverse rows is about sixteen. The colour of the frustule is dark and smoky, and when accurately focused, the pores appear to transmit light, as if through a thin membrane. The valve is narrow, elliptical, oblong, slightly contracted near the extremities, which are much rounded.

COSCINODISCUS.

Coscinodiscus angulatus, n. sp., Grev.—Cellules equal, in radiating lines, about eight of which extend from the centre to the circumference, where each terminates in a submarginal tubercle; tubercles united by a straight line of shade; margin rather broad, striated. Diameter ·0034″ (Pl. II, fig. 11).

Hab. Barbadoes deposit, Cambridge estate.

A well-marked species. Cellules all equal, about 7 in ·001″. Marginal striæ 16 in ·001″. The arrangement of the lines of cellules is very simple. A certain number meet in the centre, and these are *strictly* radiating, forming, as it were, a series of compartments within each of which the lines take the direction of the inverted letter Λ, one pair within another, until the space is filled up, the shortest lines being, of course, midway between the tubercles.

AULACODISCUS.

Aulacodiscus umbonatus, n. sp., Grev.—Disc broadly umbonate, with a circular umbilicus; processes small, numerous (6 or 7) at a short distance from the margin, situated in the rounded axils of the nearly linear furrows;

granules rather large, subquadrate, the lines mostly continued simple to the margin. Diameter ·0050″. (Pl. I, fig. 2.)

Hab. Barbadoes deposit, Cambridge estate; George Norman, Esq.

It is to be hoped that this species will be found to retain its apparently strongly marked characters. I have represented it as focussed for the depressed margin and processes. The furrows do not, as is most frequently the case, terminate in a suddenly expanded blank space surrounding the processes, but are simply rounded at the end, the processes themselves lying in the axils. The subquadrate granules (or cellules) are of much the same size throughout, and for about a third of the radius from the margin form close, undivided lines. The colour is rather dark. This must be an exceedingly rare diatom, as neither Mr. Johnson nor I, nor, I believe, Mr. Ralfs, have observed it in the innumerable slides we have examined.

Aulacodiscus amœnus, n. sp., Grev.—Disc with numerous (6 or 7) sublinear, elongated, submarginal processes, and a circular umbilicus; furrows defined by a single row (on each side) of granules, and scarcely at all dilated at the extremities; granules large, subremote, the lines passing suddenly near the margin into a corresponding number of short, broad striæ. Diameter ·0047″ (fig. 3).

Hab. Barbadoes deposit, Cambridge estate; C. Johnson, Esq., George Norman, Esq.

A very beautiful and distinct species. The disc very convex, the convexity ceasing suddenly near the margin, and causing a narrow line of shade between the processes, the small space between this shaded line and the margin being flat. Granules subremote, each occupying the centre of large, delicate, hexagonal cellules, requiring careful adjustment to bring out clearly. In the example now before me the furrows between the centre of the disc and the processes are considerably wider than are the other lines from each other; but in a specimen discovered by Mr. Norman this distinction almost entirely disappears, while the other characters remain the same.

Aulacodiscus Grevilleanus, n. sp., Norman.—Very large. Disc with numerous (about 10) submarginal processes, and circular umbilicus; compartments between the furrows covered with diagonal, intersecting rows of little cushion-like warts, rough with elongated and coral-like granules. Diameter ·0110″. (Pl. I, fig. 1.)

Aulacodiscus Grevilleanus, Norm. *in litt.*

Hab. Deposit at Moron, in the Province of Seville; George Norman, Esq.

The discovery of such a species as I have now the privilege of describing will provoke the envy of all keen diatom-hunters, and I may be pardoned the confession, that to have my own name associated with it by my kind friend Mr. Norman, is one of those rewards which labourers in the field of natural science most highly appreciate. In its large size and inconceivably rich decoration, this wonderful species stands alone among its congeners. The umbilicus is small and irregular; and in the centre of the disc, for about a fourth part of the radius, the compartments are filled with verrucose, more or less rounded or oblong, irregularly radiating clusters of granules. These gradually pass into others more equal in size and more regularly arranged, so that they not only radiate, but are beautifully diagonal and intersecting. On the little wart-like cushions are clusters of four to six coral-like granules, which, when viewed vertically, appear like ordinary spherical, brilliant granules, but are in fact considerably elongated, as is shown at the edge of the furrows, and, indeed, wherever the surface happens to be so undulated as to bring them into an oblique position. The furrows are very narrow, slightly widening in their course, and suddenly dilating into a small blank space beneath the submarginal processes. On each side of the latter are a few broad striæ, having externally a sort of scalloped outline, which does not extend to the middle of the compartment, while within the margin itself a pale circle of fine striæ is visible, such as exist probably in all the species.

Aulacodiscus radiatus, n. sp., Grev.—Disc pale, with very minute radiating puncta; furrows inconspicuous; processes (5) minute, submarginal, surrounded by a broad, somewhat oblong, blank space. Diameter ·0047″ (fig. 4).

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

This and the following species possess considerable interest, as they appear to form, along with *A. pallidus* ('Trans. Mic. Soc.,' vol. xi, p. 72), a section of the genus characterised by the pale colour, punctiform structure, minute processes, and relatively large blank areas in which they are situated. The general aspect of the species last mentioned is quite lost in the coarseness of the engraved figure. In all the three species there is a sort of circular ridge following the line of the processes, and upon this ridge some opaque markings, which suggest the idea of cellulate structure filled with colouring matter; but the extremely irregular form of the marks in the following species seems to contradict such a supposition. In the one under consideration they are more uniform, constituting, in fact, a band of short, thick, radiating, dark lines. Between this band and the margin the puncta are much more minute, and might almost be called moniliform striæ.

Aulacodiscus pellucidus, n. sp., Grev.—Disc pale, with minute, not very close, radiating puncta; furrows inconspicuous; processes numerous (8), at some distance from the margin, within a narrow, oblong, blank area; margin with moniliform striæ, and a very slight inflation beneath the processes. Diameter. 0045″ (fig. 5).

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

In this species the structure is not so minute as in the preceding, and the furrows can be more easily traced. The processes are more numerous, and the vacant spaces in which they are situated are of a quite different shape; and, whatever may be the cause of the little dark markings, there can be no doubt that their different shape and arrangement indicate a specific difference in the two objects. A convex, shaded line, opposite to and beneath the processes, seems to show a slight inflation; and this line, continued in a fainter degree and straight direction from one process to another, gives a somewhat angular character to the ridge.

Aulacodiscus orientalis, n. sp., Grev.—Disc coloured, very convex; processes numerous (7 to 15, or more), cylindrical, submarginal; umbilicus circular; structure minutely and distinctly cellulate, the cellules arranged in both radiating and concentric lines, which suddenly pass into moniliform striæ at the margin. Diameter ·0045″ to ·0060″. (Pl. II, fig. 6.)

Hab. Ceylon; Dr. Macrae.

A most charming diatom, delighting the eye with its exquisite symmetry. At first sight it is so like *A. Oreganus,* that one is apt to reject at once its claim to novelty. At the same time, a single really searching glance is sufficient to decide the question. Of *A. Oreganus,* Mr. Ralfs remarks, "Under a low power its minute granules appear arranged in waved or oblique lines, but imperfectly radiant under higher powers." In the present species, on the contrary, the structure is essentially and exquisitely radiant, whatever power may be used. In the description of *A. Oreganus* the term granules is appropriately used, as the structure is apparently composed of granules; in *A. orientalis* it is impossible to use such a term, as there is not the very slightest appearance of granules, but simply a sort of cancellated cellulate arrangement, with the light coming through the interstices so clearly as to establish its character beyond dispute. The beautiful concentric cellulation is also totally wanting in *A. Oreganus.* On the other hand, there is a great resemblance in the numerous processes. In both species they are linear when viewed laterally; but in our new species they are not so apparently "emarginate" as they have been defined to be in *A. Oreganus.* When very minutely examined, however, the processes in both are found to be rounded at the apex. The furrows in our present species are extremely narrow, having much the appearance of transparent ribs, dilating suddenly into small, blank spaces at the processes. My friend, Mr. George Norman, informs me that on searching his slides marked for *A. Oreganus* he has found a specimen of *A. orientalis* in some pearl shell débris obtained from a dealer, the locality being unknown.

BIDDULPHIA.

Biddulphia gigantea, n. sp., Grev.—Side view more or less broadly elliptical, subacute, inflated; horns long, cylindrical, capitate; cellules large, radiating. Longest diameter about ·0080″ (fig. 9).

Hab. Barbadoes deposit, Cambridge estate; C. Johnson, Esq., R. K. G.

Of this magnificent species I have seen several tolerably entire valves, besides fragmentary ones. Perfect horns, however, are very rare, as, being long and slender, they are readily broken off. The large subquadrate cellulation, inflated centre occupying nearly the whole surface, and flat margin, conspicuously distinguish it. The ends are carried out considerably beyond the base of the horns, like the ears of the Scottish shallow drinking-cup called a quaich, which the valve not a little resembles, especially the broad form represented in the figure. Generally, the outline is much narrower, more or less oblong; but the leading characters remain essentially the same.

TRICERATIUM.

Triceratium concinnum, n. sp., Grev.—Valves with straight sides, rounded angles, and very remotely scattered puncta, the centre an obscurely defined triangular space; margin with a row of puncta, and the extreme angles with a dense luster of very minute puncta. Distance between the angles, ·0033″ (fig. 7).

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

The marginal puncta are nearly of the same size as the scattered ones on the surface, and are 8 in ·001″. At the angles the very tip is cut off by a row of three or four puncta; and the small enclosed area crowded with much more minute puncta.

Triceratum partitum, n. sp. Grev.—Valve with slightly concave sides and very rounded angles, which are filled with minute puncta; each angle having two transverse septa, one midway between the centre and the angle, the other cutting off the angle itself; surface dotted with remote scattered puncta. Distance between the angles, ·0030″ (fig. 8).

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

A beautiful and well-marked species. The angles are so much rounded as to appear somewhat capitate. The centre is marked by a small indefinite cluster of puncta, and there is a slight indication of a radiate direction in the other more remote puncta. The septa nearest the centre have a curious faint interruption in the middle.

COCCONEIS.

Cocconeis Barbadensis, n. sp., Grev.—Valve circular or nearly so, punctate; median line linear, attenuated; puncta minute as they form converging lines towards the extremities, while they are larger and form intersecting lines on each side; border striated. Diameter about ·0032″ (fig. 10).

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

One of my specimens of this beautiful species is exactly circular, others nearly so. In the centre is a transversely oblong, blank, nodular space. The median line, taken in connection with the narrow, blank space on each side is linear, attenuated at each end. The puncta are minute towards the apices, considerably larger on each side, and are arranged in lines incurved towards the ends. Border rather narrow, and coarsely striated.

On the Distribution *of* Nerves *to the* Skin *of the* Frog, *with* Physiological Remarks *on the* Ganglia *connected with the* Cerebro-spinal Nerve. By J. V. Ciaccio, M.D., of Naples.

(Read Nov. 11th, 1863.)

From a paper on the "Anatomy of the Skin of the Frog," illustrated by 28 drawings, and which I am not able at present to exhibit to the public, I have extracted that portion which relates to the distribution of nerves, and I hasten to lay it before the Society with the hope that it may meet the consideration due to so important a subject.

On the Method of preparing the Specimens.

I feel certain that, in most instances, the different conclusions which observers have arrived at in studying the same object are mainly owing to the divers methods they have employed in preparing the objects of their investigation. No doubt that in every microscopical inquiry that method of preparation should be adopted which will distinctly show the organic textures in all their individual parts, and at the same time preserve their natural appearances from any alteration. But unfortunately the method possessing such indispensable properties is still a desideratum; for all those usually adopted tend, more or less, to alter the natural appearances of the tissues of the body. In this inquiry, after trying the methods of other observers unsuccessfully, I was obliged to adopt again that of Dr. Beale's, which, in a previous investigation, I had employed with the most satisfactory results. The specimens from which the drawings illustrating my paper have been taken have all been prepared in the same way, and kept permanently in a compound liquid of which glycerine is the chief ingredient. In order to avoid falling into any error of observation the nuclei of the different parts composing the skin have been coloured by carmine, and the vessels injected sometimes with Prussian blue and sometimes with carmine solution prepared after Dr. Carter's formula. In my hands this new carmine-injecting fluid has answered the purpose with the most satisfactory results. I have very often succeeded with it in filling the finest capillaries so completely, that I have been able to determine their real size with the utmost exactness. There is, however, in carmine solutions generally one serious defect, which cannot at present be corrected—that is, the nuclei connected with capillary walls can hardly be discerned; for we can find no means to colour them deeper so that they may be rendered visible after the addition of a little diluted acetic acid. It is evident, therefore, that the capillaries must be injected with Prussian blue, if we wish to ascertain the number and size of the nuclei connected with their walls, because, by soaking afterwards the blue injected capillaries in an ammoniacal carmine solution, their nuclei, by being coloured red, are clearly displayed.

Having given this outline of the process I have followed in carrying out the present inquiry, I proceed now to detail the results of my observations on the distribution of nerves to the skin of the frog, and I think it will be convenient to arrange the subject under the following heads:—

1. Of the dark-bordered nerve-fibres, their course, and the manner in which they terminate.
2. Of the fine nerve-fibres, which run in the same sheath with the dark-bordered fibres.
3. Of the nerve-fibres distributed to the capillary vessels.
4. Of the nature and origin of the fine nerve-fibres travelling in company with the dark-bordered fibres.

1. *Of the dark-bordered nerve-fibres, their course, and the manner in which they terminate.*

When the inner layer of the derma of a frog is examined with a power magnifying from 200 to 350 diameters, a considerable number of dark-bordered nerve-fibres may be observed, which are arranged in bundles of different sizes. Each bundle consists of a hyaline investment of connective tissue, and of two or more dark bordered fibres. I have seen, but rarely, small bundles containing a single large dark-bordered fibre. The primitive nerve-fibres of which the bundles are composed, vary much in size, and sometimes exhibit a slight waviness of their margins, and sometimes, at irregular intervals, varicosities. These varicosities vary greatly both in size and shape, and very probably are not natural, but depend on the change which takes place soon after death in nerve-fibres generally, or on the method adopted in the preparation of the specimens. The primitive fibres of each bundle not unfrequently lie parallel to each other, but sometimes fibres are seen to pass from the one side of the sheath to another, crossing other fibres more or less obliquely. Some fibres, while running in the sheath, are seen actually to divide, and the division often occurs at the point whereat the bundle bifurcates.

It is very remarkable, that the dark-bordered fibre, a little before its division, is observed to contract abruptly and reduce itself into a subtile filament, which divides into two others of an equal size, and which sometimes gradually, but more frequently suddenly, swell up as to form two dark-bordered fibres much larger than the originary one. Less frequently, however, the dark-bordered fibre, without any previous contraction, is seen to divide into two very fine fibres, which, shortly after, increase considerably in size. The appearances I have just described do not appear to me to be sufficiently explained in the doctrine at present generally received of the anatomical constitution of the primitive nerve-fibre. I must here add, that in preparations wherein very strong glycerine has been used, and through the medium of which the dark-bordered fibres are seen, these appear quite homogenous, with a pearly brightness, and without the slightest indication of their three distinct structures.

In connection with each dark-bordered fibre are observed, at irregular distances, several oval nuclei, which are deeply coloured by carmine, and generally equal in breadth to the fibre itself. Sometimes they seem to lie in the middle of the fibre, and sometimes at one of its sides. It is very probable that they are seated within the white substance of Schwann. These oval bodies, or nuclei, can be distinctly seen only in specimens which, after being stained in carmine solution, are kept in maceration for some time in strong glycerine, and then treated with glacial acetic acid. According to my observations the glacial acetic acid disintegrates the white substance, but has no influence on the nuclei, which become clearly visible.

The bundles of the dark-bordered fibres which, as I have stated, are distributed to the inner layer of the derma of the frog, do not accurately follow the capillary vessels in their course. True it is that some large bundles are seen running parallel with and close by the capillaries for some distance; but, as a rule, the plane of distribution of the former, and that of the latter, are quite distinct. The bundles, during their course, divide more frequently in a dichotomous manner, but at times some of them are seen to divide into three or four smaller bundles, which pursue different courses. The division generally occurs at acute and, very rarely, at right angles. It is interesting to remark here that all the bundles, which result from the repeated division of the main ones, never loose their sheaths; nay, it seems to me more conformable to the truth to say that all the sheaths of the different bundles are immediately continuous with one another.

While the bundles of the dark-bordered fibres, continually dividing and subdividing, pursue their courses, the numerous branches resulting from their repeated division unite with each other. The union of one branch with another is not effected after the manner of the capillaries, but by an interchange of their respective fibres. It may be easily understood, therefore, that from such an arrangement a nervous network is formed, with meshes varying in size as well as in shape, which is interwoven with the network of the capillaries. I think we shall form a correct idea as to the precise manner in which this network is arranged, if we imagine a network of homogenous hyaline tubes of different sizes, wherein nerve-fibres are contained, which pass alternately from one tube to another.

As is shown by vertical and transverse sections, the network which has been just described is not terminal, because the bundles of the dark-bordered fibres, after taking part in its formation, pass off towards the surface, crossing the middle layer of the derma in an almost straight direction, and without sending to it any dark-bordered fibre. As soon as they reach the inferior part of the outer layer of the derma, they again branch, and form another network exactly corresponding in its arrangement with the network existing in the inner layer. Hence two networks of dark-bordered fibres exist in the derma of the frog, connected together by intermedial bundles, one in the inner and the other in the under surface of the outer layer.

Having formed this second network, the bundles of the dark-bordered fibres, while repeatedly dividing, continue their way towards the surface of the derma, are seen, sometimes gradually and sometimes abruptly, to loose the white substance and to become pale nerve-fibres. It must be here noted, that not all the individual fibres which enter into the composition of a bundle are transformed into pale fibres at the same time, as in some of them the transformation takes place sooner than in others. At the point where a dark-bordered fibre seems to cease, very frequently a single pale fibre, and sometimes more than one, can be traced in immediate continuation with it. When the dark-bordered fibres of every bundle have been thus transformed, they are still observed to run together in the same sheath for some distance, and the fibres of one bundle to pass into another, and *vice versa*. But when these rather large bundles of pale fibres, by repeatedly dividing, are reduced in very fine bundles, then no appearance of sheath can be demonstrated in them. These exceedingly fine bundles, which are very numerous, pass in every direction towards the surface, frequently interchanging their respective fibres, and as they arrive at the capillary network,* there they form an intricate plexus with rather narrow meshes. The plexus, which, for the greater part, lies immediately beneath the capillaries (only a few bundles of the finest kind passing over them), is not composed of single separate fibres, but of bundles alternately exchanging their fibres.

The fine bundles composing the plexus above referred to are connected, at unequal intervals, with certain small bodies, or nuclei, as they are usually termed, which vary both in size and shape. They are either oval, or triangularly, or indeterminately shaped. Carmine solution colours them deeply, and under the action of diluted acetic acid they appear uniformly granular. If oval, they usually are found imbedded among the nerve-bundles, but if they present a triangular or some other shape, their ordinary seat is either at the point at which a bundle divides, or where two or more bundles meet together. These small bodies are in general far less numerous than the oval nuclei, which are found in connection with the dark-bordered fibres, and by the size and the relation they bear to the pale fibres greatly differ from the nuclei connected with the dark-bordered fibres. In fact, as already stated, the nuclei of the dark-bordered fibres are commonly equal in width to the fibre, and their long axes are parallel to the latter. They are separated by short intervals, and seem to be situated within the white substance, and sometimes to be actually connected with the axis cylinder itself. On the contrary, the small bodies which are found in connection with the terminal pale fibres are generally much broader than the fibres connected with them, and their relation to the latter is, in a certain respect, similar to that which the nerve-cells bear to the fibres arising from them. It appears to me, therefore, quite unreasonable to comprehend under the same name things so widely different.

Respecting the intimate structure of the pale fibres in continuation with the dark-bordered fibres, my own observations lead me not to consider them as a mere prolongation of the axis cylinder. I agree with Kölliker on this point, and firmly believe that the pale fibres derived from the dark-bordered fibres, besides the axis cylinder, are provided with the tubular membrane, and a very thin layer of white substance, which can only be

* In order to avoid misapprehension, it must be borne in mind that, in the derma of the frog, the capillary vessels are so arranged as to form two networks; the one, with wide meshes, is seated in the inner, the other, with narrow meshes, is seated in the outer layer. These two networks are connected with one another by a few intermediate capillaries, which simply traverse the middle layer of the derma in nearly straight directions.

demonstrated by the use of certain reagents. This view seems to me to be strongly corroborated by the manner in which the pale fibres and the dark-bordered ones near the point, where they appear to cease, comport themselves with diluted acetic acid and concentrated sulphuric acid. Indeed, diluted acetic acid causes on the former as well as on the latter a granular appearance, with this difference only, that the granules in the pale fibres are smaller than in the dark-bordered fibres, but both kinds of granules refract light in the same way. On treating afterwards with concentrated sulphuric acid the pale fibres which have been thus acted upon by acetic acid, the granules disappear, and the fine nerve-fibres remain as transparent tubes with faint outlines. It is plain, therefore, that concentrated sulphuric acid acts only upon the granules produced by the action of acetic acid, but has no influence on the tubular membrane, nor on the axis cylinder.

2. *Of the fine nerve-fibres which run in the same sheath with the dark-bordered fibres.*

I believe that no one, upon close observation, will doubt the existence of very fine nerve-fibres running in the same sheath with the dark-bordered fibres distributed to the skin of the frog. These fibres were described first by Dr. Beale,* who affirms that they exist not only in relation with almost all the dark-bordered fibres distributed to the tissues of the frog, but he also believes that they exist in vertrebata animals generally. As for myself, I can truly say that I have seen such fine fibres running with peripheral dark-bordered fibres, both in several tissues of the frog and in the human skin.

The fibres already mentioned become granular by the prolonged action of acetic acid, and in refractive power they differ from the dark-bordered fibres. They vary in size, and they may be demonstrated more easily in the finer than in the larger bundles, because, in the finer, the dark-bordered fibres are far less numerous, and therefore the fine fibres are not hidden from sight. Each bundle of dark-bordered fibres contain several of them, but not all the bundles have the same number. They sometimes run among the dark-bordered fibres, and perhaps, on their way, cross them in different directions, but more frequently they are seen running between

* 'Phil. Trans.,' 1862, p. 900; see also 'Archives of Medicine,' No. xii, p. 247, and No. xiii, p. 13.

the dark-bordered fibres and the outlines of the sheath. I have very often found that the apparent outlines of the sheath usually consist of two or more of these fibres blended together, and the spindle-shaped swellings, which are generally believed to be the proper nuclei of the sheath, in most instances, pertain to the fibres just alluded to exclusively.

In the inner layer of the derma, where, as has been stated, the dark-bordered fibres form a very complicated network interwoven with that of the capillaries, very frequently may be distinctly seen two or more fine fibres, leaving, at intervals, the sheath of the bundles of the dark-bordered fibres sometimes at acute, and sometimes at right angles. These fibres which usually come out from different parts of the sheath, immediately after blend into a single bundle; and so intimately mingled together are the individual fibres in the bundle, that it appears to be not a compound, but a larger single fibre. On following some of these bundles throughout their course, they are seen to divide and sub-divide, and at the point where the division takes place are sometimes found triangularly-shaped swellings, which contain fine granular matter, and a large granule seated either in the centre or at one of the angles. The granule, which is either oval or spherical, is alone coloured by carmine. When that occurs, it is always observed that the originary bundle is connected with one of the angles of the triangular swelling, while from the remaining angles spring two smaller bundles, which pass in different directions. The secondary bundles (either they are derived from the simple division of the primary one, or from the two angles of the swelling just mentioned), on reaching a capillary vessel, one of them is seen to pass over it, while the other divides into two branches. Of these two branches one is frequently observed to cross the capillary more or less obliquely, and the other to enter its sheath, and to run parallel to it. The branches into which the primary bundle divides, present, at inequal distances, spindle-shaped swellings, which are sometimes also found in the originary bundle before the commencement of its division. Respecting those branches, which I have said to pass over the capillary vessel, they are seen after a long and tortuous course to ramify in the same way over distant capillaries.

When a bundle of dark-bordered fibres happens to pass near some of the capillaries, to which are distributed the branches resulting from the division of the bundles above mentioned, it is not unfrequently observed, that from the bundle of the dark-bordered fibres two or more fine fibres issue, which divide into branches, which unite with those derived from the division of other bundles, and thus a plexus with varying meshes is formed, which is generally situated on one or more capillaries.

Although it is generally the case that the bundles of very fine nerve-fibres, which leave the sheath of the dark-bordered fibres, after dividing and sub-dividing, pass to their distribution to the capillary vessels, yet some of them, without branching, are seen to pass directly from one bundle of dark-bordered fibres to another. This circumstance, however, seldom occurs, but more frequently these bundles divide into two branches, the one of which is distributed to the capillary vessels, while the other passes into the sheath of a bundle of dark-bordered fibres.

According to my former statement, the plexus which the bundles of dark-bordered fibres form in the inner layer of the derma is not terminal, because the main bundles, which enter into its formation, pass off towards the outer layer. Now, while the bundles of dark-bordered fibres are passing through the middle layer of the derma, they give off branches consisting of two or more fine fibres, which are exclusively distributed to the fibrous tissue of this layer. These branches are of different sizes, and change very frequently the plane of their distribution. They sometimes run in straight directions for some distance, but more frequently their course is tortuous. It is not unusual to see some of these branches crossing others at a right angle. When some branches can be followed to a great distance, they are seen to divide repeatedly into smaller ones, either at acute or right angle. I have seen, but not frequently, some fine branches dividing on their way into three or four single fibres, which sometimes pursue different courses as individual fibres, and sometimes, after proceeding for a very short distance separately, they again unite into a single branch. When a branch meets another at almost right angle, it usually gives off two smaller branches, which pass in opposite directions. All the branches from the largest to the smallest are in frequent connection with one another, so that they form a continuous extensive network, which in the main resembles that I have described in another paper as existing in the cornea of the sparrow and of small birds generally. Connected with some of the branches forming the network, at a great distance from one another, I have found small bodies which exhibit sometimes a triangular, and at others an irregular shape. They are remarkable for a distinct oval nucleus they contain imbedded in the middle of finely granular matter.

In examining transverse sections of this layer of the derma, several fine branches cut across by the knife may be observed, This fact appears to me to prove, that from the branches forming the network some very few branches arise which pass on and tend to reach the outer layer of the derma. Indeed, I have distinctly seen in the latter situation some of these fine branches, which, on being traced as far as the capillary network, I have observed them still further dividing, and the resulting branches to be distributed partly to the capillaries, and partly to some of those follicular glands which are found underneath the capillary network. The fine nerve-fibres in question are easily distinguished from the dark-bordered fibres, until the latter preserve their structure unchanged. But when they, by loosing the white substance, become pale fibres, it must be confessed that such distinction is accompanied with great difficulty. The difficulty is exceedingly increased by the circumstance, that both kinds of nerve-fibres, as they approximate towards the surface of the derma, blend together and form bundles, in which the individual fibres are so close that they can hardly be discerned from one another. Nevertheless, I think that, if we look diligently at those spindle-shaped swellings which the fine fibres imbedded in the sheath of the dark-coloured fibres present, at inequal intervals, and also at their ultimate distribution, we may possibly arrive to a distinction between these two kinds of nerve-fibres. Because as I have already stated, in the outer layer of the derma, the fine nerve-fibres accompanying the dark-bordered ones are almost exclusively distributed to the capillaries and glands.

In my paper on the nerves of the cornea, which has been already published in the 'Transactions of the Society,' I believe I have proved against Kühne's opinion that, between the finest nerve-fibres and the cornea-corpuscles, there is no other relation than that of contiguity. In confirmation of my former statement, I now wish to draw attention to the description I have just given of the manner in which the nerve-fibres are arranged in the middle layer of the derma of the frog, because there exists some similarity between it and the corneal tissue. In fact, both contain a large number of nucleated corpuscles, with several branched anastomosing processes, and both are supplied with pale nerve-fibres. But in the middle layer of the derma of the frog the nerve-fibres and the nucleated corpuscles are far less numerous. I deem this circumstance very favorable for investigating what relation the former bear to the latter. Now I can positively state, that, notwithstanding that I have several times succeeded in following fine nerve-fibres for a very long distance through this fibrous layer, I have never been able to discern any of them to enter into connection with the uncleated corpuscles, but I have always seen the finest nerve branches to unite with one another.

3. *On the nerve-fibres distributed to the capillary vessels.*

When the finest arteries and the capillaries distributed to the skin of the frog are closely examined, they are seen to be loosely surrounded by a certain amount of connective tissue, which forms to them a special covering or sheath. This sheath is better defined and more distinctly seen in the smallest arteries and in largest capillaries than in the finer ones. When a bundle of dark-bordered fibres passes close by a capillary vessel, it very often happens that their respective sheaths mix so intimately together as to form only one. In the sheath just referred to nerve-fibres may be readily discerned, which are found to vary both in number and size in each capillary. These fibres exactly resemble those which branch out from the sheath of the dark-bordered fibres, and, like them, present, at irregular distances, spindle-shaped swellings, which are coloured by carmine. As I have already remarked with regard to the bundles of dark-bordered fibres, so in the capillary vessels, what appears to be the limit of the sheath, very often is found to consist of two or more fine nerve-fibres. Again, what seems to be, at the first sight, the nucleus of the sheath itself, on closer observation, is found to be one of those spindle-shaped swellings before alluded to. It is frequently observed that some of the fibres contained in the sheath of the capillary vessels, here and there, diverge from it; but after running for some distance they return into the same sheath at some other point. But oftener some fibres, after leaving the sheath, are seen to pursue a long and tortuous course, passing through several meshes of the capillary network. These fibres, during their course, are seen to divide and subdivide, and the resulting branches exhibit at intervals spindle-shaped swellings, and are connected with some very small bodies usually triangularly shaped, which, besides granular matter, contain a larger granule in the middle. From these bodies nerve-fibres are seen to proceed in three different directions, some of which are distributed to the capillaries, while others unite with fibres derived from the sheath of other capillaries, or from the sheath of some bundles of dark-bordered fibres. In this case a nervous plexus with meshes varying in size and shape is produced, which sometimes is situated in the connective tissue between the meshes of the capillary network, and at others lies on two or more capillaries.

It is interesting to notice here a fact with reference to the nerve-fibres of the capillary vessels, which has very often fallen within my observation; that is, that several of those branches resulting from the repeated division of the fine bundles, which have left the sheath of the capillaries, after a more or less lengthened course, enter the sheath of some bundles of dark-bordered fibres. It is very probable that these fibres, after running for some distance in the same sheath with the dark-bordered fibres, leave the sheath at another point, and pass to their distribution.

In short, the capillaries of the skin of the frog are largely supplied with nerves. In the finest arteries and the largest capillaries the nerve-fibres run parallel to and close by them; but in the finest ones the nerve-fibres, after running with them for some distance, generally cross them and pass from one capillary to another. The nerve-fibres distributed to all capillaries are in connection with one another, so that they form a lax plexus which lies on different planes.

4. *Of the nature and origin of the fine nerve-fibres travelling in company with the dark-bordered fibres.*

I come now to the last and most difficult part of this paper. What is the nature and what is the origin of the fine nerve-fibres running in the same sheath with the dark-bordered fibres? These two questions seem to be so linked together that, by the solution of the first, the second will be greatly facilitated. With regard to the first question I observe that there exists the most perfect similarity between the fine nerve-fibres just mentioned and those which accompany the capillary vessels; in fact, both kinds of fibres have the same refractive power and are acted upon by acetic acid in the same way. In both of them are found those characteristic spindle-shaped swellings which have been already spoken of. They very frequently unite with each other, and the fine fibres which run in the same sheath with the dark-bordered fibres are seen very often to pass to the capillaries, and *vice versa*. Not only so, but the fact must be here noted, which I have frequently observed, viz., that when a large bundle of dark-bordered fibres happens to run close to a capillary for some distance, after leaving it, the capillary is observed to be supplied with a greater number of nerve-fibres, than before. Hence it may reasonably be inferred that the greater part of the fine nerve-fibres which are seen in company with the capillary vessels at the periphery, are divided from those running in the same sheath with the dark-bordered fibres.

If, therefore, the vascular nerve-fibres, according to our present knowledge, must be regarded as ganglionic, it is evident that the fine nerve-fibres in the sheath of the dark-bordered fibres perfectly resembling them must also be looked upon as fibres of the same nature.

But if by every appearance we are led to consider the fine nerve-fibres in question as ganglionic, from what ganglia may they derive their origin? In answering this second question, it is necessary at first to remark, that in the skin of the frog I have never succeeded in finding any of those very small ganglia which have been observed by Dr. Beale in the bladder of the same animal. Their origin must, therefore, be looked for elsewhere. It is well-known that in connection with the posterior root of each spinal nerve is found a ganglion composed of numerous ganglionic cells. These cells, according to many observers, are connected with one or two, or very rarely with several nerve-fibres. But Dr. Beale's recent and very accurate observations* have shown that this opinion is incorrect, for all ganglion-cells are bipolar or multipolar. Among the cerebral nerves the fifth nerve very nearly resembles the spinal nerves. It has, like them, two roots—one large is gangliated and sensitive, the other ganglionless is motor. It is true that some anatomists have endeavoured to find a resemblance between all the sensitive and motor cerebral nerves and the spinal ones, but it seems to me that analogy has been over overstrained. With regard to the nerve-fibres from the ganglia above mentioned, almost all observers agree in stating that the most part of them proceed in a peripheric direction, and accompany the cerebro-spinal nerves in their ultimate distribution.

Besides these ganglionic fibres, which the cerebro-spinal nerves derive from their own ganglia, they receive others from the sympathetic. Anatomy shows that from the gangliated cord of the sympathetic seated on each side of the vertebral column nerve branches set out which connect it with the spinal nerves. Each branch on close investigation is found to consist of two bundles, the one composed of dark-bordered fibres, and the other of gray or gelatinous fibres. The fibres of the former seem to emanate directly from the roots of the spinal nerves, while those of the latter appear to take their origin in the sympathetic. On following the gray bundle to the spinal nerve, its fibres are seen passing for greater part

* "On the Structure of the so-called Apolar, Unipolar, and Bipolar Nerve-cells of the Frog." 'Proceedings of the Royal Society,' vol. xii, No. 56, p. 569.

into the ganglion in connection with the posterior root, while others pass into both the roots. Whether that portion of fibres which appear to pass into the ganglion enter or not into any organic connection with its cells, it has not yet been ascertained. As to the other bundle, Beck's observations show that it passes through the sympathetic ganglion, its fibres spread out without being connected with the ganglion-cells, and afterwards they proceed in company with those of the sympathetic, principally to the visceral organs. According to the observations of Bidder and Volkmann, in the frog the greater part of the fibres of the so-called *rami communicantes* pass with the spinal nerves towards the periphery. As for myself, I believe that some of the fibres composing the gray bundle of the *rami communicantes* really pass to the periphery, but others very probably connect the sympathetic ganglia with those on the posterior roots of the spinal nerves.

As with the spinal nerves, so there exists a similar connection between the ganglia of the sympathetic and the cerebral nerves. This connection is effected by branches or filaments, which very likely are composed of gray and dark-bordered fibres, the former passing from the ganglion to the nerve, and the latter from the nerve to the ganglion. As shown by anatomy, the superior cervical ganglion is connected with the sixth nerve by two branches which spring from the *plexus carotideus*, and by one or two filaments with the third nerve. Some other connections are also found between the same ganglion and the various portions of the eighth and ninth nerves at their issue from the cranium. The ophthalmic ganglion is connected with the third nerve by a thick and short nerve branch, and with the nasal branch of the ophthalmic division of the fifth by a long nervous filament. The spheno-palatine ganglion is joined with the infra-orbital nerve by two or three short nerves, and with the inferior maxillary branch by two nervous filaments. The sub-maxillary ganglion is united with the gustatory nerve by one or two fibres. It is probable that all the gray fibres of these connecting branches pass to the periphery, accompanying the cerebral nerves in their terminal distribution.

The view which has been received with regard to the anatomical connection of the sympathetic with the cerebro-spinal nerves was put forth by Mr. Beck, with whom I agree in holding the sympathetic system as a distinct portion of the nervous system, at least as far as concerns the peculiar nerve-fibres originating in its own cells, which are undoubtedly physiologically distinct from other nerve-cells, in consequence of being endowed with special vital power. True it is that some authorities in microscopical anatomy still maintain that the gelatinous, or Remak's fibres, are not nervous, but only a form of connective tissue. But this opinion is strongly opposed by observation. In insects, as was stated by Tood and Bowmann some years since, the nerve-fibres strictly resemble the gelatinous fibres of vertebrata; and my observations on the nervous system of several insects (Hydröus piceus, Blatta orientalis, Musca vomitoria, Hippobosca equina) fully accord with the statement of these able observers. Should any persist in asserting that this description of fibres in insects are not nervous, it will be necessary for them to point out which are the true nerve-fibres in the same.

From the anatomical facts which have been taken into consideration, I think it may reasonably be inferred that the fine nerve-fibres accompanying the dark-bordered fibres at the periphery are derived both from the ganglia in connection with the cerebro-spinal nerves, and from those of the sympathetic. I feel confident that the fine nerve-fibres which are found in company with the peripheral sensitive branches of the spinal nerves arise, for the most part, from the ganglia on the posterior roots, and a few from the gray bundle of the *rami communicantes*. As to the other fine fibres, which run together with the terminal motor branches of the spinal and cerebral nerves, they are, in my opinion, derived in the former, for the greater part, from the gray fibres of the *rami communicantes*, and in the latter entirely from the sympathetic ganglia with which the motor cerebral nerves are connected.

It remains now to be seen whether the view which has been adopted is supported by experiments and clinical observation. It will be easily understood that if the fine nerve-fibres running in the same sheath with the dark-bordered fibres, and which I have demonstrated to be chiefly distributed to the capillaries, emanate from the ganglia connected with the cerebro-spinal nerves, or from the sympathetic ganglia, we may, as a natural consequence, expect to see nutritive disorders arising in those parts where the fine fibres ramify, either from the lesion of the ganglia, or from the division of the fibres connected with them.

I will first give a short account of the results of Bernard's experiments on the fifth nerve. It is well-known that as long as 1822 Magendie observed the fact, that when the fifth nerve is divided between its origin and the gasserian ganglion, the disorders of nutrition not only take place later, but they are far less remarkable than when the section is made on the nerve after the formation of the ganglion, or on the ganglion itself. The experiments of Magendie have been accurately repeated by Bernard* with the following results—that the section of the fifth nerve, very near its origin, produces sensitive and muscular paralysis, but when it is divided beyond the gasserian ganglion or on the ganglion itself, then the division of the nerve is followed by remarkable signs of impaired nutrition.

In confirmation of these results of experiment, Bernard records the case of a patient observed by him at La Salpetrière, who was labouring under paralysis of the fifth nerve, accompanied by great disorder of nutrition and almost complete destruction of the corresponding eyeball. The patient died, and at the post-mortem examination was found a tumour, which had not only compressed, but nearly destroyed the gasserian ganglion.

Respecting the office of the ganglia in connection with the posterior roots of the spinal nerves, there are the results of Waller's experiments, which throw a new light on this difficult point. This physiologist first made known the striking fact, that when both the roots of a spinal nerve are divided, namely, the posterior between the ganglion and the cord and the anterior before its union with the posterior, it is always found that that part of the posterior root, which remains in connection with the ganglion does not undergo any alteration whatever, while the other part of the spinal root connected with the cord is remarkably altered. A similar alteration takes place in the anterior spinal root, but invertedly. Hence Waller believes himself justified in drawing the conclusion that the ganglion governs the nutrition of the sensitive and the cord of the motor nerve-fibres.

Bernard has repeated Waller's experiments with precisely the same results; but he thinks that the only conclusion which may be safely drawn from Waller's and his own experiments is, that the spinal cord conserves the anterior and the ganglion the posterior root, or, in other words, the ganglion plays the same part in the nutrition of sensitive fibres as the cord in that of the motor ones. It must also be added that in all experiments of Bernard no remarkable signs of impaired nutrition followed the section of the posterior roots of the spinal nerves.†

Although Bernard's experiments seem to prove that we must assign to the spinal ganglia an office different from that of the gasserian ganglion, yet it may be justly objected that in all his experiments, except one, were only divided the pos-

* 'Leçons sur la Physiologie et la Pathologie du Système nerveux," vol. ii, p. 49. Paris, 1858.

† 'Même Ouvrage.' "Treizième Leçon," p. 233, vol. i.

terior roots of the spinal nerves between the ganglion and the cord. It is evident, therefore, that in such conditions of experiment no disorder of nutrition should be expected to take place, as the spinal ganglion had been preserved uninjured. As to the single experiment in which, at the same time, were cut several posterior roots of the spinal nerves, and three ganglia removed, I should remark that the animal on which the experiment was made, died two days after. The period of time was, therefore, too short for allowing the nutritive disorders to take place. It is very probable that had the animal lived longer the signs of impaired nutrition would have manifested themselves. What has just been remarked is strongly supported by the fact that the nutritive disorders which follow the section of the fifth nerve are not unfrequently seen to take place some days after experiment.

The effects which follow the division of a compound spinal nerve resemble, in a certain degree, those which are observed after the section of the fifth nerve. Schiff,* on experimenting on several animals, has found that the division of the sciatic nerve always induces dilatation of the capillaries, and an increase of temperature in the lower member.

I am perfectly aware that I have only made an attempt to solve the two questions which I proposed at the beginning of this part of my paper; but I hope that I may be able, in a future communication, to bring before the Society further and more conclusive observations on this important subject.

I conclude this paper with the following inferences, which, in my opinion, are justified by the anatomical facts which have been described:—

1. In the skin of the frog are distributed two sorts of nerve-fibres, namely, the dark-bordered and the fine fibres, which run in the same sheath with them or with the capillary vessels.

2. The dark-bordered fibres are so arranged as to form two networks; one is seated in the inner, and the other in the outer layer of the derma. These two networks are connected by intermediate bundles, or, in plainer terms, the originary bundles of the nervous network in the inner layer of the derma, after its formation, pass off, crossing the middle layer more or less obliquely, and when they arrive at the under surface of the outer layer of the derma, there they branch again and form a second network. Continuous with this second network there is an intricate plexus, composed only of fine bundles of pale fibres, which are partly prolongations

* "Untershungen zur Physiologie des Nervensystems mit Berüch sichtigung der Pathologie." Francfurt am Main, 1855.

of the dark-bordered fibres, and partly belong to the fine fibres imbedded in the sheath of the dark-bordered fibres. The very terminal portion of the plexus lies immediately beneath the capillary network of the outer layer of the derma.

3. The fine nerve-fibres existing in the same sheath with the dark-bordered fibres, neither in refractive power, nor in the manner in which they comport themselves with the chemical agents, nor in the appearances of those spindle-shaped swellings, which they present at intervals, differ from the nerve-fibres accompanying the capillary vessels.

4. The fine nerve-fibres running in the same sheath with the dark-bordered fibres are distributed to the capillaries, the connective tissues, and the numerous glands which exist in the outer layer of the derma.

5. No dark-bordered fibre is distributed to the middle layer of the derma. It is only supplied with fine bundles consisting wholly of the fine nerve-fibres which are contained in the same sheath with the dark-bordered fibres.

6. The fine nerve-fibres accompanying the capillary vessels for the greater part arise from those imbedded in the sheath of the dark-bordered fibres.

7. The fine nerve-fibres which are found in company with the dark-bordered fibres at the periphery are not a prolongation of the latter. They are derived from ganglionic cells.

8. Finally, in the skin of the frog, neither the dark-bordered fibres, nor the fine fibres in the sheath of the dark-bordered fibres, or in company with the capillary vessels, end in free extremities. They always, in their ultimate distribution, form networks or plexus, consisting of very fine bundles, connected, at irregular distances, with some small bodies of an oval, triangular, or some other shapes.

Observations *upon the* Nature *of the* Red Blood-corpuscle. By Lionel S. Beale, M.B., F.R.S., Fellow of the Royal College of Physicians; Professor of Physiology and of General and Morbid Anatomy in King's College, London; Physician to King's College Hospital, &c., &c.

(Read Dec. 9th, 1863.)

The red blood-corpuscle is admitted by every one to be one of the simplest forms of cell structure. Its nature was discussed long before other cell structures were known, and scarcely a year passes without several papers being published upon the structure, mode of development, or composition of the red blood-corpuscle. On these points, however, the most conflicting opinions are entertained by the different observers, and the history of the life of the red blood-corpuscle has yet to be written.

Is the red blood-corpuscle a cell with membranous cell-wall, and fluid contents? or is it simply a mass of viscid material differing perhaps slightly in density in the outer and inner portions? Is it a living corpuscle that distributes vitality to all parts of the organism? or is it simply a chemical compound which readily absorbs oxygen and carbonic acid gases and certain fluids? Is it composed of formative living matter? or does it consist of matter that is inanimate? Does it absorb nutrient matter, grow, divide, and thus give rise to other bodies like itself? or does it consist of passive material destitute of these wonderful powers and about to be resolved into substances of simpler composition and more nearly related to inorganic matter? Again, it may be asked, Does the red blood-corpuscle possess the power of altering matter at a distance from it, or in contact with it? or must certain material pass into its very substance before it can be changed? If the latter view be accepted, we might further inquire if the metabolic power resides in the supposed cell-wall or in the 'nucleus' in those cases where such a body exists; or does the hæmatine itself convert by some catalytic power the albuminous or other matter which may be mixed with it into hæmatine of the same kind?

Of all the points lately ascertained in connection with the red blood-corpuscles, perhaps by far the most important is the property of crystallization which its colouring matter possesses. It is most remarkable that the red colouring matter of the blood-corpuscles of different animals should crystallize in different forms; and there are instances of animals which are closely allied to each other the blood-crystals of which are quite distinct; for example, the red colouring of the Guinea-pig assumes the form of tetrahedra, while that of the squirrel crystallizes in six-sided plates, and that of the hamster in rhomboidal crystals. The general view that these animals exhibit inherent specific differences is strongly confirmed, for the hæmato-crystallin of their blood exhibits specific differences not less distinct than those which may be observed in their general form and habits, in the structure of their skeleton, in the anatomy of many of their tissues, or in the chemical composition of their textures, milk, bile, urine, and other fluids. Nay, the cells of corresponding tissues in different animals differ from one another. So that inherent specific differences are to be demonstrated in the component cells of species as distinctly as in the entire organism; and the more minutely investigation is carried, the more remarkable do these differences appear, and the more numerous do they become.

Moreover, it would seem that the cause of these specific differences is in action at a period which precedes the formation of the various substances with which we have to deal. It is while matter possesses *vital properties*, and before it possesses form, structure, or defined chemical composition, that the causes of which these things are but the consequence must be sought for.

It seems to me that there is strong evidence in favour of the conclusion that the red colouring matter of the blood-corpuscle was once in the condition of living germinal matter, and that its particular specific characters are the result of the occurrence of a series of changes, which changes are very complex and most difficult to investigate. They must be attributed partly to the conditions under which the living matter existed, and partly to powers inherent in the living matter itself. Of the exact nature of these inherent powers we know nothing; but until the changes referred to have been proved to be physical, we are justified in terming them vital changes, and referring them to an agency which may still be correctly spoken of as *vital power*, since such power is only known to manifest itself in living beings.

In the blood we have—1. Matter that is living and active; 2, matter that has ceased to live, and which now possesses peculiar properties and chemical composition; 3, matter which results from the disintegration of the formed material; and 4, matter (pabulum) which is about to live or about to be converted into living matter.

In the blood of the frog and oviparous vertebrata, as is well known, there are coloured, flattened, oval corpuscles, each with a colourless oval "nucleus," and the so-called white or colourless corpuscles, which are spherical. In man and mammalia there are circular coloured corpuscles without a nucleus, and the so-called white or colourless corpuscles, which are spherical.

Now, I believe that the "colourless corpuscles" and the "colourless nuclei" of the red corpuscles consist of matter in a living state, while there are reasons for the conclusion that the coloured material has ceased to exhibit vital properties.

The outer coloured part of the oval, red, nucleated corpuscles of the oviparous vertebrata corresponds to the entire fully formed circular red corpuscles of mammalia. Of the two kinds of corpuscles, colourless and coloured, the former are the most constant. For, colourless cells resembling those in the blood of vertebrata exist in colourless fluids which not unfrequently contain fibrin. Such cells are found in the lymph and in the chyle, and are present in the circulating fluids of the lower animals, which are destitute of any cells corresponding to the red blood-cells of vertebrata.

The oval form of the oviparous blood-corpuscle seems to depend upon the conditions under which the circulation is carried on, rather than upon any peculiarities in its formation; for if the oval corpuscles of the frog be left at rest in a fluid of about the same density as themselves, they become completely spherical, and a similar change of form occurs in the oval blood-corpuscles of all animals that I have examined. (Pl. VII, figs. 16, 19, 20.) And it is well known that the flattened, circular, red corpuscles of mammalia readily assume the spherical form when placed in fluids of a certain density. Nor must I omit to notice here that many kinds of crystalline matter assume, under certain circumstances, biconcave, oval, and circular forms. Oxalate of lime, when it crystallizes with viscid matter, very frequently assumes these characters ('Illustrations of Urinary Deposits,' &c., pl. xi), and on the process of crystallization as modified by the presence of viscid material, see Mr. Rainey's work 'On the mode of Formation of Shells,' &c., 1858.

I incline, therefore, very strongly to the opinion that the oval form and flattened condition, both of the outer coloured material and included colourless "nucleus," of the frog's blood-corpuscle, and the biconcave flattening of the mammalian red corpuscle, are due to the consistence of the material entering into its composition, to the movements of the blood-corpuscles, and to the action of fluids and gases upon them, and that therefore they must not be regarded as *structural* or *morphological* characters.

Of the so-called cell-wall.

Next comes the important question concerning the existence of a cell-wall. Although many observers have stated that there was no such structure in the red corpuscle, others have brought forward evidence of its presence, and the recent interesting and important observations of Dr. Roberts seem rather to confirm the view generally entertained as to the existence of such a structure.*

I should remark that, under certain circumstances, there is no doubt whatever that the red corpuscle exhibits a distinct outline, and really consists of a membranous cell or envelope, closed at all points, with fluid contents; but the real question to be decided is more than this matter of fact. Is the cell-wall, in those cases in which it has been observed, a real structural peculiarity, or does the appearance result from the condensation and chemical alteration of the outer part of the soft, red, viscid material of which the red blood-corpuscle is considered to consist, according to other views? If red blood-corpuscles are immersed in various fluids, or even if allowed to remain for some time in serum, the outer part of the blood-corpuscle does assume the appearance of a closed vesicle; and by the action of tannin, according to Dr. Roberts, the appearance as of two membranes, one within the other, results. In blood-corpuscles which have been immersed in urine and most saline solutions, a very dark outline is produced, and granular matter, suspended, apparently, in a clear, colourless fluid, occupies the interior of the corpuscle. But these facts, and many others which might be adverted to, serve but to show that, under certain circumstances, the outer part of the material of which the blood-corpuscle is composed can be rendered insoluble in water, and thus it is caused to present the appearance of a cell-wall. Many observers who maintain that a cell-wall is a structure necessary to the very existence of a cell, admit that the appearance of a membrane may also be produced artificially. Such an appearance can be readily produced in the case of "cells," or elementary parts after death, which certainly have no such structure investing them during their life, and it can be produced in inanimate matter. It has been argued that, as bodies resembling these cells obtained from living structures, although altered by various methods of examination, can be produced artificially, all cells result from

* "On peculiar appearances exhibited by blood-corpuscles under the influence of Solutions of Magenta and Tannin." ('Proc. Royal Society,' No. 55.)

physical and chemical changes alone. But those who argue in this way have never been able to produce artificially cells which could not be distinguished from those formed in living structures; and the existence of the most important and only vitally active part of the cells has been by some altogether ignored. Many observers who have admitted its existence have regarded it as the least important part of the cell (see Huxley's views on the cell).

It may be possible to produce, artificially, coloured bi-concave, circular, or oval discs, like the red blood-corpuscles; but I am confident that the colourless nucleus of the oval corpuscle and the white corpuscles cannot be produced except in the body of a living animal, for this colourless material has very remarkable properties, which do not exist in connection with any lifeless matter known.

I would consider frog's blood-corpuscles as consisting simply of (*a*) a mass of colourless, living, or germinal matter within, which is surrounded by (*b*) the coloured formed material. Like other kinds of germinal matter, the "nucleus" of the oval blood-corpuscle, and of the young mammalian blood-corpuscle, and the ordinary colourless blood-corpuscles in all animals, as well as very small ones having the same general characters, are coloured red by an alkaline solution of carmine. On the other hand, the fully formed mammalian red blood-corpuscle and the coloured part of the frog's corpuscle are not coloured by this reagent. That a cell-wall is a necessary structure or essential to the being of what we call a red blood-corpuscle, I think is distinctly disproved by the following facts:

Facts incompatible with the existence of a membranous envelope possessing properties and composition distinct from the coloured contents.

1. I have seen corpuscles change form under the microscope, as represented in Pl. VI, fig. 1. This was not due to pressure, because there were other corpuscles close to these of the usual form. It seemed to me that the phenomenon was easily explained upon the supposition that the mass was composed of matter of the consistence of treacle, and it is not possible to conceive that portions could be detached in the manner represented, if a membranous cell-wall exists.

By the application of a gentle heat, about 100°, similar changes may generally be produced (fig. 3). It seems as if the viscid material of which the blood-corpuscle is composed became, in the first instance, more fluid; and then, as the slide became cooler, the material again became firmer. Under these circumstances long and very fine threads are, as it were, drawn out from the red viscid matter, and these threads exhibited perpetual vibratory movements. I have seen them oscillating in many different places at the same time, like the minute vegetable threads developed in the mouth (leptomitus ?). Not only so, but many exhibit a distinctly beaded appearance; and when these thin filaments are detached, they certainly very closely resemble bacteria. I have produced precisely similar filaments in human blood (fig. 2). It is very likely that such alteration in the matter of which the red blood-corpuscles are composed may occur under certain circumstances in the organism itself, and we must be extremely cautious not to mistake such particles, which would, no doubt, soon be dissolved, for bacteria, which are sometimes developed in blood in the living body towards the close of certain fatal maladies.

The movements above referred to, it need scarcely be said, are molecular in their nature, and are not dependent upon any vital properties. They continue until the fluid becomes so concentrated by evaporation that no further movements in the particles can occur.

2. If frog's or other large blood-corpuscles be carefully subjected to sudden pressure under very thin glass, as, for example, by drawing a needle-point quickly and firmly across the thin glass, many corpuscles in the line of the pressure will be subdivided into smaller ones. Each of these small portions instantly assumes the spherical form. There is no appearance of a cell-wall being ruptured, nor do the supposed "fluid contents" mix with or become dissolved in the surrounding fluid. The spherical masses resulting from the subdivision of the red blood-corpuscles resemble in colour, shape, refractive power, and in sharpness of outline, the original corpuscle (Pl. VII, fig. 9). These phenomena seem fatal to the hypothesis that each corpuscle is composed of a closed membrane, with fluid contents. To say that the membrane is composed of matter which is itself semifluid, and that, even if ruptured at different points, the torn edges reunite, involves almost an impossibility; for if a rupture were to occur in such a semifluid expansion, the separated portions would rather separate further, and the whole would soon collect together instead of expanding again over portions of its contents.

3. I have many times seen portions of the nucleus of a frog's blood-corpuscle pass completely through the coloured material, which would seem impossible if this were enclosed in a membrane (Pl. VII, figs. 24, 25). Dr. Roberts has

also observed this fact. He says, "I have on several occasions witnessed, after adding magenta, the total extrusion of the nucleus, both in the frog and in the newt, without *the least collapse of the corpuscles.*"

4. But I will now bring forward another fact, which seems to me not only to settle the question of cell-wall most conclusively, but determines the nature of the material of which the red blood-corpuscle is made up, and bears in a most important manner upon the mode of formation of these bodies. If a drop of Guinea-pig's blood obtained from a living animal be placed upon a glass slide, and covered with thin glass, it will often be observed that within an hour after it has been drawn a striking change will occur in the corpuscles. Many corpuscles exhibit sharp angles, and in a short time crystallization commences (Pl. VI, fig. 4).

In figs. 5 and 6 some blood-corpuscles are represented which were seen breaking up into very small rounded portions. After a few minutes these small particles were seen to change their form and become angular, and gradually very minute, but most distinct tetrahedral, crystals were produced. Thus the coloured material of which a single blood-corpuscle was composed gave rise to several distinct tetrahedral crystals. The crystals did not seem to have been precipitated from any fluid contents of the corpuscle, nor was there any indication whatever of a cell-wall remaining. The whole of the soft, red, viscid matter of which the blood-corpuscle was composed became crystalline. In many instances a corpuscle would become very angular; sometimes exactly four angular projections were formed, and sometimes eight, but in most cases the number was irregular. After the formation of several angular projections an entire corpuscle became gradually converted into a single crystal. I have also seen a double tetrahedron result from one blood-corpuscle. In other instances several blood-corpuscles ran together to form one large crystal (figs. 4, 5, 6, 7).

The appearance above described as occurring in some of the corpuscles of Guinea-pig's blood would appear to afford some explanation of the change which so commonly occurs in red blood-corpuscles generally, very soon after they have been removed from the living body. As is well known, many exhibit a number of very sharp-pointed processes, springing from every part of the surface of the corpuscles. It must, however, be noticed as a fact, that by no means do all the blood-corpuscles exhibit these numerous angular projections, and that in some of the smallest they are formed most quickly and are most numerous. I have seen them in the case of small particles resulting from the division of red blood-corpuscles (Pl. VII, fig. 9). As this change occurs immediately blood is drawn, and in many instances has taken place before sufficient time has elapsed for the specimen to be placed under the microscope, and seems to affect the youngest corpuscles, it seems to me very probable that it is to be explained by the tendency to form processes which germinal matter often exhibits when stationary. It will be shown presently that many of these small, and probably younger, corpuscles contain germinal matter. A somewhat similar phenomenon is observed in the case of white blood-corpuscles, and also in the lymph-corpuscles.

In connection with this question of crystallization of the blood-corpuscles, I would remark that when water is added to blood-corpuscles they swell, but they do not burst, as is generally stated. They become very transparent, and doubtless a certain quantity of the fully formed colouring matter is dissolved out; but as the water evaporates, the corpuscles again assume their ordinary characters, the only change in many being that they are paler than before.

When crystallization commences in Guinea-pig's blood after treatment with water, individual corpuscles may be seen to assume the crystalline form, as in specimens to which water has not been added. The material which crystallizes is capable of being dissolved in water, but it is not very readily soluble.

On the nature of the oval blood-corpuscle of the frog, and of the changes occurring during its formation.

The same facts to which I have adverted in several papers may be observed in the case of the oval red blood-corpuscle of the frog. Within is the mass of germinal matter, usually termed the nucleus. This, like all matter corresponding to it (living or germinal matter), is perfectly colourless, but becomes coloured by the carmine solution. The outer part, which is naturally coloured, is not coloured by the carmine solution. This, therefore, is the formed material which was once in the state of germinal matter, and was capable of producing matter like itself, and of being resolved into coloured formed material. But this formed material, being once produced, cannot form matter like itself, although it can *be changed, dissolved,* and *converted* into other substances. *It is the seat of physical and chemical actions alone. Vital changes are restricted to the germinal matter.*

The young blood-corpuscle, like the young elementary part of epithelium, cartilage, fibrous tissue, muscle, or nerve, consists almost entirely of germinal matter, and during this period of existence it grows and divides into smaller portions, and this process of multiplication is determined simply by the quantity of pabulum present (Pl. VII, figs. 11, 15). These colourless masses of germinal matter are the so-called white blood-corpuscles. Many are, however, much smaller than usually described. Much of the pabulum present having thus been converted into masses of living matter, the process of division and subdivision ceases. Each mass continues to grow, but more slowly than before, and its outer part becomes resolved into formed material. This matter continues to be formed, and accumulates around the corpuscle (figs. 12, 13, 16, 19, 21, 22).

The relative proportion of germinal matter to formed material, just as in other cells or elementary parts, is different in corpuscles of different ages, and the refractive power of the formed material of different discs varies greatly (see figs. 11 to 25). The refraction of the corpuscle may so nearly coincide with that of the serum, that the outline of the corpuscle is only visible if great precautions are taken in illumination. In the nutrition of the blood-corpuscle, I conceive, pabulum passes through the outer coloured portion into the germinal matter, where it acquires the same vital powers which the germinal matter already existing, possesses. The latter is gradually resolved into the coloured material. This coloured viscid matter in the physical condition of *colloidal* substance, being slowly combined with more water, is dissolved out from the changing mass and gradually converted into excrementitious substances, such as carbonic acid, urea, &c., and substances which take part in the nutrition of the tissues. If, however, the red colloidal matter lose water, it passes at once into the crystalline condition. This conversion of living matter into colloid, and the latter into a crystalline substance, is a most interesting fact.*

When blood becomes stationary, as in a capillary vessel, or extravasated in a tissue, the red corpuscles soon undergo change. Sometimes blood-crystals soon form. In other cases the hæmato-crystallin becomes concentrated, and coloured granules of no definite form are all that remain of the red corpuscles. But under these circumstances the white corpuscles and the nuclei of the nucleated red blood-corpuscles increase in size. Nutrient pabulum is necessarily absorbed more rapidly by the germinal or living matter when stationary,

* Professor Graham divides substances into *colloids* and *crystalloids.* See 'Phil. Trans.,' 1861, page 183.

than while the corpuscles were circulating. It therefore grows, and divides, and subdivides. In the case of frog's blood extravasated into the tissues of the living body, I have seen appearances which have led me to infer, that spherical granular cells have been produced from the germinal matter of the red corpuscles. In clots in vessels of mammalia, granular cells are often found in considerable number. They result from the white corpuscles, and from what may be called young red corpuscles. Just as the germinal matter of an ordinary cell may take up the softened, formed material which surrounds it, so it is possible that the germinal matter of a frog's blood-corpuscle may increase by taking up the coloured material—may, in fact, live at its expense. This is one way in which the colouring matter of stagnant blood may be removed.

In the fully formed frog's blood-corpuscle the germinal matter seems to cease abruptly, rather than gradually to pass into the formed material; but in young cells a gradual transition may sometimes be observed. In young corpuscles (mammals as well as reptiles) it would seem that the coloured matter is deposited amongst the particles of germinal matter, which accords with what occurs in some coloured vegetable cells, so that the coloured formed material may be removed in the form of solution, leaving the colourless living germinal matter behind; or the coloured material may collect in the form of globules, which may remain imbedded amongst the germinal matter, or pass through it into the surrounding fluid. Blood-corpuscles of this kind are capable of growth, and doubtless also of multiplication. The crystallization of many entire blood-corpuscles is, however, opposed to the view that such is the constitution of the mammalian red blood-corpuscle at all ages. And although certain phenomena observed to occur in the outer coloured portion of the red blood-corpuscle might be advanced in favour of the view that this may have living, germinal, or protoplasmic matter diffused through it, I cannot but think that a careful consideration of the facts alluded to in the earlier part of this paper render such a conclusion untenable.

Of the nature and mode of formation of the mammalian red blood-corpuscle.

As is well known, in the blood of the embryo, and in young animals, corpuscles possessing a so-called granular nucleus, surrounded by a smooth external portion, are common enough; but in the blood of the adult are numerous corpuscles differing very much from the ordinary red corpuscles in size, colour, and refractive power. They are much smaller than the latter; they exhibit a granular appearance, and are colourless. They might be described as small white corpuscles, but many are much smoother than the colourless corpuscles. It is not easy to see these corpuscles unless the blood is examined by powers magnifying upwards of 1000 diameters. Such corpuscles are exceedingly faint, and can only be distinguished if great care be employed. I believe that corpuscles exist which are so very transparent as not to be visible. The small, faintly granular corpuscles are coloured by the carmine solution, but the ordinary red blood-corpuscles, like the external coloured portion of the frog's blood-corpuscle, is not coloured.

These blood-corpuscles are probably young ones, the germinal matter of which has only just commenced to undergo conversion into the red formed material. In some cases I have seen a delicately granular, colourless material protruding from a small coloured corpuscle. From the appearance, there can be little doubt that the living matter had separated from the coloured formed matter (Pl. VII, fig. 10). This colourless material I regard as the germinal matter of a young corpuscle, and think it probable that some of the appearances which have been delineated by Dr. Roberts result from the action of the solutions employed upon a small quantity of this granular germinal matter.

The red corpuscles vary in size much more than is usually supposed, and they differ very much in transparency and refractive power, some being only just visible, in consequence of the extreme transparency of the material of which they are composed. Some are actually invisible; but when surrounded by red corpuscles, their presence is proved by the grouping of the red corpuscles around what appears as a circular clear space (Pl. VI, fig. 8). After such corpuscles have remained still for some time, slight fissures may be seen converging in straight lines towards the corpuscle. I believe these to be channels made by the flowing of nutrient pabulum towards the corpuscle. This fact proves that the young and colourless, or nearly colourless, corpuscles absorb nutrient material after removal from the body, which is not taken up by the red corpuscles, between which it flows; so that I am led to the conclusion that the red corpuscle exists first as a very small spherical mass of transparent, colourless, germinal matter, which continues to grow for a time, and gradually undergoes conversion into the red colouring matter, which corresponds to the formed material of cells generally.

This formed material at length undergoes disintegration, and is resolved into other chemical substances. So long as it circulates in the current, it retains its semifluid character; but if it becomes stationary and slightly concentrated, it tends to assume the crystalline form, and in some cases this change occurs within a very short time after the blood has ceased to move.

If these conclusions be justified by the facts, the red material is not living, but results from changes occurring in colourless living matter, just as cuticle, or tendon, or cartilage or the formed material of the liver-cell, results from changes occurring in the germinal matter of each of these cells. The colourless corpuscles, and those small corpuscles which are gradually undergoing conversion into red blood-corpuscles, are living, but the old red blood-corpuscles consist of inanimate matter. They are no more living than cuticle or the hard, horny substance of nail or hair is living. The red colouring matter is composed of formed material, which cannot produce matter like itself, and which does not possess vital powers. In another communication I propose to discuss the nature of the vertebrate colourless corpuscle, which consists almost entirely of matter in an active, living state. Matter of this kind is present in every living, growing tissue, in every single living cell, and, indeed, in everything that has life.

TRANSACTIONS.

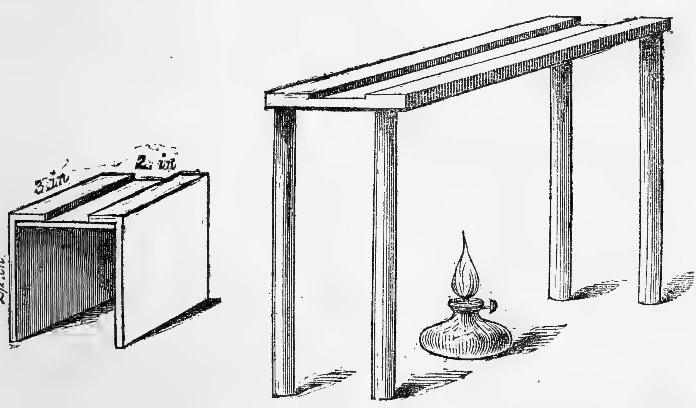
On an Improved Mounting Table.
By Mr. D. E. Goddard.

(Read Jan. 13th, 1864.)

This table is intended to assist amateurs in drying and hardening preparations mounted in Canada balsam, so that no time is lost before the specimens are ready for the cabinet

This operation has presented no small difficulty to many. Baking the slides in the oven and heating them on tables of flat metal have not been attended with complete and immediate success.

My esteemed friend, Mr. W. L. Freestone, kindly showed me how this fruitful source of perplexity and delay could be



overcome. He uses a piece of sheet zinc, from 8 to 10 inches long and 3 wide; the ends are bent at right angles, so as to stand on the shade-holder of an ordinary parafin lamp. The top of the table is sunk or grooved in the centre, so that the glass slide is supported by two ridges of thin metal.

The construction of the tables before us is the same. The smaller is intended to be used with an ordinary lamp, and made of thin brass (fig. 1). The largest is to be heated by a spirit lamp, and consequently much more substantial.

It consists of a plate of brass 12 inches by 3 and $1\frac{1}{8}$th of an inch thick; upon this two pieces of metal of the same thickness, and 12 inches by 1, are rivetted, leaving a clear space 1 inch wide in the centre of the plate; the whole being supported on tubular legs 7 or 8 inches high (fig. 2.) By means of the flat surface in the centre of the table, a great amount of heat is obtained by radiation; the thickness of the side pieces allows a current of air to pass between the slide and the hot metal, so that direct heat is avoided, and the object to be mounted does not come in contact with the hot surface. The use of metal one inch wide has this advantage—two inches of the glass are strongly heated, and though that material is a bad conductor, sufficient is conveyed to the centre of the slide for the purpose required.

By changing the position of the lamp, or by regulating the flame, the operator can obtain exactly the degree of heat he requires.

By the assistance of this apparatus I have prepared the accompanying slides, the whole process of mounting, hardening, cleaning, and finishing being completed in one evening; the most delicate algæ, such as *Delleseria alata, Plocanicum coccineum, Plilota plumosa, Ceramium rubeum,* and even the *Cladophora,* retaining their colour, though mounted in Canada balsaam.

On the Germinal Matter *of the* Blood, *with* Remarks *upon the* Formation *of* Fibrin.

By Lionel S. Beale, M.B., F.R.S., Fellow of the Royal College of Physicians; Professor of Physiology and of General and Morbid Anatomy in King's College, London; Physician to the Hospital; &c. &c.

(Read Dec. 9th, 1863.)

PLATE IX.

"*Living*" or *germinal matter* is always soft or semifluid, and when placed in a medium in which it is free to move, or alter its shape, a mass will always assume the spherical form. If surrounded by viscid matter, as in *mucus*, the form of each mass of germinal matter may be temporarily changed by pressing or stretching the mucus in different directions; and if in the process of growth the viscid medium is continually stretched or extended in one particular direction, the masses of germinal matter will exhibit an oval shape as long as the extending force is exerted.

In my last paper I showed that the peculiar oval form of the germinal matter of the frog's red blood-corpuscle was not due to structural or morphological changes, for when such corpuscles were placed in a medium of about their own density, it was observed that both the germinal matter and the surrounding formed material soon became spherical, unless the latter was too firm or condensed for change in form to occur; but even in this case it has been observed that the mass of germinal matter often becomes more spherical than it was when the corpuscle was first removed from the body. And not unfrequently the living matter undergoes division into several portions, each of which assumes the spherical form. The material in the inner part of the corpuscle being probably semi-fluid, permits this change even in old blood-corpuscles, the red material of which is so firm that it retains the oval form.

White blood-corpuscles, chyle-corpuscles, lymph-corpuscles, and the bodies corresponding to these in different animals, the so-called finely granular cells found in the spleen, thyroid, and other localities, the so-called "granular cells," "free nuclei," "nuclear particles," &c., found in fluid, or nearly fluid, media in a vast number of morbid products, are all spherical. The bodies resulting from the division of an embryonic granular mass are, in all cases, at first spherical.

When germinal matter is set free from cells of any form into a fluid medium, it becomes spherical. If a mass of germinal matter be divided into any number of particles, each one assumes the spherical form, and the most minute mass of living or germinal matter which can be seen by the highest power we can yet obtain, is spherical.

It may therefore be laid down, that a mass of germinal matter always takes the spherical form, unless this is prevented by the action of forces external to it. It may of itself assume, or it may be made to assume temporarily various shapes, but it will always *of itself* return to a spherical form.

White blood-corpuscles, and those numerous small, colourless corpuscles which I have referred to in a former paper, consist principally of living or germinal matter, and therefore always exhibit the spherical form. See Pl. IX. fig. 1, *b*, and the small spherical bodies in different parts of the drawing.

Of very minute particles of germinal matter in the blood.

In the blood of man and the higher animals a great number of minute particles, of the same general appearance and refractive power as the matter of which the white blood-corpuscles are composed, may be demonstrated. Some of these particles, probably, under certain conditions, grow into ordinary white blood-corpuscles; while others, after increasing to a certain size, become red blood-corpuscles.

The white corpuscles vary in size to a much greater extent than is stated in books; it is easy to find corpuscles as much as the $\frac{1}{2500}$th of an inch in diameter, and others less than the $\frac{1}{4000}$th of an inch.

It has been shown that red corpuscles vary much in size; and as the smallest are only just visible from their extreme transparency, it seems not unreasonable to infer that some corpuscles may exist, which are so minute and so transparent as to be invisible to us.

Of the multiplication of the masses of germinal matter.

Now, I have elsewhere discussed the mode in which germinal matter absorbs inanimate nutrient matter, converts it, or some of its constituents, into matter like itself, and gives origin to a number of smaller masses. From these living masses of germinal matter, as in other cases, protrusions or outgrowths occur. At different parts of the circumference a portion of the mass moves away from the rest. At first it remains connected by a pedicle, and may be drawn back again; but oftentimes separation proceeds, the pedicle becomes drawn out finer and finer; at last, this thin thread which connects the two portions gives way at some point, and two masses result. Thus, from one, two separate bodies, which becomes spherical, are formed. These do not fuse together again, but, if nutrient material is present, each grows, and the process above described is repeated. One mass may divide into two only, or it may give origin to a great number of separate masses at different parts of its circumference.

Of the "living," moving, basis substance.

The moving power above referred to evidently resides in the so-called "*basis substance*" of the corpuscle, and the movements originating in this transparent semifluid matter are communicated to any insoluble particles which may be embedded in it (figs. 3, 4). But this "basis substance" is not a simple fluid, it consists of very minute, colourless particles, free to move upon each other; and I believe that motor power resides in these particles, and that this inherent power of movement is one of the peculiar and constant attributes of living matter. In the cells of Valisneria the current which passes round the circumference of the cell appears to consist of colourless fluid, but if examined by the $\frac{1}{25}$th the apparently *clear* fluid is seen to be made up of a vast multitude of minute, colourless particles. In other vegetable cells, especially in Tradescantia, the same phenomena may be observed. The transparent matter of the mucus-corpuscle and young epithelial cells, which looks like clear fluid, really possesses a similar constitution, and consists of very minute, transparent, spherical particles of living matter, which possess inherent power of movement.

I ought to state that, in all these movements, the so-called nucleus plays no active part. The protrusions affect the germinal matter outside the nucleus, and in the detached masses of germinal matter new nuclei may arise. The so-called nuclei are new centres, appearing, arising, or originating in pre-existing living matter. Certain conditions might destroy the vitality of the outer part of the germinal matter, while the new centres or nuclei remained intact. At any future time, this portion of the germinal matter yet remaining alive, being placed under favorable conditions, would grow, and soon a mass of germinal matter like the original one would result, and in this, new "nuclei" would appear.

Absorption of inanimate formed material by living germinal matter.

The germinal matter of the frog's blood-corpuscle may grow if the corpuscle be still; and as the outer formed material becomes softened, this may be taken up, just as the formed material of a cell of epithelium, or that of cartilage or bone, may be removed, and (at least in great part) be converted into living matter, by the germinal matter in these tissues, in the process called "*inflammation.*" The living matter in all these cases being much more freely supplied with nutrient matter than in the normal state, grows faster, and at the expense of the very material it has already formed. The white blood-corpuscles of the frog grow and increase under the same circumstances. The white blood-corpuscles of man exhibit similar phenomena. That they absorb nutrient matter when stationary seems to be proved by the channels which converge towards each mass of living matter, as may be seen in a very thin coagulum covered with thin glass, two or three hours after coagulation.

Increase of white corpuscles in vessels in inflammation and in clots.

The absorption of nutrient material by the corpuscles, their growth, and subdivision, are, of course, favoured by the slower movement of the fluid in which they are immersed. As would be supposed, the multiplication of these bodies takes place to the greatest extent where the circulation is slowest. In the spleen the conditions are specially favorable for the growth and multiplication of white blood-corpuscles. The process also occurs, but to a less extent, in the large capillaries of the liver. If in any capillaries of the body the circulation is retarded from any cause, an increase in the white blood-corpuscles invariably takes place. In congestion and inflammation of the vessels of the frog's foot, the number of white blood-corpuscles soon becomes so great as to impede and ultimately to stop the circulation through the vessel. Although the great majority are merely corpuscles that have been retarded in their passage, there can be little doubt that the corpuscles actually multiply in number in the clot that is formed. In clots, the number of these corpuscles is very great, and in some cases the great bulk of the clot seems to consist of them. In carmine preparations this point is demonstrated most conclusively. (See fig. 6.)

Of the origin of the white blood-corpuscles.

In the next place, I would venture to offer further remarks upon the origin of the white blood-corpuscles, for these are not alone produced by division of corpuscles already existing, and from chyle- or lymph-copuscles.

Origin, from germinal matter of stellate cells and vessels.—In the development of blood-vessels the general opinion is, that cells become stellate, and that the processes formed by contiguous cells meet together, and thus, it is conceived, the cavities of the adjacent cells become connected together by tubes. I have contested this inference, and have endeavoured to show that, so far from any coalescence between cells occurring, the communicating tubes, in all cases, result from the separation or moving away from each other of "cells" which were originally continuous. Supposing a mass of germinal matter, with a slightly hardened layer of formed material or cell-wall on the surface, to exhibit a tendency to division;—as the two portions separate farther and farther from each other, while at the same time they still continue to grow, a narrow communicating tube is formed. The walls of this tube clearly correspond to the so-called "cell-wall," while its cavity contains germinal matter, just as I have shown that the prolongations of young connective-tissue-corpuscles contain germinal matter, which extends from the central mass (nucleus). Now, in the formation of capillary vessels, a portion of this germinal matter, which is derived from the germinal matter of the original cell, in all probability gives rise to white blood-corpuscles.

Development of capillaries and white blood-corpuscles in the "periosteum" of a tooth.—In the periosteum of the fang of the tooth, in an inflamed state, the changes occurring during the development of capillaries may be studied in the adult; the firmness of the tissue renders it possible to cut exceedingly thin sections, which may be examined with the highest powers, and investigated with precision.

In fig. 5, at *b, c,* cells, which would be called by some "enlarged connective-tissue-corpuscles," are represented. The germinal matter has already divided into several spherical masses (small white blood-corpuscles). The cell is connected with neighbouring cells by channels as yet too narrow to permit the corpuscles to pass. The large figure represents a portion of a tube in a more advanced condition; this was seen to be actually continuous with a true vessel at *a,* so that no doubt could exist as to its real nature. This tube was also packed with similar masses of living or germinal matter which might fairly be termed white blood-corpuscles, and in some places a few red corpuscles could be seen which had doubtless passed in from the general circulation.

Origin from the "nuclei" of fully formed capillaries.—As the formation of the young capillary vessels proceeds, the free particles of matter continue to multiply in number, and it is probable that the serous fluid in which the corpuscles are suspended, is formed by them. In that part of the tube which corresponds to the body of the original cell germinal matter still remains. This may take part in the formation of new vessels. It is usually called the "nucleus" of the capillary, and is said to represent the "nucleus" of the original cell. In it, smaller nuclei often appear.

These masses of germinal matter connected with the capillary walls vary much in size under different circumstances. In some cases the masses of germinal matter seem to be embedded in the substance of the capillary wall, but oftentimes they project quite into the capillary tube in such a manner as to interfere with the free passage of its contents (figs. 8 and 12). The blood-corpuscles, one after the other, impinge upon and gradually pass by this imperfect obstruction. I think it probable that small particles of this so-called "nucleus" may be detached from time to time, and these, passing into the current of the circulation, would become small corpuscles of the nature of white blood-corpuscles. In fig 9, one of these nuclei, from which protrusions are taking place, is represented.

I conclude, therefore, that white blood-corpuscles may be derived not only from the germinal matter of the cell which takes part at an early period of development in the formation of capillaries, and that which is concerned in the formation of capillaries in the adult tissues and in morbid growths, but also from that mass of germinal matter (nucleus) which exists in connection with the capillary walls generally. An increase of white blood-corpuscles will take place in all conditions in which the access of pabulum to these masses of germinal or living matter is favoured.

New views with regard to exudations.

As already stated, I have been led to the conclusion that very small particles of living or germinal matter detached from a white corpuscle, or from the "nucleus" of a capillary or small vessel, may give rise to the formation of a new one. I now propose to pursue this part of the inquiry somewhat further, for it involves pathological questions of the utmost interest and importance with reference to the "exudation theory," and the production of what has been called "heterologous new formations." Some pathologists believe that a clear transparent plasma may give rise to the formation of living cells; and it has been confidently and most positively urged that particles may be precipitated from such a formative fluid, become aggregated together, and thus it is asserted, a body may be formed which afterwards becomes *living* (Bennett). On the other hand it has been most dogmatically laid down that every cell comes from a pre-existing cell—"Omnis cellula e cellulâ" (Virchow). There are living bodies which do not fall within the definition given of a "cell," which nevertheless *grow* and *multiply*, and it is undoubtedly true that bodies which are regarded as cells do appear in fluids which appear perfectly clear and transparent.

I am therefore prevented by facts and observations from adopting the views entertained by those who accept the "*exudation theory*," while I am equally unable to accept the "*cell theory*," either in its new or in its orignal form. Those who advocate the first have assumed that a fluid which appears to be clear cannot have particles of matter suspended in it which are so small or so transparent as to have escaped observation; while those who support "cellular pathology" have ignored the fact that in some cases bodies which they would admit to be cells do appear under circumstances which render it unreasonable, if not impossible, for any unprejudiced observer to attribute their origin to pre-existing *cells*.

For example, in pneumonia the material which is poured into the air cells of the lung is seen to consist almost entirely of very small granular "corpuscles" or "cells" which consist of living matter, and which grow and multiply very rapidly.

Now, the evidence in favour of the view that these are entirely derived from the normal cells connected with the pulmonary tissue, is, to say the least, very unsatisfactory, while many facts seem in favour of the conclusion that they are developed in the exuded plasma.

In certain conditions of the kidney a quantity of clear and perfectly transparent coagulable material is poured out into the uriniferous tubes and coagulates there; now I have seen, in the very *centre* of this coagulum, small granular "cells" in process of increase. From what "cell proliferation" could these bodies result? (See 'Archives of Medicine,' vol. ii, page 286); also 'Urine, Urinary Deposits, and Calculi,' 2nd ed., p. 68.)

Again, in many cases are found delicately granular cells and corpuscles external to the vessels, and amongst the so-called connective-tissue-corpuscles and their prolongations. The connective-tissue-corpuscles are not enlarged, nor do they exhibit any irregularities, so that it seems to me unreasonable to assume that the granular corpuscles were formed in the connective-tissue-corpuscles and then set free, as some would assert.

I have thus been led to entertain views different to those already advanced, and I think the inferences I have deduced will serve to explain satisfactorily facts which are opposed to the cell doctrine, but which certainly cannot be explained by the exudation theory.

When the capillary vessels are distended as in that extreme congestion which soon passes into inflammation, a fluid which possesses coagulable properties transudes through the stretched capillary walls. It is probable that in such cases minute and narrow fissures result, which, however, are too narrow to allow an ordinary white or red blood-corpuscle to escape, but nevertheless wide enough to permit many of the minute particles of living or germinal matter (the existence of which in the blood has been already referred to), to pass through. The small protrusions upon the surface of the white blood-corpuscles might grow through the capillary walls, become detached, and pass into the tissue external to the vessels. Such minute particles of living matter external to the vessels being surrounded with nutrient pabulum, and stationary, would grow and multiply rapidly, while a similar change would of course go on in the now stagnant fluid in the interior of the capillary. The result would be exactly that which is actually observed, viz., the presence of a vast number of cells like white blood-corpuscles in the interior of the capillary vessel and immediately around its external surface, and sometimes these extend for some distance in the substance of the surrounding tissue; and they increase in number.

I venture, then, to conclude that many of the clear fluids which have been considered as "*exudations*" from the blood, really contain a multitude of extremely minute particles of living matter, which are intimately related to the white blood-corpuscles, and that these grow and become one source of the small granular cells or corpuscles which are so familiar to all who have studied morbid changes in the tissues as they occur in man and the higher animals.

Some of these active living particles may be so small as to be invisible by a power magnifying 5000 diameters. I have seen such particles less than the $\frac{1}{50000}$th of an inch in diameter, and have no reason whatever for assuming that these are really the smallest that exist.

Let me, however, remark here that such minute granular "cells" or corpuscles are not *alone* produced in the manner described, but they may result, of course, from the multiplication of any form of germinal matter as well as that of which white blood-corpuscles are composed.

The living or germinal matter may retain its vitality so that particles may be formed in one organism and be carried to another where they may grow.

I have already shown that it is not the so-called "cell" as a whole which is concerned in vital phenomena, *but only the germinal or living matter of the cell.* This alone absorbs and changes nutrient material. This alone can be said to *live.* In many cases the most minute portion of this living or germinal matter may retain its vitality even when detached and removed from the body, and germinate if placed under favorable conditions. Living germinal matter, even in man and the higher animals, may retain its vitality so that it may be transferred from one body to another, and when particles are detached from a low form of germinal matter which grows very actively, they may even be kept for some time away from the body and yet retain their vitality. Perhaps the best example of this is met with in the propagation of purulent ophthalmia. In this and some other conditions there is reason to believe that a very minute portion of the living matter of a pus-corpuscle may be transferred from one organism to another, and give rise to changes resembling those which have already occurred in the individual first affected.

It seems to me very probable that living matter allied to these so-called colourless corpuscles, including the small masses of germinal matter before described, are the agents which are directly concerned in the introduction and distribution of various so-called animal poisons. In this way a reasonable explanation may be offered of the marvellous results following the communication of small-pox as well as of the protective influence of vaccination. Germinal matter from vaccine lymph is represented in fig. 10.

Nor are there any facts which are incompatible with the view that in such diseases there is an actual transference of living particles from the diseased organism to that which is to be affected in a similar way. We know not how very minute such active living particles may be; but we do know that living vegetable organisms exist which are only just visible by a power of 5000 linear, and we are justified in inferring that active living independent particles exist which are too minute to be seen. Pus-corpuscles and ordinary lymph-corpuscles are too large to be carried through the air, but minute particles may be detached from any of these bodies not larger than the germs of fungi which we know exist in the atmosphere, and are thus transferred from one place to another. No doubt the great majority of such minute particles of living matter, in a peculiarly active state of vitality, would die long before they reached a new locality favorable to their propagation, but a few might escape and, meeting with a favorable surface, would germinate.

Warmth, moist air, little change in the atmosphere, are conditions under which the life of such minute particles of living matter would probably be preserved, and what are the conditions favorable to the propagation and spread of many of those contagious diseases which have long been attributed to the transference of matter which acts like "ferments?"

It seems to me probable that many such contagious diseases are due not to the propagation and transference of vegetable organisms, but to small particles of living animal matter which have descended from the germinal matter of one organism and have been transferred to another. There is even a condition of germinal matter derived from the body of an animal in which it may be transported without destruction, and may grow upon the organism of man. If these notions be true, it must be possible that some of these particles may become nearly dry without their vitality being destroyed. We know that many of the lower and simpler organisms may undergo this change without destruction, and it is reasonable to infer that a low form of living matter from man and the higher animals might also be nearly dried without being killed.

More minute examination, by the aid of higher powers, render such inferences at least plausible, and upon the whole these considerations serve but to support the general conclusion I have already arrived at, viz., that in every case "particles of living matter are derived from pre-existing living matter."

Certain forms of living matter placed under particular conditions may exhibit special peculiarities in growth, or as regards the composition and properties of the substances resulting from changes occurring in them, and these peculiarities may be retained by a very minute particle, which being removed from the seat of its formation and transferred to a new organism in which no such phenomena have ever occurred previously, will grow and exhibit the same peculiarities as the mass from which it was derived. Living particles may have acquired new endowments depending upon the new conditions under which they have been placed, and these new powers thus acquired are in many cases transmitted to particles which have descended from the first.

On the formation of fibrin.

When discussing the anatomy of the red blood-corpuscle, I endeavoured to show that the coloured matter bore to the colourless living or germinal matter, the same relation as formed material in other cases bears to germinal matter. It is formed from it, or rather it results from changes occurring in it. If the living or germinal matter die under certain conditions, the red colouring matter is one of the substances resulting from its death. Now, numerous facts render it almost certain that these and other masses of germinal matter give rise to different substances according to the conditions under which the particles cease to exhibit vital phenomena. So that, with the view of offering some explanation of phenomena familiar to us, I would venture to suggest that, if the particles of living matter of small colourless corpuscles died very slowly under the conditions present in the healthy circulation, red hæmato-crystallin would result, while if more rapid death occurred, an insoluble substance which for some time after its formation continued to become firmer—in fact, *fibrin*, would be produced, and if the death of the living particles of which each mass of germinal matter is made up, occurred quite suddenly, and as it were, *en masse,* the living matter would become resolved into soluble substances which possess neither the properties of the red colouring matter of the blood nor those of the fibrin.

I think, then, that the production of the material we know as fibrin is due to that gradual death of minute particles of the living matter of the white, and small colourless, corpuscles which takes place under ordinary circumstances when blood escapes from the vessels of the living body. The blood does not die the very instant it leaves the vessels, and, as is well known, it may be caused to retain its vitality much longer under some conditions than others. It is even probable that these particles of living matter may absorb nutrient matter and increase for some time after the blood has left the vessel, so that it is possible not only that some of the fibrin, but that the living matter from which it resulted, may have been produced after the blood was removed from the organism. A white blood-corpuscle will *live and move* for hours after the blood has been drawn from the body.

On the other hand, in certain cases in which it is said that the fibrin does "*not coagulate,*" it may be that all the particles of living matter are instantly destroyed and soon afterwards break down into substances which do not possess the property of coagulation.

Fibrin having been produced, may at once pass into the solid state, or it may be diffused through the blood in a state of extreme tenuity. This state may be maintained for a considerable period of time by the chemical and physical action of certain substances present. The density of the fluid through which it is diffused, probably exerts a very powerful influence upon its further condensation. A slight alteration of circumstances may cause fibrin once formed to contract, and the diffused transparent material gradually to become coherent, so as to form threads or masses (fibrin) which refract the light more highly than serum or "liquor sanguinis;" or a web of fibres makes its appearance in the fluid, from which it seems to be precipitated. These fibres, so delicate at first as to be quite invisible, gradually become thicker as the process of contraction proceeds, until a firm clot results. For some time afterwards the contraction goes on, so that much fluid is expressed from the meshes of the clot, and the fibrin is found to be very elastic.

It is as if the particles of matter of which the fibrin is composed had been prevented from exerting their ordinary attraction by the conditions which existed, but a slight change having allowed the ordinary attraction to come into force, the process would continue until a firm "clot" resulted.

The formation of fibrin, therefore, it seems to me, is to be regarded as the *result of a vital process.* I consider fibrin as "formed material," and hold that living germinal matter becomes fibrin.

Fibrin is produced by the white blood-corpuscles, chyle, and lymph-corpuscles, by corpuscles of the same essential nature in the intercellular fluid, by some the corpuscles in the so-called exudations; germinal matter generally, in dying under certain circumstances, gives rise to the production of an elastic fibrinous material which is closely allied to the fibrin of the blood. Even in vegetable cells there is a substance closely allied to fibrin, and "spontaneous coagulation" is a phenomenon that usually follows the death of living or germinal matter.

Now, I have already shown that the living germinal matter, so long as it possesses the power of moving and forming outgrowths and protrusions, is very transparent and refracts very slightly, but when this dies, a firm, more or less elastic material results which resists the action of acetic acid, and *refracts light in a much greater degree,* results These characters have, it seems to me, led observers to infer too hastily that the matter which extends from the masses of living or germinal matter, as for example in white fibrous tissue, should be called *elastic tissue.* There is a material resulting from the death of particles of germinal matter under certain circumstances, which refracts the light highly, which resists the action of acetic acid, potash, and soda,—but it by no means follows that this in all cases is "elastic tissue."

Cause of the granular appearance of the white blood-corpuscle.

In the white blood-corpuscles the "granular appearance" is caused by the presence of a number of spherical or oval particles which refract in a greater degree than the transparent material of which the greater part of the corpuscle is composed. These particles are more numerous in old white blood-corpuscles than in others; and in the youngest they do not exist at all. They increase in number afer death. I believe that the matter of which these granules are composed is already dead, is, in fact, fibrin. (See Pl. IX, figs. 3 and 4.)

If the fibrinous mass from Guinea-pig's blood, which coagulates very rapidly, be examined under a very high power, it presents a similar appearance, there being no distinct "*threads*" visible. (See fig. 7.)

The formation of a thread of fibrin.

I have seen a thread of fibrin in process of formation. Sometimes when a drop of blood is placed upon a glass slide and covered with thin glass, it will happen that in consequence of the unequal pressure of the glass, rapid currents will occur in different parts of the thin layer. Red corpuscles will be seen rushing along in streams with great velocity, and here and there diverging in consequence of some impediment; oftentimes a stream is split into two in consequence of being urged against a small body which adheres most forcibly to the glass. Now, the bodies which thus adhere to the glass are *white blood-corpuscles*. The red corpuscles are still carried along in the stream of fluid. A white blood-corpuscle thus adherent is often in part forced onwards, and thus a thin thread is formed, as shown in fig. 11. This thin thread I believe to be fibrin. When blood is poured into a glass or other vessel, the corpuscles which adhere to the sides, and which take active part in the formation of the coagulum, are the *white corpuscles*. The red are entangled in the coagulum formed by the white corpuscles, but they are *passive*, and such a clot or coagulum may, as is well known, be formed *altogether without the red corpuscles.*

In an "inflamed vessel" the bodies which cleave to the sides are the *white corpuscles*, and it is easy to conceive how in this process a considerable mass of fibrinous matter might be formed, as upon the surface of a valve of the heart in cases where there was any little roughening, or where other changes had ensued in the membrane so as to favour the adhesion of white blood-corpuscles. In all these deposits occurring in the interior of the vascular system the *white corpuscles* are the agents most directly concerned. It is probable that upon the outer part of each white corpuscle is a thin layer of adhesive viscid matter, which may be considered imperfectly formed fibrin. This adheres to any inequalities of surface with which the corpuscle comes into contact. Being stationary, it contracts and gradually becomes firmer and more condensed and at last assumes the characters of ordinary fibrin. The same changes continue to go on upon the surface of the corpuscle, and thus the fibrin accumulates. More corpuscles become entangled, until a mass of fibrin results, in the substance of which masses of living germinal matter still remain. These masses of living germinal matter may divide and subdivide; they may move amongst the fibrinous mass in which they are embedded; and they may produce "fibrous tissue," or give rise to granular, rapidly-multiplying corpuscles, like pus-corpuscles, which grow at the expense of the fibrin and substances in the surrounding fluid. But I will not pursue further the changes which take place in a coagulum after its formation in the living body.

According to my view the fibrin is the formed material produced which results when the living or germinal matter of the white corpuscles dies under certain circumstances. In the course of these observations it will be remarked that I have scarcely referred to the observations of others. So much has been written upon this subject that to have given even a brief account of the views of modern writers would have required more space than has been devoted to this paper. I have, therefore, only attempted to give my own views upon this most difficult subject, and as they differ in all important particulars from the conclusions arrived at by others, I have not considered it necessary to refer to the literature of the subject.

Prof. Lister's Researches.

But it would not be right to pass without notice the recent important observations of Prof. Lister "On the Coagulation of the Blood," "The Croonian Lecture," June 11, 1863, "Proceedings of the Royal Society, vol. xii, No. 56. Although Prof. Lister's experiments are mainly directed to disprove the ammonia theory of Dr. Richardson, a new theory is advanced which involves the remarkable hypothesis, that "ordinary solids" and vessels in a state of inflammation (when "temporarily deprived of all vital power") exert an active or attractive influence upon the fibrin, while healthy vessels and "living tissues" are perfectly "passive." It is impossible to admire too much the very careful and beautiful experimental observations of Prof. Lister, and it is certain they add much to our knowledge of the intricate subject of the coagulation; but I confess myself unable to agree with the conclusions he has deduced from them. It seems to me that in many instances an explanation different to that arrived at by him might be offered. Nor do I think that he has fully borne in mind the different effects of a *rough* and *smooth* surface upon the process of coagulation. The surface of the smoothest of Prof. Lister's ordinary solids presents inequalities and irregularities which do not exist in the living vessels.

I cannot accept, as an explanation of a process, any "subtle mysterious agency" of inanimate ordinary solids; nor do I admit that, in inflammation tissues, have lost their "vital properties." On the other hand, *growth* and those phenomena which may be fairly termed "vital," occur with *increased activity* in tissues in a state of inflammation. Prof. Lister says that a tissue acts so-and-so when deprived of its "vital properties," and defines these "vital properties" as "properties peculiar to the tissues, as components of the healthy living body." Prof. Lister has not distinguished between physical and vital properties. The explanation offered involves the acceptance of forces, actions, and properties on the part of tissues which they have not been proved to possess, and I think we ought not to be called upon to admit these *mysterious agencies* unless strong reasons are advanced.

Prof. Lister's experiments do not show that foreign solids have an *attraction* for fibrin. He assumes that inanimate matter, like glass or china, &c., possesses an active power of attracting matter towards it and causing a change in a state of matter at a distance from it. The "attractive agency" is not proved. Prof. Lister, it seems to me, has not distinguished the mere physical alterations which may be shown to occur in an inflamed tissue as compared with a healthy vessel, and yet he assumes the existence of changes in *vital properties* of the tissue; nor has he shown that tissue exhibits *vital properties*. No one has, I think, yet shown that any living tissue acts upon the vital properties of living matter at a distance from it. Prof. Lister, however, assumes not only that ordinary matter exerts an "*active influence*" in promoting coagulation, but that this influence may be exerted *through other bodies*. "The agency of the ordinary solid leads the *corpuscles* to communicate to the liquor sanguinis before they subside, a *material*, or at least an *influence* which confers upon it a disposition to coagulate."

It should, however, be clearly stated that Prof. Lister and I have studied the question from very different points of view, and although I cannot accept without further explanation the general conclusions he has arrived at, it is very possible that I may be unduly influenced by the method of study I have followed.

I have also been unable to accept the conclusions arrived at by Prof. Lister upon the important subject of inflammation. His views are peculiar, and I am surprised that his inferences have not excited the attention in this country which they deserve. He supposes that by the action of "irritants" the tissues are reduced to a state in which, although not dead, they are temporarily deprived of all vital power. He thinks that the irritated tissues act towards the blood-corpuscles like ordinary solids, and cause them to acquire adhesiveness such as they exhibit when removed from the body, and that to this change inflammatory congestion is due.*

Surely these views, which were published in 1858, should be subjected by the reviewers to the most careful and searching analysis; their importance and interest must needs be great, as first principles are involved in them. All Prof. Lister's papers fully deserve much more careful study and criticism than they have yet received.

It is to be regretted that those engaged in writing reviews upon the work of observers in this country do not take more pains to give careful analyses than is generally the case; and I think that British scientific observers generally may fairly complain of the treatment they receive at the hands of reviewers; for while not unfrequently foreign observations upon minute points of special interest only to a few, are subjected to a most honest, careful, and elaborate analysis, general conclusions advanced by men in this country, and perhaps supported by a vast amount of most careful experimental observation, are dismissed with a few complimentary remarks, or passed unnoticed by journals which pretend to give critical and analytical notices of scientific work carried on in this country as well as abroad. There is more good and sound physiological work done here than most readers of our reviews would be inclined to suppose.†

* Observations in opposition to the doctrine of irritation will be found in a lecture published by me in the 'Lancet,' Dec. 6th, 1862.

† In the last Half-yearly Report on Physiology in the 'Medico-Chirurgical Review,' the editor has "not space" for short analyses of the following memoirs of British authors:—

"On the Arrangement of the Muscular Fibres of the Ventricular Portion of the Heart." By J. Pettigrew.
"On the Coagulation of the Blood." By Joseph Lister.
"Lectures on the Blood." By George Gulliver.
"On the Brain of a Bushwoman, and on the Brains of Two Idiots." By J. Marshall.
"On the Nerves of the Liver, Biliary Ducts, and Gall Bladder." By Robert Lee.
"On Animal Dextrine or Amyloid Substance: its History and Physiological Properties." By R. McDonnell.
"On the Amyloid Substance of the Liver, and its Ultimate Destination in the Animal Economy." By R. McDonnell, M.D.
"On the Effect of Temperature on the Excretion of Urea, as observed on a voyage to China and at Hong Kong." By E. Becher, M.D.

Every one of these papers contains topics of the utmost interest to the medical profession, and "space" ought to be found for analyses in a journal which professes to give "half-yearly reports" on Physiology.

MICROSCOPICAL SOCIETY.

Annual Meeting, February 10th, 1864.

Report of Council.

According to annual custom the Council have to make the following report on the progress and present state of the Society.

The number of members reported at the last Annual Meeting was 337; since that time 27 have been elected, making the number 364. This number must be reduced by 11 resignations, making a final total of 353, thus showing an increase of 16 on the number reported at the last anniversary. The Council have to congratulate the Society on the fact that not a single death has been reported as having taken place among the members during the past year.

The library has been increased by many volumes, and the collection of objects has been considerably augmented by donations of various slides amounting to 98, one collection of objects illustrating the fibre of cotton and the effects of dyeing upon it, with a work on the same subject, presented by the author, Mr. Crumb, may be particularly noticed as being of great value and interest. The collection now consists of 1235 objects.

The Society has also the pleasure of stating that the promise made by Mr. T. Ross, of presenting the Society with a first-rate microscope, has been most amply fulfilled, and also that this beautiful instrument is now regularly placed on the table, on the nights of meeting, for the inspection and use of the members.

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

AUDITORS' REPORT.

Receipts.

	£	s.	d.	£	s.	d.
By Balance from previous year				153	14	0
Admission Fees of 28 new Members				29	8	0
Compositions				21	0	0
Dividends on £753 6s. Consols				21	19	5
Dalmeyer, for Tools				0	7	0
Annual Subscriptions—						
For the year 1860	1	1	0			
,, ,, 1861	9	9	0			
,, ,, 1862	33	12	0			
,, ,, 1863	170	2	0			
,, ,, 1864	46	4	0			
				260	8	0
				£486	16	5

Payments.

	£	s.	d.	£	s.	d.
To Salary of Assistant Secretary				21	0	0
,, Curator				8	0	0
Editors of the 'Microscopical Journal'	153	8	3			
Postage and Delivery to ditto	11	15	10			
				165	4	1
Rent				25	0	0
Expenses of Soirée, viz.—						
Fittings and Gas	5	4	6			
Refreshments	16	9	0			
				21	13	6
Printing and Stationery—						
Printing	7	2	6			
Books	2	7	6			
				9	10	0
Purchase of £100 13s. 4d. Consols				94	10	0
Power of Attorney for ditto				1	1	6
Paid Mr. Webb, Reporter				6	6	0
Lamp Oil, &c.				4	6	9
Assistant Secretary, Collection of Subscriptions				15	11	0
Ditto, Petty Expenses	7	7	3			
Engraving Microscope and Fittings	1	1	5			
Writing Vote of Thanks to Mr. Ross	3	3	0			
				11	11	8
Balance in hands of Treasurer				103	1	11
				£486	16	5

ELLIS G. LOBB.
ALEX. FITZGERALD.

The President then delivered the following address:

The President's Address *for the year* 1864.

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

Gentlemen,—It is my pleasing duty to record on the present occasion the steady progress of our Society in its career of usefulness during the past year, which has, however, been more conspicuous for progress in the applications of the microscope, than in the development of the instrument itself.

Contemporaneously with the establishment of our Society in the year 1840, the paucity of British microscopical investigations was a subject of remark by Schleiden, and was by him attributed to a want of efficient instruments. This desideratum has, in the intervening period, been most amply supplied; nevertheless it must be a subject of regret to all who are interested in the microscope and its applications, that the novelty and importance of original investigation has been hardly commensurate with the unrivalled excellence of our instrumental means.

It appears to me to be a subject of congratulation that our proceedings during the past year have been enriched by several communications of more than usual importance. In the department of Minute Anatomy and Physiology three papers have been read by Dr. Beale:

I. "On the Formation of the *so-called* Intercellular Substance of Cartilage, and its relation to the so-called Cells, with observations on the process of Ossification."

II. "On the Nature of the Red Blood-corpuscle."

III. "On the Nature and Development of the White Corpuscle."

The views developed by Dr. Beale in these papers are of great physiological importance, and are so lucidly stated and logically argued, that their effect would be merely weakened by any attempt of mine to epitomize what is already (or will shortly be) in the hands of every member of this Society.

Two papers have been communicated by Dr. Ciaccio, of Naples:

I. "On the Nerves of the Cornea."

II. "On the distribution of Nerves to the Skin of the Frog; with physiological remarks on the Ganglia connected with the Cerebro-spinal Nerve."

These papers evince much careful research, and elaborate investigation of the structures to which they relate.

The contributions to the vast and inviting field of Natural History have unfortunately been restricted to one of the lowest types of organization,—the Diatomaceæ. In this department we are indebted to the habitual industry and skill in delineation of Dr. Greville for four papers:

I. "A Monograph of the Genus Auliscus."

II—IV. "Descriptions of new and rare Diatoms," Series IX, X, XI.

Mr. H. S. Lauder has given a descriptive paper of several forms of new diatoms, and we are indebted to our indefatigable Secretary, Mr. Roper, for a paper "On the Genus Licmophora."

In the interest of science I cannot here avoid expressing a regret that some attention has not been devoted, by those who have the opportunity of so doing, to the more difficult, but far more important, investigation of the development and specific differences of these minute but interesting organisms.

On the subject of the improvement of the microscope and its accessories, we are indebted for two communications from Mr. R. Beck:

I. "A Description of a new Stand for a Single Microscope, with a Binocular Arrangement."

II. "On the new forms of Reversible Compressors."

In the contrivances here described the author has exercised his accustomed ingenuity in placing at our disposal useful and convenient appliances.

I am happy to have the opportunity of stating that during the past year we have not sustained, either by decease or resignation, the loss of any member, whose name has been made familiar to us by any important services in promoting the objects of the Society.

Our present numerical strength is 353, compared with 337 at the period of the last anniversary, showing an increase of sixteen members.

Our library has been augmented by many volumes. The collection of mounted objects has been enriched by several liberal donations, amongst which may be mentioned thirty-four specimens of vegetable fibre presented by Mr. Crum, and thirty of diatoms from Prof. Jones, of Calcutta. It has also been augmented by the purchase of thirty-seven slides. The number of objects, which, in 1858, amounted to only 350, had at the last anniversary advanced to 1100, and at the present time is 1235. But the improvement in our instrumental department is the most conspicuous, in reference to which it is my duty to recall to your recollection the munificent donation of Mr. Ross of a complete microscope of his newest and best construction, with a series of objectives up to the $\frac{1}{12}$th, and an ample variety of accessory apparatus. Some useful objectives of the most modern and approved construction have also been ordered for the Society from Messrs. Powell and Lealand, and Smith, Beck and Beck. Thus it appears that the instrumental means at the present disposal of the Society are the best that can be obtained; and in the hope that the members of the Society and their friends would avail themselves of these ample means of investigation, it has been arranged that the curator should be present at seven on each evening of meeting, for the purpose of producing any instruments or objects that may be required; and these opportunities, I trust, may not be lost sight of by the members of the Society.

The only remaining act of the Society during the past year that appears to require any special notice is the institution of the Queckett Medal, established in memory of one who, for many years, laboured more assiduously and successfully in microscopic investigation than probably any one of his contemporaries, and to whom this Society (especially in its early progress) is more largely indebted than to any other individual. It has been proposed to give a gold medal, periodically, to the most successful cultivator of microscopic science; but as the world requires gold to be weighed against gold, the means are unfortunately wanting for fully carrying out this commendable design, and contributions to the Queckett Medal Fund will be thankfully received. Many of those who have profited by Prof. Queckett's admirable microscopic demonstrations at the College of Surgeons would probably be glad to pay such a final tribute to his memory, if their attention were once directed to the subject.

Having thus briefly recapitulated the state and progress of the Society during the past year, I will avail myself of the present opportunity of making some observations that I think may not be without interest to the members of this Society.

Having been one of the members of the jury of Class XIII, in the recent International Exhibition, to whom the duty of reporting on the microscopes was specially deputed, I examined with considerable care the various instruments and apparatus exhibited both in the British and foreign departments, and the result of my observation was certainly very flattering to British industry and intelligence, as devoted to the construction of the microscope.

It would ill become me on the present occasion to institute invidious comparisons at home, but I am equally bound to say that no foreign microscope that was exhibited was at all comparable, either in the convenience of its mechanical, or the perfection of its optical arrangements, with the instruments of our best makers. Unquestionably the best foreign objectives were those exhibited by M. Hartnack (the successor, I believe, of Oberhaüser), in the French department. Some of these were very deep powers; the deepest of these being only 1 m. m. focus, and therefore about equal in power to the $\frac{1}{25}$th of Messrs. Powell and Lealand; but an evening was devoted to the comparison of these lenses at my residence, and the superiority of the latter (which must be looked upon as a triumph of artistic skill) was freely admitted.

There is one point of construction, frequently met with in the foreign objectives of high power, to which I would especially call the attention of our professional members, as, from what I have seen, I do not think that it has received in this country the attention it deserves; it is their being corrected for immersion in water, that is, that a plate of water should intervene between the objective and the covering-glass of the object. From the increased facility of transmission of the oblique rays through a plate of water, the quantity of light under any given condition of illumination is obviously increased. With a $\frac{1}{12}$th objective of moderate angular aperture, which is corrected for immersion in water, I have, I think, in some instances, obtained better definition than by any other means.

In regard to the angle of aperture of objectives, it may be remarked that, for physiological purposes, and, indeed, for almost all practical purposes except revealing the markings of diatoms, large angle of aperture is not necessary, nor even desirable, being incompatible with that far more generally useful quality of a good objective, *penetrating power,* which is, in fact, synonymous with *depth of focus,* that is, the extreme distance of two planes, the points of which are, *at the same time,* sufficiently in focus for the purpose of distinct vision. This distance will obviously increase as the angle of aperture diminishes, just as in a landscape camera the fore- and back-grounds can be brought into sensible focus simultaneously only by the employment of a diaphragm with a small aperture, which greatly diminishes the angular aperture of the incident pencils. But, at the same time, it must be borne in mind that illumination, *cæteris paribus,* increases or diminishes with the angle of aperture, and the most efficient objective will be that in which the best compromise is effected between these two conflicting requisites.

I may here mention a very satisfactory method of determining the *available* angle of aperture of an objective, that was shown by Prof. Govi, of Turin, to the jury of Class XIII of the recent International Exhibition. This consisted in placing the body of the microscope perpendicular to a table covered with any dark, non-reflecting substance, such as green cloth; and having converted the instrument into a telescope, by placing above the eye-piece a suitable combination of two lenses (such as the examining-glass of Mr. Ross), in observing the greatest distance on either side at which a clear image of some distinct object, as a narrow slip of white cardboard or paper, laid on the table, can be perceived. Half the interval between these two points, divided by the vertical distance of the focal point of the objective from the surface of the table, will, by reference to a table of natural tangents, give half the required angle of aperture.

MM. Nachet and Son, to whom we are indebted for the first practicable arrangement of a binocular instrument, exhibited a very creditable collection of microscopes. The prismatic arrangement for bisecting the visual pencil in their binocular is a great improvement on their former plan, and produces perhaps as good results as can be expected from any plan involving the symmetrical bisection of the pencil; but all such contrivances are manifestly inferior to the unsymmetrical plan of Mr. Wenham, in which one half of the pencil suffers no disturbance, and the other half no refraction, as it enters and emerges from the prism perpendicularly. A pencil of rays can hardly be expected to pass through a prism without encountering some disturbance, which will be made evident by impaired definition; but it is well known that two equally perfect images are not essential for the production of a satisfactory binocular effect; it seems, therefore, to be a necessary inference that a better result will be obtained by Mr. Wenham's arrangement than by any of those in which the pencil is symmetrically bisected. There is also the further advantage that, by simply withdrawing the prism, which is mounted in a small sliding frame, the microscope is at once restored to its original uniocular form.

M.M. Nachet also exhibited some ingenious devices by which the pencil transmitted by the objective is prismatically divided into three or four parts, and directed into as many divergent tubes, to enable a like number of persons to view an object simultaneously; but the advantage they would derive from seeing an object imperfectly together, in preference to seeing it well in succession, is not very apparent.

The only conceivable practical utility of such an instrument is to enable several persons to observe simultaneously rapid chemical, physical, or vital transformations.

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

M. Nobert, of Berlin, exhibited a microscope of his own design, and his well-known test lines. The microscope was not conspicuous for the convenience of its arrangements; it is tall and vertical, and has a micrometer stage-movement, consisting of a micrometer-screw with a large graduated head attached to an adjacent *fixed* pillar, and connected with the stage by a Hook's joint, in order to admit an adjustment of the *stage* for focusing. The vertical position of a microscope is always undesirable, as the necessarily flexed position of the head incommodes the circulation of the blood, and tends, in conjunction with the active exercise of vision, to produce congestion in the eye; moreover, vision is liable to be rendered indistinct by the gravitation of any humours, floating on the surface of the eye, to the then lowest point, the centre of the cornea.

Having been for some time past occupied in endeavouring to determine the best method of obtaining very high magnifying power, I am induced to lay before you the results at which I have at present arrived, in the hope that they may not be altogether devoid of interest, and, moreover, that some of my hearers, who have had much more experience than myself in the use of the microscope, may be induced to co-operate in determining this important practical question.

Three different modes of augmenting magnifying power have been under consideration:

I. By increased power of the objective;
II. By increased length of tube;
III. By increased power of the eye-piece.*

* To these might be added a fourth method, that of doubling the objective, and magnifying by the second the image obtained from the first; this

I. The construction of perfect objectives of very high magnifying power has long been an object of ambition amongst the most eminent opticians; but the history of the progressive development of the achromatic objective is so well known to most of my hearers, that it would be superfluous in me to expatiate upon the subject. It may, however, be remarked that the employment of crystallized substances, possessing larger indices of refraction than glass, was long since proposed by Sir D. Brewster and Dr. Goring, and attempted to be carried out by Mr. Pritchard; but, unfortunately, the crystals capable of being thus employed possess the property of double refraction, and the disturbance of the rays thus produced defies correction. The diamond is, I believe, the only highly refracting transparent and colourless natural substance that exhibits no double refraction, but the expense of constructing diamond lenses would be enormous. If quartz could be rendered not only amorphous, but homogeneous, by fusion in masses of sufficient size for the construction of small lenses, it would doubtless be a great acquisition to the optician, but this, it is feared, is unattainable. Glass of high refractive power has, I believe, been advantageously employed; it is obvious that, where the index of refraction is high, less curvature will suffice for chromatic correction, and, consequently, there will be less spherical aberration to contend with.

Objectives of $\frac{1}{12}$th and $\frac{1}{16}$ of an inch focus have been most satisfactorily constructed for many years. In the beginning of 1862 Messrs. Powell and Lealand accomplished the construction of a $\frac{1}{25}$th of an inch objective, of extremely good defining power; and, more recently, Mr. Wenham has, I am informed, succeeded in constructing a $\frac{1}{50}$th of an inch objective. It must, however, be borne in mind that, in the construction of these very deep objectives, the difficulty of maintaining the correct curvature of such very minute lenses is immensely increased; and, moreover, that each surface, be it ever so carefully polished, presents but a rocky shore for the ethereal waves of light to break upon, and each individual ridge or furrow (supposing them in all cases to be the smallest possible) will have a greater disturbing effect on the entire pencil, in proportion to the smallness of the surface of the lens through which it is transmitted. It hence appears to me that there must be *some* limit to the magnifying power of an objective, beyond which defining power must neces-

plan, however, was tried many years ago, by the late Mr. A. Ross and myself, but the results were by no means promising, and I have not thought it worth while to repeat any attempts in this direction.

sarily be impaired, supposing the workmanship to be in all cases equally perfect.

With a given objective, I believe the only available modes of increasing the magnifying power to be by increasing—

II. The length of the body;

III. The power of the eye-piece.

In comparing these two modes of augmenting power, my own observations are fully borne out by the concurrent testimony of several independent and able observers, that with the same object and objective, under the same conditions of illumination, any required amount of amplification is obtained, with more light, and with far better definition, by elongating the body of the microscope, than by employing a deep eye-piece.

It will doubtless be conceded as an axiom, that the most perfect view of any given object will be obtained by that amount of amplification which is *just sufficient* to distinguish and separate its smallest visible parts; beyond this point further amplification is only injurious, in rendering unavoidable instrumental imperfections more conspicuous.

In using the $\frac{1}{25}$th objective and equivalent magnifying powers, I have tried every mode of illumination with which I am acquainted—the condensers of Gillett, Kingsley, Powell, and Ross; objectives of all powers, from 3 inches to $\frac{1}{12}$th; and eye-pieces from A to F, and of various kinds. Amongst all these contrivances, the most satisfactory effects I have obtained in developing the most minute visible points of structure in animal tissues, were produced with a Kelner C eye-piece, the focus of the eye-glass being a little below the object, and the light (direct light from a paraffin lamp, or argand gas burner) toned down by a diaphragm of suitable aperture placed immediately beneath the field-glass.

With a magnifying power of about 3000 diameters,* one

* The magnifying power in this instance, according to Dr. Beale's mode of estimation, would have been 6000 diameters; but this method of estimating the power employed is likely to produce some misapprehension. Dr. Beale compares the apparent magnitude of the distance between two contiguous fine lines (2000 or 5000 to the inch) of a ruled micrometer with the interval between the points of a pair of compasses placed *by the side of the stage*, irrespective of the distance of the stage from the eye. His alleged reason is that he is in the habit of making his drawings at about the same distance from the eye as the object is, and therefore that his mode of estimating will correctly represent the amplification of the object *in his drawing*; and this is doubtless perfectly correct. But in speaking of *absolute* magnifying power, it is necessary to compare the apparent magnitude of the object with a known magnitude placed at a constant distance from the eye, and for this purpose a distance of ten inches is generally adopted.

of the most interesting sights I ever witnessed was the evolutions of a living mucus-corpuscle, obtained from the saliva. The rapidly moving particles within the corpuscle were distinctly seen; after a little while the outline of the corpuscle was subject to frequent changes, bulging out first at one point and then at another, and the moving particles freely entering and returning from these projections: these movements might be compared with the convulsive throes of parturition of the higher organisms. After a time a large projection was formed at one side, and as this increased, the outline of the corpuscle became regular and quiescent. Presently an indentation appeared between the corpuscle and its offset, and, no doubt, had time permitted, the complete separation of the young corpuscle from its parent would have been observed.

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 objectives on the same objects, 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.

Remarks on the MARINE DIATOMACEÆ *found at* HONG KONG, *with* DESCRIPTIONS *of new* SPECIES. By HENRY SCOTT LAUDER, Assistant-Surgeon, Royal Navy; with Notes by J. RALFS, Esq.

(Read Feb. 10th, 1864.)

THE Diatomaceæ are generally very abundant in Hong Kong harbour; so abundant, indeed, that in a few minutes, by means of a small muslin towing-net, a jelly-like mass, about the size of a walnut, is obtained, consisting of about equal parts of diatoms and Estomasbtarca, &c. It is worthy of notice that, in different months, different forms are prevalent, giving distinct characters to the gatherings. For instance, in January, very few diatoms are obtained. In February the Coscinodisceæ are most plentiful. In March and April numerous species of Rhizosolenia and Chætoceros make their appearance, and about the end of April nearly every diatom (except a few Coscinodisceæ) has disappeared, being replaced by an increase of animal life, and a species of Oscillatoriæ.

As species of Chætoceros are the most frequent in the gathering, and at the same time very curious, I shall attempt their description in this paper.

Genus *Chætoceros,* Ehr., frustules smooth or minutely punctated, united with the adjacent ones by the interlacing of awns proceeding from the frustule.

Frustules in the front view, quadrangnlar generally, with concave valves, leaving a fenestra of a size and shape varying in different species between the contiguous frustules, with awns arising from the angles, or from the lateral surface of the valve. The awns are usually many times longer than the breadth of the frustule, tubular, circular, quadrangular, or hexagonal; cellulose, spinous, or with bead-like dots. I have seen none indubitably smooth, although some are so delicate that no markings can be detected on them. Length of filament varying according to age, from two or three frustules to more than a hundred. In perfect filaments the awns of the terminal valves, that is to say, the two valves of the original frustule produced from the Sporangium, are usually shorter and stouter than the others, and often differ from them in shape.

The mode of growth in Chætoceros is similar to that of the Biddulphiæ. The endochrome increases in quantity, then shrinks away from the sides, generally forming a central spherical mass, with a strongly defined outline. The defined outline gradually disappears; the mass of endochrome becomes paler in colour; a clear space is formed in its centre; the connecting hoop of the frustule at the same time increasing in breadth, until it equals the original length of the cell. The endochrome divides into two equal portions; a line of demarkation is formed in the connecting hoop, from which new awns begin to sprout, and thus two frustules are enclosed within the enlarged connecting zone; each composed of a new and an old valve.

At certain seasons, or at certain ages of the fronds, this process takes a different direction. The condensed endochrome, instead of becoming paler and dividing, gradually assumes another shape, varying with the species, and secretes a siliceous envelope. In some species it becomes a body, with a capitate head and constricted neck at one end, and at the other end merely curved, and a broad connecting zone between them (Pl. VIII, fig. 4, *a*, *b* : *a*, filament; *b*, side view of sporangium).

In other species the neck is wanting; some have the sporangium smooth, others bristly. Finally, the endochrome forms roundish, highly refractive globules within the Goniothecium-like body; the filaments become very fragile, breaking up on slight disturbance, and set free the enclosed bodies. The contents of the sporangium soon escape, but I have not been able to follow out the further processes they undergo towards the reproduction of a Chætoceros.

These bodies have hitherto been placed in a distinct genus of Diatomaceæ, viz., Goniothecium, although Mr. Brightwell has already shown that some of them at least were connected with Chætoceros. I imagine that they are sporangia, formed by the conjugation, as it were, of the two valves of a frustule. It is rarely that all the frustules of a filament are in this sporangial state, some having these bodies enclosed, whilst other cells are undergoing the ordinary process of division.

I am inclined to believe that many, if not all the species in Goniothecium, Omphalotheca, Hercothea, and perhaps in Dicladia, Periptera, and Syndenbrium, may, when found in the living state, turn out to be the sporangial bodies of species of Chætoceros.

Those figured in fig. 2, *d*, are very like Ehrenberg's figure of *Hercotheca mamillaris;* the circumference of the connecting hoop being set round with minute setæ, or a striated portion of the hoop projects beyond the valve.

It is often difficult to distinguish species from varieties, as the awns seem to vary much in size, length, and stoutness, and even the sporangium differs very much in shape in apparent varieties.

The best division of the species is into those having dotted and those having spinous awns, the members of each group generally having other characters in common.

* Awns beaded, the beads or dots passing round the awns in a spiral manner.

Chætoceros socialis, n. sp. Filaments slender, aggregated, embedded in gelatine, with wavy, spirally dotted awns, some of which are more elongated, and converge to a common centre (fig. 1). Hong Kong.

This is the smallest species I have seen. By the aggregation of the filaments in gelatine, it forms roundish, flattened fronds. Frustules quadrate, with an awn from a little within each angle, one of them being more elongated, varying in length, according to the distance of the frustules, to a common centre, to which the elongated awns converge; many frustules, however, occur, in which the awns are not thus connected; side view oval.

C. ciliata, n. sp. Filaments elongated, spiral, with oval fenestræ and short awns; sporangium with smooth, convex valves, surrounded by setæ arising from the margins of the connecting zone (fig. 2). Hong Kong.

Filaments composed of 100 frustules or more, which have concave sides, forming interstitial, oval fenestræ, and a stout awn from each angle, recurved away from the centre of the spire. About November, in many of the frustules, a highly reflective Goniothecium-like body or sporangium appears. Side view of valve broadly oval. Breadth of frustule, $\frac{1}{1000}''$; length of awn, $\frac{1}{300}''$.

C. Lauderi, n. sp., Ralfs. Filaments with quadrate frustules, narrow-oblong fenestræ, slightly and gradually constricted at the middle, and long awns; sporangia with very unequal, spinous valves, the larger one capitate (fig. 4). Hong Kong.

About the middle of April, and shortly previous to the disappearance of the filaments, sporangia are seen, in which the larger valve is capitate, hirsute, and connected to the hoop by a broad, smooth neck. The smaller conical valve is furnished with spines, or a delicate plicated membrane resembling spines. I think the latter, because there is no trace of this lower part with membrane attached after boiling in acid. There is also a fine plicated membrane attached to the margins of the hoop). I think it is a large variety without the constricted neck. Breadth of *a*, $\frac{1}{900}''$.

*C.** *variety* of *C. Lauderi?* Filaments larger, with abruptly constricted fenestræ, and long, slightly curved awns; lateral view oval (fig. 3). Breadth of frustule from $\frac{1}{0100}''$ to $\frac{1}{500}''$.

C. affine, n. sp. Filaments as in *C. Lauderi*, but with the terminal awns incurved and stouter than the rest; sporangia with unequal, convex, hirsute valves (fig. 5).

Occasionally some of the intermediate awns are enlarged similar to the terminal ones. *C. affine* differs from *C. Lauderi*, principally in its sporangia, which are not constricted, have more delicate spines, and the lesser valve is siliceous and permanent. Breadth of frustule, $\frac{1}{1300}''$.

C. compressa, n. sp. Filaments with broad, constricted fenestra, and awns arising from a little within the angles; lateral view of valves compressed oval (fig. 6).

Filaments straight, here and there having the awns of contiguous valves much longer and stouter than the intermediate ones, and conspicuously beaded and flexuose. Sporangia unknown. Breadth, $\frac{1}{1000}''$; length of awn, about $\frac{1}{140}''$.

** Awns cellulose.

C. cellulosa, n. sp. Awns cellulose, varying in size and length (fig. 12).

Filaments straight, with oval, constricted fenestra, quadrangular awns, having regular oval or quadrangular depressions over their whole surface, the terminal awns stouter and shorter than the others. Frustule quadrangular, with a curved line running across from the insertion of one awn to that of the other, and which is apparently the line of junction between the hoop and the valve, the latter, from its slightly turgid shape, being seen in the front view; lateral view oval. Breadth of frustule, from $\frac{1}{1000}''$ to $\frac{1}{350}''$

*** Awns spinous. Filaments usually stouter than in the preceding divisions.

C. boreali? Frustules quadrangular, with four-sided, stout, striated, and coarsely spinous awns, arising from the centre of the depressed valves (fig. 7).

I have only met with this species in single frustules. Awns $\frac{1}{2000}''$ broad, about thirty times longer than broad, with spines arising in an alternate manner from the angles, those of upper valve recurved, and parallel with those of the

* The form of the interstial foraminæ differs so much from that of *C. Lauderi*, that it is probably a distinct species, which we propose to name *C. incisor*.—J. RALFS.

lower valve and with the axis of the frustule. Spines, two in $\frac{1}{1000}''$; striæ resolvable into dots; lateral view roundly oval.

C. coarctata, n. sp. Filaments composed of quadrangular, closely approximated frustules, without fenestra, with stout, spinous, and striated awns arising from within the angles (fig. 8).

Filaments straight, with the terminal awns hexagonal, tapering at each end, shorter and stouter than the others, with serrated angles, and incurved; the other awns quadrangular and spinous, those nearer the end ones coarsely spinous and curved on themselves, like the crook of a crosier or sheep-hook; the rest more slender, minutely spinous, and simply recurved. Side view oval, with two triangular depressions for the insertion of the awns. Breadth of frustule, $\frac{1}{900}''$; of terminal awn, $\frac{1}{1000}''$. This species is often covered with a species of Vorticella, which, when in full life and motion, gives it a very extraordinary and *outré* appearance.

C. denticulata, n. sp. Filaments with quadrangular frustules, long, quadrangular, delicately spinous awns, which are situated on surface of valves, suddenly expanding at the base, and furnished on the inner side with a notch-like tooth (fig. 9).

Filaments straight; awns parallel, and at right angles to the axis of the filament, expanding suddenly a little before insertion, like the bowl of a pipe, and usually having a small process on the inner side, giving it a still more striking resemblance to a pipe. This process seems to be for the purpose of articulation with the contiguous frustule, as it is not present in the terminal awns. Side view oval, with the insertions of the awns strongly marked. Breadth of frustule, $\frac{1}{650}''$. Length of awn, $\frac{1}{50}''$; breadth, about $\frac{1}{5000}''$.

C. rostrata, n. sp., resembles *C. denticulata*, but is usually smaller, without the articulating process of the awns, and the valves have a tubular, conical, central process, which articulates with the similar process of the adjacent valve (fig. 10).*

C. protuberans, n. sp. Filaments with minutely spinous awns, having between them a mamilliform protuberance, which projects into the fenestra (fig. 11).

Filaments straight, with very slender, delicate, intermediate awns, and stouter and shorter terminal ones. Valves with a central projection; compressed oval in the side view. Breadth of frustule, about $\frac{1}{700}''$; length of terminal awns, about $\frac{1}{150}''$.

* This form is regarded as a variety of *C. denticulata* by Mr. Lauder, but we believe the differences pointed out by him sufficient to distinguish them. —J. R.

TRANSACTIONS.

Descriptions *of* New *and* Rare Diatoms. Series XII.

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

(Communicated by F. C. S. Roper, F.L.S.)
(Read Feb. 10th, 1864.)

(Plates X & XI.)

Eupodiscus.

Eupodiscus scaber, n. sp., Grev.—Very large; disc with two large submarginal flat processes and a broad striated border; cellules very minute; whole surface rough, with scattered raised points. (Pl. X, fig. 1.)

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

The treasures of the Barbadoes earth really seem to be inexhaustible, and do not cease to reward the persevering research of my excellent friend Mr. Johnson. The subject is becoming exceedingly interesting—far beyond the mere publication of a few novel diatoms; for here is an extensive and truly fossil deposit, richer already in some extensive genera than any other known locality, while various genera of singular structure appear to be altogether peculiar to it. It will now be a matter of some importance to make our record of this wonderful deposit as complete as possible.

The present diatom is one of the finest and most distinct of its genus, attracting the eye instantaneously by the large, flat, circular *Auliscus*-like processes which project somewhat from the surface. The structure is dense, composed of very minute cellules, about 12 in ·001″. The little rough apiculi, which appear like so many dark specks remotely scattered in the middle of the disc, are more numerous towards the margin; striæ of the border 13 in ·001″. Diameter of disc ·0075″.

AULACODISCUS.

Aulacodiscus decorus, n. sp., Grev.—Large, coloured; disc with numerous (about six) submarginal processes; furrows open, defined by parallel lines of granules, terminating in very small blank spaces surrounding the processes; granules minute, irregularly disposed in the centre, soon passing into closely moniliform slender lines, with intermediate shorter ones. (Fig. 2.)

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

A fine large species, without any umbilical space, the centre being filled up with somewhat remote and irregularly scattered, minute, spherical granules, which soon arrange themselves into long slender lines, strongly marked by the brownish colour of the closely placed granules. As the lines proceed towards the margin there is no appearance of dichotomous division in order to fill up the increasing space; but shorter lines are introduced like the gills of many *Agarici*, and furnish a conspicuous character. This arrangement, however, is irregular, as several long lines are sometimes continued side by side to near the margin, while in other cases the shorter lines occur more frequently. In this character our present species is allied to *A. Kilkellianus*. The diameter of the disc is from ·0060″ to ·0080″.

AULISCUS.

Auliscus Normanianus, n. sp., Grev.—Very large; valve circular, with a large smooth umbilicus, and very fine, close, radiating, plumose lines; a row of submarginal puncta, and numerous apiculi scattered over the outer parts of the disc; processes 3, large. (Fig. 11.)

Hab. Deposit at Moron, province of Seville; George Norman, Esq.; C. Johnson, Esq.

A splendid, well-marked, and rare fossil species. It appears to be strictly circular, and may be distinguished at a single glance by the submarginal row of puncta, combined with the scattered apiculi which are considerably more numerous than those in the disc of *Aulacodiscus scaber*. The lines which converge from the centre to the processes are very numerous and delicate, but sharp and distinct; those which radiate to the circumference exceedingly fine and faint. In the example figured, the processes are situated at a considerable distance from the margin, but this is not a constant character. The diameter of the valve varies from ·0050″ to ·0073″. My friend Mr. Norman, who was the first to examine the Moron deposit, well deserves that this magnificent species should bear his name.

Auliscus Moronensis, n. sp., Grev.—Large; valve broadly oval, with a circular smooth umbilicus; converging and radiating lines beset with numerous minute puncta, the lateral ones widely plumose, dichotomous; processes 2. (Fig. 6.)

Hab. Moron deposit; George Norman, Esq.; R. K. G.

This fine diatom is evidently allied to *Auliscus pruinosus* of Bailey, from which, indeed, it is not easy to separate it in words, although it is abundantly distinct. The essential difference lies mainly in the radiating lines. These, in *A. pruinosus*, are very fine and delicately scabrous, the latter effect being produced by the minute *jaggedness* of the lines themselves. In our new species the lines are far more robust, less exquisitely symmetrical, and the apparent roughness is caused by minute, distinct puncta occurring on their surface at short irregular intervals. *A. pruinosus* is supposed to be always circular, but I do not venture to place much confidence on that character. Nevertheless it is worthy of remark that all the examples of *A. Moronensis* which have come under my observation are broadly oval. Long diameter about ·0055″.

BIDDULPHIA.

Biddulphia punctata, n. sp., Grev.—Side view elliptical-oval, the ends sub-obtuse, with short, obtuse, roundish processes and two transverse blank lines; structure uniform, composed of minute puncta. (Fig. 10.)

Hab. Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; R. K. G.

Of this species I have met with four or five examples, all agreeing so closely that I feel justified in regarding it as well-defined. The transverse lines do not appear to indicate any septum, but they are very conspicuous. The position they occupy towards each end of the valve is at about a third of its entire length. The short processes very much resemble those of *B. pulchella*. Longest diameter about ·0055″.

TRICERATIUM.

Triceratium zonatum, n. sp., Grev.—Small; valve with nearly straight sides, and obtuse angles, furnished with roundish pseudo-nodules; surface minutely punctate, with a circular blank umbilicus, and with the angles cut off by two broad blank lines. (Fig. 3.)

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

A handsome and striking little diatom. Pseudo-nodule filling up the external angle. Surface closely and minutely punctate, with a row also of minute puncta (15 in ·001″) along the margin. Umbilicus distinct, smooth, circular. Angles separated from the centre by two blank lines or bands; the first situated considerably nearer the centre than the apex; the second just beneath the angle itself, there being only a single row of puncta between them. Distance between the angles about ·0030″. The species to which this diatom is most nearly allied is *T. cellulosum*, ('Trans. Mic. Soc.,' vol. I, N. S. Plate iv, fig. 14.) At the same time the differences are so marked that it is quite unnecessary to point them out.

Triceratium pallidum, n. sp., Grev.—Small; valve with straight sides, subacute angles, 4—6 short vein-like lines given off from the margin, and the whole area filled with scattered puncta, larger in the centre, extremely minute towards the margin and in the angles. (Fig. 7.)

Hab. Barbadoes deposit, Cambridge estate.

I am not acquainted with any species to which the present one bears any affinity unless it be *T. areolatum*, which it somewhat resembles in outline and in the sharp vein-like marginal lines. In other respects the structure is totally dissimilar. The distance between the angles is ·0030″.

Triceratium definitum, n. sp., Grev.—Small; valve with the sides straight in the middle, the angles broadly ovate, with transverse lines of separation, which convert the interior into a nearly equal hexagon; pseudo-nodules large; surface filled with lines of minute radiating puncta, the margin with a row of larger puncta. (Fig. 8.)

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

This species approaches *T. insigne*, but differs in various essential particulars. That somewhat variable diatom, of which I have examined a considerable series, has the sides invariably and decidedly concave. In the present species they are (apart from the trifling curve of the angle) perfectly straight. Then, I have never seen *T. insigne* with anything more than a row of puncta, cutting off the angles; whereas in *T. definitum*, an actual line is quite conspicuous. It may also be remarked that the angles are not rounded (to the extent of the segment of a circle) as *T. insigne*, but are rather ovate in outline. The distance between the angles is ·0028″, and the marginal puncta 8 in ·001″.

Triceratium unguiculatum, n. sp., Grev.—Large; valve with 4 angles, very concave sides, and rather large hexagonal cellules; angles somewhat obtuse, furnished with a minute claw-like process. (Fig. 9.)

Hab. Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; R. K. G.

Of this, one of the most distinct and constant species in the whole genus, I have examined a number of specimens. The hexagonal cellules (6 in ·001″) are uniform in size, and form a delicate reticulation. The most remarkable feature, however, in the valve is the slender claw-like process which seems to occupy the place of pseudo-nodule, and to arise from a small callous base just within the angles. Distance between the angles ·0040″.

Triceratium plumosum, n. sp., Grev.—Large; valve with nearly straight sides and broadly rounded angles; structure composed of a central large umbilicus, from which radiate plumose lines of hexagonal cellules; pseudo-nodules absent. (Fig. 4.)

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

An exceedingly beautiful species, and as distinct as the preceding. The radiating lines of cellules are very narrow as they originate from the umbilicus, and gradually increase in size until they are about 7 in ·001″. As they proceed they keep giving off new lines to fill up the space, and near the margin the cellules again diminish in size, especially within the angles. Diameter between the angles ·0060″.

ENTOGONIA.

Entogonia reticulata, n. sp., Grev.—Valve with nearly straight sides and obtuse angles with extremely prominent pseudo-nodules; compartments of the border minutely but distinctly reticulato-cellulate; central triangle with fine radiating costæ. (Fig. 5.)

Hab. Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; R. K. G.

The only species with which the present diatom can be compared is *E. amabilis* ('Mic. Journ.,' vol. III, N. S., Pl. X, fig. 21); but the structure of the border in the latter is very different, being composed of distant transverse rows of minute, distinct, and somewhat remote pore-like cellules. In the species under consideration, on the contrary, it is a uniform and continuous network of hexagonal cellules. In both, the pseudo-nodules are unusually developed, especially in *E. reticulata,* where they are so long as to make the valve, when seen obliquely, look like a low three-legged footstool. As in the other species of this genus, the costæ of the border are extremely variable in number. I have seen as many as nine on one side, without reckoning the short ones connected with the angles. The distance between the angles is about ·0035″.

TRANSACTIONS.

DESCRIPTIONS *of* NEW *and* RARE DIATOMS. SERIES XIII.

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

(Communicated by F. C. S. Roper, Esq., F.L.S.)
(Read May 11th, 1864.)

(Plates XII & XIII.)

AULACODISCUS.

Aulacodiscus extans, n. sp., Grev.—Large; rays 4, forming elevated ridges terminating in broadly rounded marginal inflations; processes oblong; granules small; minute raised points remotely scattered over the surface of the disc. Diameter ·0090″. (Pl. XII, fig. 1.)

Hab. Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; R. K. G.; extremely rare.

A noble species, which for a long time I only knew by small fragments. It is conspicuous at once for the large cruciform ridges, which are, in fact, inflations of the disc extending from the centre to the circumference, and preserving a nearly horizontal position, while the intermediate spaces following the usual convexity of the disc pass out of focus. In the centre is a small circular blank space from whence the close lines of minute granules radiate, having a great similarity to those of *A. decorus*.

The processes are so marginal that when the disc is viewed vertically, they reach or pass slightly beyond the outer line. Over the whole surface of the disc minute apiculi are remotely scattered, but are most evident on the large terminal inflations. This fine diatom is allied to *A. mammosus*, in which the inflations are also dotted with apiculi, which were overlooked in the representation. That species, however, is much smaller, and the inflations are suddenly elevated like a cone, instead of being continued in a horizontal direction, as in *A. extans.*

AULISCUS.

Auliscus ornatus, n. sp., Grev.—Small; valve circular, without any umbilical space, the whole surface very minutely granulose; processes 5. Diameter ·0027″. (Fig. 2.)

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

The more recently discovered species of this beautiful genus considerably disturb what have been usually regarded as its typical characters. In *A. Ralfsianus*, it is with difficulty that any trace of converging lines can be perceived through the meshes of the network which appears to envelope it. In *A. ambiguus* the entire surface is filled up with a very minute cellulation, not the slightest convergent arrangement of any kind being apparent. And now we have a species in which the surface is throughout, uniformly and exceedingly minutely granulose. In addition to this peculiarity it stands alone in possessing five processes; and as the alternating ones of the lower valve are almost equally conspicuous, the circle is nearly filled up. The occurrence of this diatom tends to confirm the idea previously thrown out, that the number of processes may furnish a reliable character.

EUPODISCUS.

Eupodiscus trioculatus, n. sp., Grev.—Valve, with 3 large, flat, circular processes; surface minutely reticulato-cellulate. Diameter ·0035″. (Fig. 3.)

Hab. Barbadoes deposit, Cambridge estate; C. Johnson, Esq.; R. K. G.

It is quite possible that this diatom, three specimens of which are now before me, may belong to the genus *Auliscus*, as the three processes appear to point in that direction. But in the absence of characters more strongly distinctive of that genus, I consider it a safer proceeding to place it in *Eupodiscus*. Indeed it seems to evince considerable affinity with the following species, as well as with *E. oculatus*.

Eupodiscus Barbadensis, n. sp., Grev.—Disc irregularly reticulato-cellulate, the cellules being equal in size throughout; processes 2, large, flat, circular; margin with a row of very minute granules. Diameter ·0030″. (Fig. 4.)

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

At first sight this species might be taken for a small variety of *Auliscus Ralfsianus,* which it greatly resembles in the processes and in the character of the reticulation. The latter, however, is much smaller and destitute of puncta. The extreme margin is minutely headed, the beads 17 in ·001″, a character never observed, I believe, in the *Aulisci.* The present species is closely allied to *E. oculatus,* found in the Monterey fossil earth, from which it differs in its much smaller diameter, and in the cellules not diminishing in size, and never becoming in the slightest degree radiate toward the margin. In proportion to the size of the disc, the processes are broader, even, than in *E. oculatus.*

TRICERATIUM.

Triceratium prætenue, n. sp., Grev.—Minute; valve with concave sides, the concavity interrupted by a small convexity in the middle; the attenuated angles with a minutely rounded apex containing an indistinct pseudo-nodule; surface with 3 central spines, and radiating puncta, the margin with a row of larger cellules. Distance between the angles from ·0013″ to ·0020″. (Fig. 16.)

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

In all the examples which I have seen, the central spines are present, although sometimes very inconspicuous. The central portion of the valve is circular and somewhat concave, and the minute puncta radiate to the boundary of this area, while beyond it they appear to be disposed without any particular order. The margin of that part which may be said to belong to the angles, is furnished with a row of larger puncta or cellules.

Triceratium perminutum, n. sp., Grev.—Minute; valve with concave sides (slightly convex in the middle portion); angles attenuated, obtuse, with a minute indistinct pseudo-nodule, separated from the centre by a slender line on which is situated a minute spine; puncta radiating, about 4 larger marginal ones in the angles. Distance between the angles ·0015″. (Fig. 18.)

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

In some respects this little species is allied to the preceding, which it resembles closely in form. But it is separated at once by the distinct but delicate line which divides the angles from the centre, and which also gives a more angular character to the central area. The spines appear to be invariably placed upon these lines, and attract the eyes as points of light.

Triceratium venulosum, n. sp., Grev.—Minute; valve with straight sides and somewhat rounded angles; surface marked with remotely scattered, minute puncta, and short vein-like lines given off in pairs from the margin. Distance between the angles ·0020″. (Fig. 21.)

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

A very distinct little species, without any appearance of pseudo-nodules in the angles.

Triceratium obesum, n. sp., Grev.—Minute; valve with slightly concave sides and very rounded angles; a few very short lines projecting from the margin, a few very minute puncta forming a central triangular figure, and a few others arranged in a line so as to cut off the angles. Distance between the angles ·0012″. (Fig. 11.)

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

The angles are perfectly smooth, and present no appearance of pseudo-nodules. The short lateral lines are equidistant and five or six in number.

Triceratium Rylandsianum, n. sp., Grev.—Small; valve with straight sides and large, rounded, capitate angles cut off from the centre by a transverse line; surface minutely granulose; margin with a few remote puncta. Distance between the angles ·0025″. (Fig. 6.)

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

A very remarkable and distinct species. The angles have the appearance of a circular loop without markings of any kind. The margin is strong, and extended round the angles, the transverse line cutting them off from the centre being equally strong. The marginal puncta (about 6 or 7) appear as if imbedded in the substance of the margin itself.

Triceratium microstictum, n. sp., Grev.—Large; valve with slightly convex sides and somewhat obtuse angles; surface filled with minute radiating puncta; margin with a row of conspicuous granules, largest in the middle; angles minutely punctate, cut off from the centre by a fine transverse line. Distance between the angles ·0052″. (Fig. 17.)

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

I am not aware of any species with which our present diatom can be confounded. The radiating puncta are pale, slightly increasing in size from the centre to the margin, which latter is well characterised by a row of larger and darker roundish cellules, 8 in ·001″, which become smaller by degrees and disappear before reaching the angles.

Triceratium attenuatum, n. sp., Grev.—Small; valve with undulate sides and attenuated angles, terminating in short minute horns; whole surface loosely cellular, with a circular umbilicus and a band of linear-oblong cellules cutting off each angle. Distance between the angles ·0027″. (Fig. 10.)

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

A singular diatom, bearing no resemblance to any recorded species of the genus. The reticulation may be compared to a pattern of fine lace-work. The rather large umbilicus contains a few obscure cellules considerably larger than those of the general area, while those of the angles are smaller. The most remarkable feature is the row of about seven or eight linear-oblong cellules placed side by side, and which cut off the angles.

Triceratium ligulatum, n. sp., Grev.—Valve triradiate, the segments somewhat ligulate, terminated by a sub-elliptical, obtuse pseudo-nodule; surface fitted with minute, radiating puncta. Distance between the angles ·0038″. (Fig. 9.)

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

This species is nearly allied to *T. Solenoceros*, but is separated from it by the pseudo-nodules, which are cut off by a fine transverse line, and are very minutely punctate. There is also a row of marginal puncta, larger and darker than those which radiate from the centre.

Triceratium inæquale, n. sp., Grev.—Minute; valve unequally triradiate, the angles minutely obtuse, the extreme ends separated by a transverse line; surface minutely and faintly punctate, the margin composed of a line of close, larger puncta. Distance between the angles ·0020″ to ·0030″. (Fig. 19.)

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

Invariably with unequal sides, so that one arm, at least, is extended more than the others. The sides are unequally concave; the angles prolonged and slender. There is no obvious radiating arrangement in the minutely punctate structure.

Triceratium perpusillum, n. sp., Grev.—Minute; valve with the sides very deeply concave, and the angles broadly rounded; centre smooth, the angles filled with an oval mass of very minute puncta. Distance between the angles ·0012″. (Fig. 13.)

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

In this minute and well-marked species I cannot perceive that the angles are cut off from the centre by a transverse line. It is not therefore so closely allied to *T. castellatum* and *Normanianum*, as it would appear to be from its form.

Triceratium Smithianum, n. sp., Grev.—Valve with slightly convex sides and rounded angles containing prominent pseudo-nodules; surface filled with closely radiating lines of very minute puncta, having a central space in which they are sparingly scattered; margin very strong. Distance between the angles ·0040″. (Fig. 7.)

Hab. Barbadoes deposit, Cambridge estate; George J. Smith, Esq.; R. K. G.

This species was kindly communicated to me by its discoverer, Mr. G. J. Smith, of Workington, and the specimen accidentally destroyed, but not before I had made the drawing now engraved. Two other examples have subsequently occurred to myself, which in all respects confirm the characters exhibited in the original specimen. This species is remarkable for the fine and extremely close radiating punctation which does not commence from the centre itself, but from the edge of a rather large half-blank space, in which a few puncta are remotely scattered. The strong margin is not striated. The pseudo-nodules are not large, but sharply defined, and are evidently very prominent. This diatom is allied to my *T. connexum*, but the structure is more minute, and the small, defined umbilicus of that species differs widely from the central half-blank space in *T. Smithianium.*

Triceratium irregulare, n. sp., Grev.—Large; valve pale, with nearly straight sides and rounded angles, generally more or less unsymmetrical; margin very slender; cellules conspicuous, radiating, and somewhat plumose, nearly equal in size; angles within slightly concave. Distance between the angles ·0040″ to ·0055″. (Fig. 5.)

Hab. Barbadoes deposit, Cambridge estate; common.

The most frequent of all the *Triceratia* which occur in the

Barbadoes deposit, and under all its variations easily recognised by its size, pale colour, and radiating, and somewhat plumose, subquadrate cellules, which are also sometimes more or less concentric. It is rarely that a truly symmetrical valve can be seen. Generally the sides of the valve differ, more or less, as well as the angles, even in the same specimen. There is no pseudo-nodule whatever, but often a slight concavity and a less conspicuous cellulation within the angles.

Triceratium foveatum, n. sp., Grev.—Small; valve with straight sides and rounded angles; surface with 6 radiating segments alternately raised and depressed; those terminating at the sides oblong, with small remote equal cellules; the intermediate ones passing to the angles with cellules, larger, remote, unequal, and pit-like. Distance between the angles ·0030″. (Fig. 15.)

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

This most remarkable species is so unlike any one previously described, that it scarcely requires any supplementary notice. The cellules in the six compartments are not arranged in any regular order. Immediately within the angles is a cluster of very minute puncta, but no obvious pseudo-nodule.

Triceratium firmum, n. sp., Grev.—Minute; valve with straight sides, rounded angles, and strong, coarsely striated margins; surface filled with rather large, subquadrate, somewhat radiating cellules; angles minutely punctate. Distance between the angles ·0022″. (Fig. 8.)

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

A stout, pretty little species; the cellules largest in the centre, where they are 5 or 6 in ·001″, somewhat radiating, and sometimes more or less concentric. Margin thick, strongly defined, broadest in the middle.

Triceratium modestum, n. sp., Grev.—Small; valve with strictly straight sides and rounded angles; surface reticulato-cellulate, the cellules angular (not hexagonal), becoming smaller towards the angles, which are somewhat concave within and destitute of pseudo-nodules; margin striated. Distance between the angles ·0025″. (Fig. 14.)

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

Conspicuously reticulato-cellulate; the cellules 5 or 6 in ·001″, with slender walls, becoming smaller within the angles, but not passing into puncta. Margin at the angles somewhat thickened.

Triceratium acutangulum, n. sp., Grev.—Large; valve with

4 acute angles, and concave sides, the angles thickened and bearing a claw-like process; granules or cellulation radiating, the cellules becoming larger as they approach the margin. Distance between the angles ·0050″. (Fig. 12.)

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

All the valves I have seen are 4-angled, and sharply acute; colour pale; cellules near the margin 7 in ·001″. The margin itself slender, with a row of darker cellules. This is a most distinct species.

Triceratium oculatum, n. sp., Grev.—Small; valve with 4 angles and nearly straight sides, the angles much rounded, with large transversely oval pseudo-nodules; surface filled with minute, radiating puncta. Distance between the angles ·0018″. (Fig. 20.)

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

Whether this be the normal condition of the species it is impossible at the present moment to say, as only a single specimen has been observed.

On the STRUCTURE *and* FORMATION *of the* SARCOLEMMA *of* STRIPED MUSCLE, *and of the* EXACT RELATION *of the* NERVES, VESSELS, *and* AIR-TUBES (*in the case of* INSECTS) *to the* CONTRACTILE TISSUE *of* MUSCLE.

By LIONEL S. BEALE, M.B., F.R.S., Fellow of the Royal College of Physicians; Professor of Physiology and of General and Morbid Anatomy in King's College, London; Physician to King's College Hospital.

(Read June 8th, 1864.)

(Plates XIV & XV.)

THE apparently structureless and perfectly transparent membranous tube called the sarcolemma contains the contractile material of striped or voluntary muscle, which may be split up in a longitudinal direction to form "fibrillæ," and in a transverse direction to form "discs." The precise relation of the sarcolemma to the contractile material of the muscle on the one hand, and to the nerve-fibres and capillaries on the other, and the mode of its formation, have long been questions of the utmost interest to anatomists and physiologists. But as the difficulty of determining these essential points is very great, and as some of the appearances seen could be accounted for in several different ways, many conflicting accounts of the arrangement have been given, and are now entertained and taught by different authorities. The consideration of the nature and mode of formation of the sarcolemma involves the discussion of the relation of the nerves and vessels to the contractile material of striped muscle; and though the question is anatomical, it has a physiological bearing of the utmost interest and importance. Sarcolemma is even more distinct, and certainly more readily demonstrated, in the muscles of many insects than in those of vertebrate animals.

Sarcolemma not constantly present.—This membrane is not to be demonstrated in connection with all the elementary fibres of striped muscle in vertebrate animals, and it would therefore appear that sarcolemma was not essential to the growth, development, and formation of muscular fibre; nor can it be a structure necessary to the due performance of the function of this highly elaborate form of contractile tissue. Sarcolemma cannot be demonstrated upon the muscular fibres of the heart nor upon those of the tongue. In the auricle of the frog's heart, in the lymphatic hearts and in the tongue of the same animal, the striped muscular tissue forms in many places a sort of web of exceedingly fine fibres, many being so fine that they are not wider than the very fine fibres or fibrillæ into which an elementary fibre of the limbs, for example, may be split up. Now, it is most certain that these very fine fibres are not enclosed in a tubular membrane, as may be proved most distinctly in many of those cases in which the fine fibres taper into tendons. Moreover, there are many other localities in the frog in which very distinct and narrow elementary fibres may be demonstrated, in which no tubular sarcolemma can be detected—for example, in the small muscles of the eyelids and eyeball, in parts of the mylo-hyoid of the green tree frog, and in *young* muscles of the limbs.

Character of sarcolemma.—Of the existence of such a tubular membrane, however, in many cases there is not the least question. It is a tube often firm and of measurable thickness, with nuclei in connection with it. It is as clear and positive as a kidney-tube from which the epithelium has been washed out. Generally, the tube of sarcolemma is very firm and most distinct in old elementary muscular fibres of the muscles of the limbs and those which possess two distinct points of attachment; but in these I have noticed that while the structure is distinct in the case of the old and fully formed elementary fibres, it is not to be demonstrated as a distinct tube in the case of the young elementary fibres of the same muscle.

THE FORMATION OF SARCOLEMMA.

Of the masses of germinal matter (*nuclei**) *in relation with striped muscle.*—In considering the development of muscular tissue, and other structures connected with it, it must be borne in mind that several tissues of very different nature are undergoing development at the same time, and in very close relation with one another, and that the apparent confusion often observed in specimens is in great measure due to the number of nuclei which take part in the formation of these different textures. Even at a very early period of development of muscular tissue nuclei of more than one kind can be clearly recognised, and have been figured by some observers. But I am not aware that any one has succeeded in following out the changes which these several kinds of nuclei undergo, or in demonstrating the precise part they play in the production of the tissues which undoubtedly exist in the fully formed muscle, but which cannot be recognised at an early period of development. There are at this early period—(Pl. XIV, fig. 1) nuclei which take part in the formation of the muscular fibres; (fig. 2) nuclei concerned in the development of vessels; (Pl. XV, fig. 3) nuclei concerned in the development of nerves. The last two series of nuclei are generally separated from the first by the thickness of the contractile tissue produced; but in some cases, in consequence of the production of muscular tissue taking place on one side only of the muscular nuclei, the latter are in such cases very close to the nuclei of the vessels and nerves. In the muscles of insects a vast collection of nuclei are sometimes seen upon the surface of the muscular fibres. These nuclei are concerned in the development of the tracheæ and of the nerve-fibres; but at this early period these structures are so exceedingly transparent that no distinct fibres, or, indeed, any form of structure can be traced between the several nuclei, and it is necessary, in order to ascertain the meaning of the appearances observed, to examine muscular fibres of animals of the same kind at different ages. The various stages of development of the nerves and tracheæ may be very clearly made out in the

* I use the term "nucleus" in a general sense only. The ordinary name by which these *masses of living or germinal matter* of the muscle are known is "nuclei," for which reason only I use it here.

common silkworm, if care be taken to prepare the specimens according to the principles I have laid down.*

The facts have an important bearing upon the question of the precise nature and origin of the nuclei which exist in connection with, or external to, the sarcolemma; but it must be borne in mind that the number of these nuclei is very different in the sarcolemma of different animals. Thus, in some cases the membrane seems to be entirely destitute of nuclei, while in other instances a vast number of nuclei exist.

The matter is rendered still more difficult of explanation by the fact that the nuclei seen in connection with the sarcolemma have a different origin in different cases. If the muscular fibres of the white mouse be examined after the application of the acetic acid, the observer would conclude that the sarcolemma contained a vast number of nuclei imbedded in its structure. If he were to examine the specimens more attentively, he would notice that in many cases nuclei followed each other as if arranged in a line, and he would further notice that these lines crossed the muscular fibre in different directions, some passing transversely, some obliquely, while some pursued for a short distance a longitudinal course. It is not possible to arrive at the explanation of these appearances, unless a specimen obtained from an animal the vessels of which have been minutely injected, and the nuclei of the tissues successfully stained with carmine, be examined after soaking in glycerine or syrup. The real meaning of the nuclei can, however, then be readily and positively determined. It becomes at once evident that the nuclei seen upon the surface of the elementary fibres are, for the most part, the nuclei of vessels and nerves. These structures (vessels and nerves) are so freely distributed upon the surface of the muscular fibres of this animal that the sarcolemma appears as a nucleated membrane in specimens which have been treated by acetic acid or potash. That they lie external to the sarcolemma is proved by the fact that they may be stripped off from the surface of this membrane. For representations of the vessels and nerves distributed to the elementary muscular fibres of the white mouse, see also my paper in the 'Phil. Trans.' for 1860, pl. xxiii, figs. 5, 6, 7, and 'How to Work with the Microscope,' third edition, pl. xxvii, page 76.

Now, at the spot where a bundle of fine nerve-fibres is about to divide into smaller bundles, to be distributed to the elementary muscular fibres, there is, of course, a large collection

* See 'How to Work with the Microscope,' 3rd edition, p. 205 *et seq.*

of nuclei, and when the very fine nerve-fibres passing between these are destroyed, or, owing to the refractive power of the fluid in which the specimen is examined, are rendered completely invisible, which is invariably the case in specimens immersed in fluids consisting principally of water—a defective method still pursued by Kühne and others in Germany—the appearance is that of a little collection of nuclei upon or beneath the surface of the sarcolemma. And as it often happens that small dark-bordered fibres (the subdivisions of which are really distributed to muscular fibres at a long distance from the point of the specimen under observation) here lose their dark-bordered character, and in preparations mounted in aqueous fluids cannot be followed much beyond this point, the dark-bordered fibre often appears as if it ceased, and was connected with the collection of nuclei.

When such collections of nuclei are protected from the immediate pressure of the thin glass by a layer of thin elementary muscular fibres, they appear, in specimens immersed in aqueous fluids, to be *beneath* the surface of the sarcolemma. This is one of the explanations of the appearances observed by Kühne, Rouget, Engelmann, and others. Such collections of nuclei, supposed to be beneath the sarcolemma, have recently been described by Kühne as *nervenhügel;* and, although twenty-four years ago such nuclei could not, by any possibility, have been seen by the microscopes then in use, or demonstrated by the modes of preparation then employed, these collections have been christened after Doyère, who traced bundles of nerve-fibres to the surface of the muscles of certain tardigrada;* and, as his means of investigation prevented him from being able to trace their further ramification, he naturally inferred that they terminated there. The eminences figured by Doyère are the points at which a *bundle* of nerve-fibres reaches the muscle, and the fibres commence their ultimate ramifications upon the surface. Kühne's recently discovered Doyèreschenhügel

* Doyère, as would be supposed (writing twenty-four years ago), says nothing about the relation of the nerve-fibres to the *sarcolemma,* but describes them as spreading out over the surface of the muscle, sometimes extending over its entire length. The muscle represented by him in pl. xvii, fig. 4, seems to be perfectly continuous in structure with the nerve-fibre. It is quite impossible to say which is nerve and which muscle. Kühne seems to support this idea of Doyère, that the contractile tissue of the muscle passes by continuity of structure into the nerve. After writing voluminous memoirs and arriving at novel conclusions, the Berlin anatomist at last discovers the truth by going back twenty-four years! See "Memoire sur les Tardigrades;" 'Ann. des Sciences naturelles,' Seconde Série, t. xiv, 1840.

are undoubtedly of the same nature—not, as he has represented them, a nucleated structure, in which the nerve *ends*, situated beneath the sarcolemma.

From what has already been said it will be inferred that I hold the opinion that many of the nuclei seen in connection with the sarcolemma of striped muscle are really the nuclei of vessels and nerves ramifying upon its external surface. Not only so, but I have proved that these nuclei may be stripped off from the surface of the sarcolemma with the vessels and nerves to which they belong, leaving this membranous tube clear and almost destitute of any nuclei whatever. I have even stripped off the layer in which the vessels and nerves ramify from the surface of the sarcolemma, by forcing injection in the interval between. (See 'Phil. Trans.,' 1860, p. 616.) In other cases, however, the capillary vessels and nerves adhere so intimately to the sarcolemma that they may be said to form part of its substance.

Of the nuclei of the sarcolemma.—Besides the three kinds of nuclei observed in connection with the embryonic muscle, and consisting of—(1) nuclei concerned in the development of the muscular tissue; (2) nuclei taking part in the formation of vessels; (fig. 3) those taking part in the production of nerves; there are in the fully formed muscle (4) nuclei imbedded in the substance of the sarcolemma; (5) nuclei in the connective tissue, upon its external surface, and continuous with it; and, (fig. 6) nuclei upon the surface of the contractile tissue, just beneath the surface of the sarcolemma. In order to ascertain the nature and mode of origin of the nuclei which are not connected with muscles, nerves, or vessels, it is necessary to consider more particularly the mode of origin of the transparent membranous sarcolemma itself.

It has been already stated that sarcolemma is imperceptible in young muscles, distinct but thin in fully formed muscles, thick and comparatively firm in old muscles. Now, it is quite certain that the sarcolemma does not result from changes taking place in an expansion of flattened cells covering the surface of the muscle—an undoubted mode of origin of some delicate membranous structures—for no such cells are to be demonstrated during the development of the muscle in any case. Next, it must be borne in mind that the apparent smoothness of the external surface of the sarcolemma is due to the action of the fluids in which it is usually immersed for the purpose of examination. If, however, the most smooth sarcolemma be carefully preserved in viscid media, readily miscible with water, as syrup or glycerine, fine fibres will be found projecting from every part of its external surface. And, as for example, in the case of many muscles of the frog, where the elementary muscular fibres can be separated from one another without being actually torn apart, and in many of the old muscles of insects, it is seen that the sarcolemma is continuous with the intermuscular connective tissue. In fact, the membranous sarcolemma seems to pass into the slightly fibrous connective tissue. And in those instances in which there is an absence of true sarcolemma investing the muscular fibres, there exists, in all cases, delicate connective tissue, which forms a bond of union between them, and in which, it may be said, the muscular fibres are imbedded. If such fine muscular fibres were to waste, a small amount of connective tissue would remain, and this would be added to that which already exists. And, in certain cases of disease, in which the contractile material becomes altered and converted into a form of connective tissue, this latter substance is continuous in structure with the sarcolemma. This, taken in consideration with many other facts tending to the same conclusion, leads me to regard the contractile tissue of muscle as consisting of a special contractile material which is imbedded in a transparent indifferent tissue, which increases in amount as the contractile material wastes.

The intermuscular connective tissue is not, in any case, developed as a framework for the support of the muscular tissue, as is generally maintained; for neither is its firmness or its amount the greatest in those cases in which the muscular tissue is most largely developed,—or at the time when the muscular tissue is softest, and therefore in greatest need of support, as at an earlier period of development,—for at this time there is really no connective tissue; but when the muscular tissue wastes or degenerates, in old age, when its action is feeble, and in cases in which, from various causes, the contractility of the muscle is impaired, the amount of intermuscular connective tissue attains its maximum. In fact, as in wasting of glands, such as the liver and kidney, the secreting structure comes at last to be represented by connective tissue, and its nuclei (masses of germinal matter) by connective-tissue-corpuscles,—so these bodies and the connective tissue between them and continuous with them are all that remain of what was once muscle.

In considering the mode of formation of the sarcolemma, it must also be remembered that this structure is continuous with connective tissue at the point where the muscle joins the tendon; in fact, the sarcolemma and the intermuscular connective tissue are represented by the connective tissue between the bundles of tendinous fibres. The nuclei of the muscle correspond to the nuclei of the tendon, the contractile tissue to the fibrous tissue. That this is so, is clearly proved by the fact that the contractile material of muscle may degenerate into a tissue which is continuous with, and cannot be distinguished from, the original normal tendon.

There are, then, many cases in which the nuclei of the intermuscular connective tissue appear as if they were nuclei of the sarcolemma, and cases in which nuclei, originally belonging to the contractile tissue, in consequence of the wasting of the latter, appear to be imbedded in the thickened sarcolemma.

In order, then, to account for the nuclei in the sarcolemma which belong neither to the nerve-fibres, nor the vessels, nor the intermuscular connective tissue, it is necessary to pass in review somewhat more in detail certain facts observed in studying the development of muscle. I have shown that in the development of a bundle of nerve-fibres the nuclei in the internervous connective tissue (the so-called nuclei of the tubular membrane) have descended from the same original nuclei which gave origin to those concerned in the production of the true nerve-fibres. Or, in other words, that of the total number of nuclei (masses of germinal matter) which result from the division of the original nuclei, some take part in the development of true nerves while others produce connective tissue. And where dissimilar structures are developed in close relation with one another—as, for example, where a nerve-trunk and vessels are developed *pari passu* in close proximity—there exists between them a certain proportion of indefinite connective tissue. The origin of the tissue in this neutral territory is obscure, but there can be little doubt that the nuclei present are in part the descendants of those which were concerned in the production of the nerve-fibres, and in part of those which were concerned in the development of the vessels. The same view will explain the origin of the connective tissue and its nuclei between the glandular elements and the vessels of glands, and other cases in which indefinite connective tissue intervenes between, and is said to connect together, dissimilar structures; it being an undoubted fact that in the development of these textures the masses of germinal matter first produced are forced to the outside by the formation of new masses within. The latter are instrumental in the development of the special structure, while the former are concerned in the production of the indefinite tissue (connective tissue) which invests this last. So it would appear that nuclei found in intimate relation with the tissue of the sarcolemma are nuclei descended from the very same nuclei as those from which the muscular tissue itself has been produced. And I conceive that the different conditions under which the former nuclei have been placed is quite sufficient to explain why, in this case, a tissue of very simple character, and without any special endowments, results. Moreover, it is quite possible that as the muscle advances in age the oldest portion of the contractile tissue degenerates, and the material which was incapable of absorption might thus go to increase the thickness of the sarcolemma from within, and a few of the nuclei, escaping destruction, would at length be imbedded in the substance of the sarcolemma, thus thickened by the addition of a simple form of connective tissue.

It seems to me that the above explanations fully account for the formation of all the nuclei which have been demonstrated to exist in connection with the sarcolemma.

The relation of sarcolemma to the vessels, nerves, and contractile tissue of muscle.—But at the present time the structure, origin, and mode of formation of the sarcolemma are of special interest with reference to the mode of distribution of nerves to striped muscular fibre. As is well known, the conclusions I have arrived at are at variance with those of Continental anatomists, not only upon the question as to whether the nerves terminate in free ends or form complete circuits, but also with reference to the position of the nerve-fibres with respect to the sarcolemma; the general opinion now entertained being that the nerves actually perforate the sarcolemma and come into contact with the contractile tissue. The existence of such an arrangement is, without doubt, supported by the investigations of a great number of observers. The question is, however, one of such extreme delicacy, and for its elucidation requires such great care in the preparation of specimens, that many of the conclusions arrived at may result from misinterpretation of the appearances observed. I would, however, remark that many of the appearances delineated are at variance with what I have myself seen and have demonstrated to others, while the conclusions are so utterly incompatible with collateral evidence, that many independent observers refuse to accept them upon this last ground alone.

ON THE SARCOLEMMA OF THE MUSCLES OF INSECTS.

As some of the most positive statements advanced respecting the arrangement of the nerves result from observations upon the muscles of insects, I propose to consider the structure of the sarcolemma and its relation to the muscular tissue on the one hand, and to the nerve-fibres and tracheæ on the other, in this class. And in order that my observations may be the more easily tested by other observers, I select the muscles of an insect which can be obtained very readily in all countries and at almost every period of the year, viz., the common maggot or larva of the blow-fly. The specimens have been prepared according to the principles already laid down.

Careful observation of the sarcolemma in this insect shows the existence of a number of transverse lines. These lines are not the transverse lines of the muscular tissue, but they are situated in the sarcolemma itself, as proved in specimens in which the sarcolemma has been torn away from the muscles. Not only so, but a thin layer, in which these lines may be discerned, may be torn from the surface of the sarcolemma, leaving the greater part of this membrane in its natural position. The distance which separates these lines from one another very nearly corresponds with that which intervenes between the transverse markings of the muscle, and for this reason they have escaped observation (Pl. XV, fig. 9).

It will presently be shown that these transverse lines in the sarcolemma are produced by the ramification of fine branches of the tracheæ. Nerves and tracheæ in considerable number may be followed to the sarcolemma covering the muscle; and when seen in profile, especially in the case of the nerve-fibres, a portion of the sarcolemma is drawn out, as it were, into a cone, the nerve, in fact, appearing to be connected with the summit of the cone. Such is the manner in which the Doyèreschen nervenhugel of Kühne result. Doyèreschen nervenhügel are represented in figs. 7 and 10. Now, in these cases one can often follow fine branches of the nerve-fibre from the point where it seems to pass into the Doyèreschen nervenhugel for some distance over the surface of the sarcolemma.

But, in order to demonstrate the highly elaborate arrangement of the nerve-fibres and tracheæ of the insect-muscle, it is necessary that in a well-prepared specimen, the contractile tissue should be ruptured within the tube of the sarcolemma, and that the tube of the sarcolemma should not be much stretched or compressed. If this contractile material is not thus removed from beneath the sarcolemma, the numerous dark lines caused by the transverse striæ of the muscle necessarily prevent the far more delicate lines caused by the finest tracheæ and nerve-fibres ramifying upon the sarcolemma from being seen. Such an accident not unfrequently happens in the preparation of specimens from the maggot. One instance in which the arrangement about to be described was remarkably distinct is represented in Pl. XIV, fig. 1, in which, also, the general mode of ramification of muscular nerves is represented.*

It will be observed in this specimen that one fine branch of the bundle of nerve-fibres traversing the muscle, after passing a short distance from the trunk, seems to cease abruptly upon the sarcolemma. Although I shall describe the arrangement of this one fibre, it must not be supposed that this is the only fibre distributed to this muscle, for many fine branches reach the sarcolemma at other points from different nerve-trunks. The mode in which the terminal branch leaves the nerve-trunk is represented in fig. 2. At this spot three sets of nerve-fibres, passing in three different directions, will be noticed. One set takes the course of the original trunk, and is not concerned in the formation of the terminal branch. The two other sets, coming from opposite directions, unite to form the fine compound bundle, the further ramification of which will be considered presently. I have already drawn attention to this peculiar arrangement of nerve-fibres at the point where a branch leaves the nerve-trunk, and have stated that it is to be observed in connection with all nerves of all animals. (See my 'Archives,' No. XIV, page 127.)

The point where the fibre in fig. 1 seems to be lost on the surface of the sarcolemma is represented magnified nearly 3000 diameters in Pl. XV, fig. 3. The fine trunk is compound, and, instead of consisting of a single nerve-fibre, as represented in some of Kühne's drawings of insect-nerve, really consists of a number of exceedingly delicate nerve-fibres, each one of these being composed of still finer fibres, which divide and subdivide very freely, forming an elaborate network, which may be traced over every part of the sarcolemma. In some places the meshes formed by the ramification of the nerve-fibres are much smaller than in others. In fig. 8, a very fine nerve-fibre, dividing into numerous branches, and forming a network or plexus, is represented. And in figs. 4, 5, 6, are some other portions of the nervous network.

* For a description of this figure see the 'Explanation of the Plates.'

Besides this elaborate network of nerve-fibres extending over the sarcolemma, there is an arrangement of the tracheæ equally elaborate, forming, in fact, a network of extremely minute tubes, which, like the network of nerve-fibres, extends over every part of the sarcolemma. The mode in which the tracheæ reach the sarcolemma and divide upon its surface, is well seen in some parts of fig. 1, and in fig. 7 many of the fine branches of the tracheæ are visible. It will be seen in this specimen that anastomoses are very frequent, but the finest branches of the air-tubes are not to be seen by the aid of a magnifying power of two or three hundred diameters. By the use of a much higher power and properly prepared specimens branches far more minute than any represented in fig. 7 are brought into view. These are represented in figs. 3, 4, 5, 6, and 9. They anastomose freely with one another, forming a network of air-tubes, which is intimately adherent to the sarcolemma. The finest branches of the nerve-fibres and the finest branches of the tracheæ are situated very close to one another. Bundles of fine nerve-fibres may often be seen ramifying with tracheæ of considerable diameter, as they pass to be distributed on the sarcolemma. The relation of the finest nerve-fibres to the finest tracheæ is shown in figs. 3 and 9.

It may, perhaps, strike some as very strange that an arrangement so elaborate as that which is represented in my drawings has not been demonstrated by any previous observer; but when it is considered how many delicate operations must be successfully carried out before it can be demonstrated—and even in properly prepared specimens, in which it is to be seen, how difficult it is to remove the most favorable portions, immerse them in fresh fluid, and cover them with thin glass, without destroying the appearance altogether—it is not surprising that it should have been overlooked. Neither the finest tracheæ nor the finest branches of the nerves described in this paper have been observed before. That the arrangement of the finest tracheæ delineated in my drawings is exactly as it exists in nature can be demonstrated by any one who will examine the specimens. But not a vestige of such minute branches is to be seen in specimens prepared according to the usual methods. The fine nerve-fibres I have described, as would be supposed, are very readily disintegrated, so that it is only in fortunate specimens that the appearances delineated can be seen; but, having seen these fine fibres in very many instances, I have no doubt that the description I have given of the distribution of the nerves and finest air-tubes to the muscles of the maggot will be confirmed by other observers who will adopt the same principles in the preparation of the specimens which I have followed.

The transverse markings upon the sarcolemma alluded to in page 103 are caused by the ramifications of the tracheæ, as shown in figs. 7 and 9. From these branches smaller ones pass off, and then a network is formed; when the muscle is firmly contracted the sarcolemma is much shortened, and the tracheæ which run transversely are seen much more distinctly, while the branches which connect them are much less evident.

It therefore follows that the membranous sarcolemma of the insect-muscle is composed of very fine air-tubes and nerve-fibres imbedded in a transparent material, and it is possible that this material itself may result from the alterations which occur in the course of the development of the above most important structures. In some cases there can be no doubt that the vessels and nerve-fibres are simply adherent to the sarcolemma, but in the insect-muscle the fine nerve-fibres and air-tubes are so incorporated with it as to form a part of its substance. The rapidity with which this elaborate sarcolemma is developed is very wonderful, since, in the case of the maggot, the entire muscle doubled in size in the course of two or three days. I doubt if it would be possible to propose for anatomical investigation any subject which would be more likely to lead to the discovery of highly interesting facts, or to the demonstration of important general principles, than a minute investigation of the changes occurring during the development of the muscles of the maggot or of the silk-worm, or of the muscles of the perfect fly or moth, during the pupa stage of existence. Although the investigation is undoubtedly extremely difficult, and the utmost patience is required to prosecute a subject apparently so limited, for a sufficient period of time to stand a chance of success, it must not be forgotten that great principles have been discovered and wide generalisations have been arrived at in the course of long-sustained inquiries into minute details.

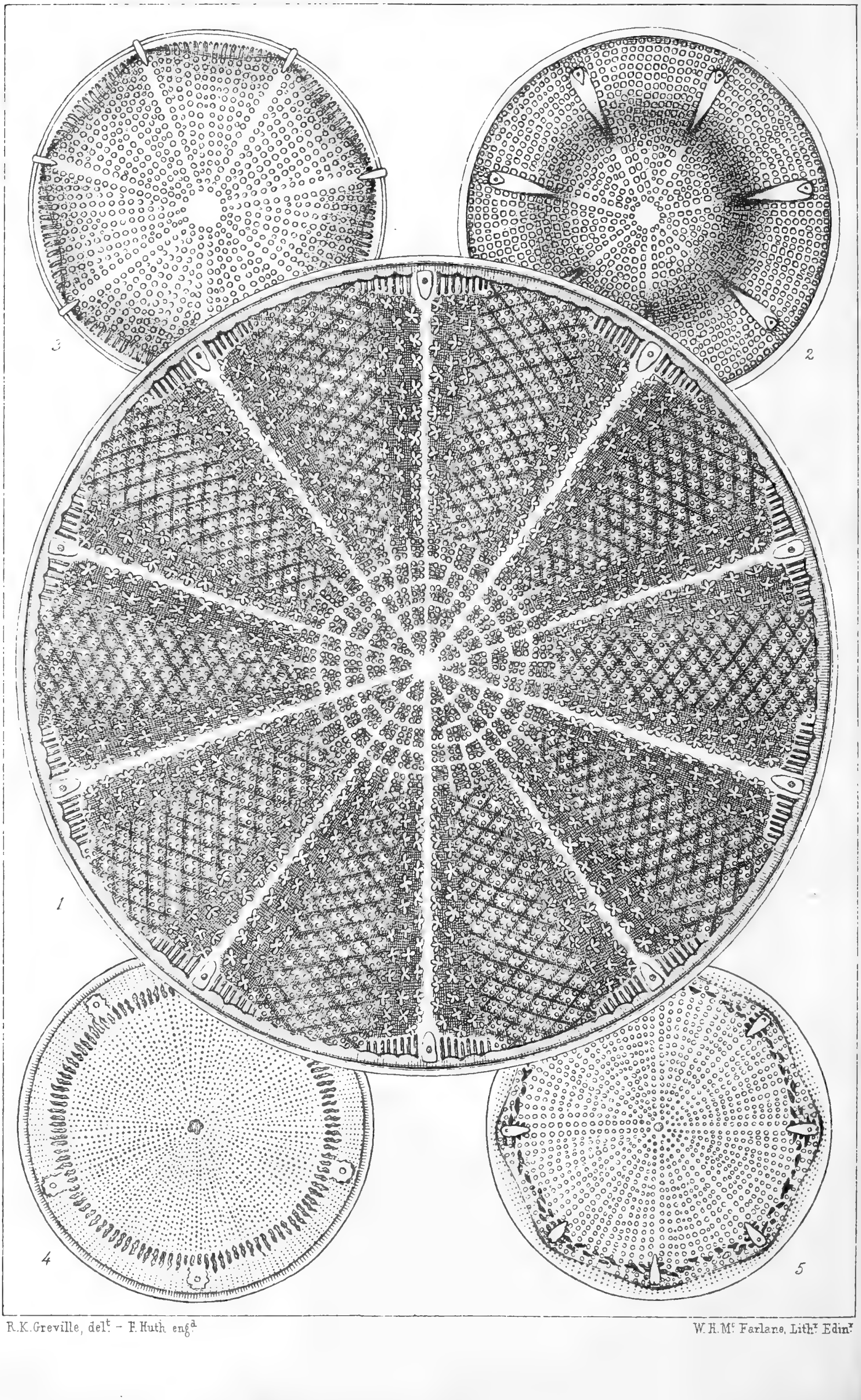
In this paper I have demonstrated an arrangement of the nerve-fibre upon the sarcolemma of insect-muscle which has not been described before, and in all probability has not been seen by any previous observer. The demonstration of this exceedingly delicate structure is due entirely to the mode of preparation followed.

From these observations I am led to conclude that nerves are distributed over every part of the surface of the sarcolemma. It is quite certain that fine nerve-fibres reach this membrane at a greater number of points than is represented in any of my drawings.

The mode of formation of the fine terminal bundle of nerve-fibres, as represented in Pl. XIV, fig 2, is a fact of the utmost importance, and, as I have shown, the arrangement is constant in all nerves in all animals. The fibre seems to divide into two bundles (*a*, *a*), which pass in opposite directions in the trunk. Oftentimes a nerve-fibre divides into two branches at the point where a bundle of fibres leaves the main trunk; of these, one passes into the branch, while the other continues its course with the other fibres in the original trunk.

There is no evidence of the nerve penetrating into the interior of the sarcolemma, as is maintained by many Continental anatomists. But, on the contrary, by careful observation of preparations properly prepared, with the aid of very high powers, the finest fibres may be focussed upon the surface of this membrane. The general course and arrangement of the nerves represented in fig. 1, and alluded to in previous memoirs, renders such a doctrine improbable, while there is a great amount of collateral evidence positively opposed to it. Moreover, not one of those who have propounded views opposed to those expressed in my first paper ('Phil. Trans.,' 1860) has adopted the mode of preparation I stated to be necessary, or has even injected the vessels, which I proved afforded important advantages in studying this anatomical question in vertebrate animals.

With reference to the observations of Kühne on the muscles of insects, I regret that my conclusions are hopelessly at variance with his, not only as regards matters of detail, but upon broad general points. His terminal nerve-fibre consists of a bundle of very fine fibres. Instead of a nerve-fibre perforating the sarcolemma at one point only of the muscle, and becoming connected with nuclei beneath this membrane; a bundle of very fine nerve-fibres, having reached the sarcolemma, ramifies freely over its surface, and is *not* connected with the nuclei beneath, which are probably only concerned in the formation of the contractile tissue. I regret being at issue with my friend upon simple matters of fact of this kind; but, as he is well aware, he has stated his conclusions so very positively, and has repeated them so frequently, with some modifications, however, that I can accept no compromise—nor can I allow the discussion to cease until the general points at issue have been more carefully investigated by others. I must again repeat the proposal I made some time since, that some one muscular structure should be agreed upon for investigation, and that those observers who have taken up this most important inquiry should write short memoirs, illustrated with drawings representing what they have seen, and, if possible, the preparations from which the drawings have been made should be preserved. The memoirs all to be published on a day previously agreed upon. Independent observers would thus have an opportunity of comparing the different conclusions one with another, and of forming their own opinion upon the questions at issue.



R.K. Greville, delt. - F. Huth engd

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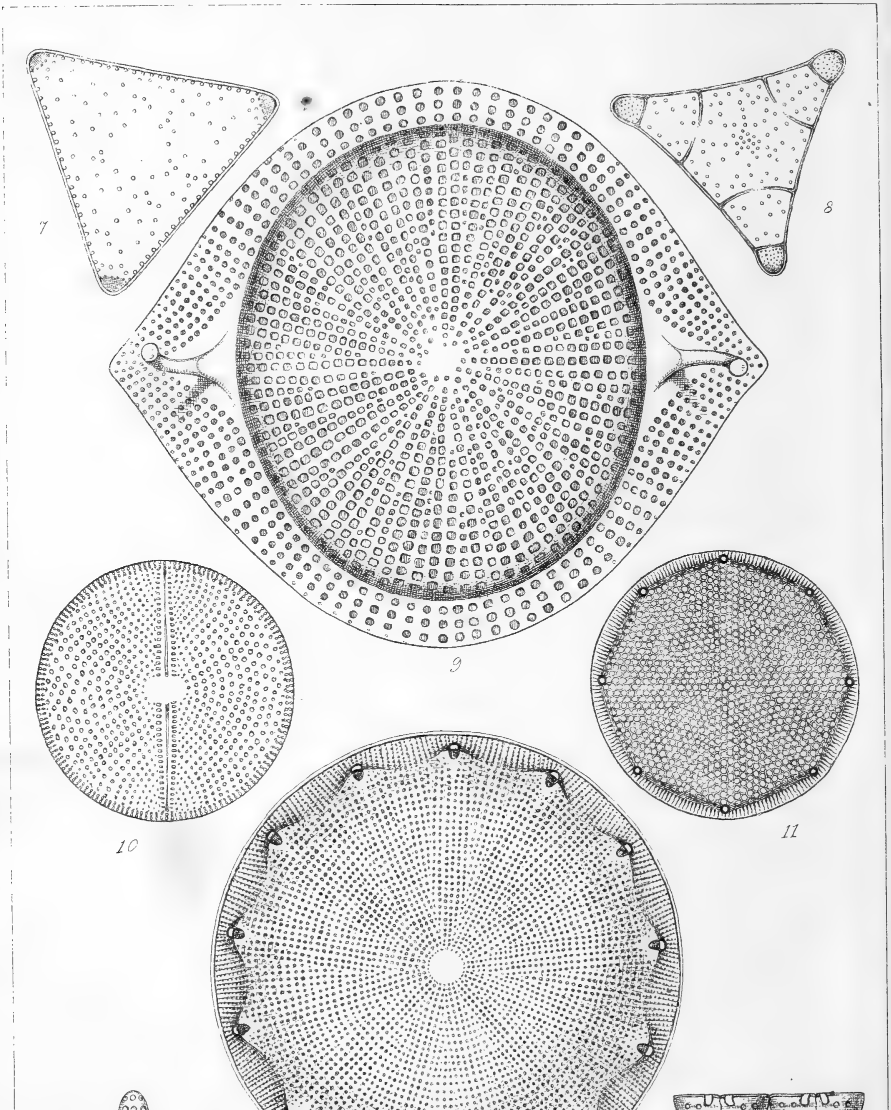

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DESCRIPTION OF PLATES I & II,

Illustrating Dr. Greville's paper on New Diatoms.
Series XI.

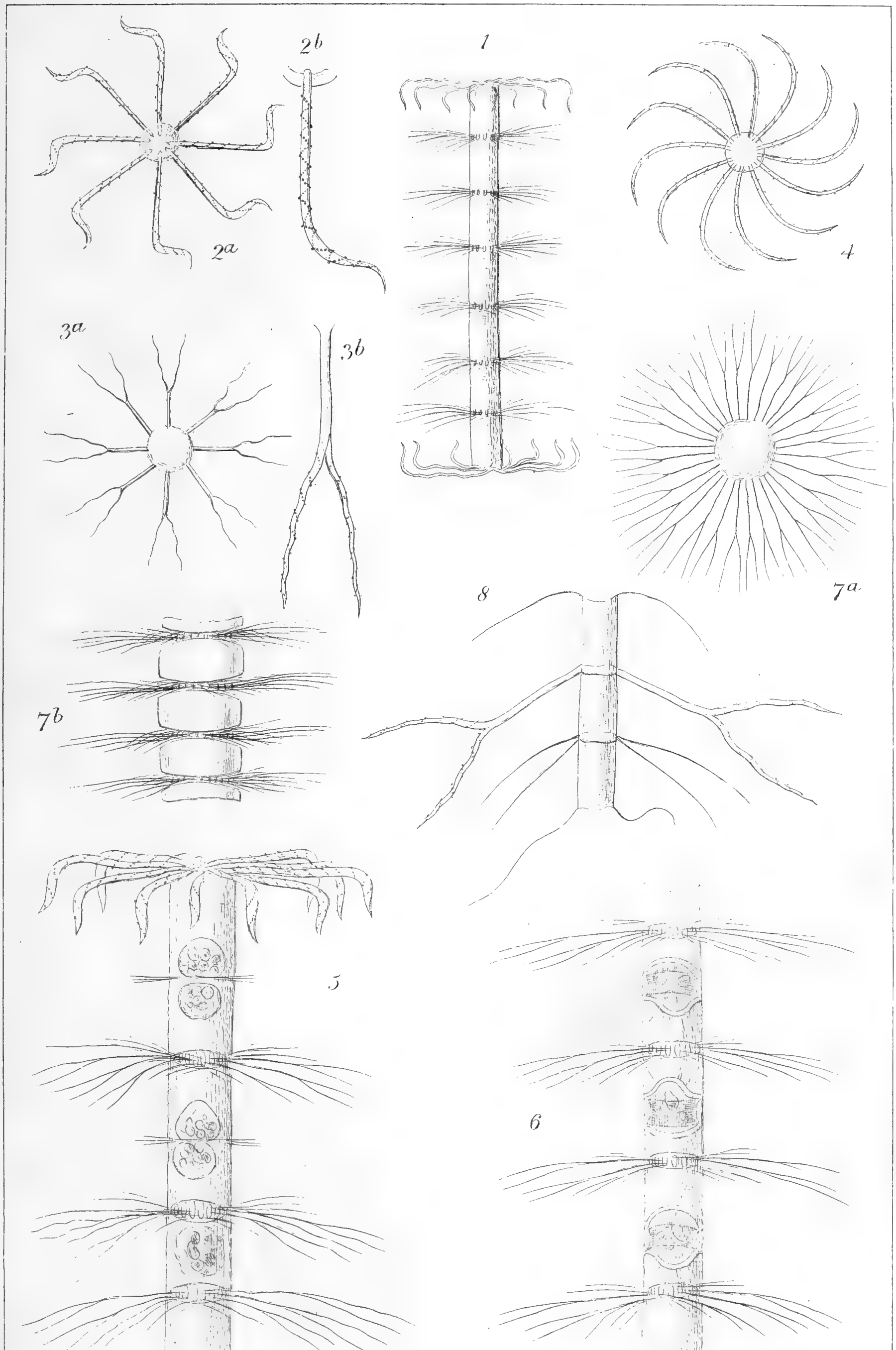
Fig.
1.—*Aulacodiscus Grevilleanus.*
2.— „ *umbonatus.*
3.— „ *amœnus.*
4.— „ *radiatus.*
5.— „ *pellucidus.*
6.— „ *orientalis.*
7.—*Triceratium concinnum.*
8.— „ *partitum.*
9.—*Biddulphia gigantea.*
10.—*Cocconeis Barbadensis.*
11.—*Coscinodiscus angulatus.*
12.—*Terebraria Barbadensis,* front view.
13.— „ „ side view.

All the figures are × 400 diameters.

DESCRIPTION OF PLATE III,

Illustrating Mr. Lauder's paper on New Diatoms.

Fig.
1.—Perfect filament of *Bacteriastrum varians.*
2 *a.*—Terminal cells.
2 *b.*—Separate awn.
3 *a.*—Intermediate cell.
3 *b.*—Separate awn.
4.—Terminal cells.
5.—Frustules of *B. varians.*
6.—Sporangium of same.
7 *a.*—*B. hyalinum.*
7 *b.*—The same.
8.—Species of Chactoceros.



W West Lith.r

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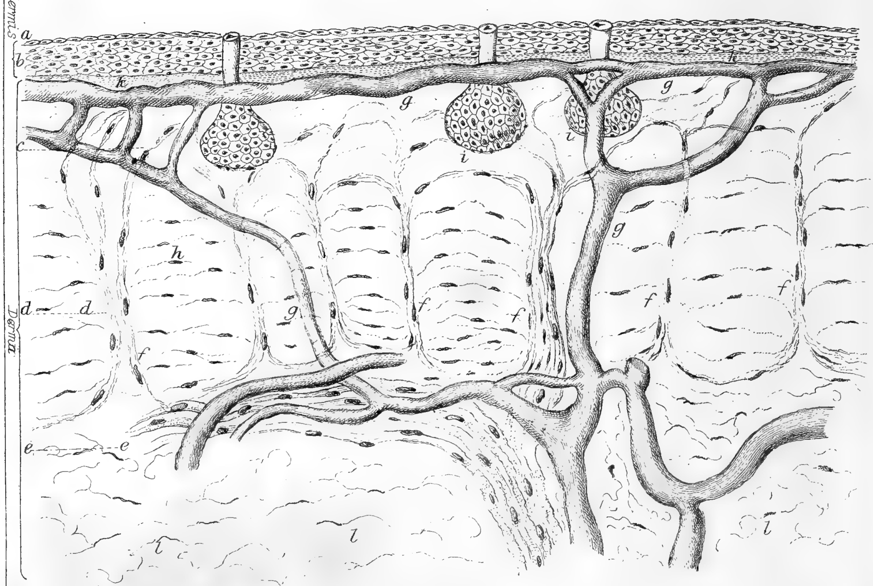
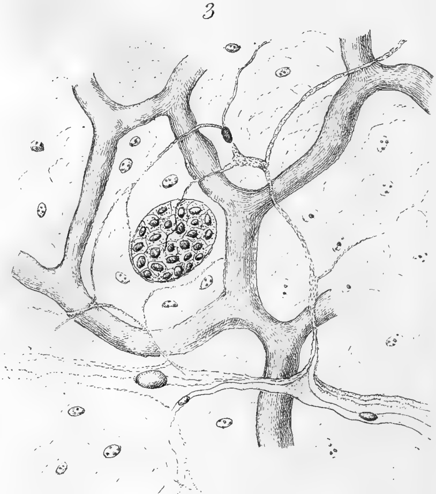


2

× 60

3



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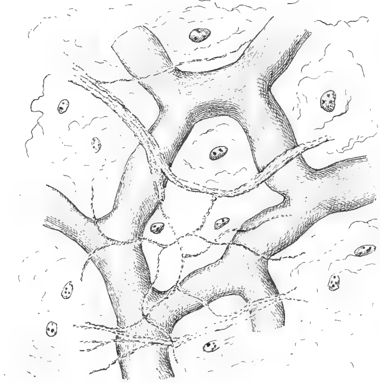
J. V. Ciaccio del. T. West sc.

W. West imp.

4



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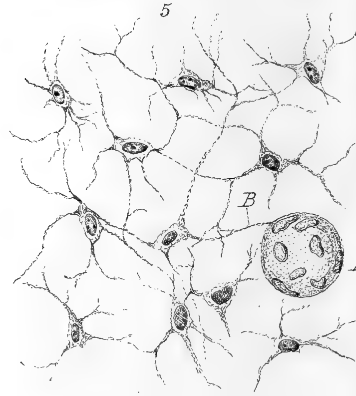

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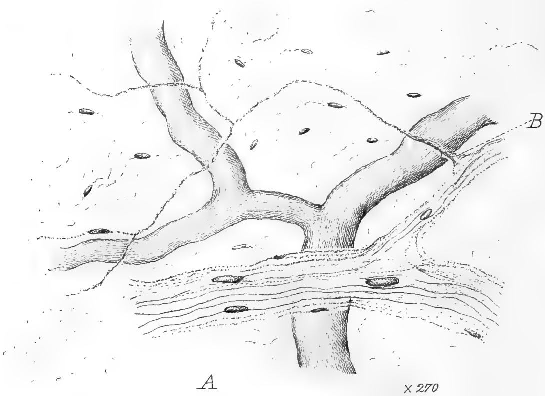

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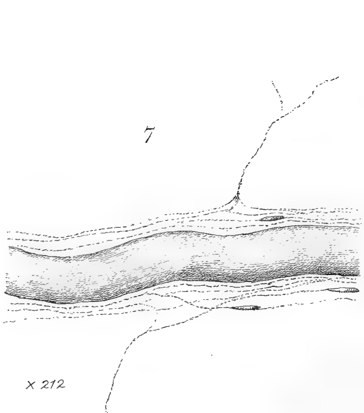

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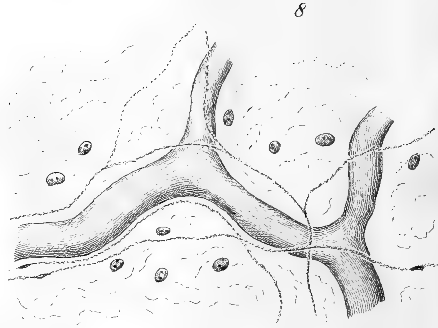

× 212

J. V. Ciaccio del. T. West sc.

W. West imp.

DESCRIPTION OF PLATES IV & V,

Illustrating Dr. Ciaccio's paper on the Distribution of Nerves to the Skin of the Frog, with Physiological Remarks on the Ganglia connected with the Cerebro-Spinal Nerve.

Fig.

1.—Perpendicular section of the skin of the frog: *a*, outer layer; *b*, inner layer; *c*, outer layer; *d*, middle layer; *e*, inner layer; *f*, bundles of dark-bordered nerve-fibres; *g*, capillary vessels; *h*, nuclei of middle layer; *i*, mucous glands; *k*, connective tissue between the superficial capillary vessels and the inner layer of the epidermis; *l*, fine fibres of elongated tissue.

2.—Division and subdivision of the bundles of dark-bordered fibres distributed to the inner layer of the derma of the frog. The bundles unite with one another in such a manner as to form a network, with meshes varying in size and shape. The nervous network is interlaced with that of the capillaries. In the drawing are also represented some branched cells of greenish pigment, and fine elastic fibres connected with nuclei. This kind of fine elastic tissue abounds in this layer. × 120.

3.—Fine nerve-fibres with one dark-bordered fibre, which divides and terminates in pale fibres. The fine nerve-fibres ramifying in the sheath, and the pale fibres in continuation with the dark-bordered fibres, very near the surface of the derma, mingle together and form bundles, which, in their course branch and pass to different distributions. Here may be seen two fine branches, distributed to one of those glands which exists in considerable number in this layer. The nuclei, which are, here and there, observed in the drawing, are the nuclei of development of the pigment-cells. From the outer layer of the derma. × 425.

4.—Terminal bundles of pale fibres continuous with dark-bordered fibres, which are not represented in the figure. The bundles are seen to divide and subdivide, and interchange their respective fibres. They form a plexus, which lies immediately beneath the capillaries. The fibres composing the bundles do not exhibit any of those spindle-shaped swellings which are so frequently observed in the nerve-fibres which run in the same sheath with the dark-bordered fibres, or with the capillary vessels. From the outer layer of the derma, seen from below. × 540.

5.—Transverse section of the middle layer of the derma:—A. Bundles of dark-bordered fibres cut across. B. Small bundles of fine fibres emerging from the sheath of the dark-bordered fibres. The bundle, on its way, is seen to divide and subdivide, and to be connected with a triangular body, which contains granular matter and an oval nucleus. C, C. Branching nucleated cells, very nearly resembling the cornea-corpuscles. The granular appearance they exhibit is most probably due to the prolonged action of diluted acetic acid. × 340.

6.—A. Bundle of dark-bordered fibres, crossing a capillary vessel and dividing into two branches. B. Fine bundle, composed entirely of some of the fine fibres running in the same sheath with the dark-bordered fibres. The bundle is seen to leave the sheath of the smaller branch, and to be distributed to the capillaries. From the inner layer of the derma. × 540.

7.—Capillary vessel from the inner layer of the derma, with nerve-fibres running on each side in same sheath. These fine nerve-fibres present, at unequal distances, spindle-shaped swellings. Some of the fibres are seen to leave the sheath, and to pass to other capillaries. × 425.

8.—Capillary vessels, with fine nerve-fibres distributed to them. From the outer layer of the derma. The fibres are seen to cross the capillaries in different directions, and to unite with one another.* × 425.

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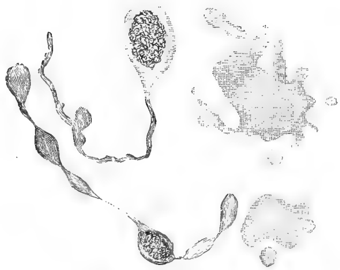
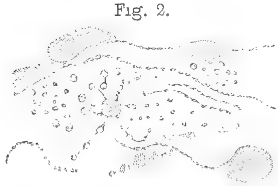
* It is necessary here to notice that, in consequence of the capillaries being injected with carmine solution, the numerous nuclei connected with their walls cannot be discerned, and, therefore, they have not been represented in the drawings.

Fig. 1.



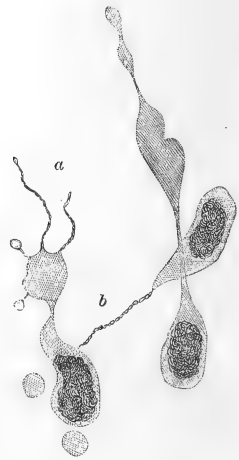
Curious spontaneous changes in form of Red Corpuscles of the Frog. × 700.

Fig. 2.



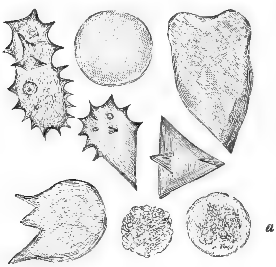
Vibratile Filaments and minute particles consisting of Viscid Coloured Matter. Blood Corpuscles of Human Subject. × 1800.

Fig 3.



Curious changes in form of Red Blood Corpuscles of the Frog, resulting from exposure to heat. The thin filaments of the red viscid matter were in constant and very active vibration. × 700.

Fig. 4.



Changes in form of Red Blood Corpuscles of Guinea Pig after removal from the body. × 1800.

Fig. 5.

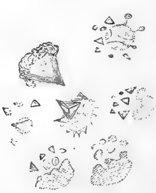
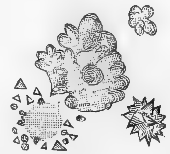
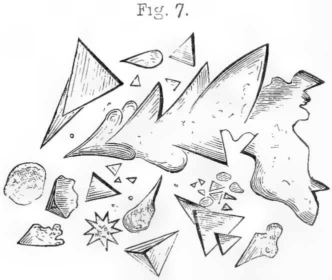


Fig. 6.



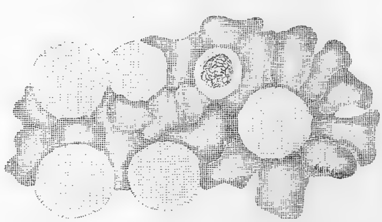
Disintegration of the Red Blood Corpuscles of the Guinea Pig, resulting from heat. Some have separated into several small particles, each of which has assumed the crystalline form. × 700.

Fig. 7.



Perfect Tetrahedral Crystals formed from Guinea Pig's Blood. In many cases one Corpuscle became one Crystal.

Fig. 8.



Colourless and scarcely visible Corpuscles in Guinea Pig's Blood (probably very young Red Corpuscles), surrounded by ordinary Red Blood Corpuscles.

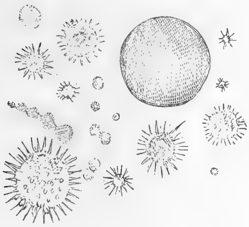
1000th of an inch × 700 linear.

1000th of an inch × 1800 linear.

L. S. B., ad nat. June, 1863.

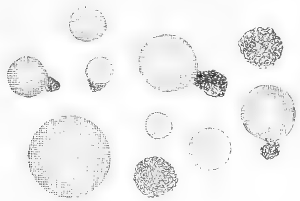
In all these drawings the colourless Germinal Matter, usually termed 'Nucleus,' is granular, and the coloured formed material is represented by a smooth tint.

Fig. 9.



Human Red Blood Corpuscles divided into spherical and stellate particles by pressure. × 1800.

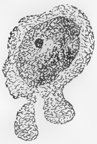
Fig. 10.



Colourless Matter separating from Red formed material of Human Blood Corpuscles. × 1800.

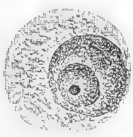
RED BLOOD CORPUSCLES.—FROG.

Fig. 11.



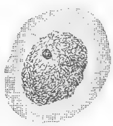
Young Corpuscle not yet coloured.—Frog. × 1800.

Fig. 12.



Young Red Corpuscle.—Frog. Formation of coloured portion, × 1800.

Fig. 13.

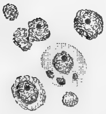


Young Red Corpuscle.—Frog. A part of coloured portion fully formed. ×1800

Fig. 14.

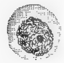
Young Red Corpuscle.—Frog. Coloured portion and Nucleus. × 700.

Fig. 15.



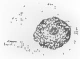
Division of very young Corpuscles (White Corpuscles) and formation of outer coloured portion.

Fig. 16.



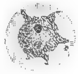
Nucleus Nucleolus and outer Red formed material.

Fig. 17.



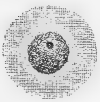
Change in form of outer Red formed material.

Fig. 18.



Movement of Germinal Matter, towards surface of Red formed material.

Fig. 19.



Oval Corpuscle become spherical in weak Glycerine.

Fig. 20.

Division of Germinal Matter or Nucleus.

Fig. 21.

Fig. 22.

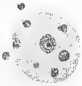
Old Red Corpuscles which have not assumed the spherical form. Nearly the whole of the Germinal Matter has been converted into colourless formed material,

Fig. 23.

Portion of Germinal Matter tending to separate into smaller portions,

Fig. 24.

Fig. 25.



Germinal Matter has divided into smaller portions, some of which have passed through the formed material into the surrounding fluid.

1000th of an inch ⊢—————⊣ × 700 linear.

1000th of an inch ⊢—————⊣ × 1800 linear.

L. S. B. ad nat. June, 1862.

DESCRIPTION OF PLATES VI & VII,

Illustrating Dr. Beale's observations upon the Red Blood-corpuscle (page 32).

PLATE VI.

Figs. 1 and 3 show the curious alterations in form observed to take place in the red blood-corpuscle of the frog. The corpuscles in fig. 1 assumed the forms represented within an hour after they had been removed from the frog, placed on a glass slide, and covered with thin glass. The change was clearly not due to pressure, because numerous corpuscles close to the altered ones retained their ordinary oval form. After the drawing was made, the thin filament in the upper part of fig. 1 became much longer, and exhibited *constant undulatory movements.*

By the application of a gentle heat (a little above 100°), long and very fine filaments were invariably formed, as shown in the case of human blood-corpuscles represented in fig. 2. All the filaments exhibited *very active undulatory movements,* and all the separate particles were in a state of *active molecular movement.* Many of these particles and filaments could not be distinguished in appearance from *bacteria.* This figure is magnified 1800 diameters.

In fig. 3 some of the curious vibratile filaments formed by the red colouring matter of the frog's blood-corpuscle, after the application of a gentle heat, are shown; *a* and *b*, filaments in active vibration.

The author considers that these changes in form could not occur if there was an envelope or cell-wall to the red blood-corpuscle.

Fig. 4 represents some of the appearances observed in the corpuscles of Guinea-pig's blood within an hour after its removal from the body. Many of the corpuscles were folded so as to appear as if they were sacs or envelopes; but the same appearances were produced when globules of strong syrup were suspended in strong glycerine. Several corpuscles were seen gradually to assume the crystalline form, but some retained their ordinary circular character, as shown in the upper part of the figure; at *a* two young corpuscles gradually undergoing conversion into red corpuscles are represented. This figure is magnified 1800 diameters.

After the application of a gentle heat, many of the blood-corpuscles of the Guinea-pig became disintegrated, as shown in fig. 5; and after the lapse of a short time each separate particle become a minute crystal. In other parts several corpuscles coalesced to form a compound mass of red viscid matter, as shown in fig. 6, which also gradually crystallized.

Fig. 7 represents fully formed tetrahedral crystals, and blood-corpuscles in process of change into crystals, from Guinea-pig's blood—magnified 700.

These facts seem to the author incompatible with the existence of a cell-wall or envelope, and seem to show that the red blood-corpuscle is composed of viscid "colloid" matter, which, by rest and slight concentration, becomes crystalline.

Fig. 8 shows some very transparent blood-corpuscles in Guinea-pig's blood. These were not visible upon examination with a power of 700 diameters, and even with a power of 1800 diameters it is doubtful if they would have been observed, but for the circumstance that they were surrounded by ordinary red blood-corpuscles, as represented in the figure. The author regards these as very young and but yet colourless, red blood-corpuscles. Magnified 1800.

PLATE VII.

Fig 9.—Red blood-corpuscles of the human subject divided into smaller portions by pressure. A needle was firmly drawn across the thin glass covering the corpuscles; many of those in the line of pressure were divided, and every particle resulting from the division instantly assumed the spherical or stellate form, as represented in the figure. An ordinary red blood-corpuscle is seen in the upper part—magnified 1800 diameters.

This fact shows that the red blood-corpuscle consists of viscid semifluid material, portions of which, when suspended in fluid, may assume the crystalline form.

Fig. 10.—Young red blood-corpuscles from human blood, showing the colourless germinal matter moving away from the coloured formed material —magnified 1800 diameters.

The germinal matter of the remaining figures was coloured red by an ammoniacal solution of carmine. The depth of the tint is shown by the darkness of the shading.

Fig. 11 is a very small and young frog's blood-corpuscle. The outer matter has not yet undergone conversion into the coloured formed material. It exhibits two outgrowths or protusions, of precisely the same nature as those seen in the living mucus-corpuscle, pus-corpuscle, and young epithelial cells (see Plate IX, fig. 15, in last number)—magnified 1800 diameters.

Fig. 12.—A frog's blood-corpuscle, in which the outer part is undergoing conversion into coloured formed material—magnified 1800 diameters.

Fig. 13.—Another very small corpuscle, in which the formation of a small quantity of the coloured matter is complete—magnified 1800 diameters.

Fig. 14.—Another corpuscle showing the same point, but magnified only 700 diameters. In this and some other corpuscles it might be said that a nucleus, nucleolus, and nucleolulus exist.

Fig. 15, 16.—Different stages in the formation of the red blood-corpuscle of the frog. The youngest particles would be called small white blood-corpuscles. They are entirely coloured by carmine.

Fig. 17.—Alteration in form of the outer coloured portion.

Fig. 18.—Movement of germinal matter towards the surface of the coloured formed material.

Fig. 19.—An ordinary fully formed but young blood-corpuscle of the frog, in which the nucleus (mass of germinal matter) is large.

Fig. 20.—Another corpuscle, in which the mass of germinal matter has subdivided into smaller portions.

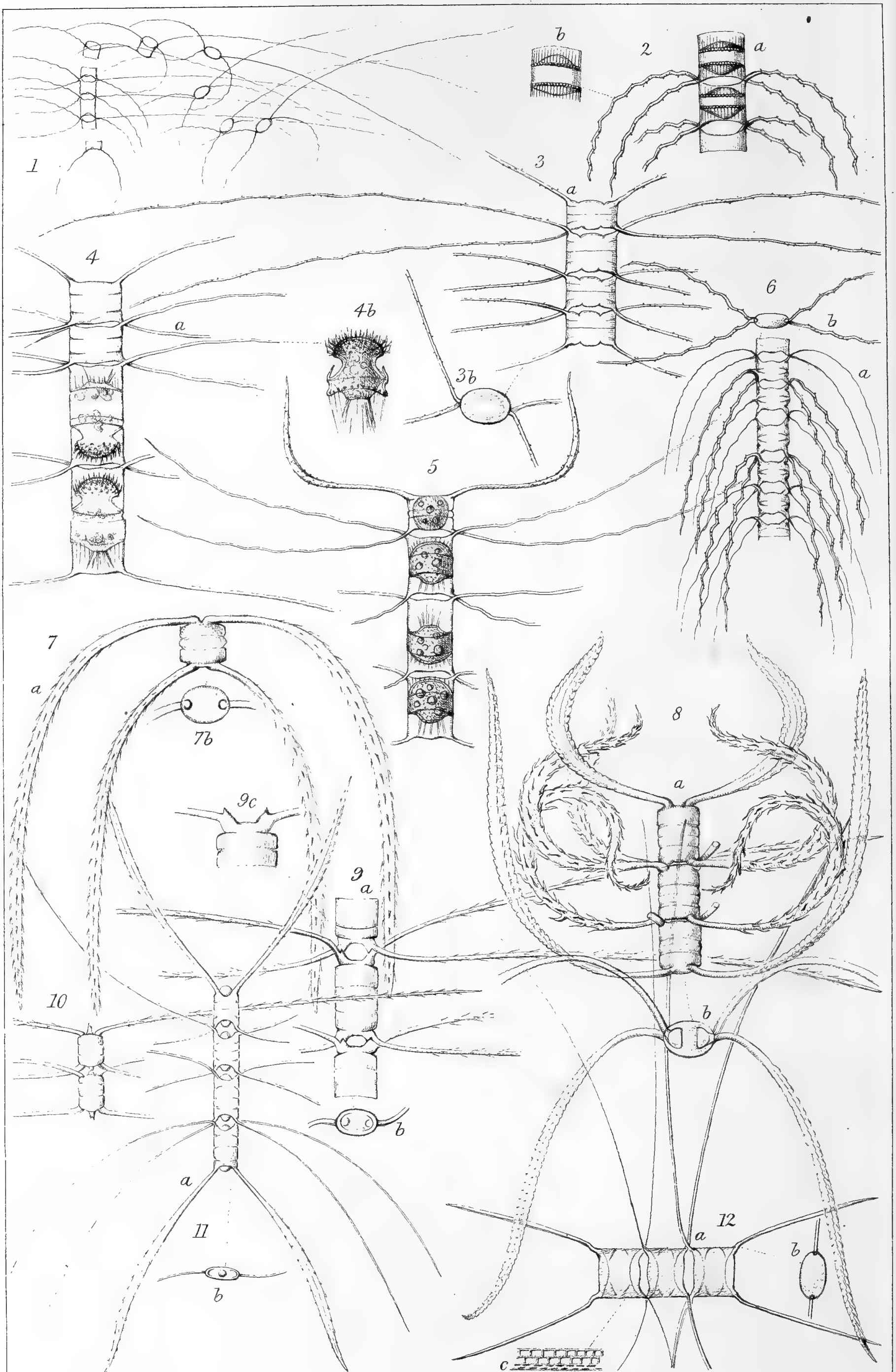
Figs. 21, 22.—Old blood-corpuscles of the frog. The coloured matter is so condensed that it does not become spherical, as in the case of the young corpuscles (figs. 14, 16, 18, 19, 20, 23), when placed in moderately strong glycerine, but retains its ordinary oval form.

Contrast the small mass of germinal matter in proportion to the formed material, in these *old corpuscles*, with the large mass which forms the greater part of the bulk of *the young frog's blood-corpuscles* (figs. 11 to 16).

Fig. 23.—Germinal matter collecting towards the surface, and about to divide into separate portions.

Figs. 24, 25.—Corpuscles in which the germinal matter has separated into small portions, some of which have escaped through the viscid red matter in the surrounding fluid.

Figs. 15 to 24 magnified 700 diameters.



Tuffen West sc. ad nat.

W. West imp.

DESCRIPTION OF PLATE VIII.

Illustrating Mr. Lauder's Remarks, with Illustrations of the Marine Diatomaceæ of New Species found in Hong Kong.

Fig.

1.—*Chætoceros socialis.*

2.—*C. ciliata.*

3.—Variety of *C. Lauderi.*

4—.*C. Lauderi.*

5.—*C. affine.*

6.—*C. compressa.*

7.—*C. boreali?*

8.—*C. coarctata.*

9.—*C. denticulata.*

10.—*C. rostrata.*

11.—*C. protuberans.*

12.—*C. cellulosa.*

TRANSACTIONS OF MICROSCOPICAL SOCIETY.

PLATE IX,

To illustrate Dr. Beale's Observations on the Germinal Matter of the Blood and on the Formation of Fibrin.—Page 47.

a

b

Red and
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L. S. B

Fig. 6.

From a pale clot in the heart of a patient who died of exhaustion, showing white corpuscles and fibres of fibrine. × 700.

Fig. 7.

Portion of a large mass of 'fibrine' from guinea pig's blood the instant coagulation had occurred. × 1800.

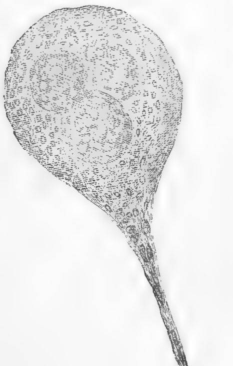
Fig. 8.

Capillary vessel from the mucous membrane of the epiglottis from a man aged 74. × 700.

Fig. 9.

One of the masses of germinal matter from the interior of the capillary (Fig. 8). × 700.

Fig. 11.



White blood corpuscle (human subject), with thread of fibrine connected with it. × 1800.

Fig. 12.

Capillary from areolar tissue. Mouse. × 700.

Harrisons Impt.

Fig. 1.

Red and white corpuscles in blood from the finger × 2800 linear. The large smooth circular bodies are the red corpuscles. Three very small red corpuscles are less than the 1-[illegible]th of an inch in diameter. The smallest particles are composed of matter like that of which the white blood corpuscle (B) consists. Threads of fibrine undergoing coagulation are observed between the corpuscles in the upper and lower part of the field. A, red corpuscle exhibiting angular projections. Above A and to the right, is another with still more pointed processes. September 1863.

Fig. 2.

Altered white corpuscle. Corpuscles of this form were common in blood an hour after it had been drawn from the finger. The projecting processes consist of germinal matter becoming changed into fibrine. × 1800.

Fig. 3.

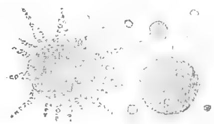
Fig. 4.

Two white blood corpuscles [illegible] granules [illegible] appearance are larger and more [illegible] (Fig. 3) than in young ones (Fig. 4) [illegible] which alone forms the [illegible] × 1800 linear.

Fig. 5.

From periosteum of tooth. Young vessel with included corpuscles (white blood corpuscles). At A it was continuous with a small artery. B, a vessel at an earlier stage. C, two cells shewing how the tube is formed. The germinal matter of the cell gives rise to the included corpuscles. × 700.

Fig. 10.



Corpuscles, consisting of germinal matter in the 'lymph,' from a vaccine vesicle shewing changes in form which occurred a few minutes after it was transferred to a warm slide. × 1800.

Fig. 6.

From a pale clot in the heart of a patient who died of exhaustion shewing white corpuscles and fibres of fibrine. × 700.

Fig. 7.

[illegible] coagulation had occurred. × 1800.

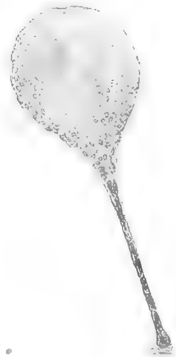
Fig. 8.

Capillary vessel from the mucous membrane of the epiglottis from a man aged 74. × 700.

Fig. 9.

One of the masses of germinal matter from the interior of the capillary (Fig. 8). × 700.

Fig. 11.



White blood corpuscle (human subject), with thread of fibrine connected with it. × 1800.

Fig. 12.

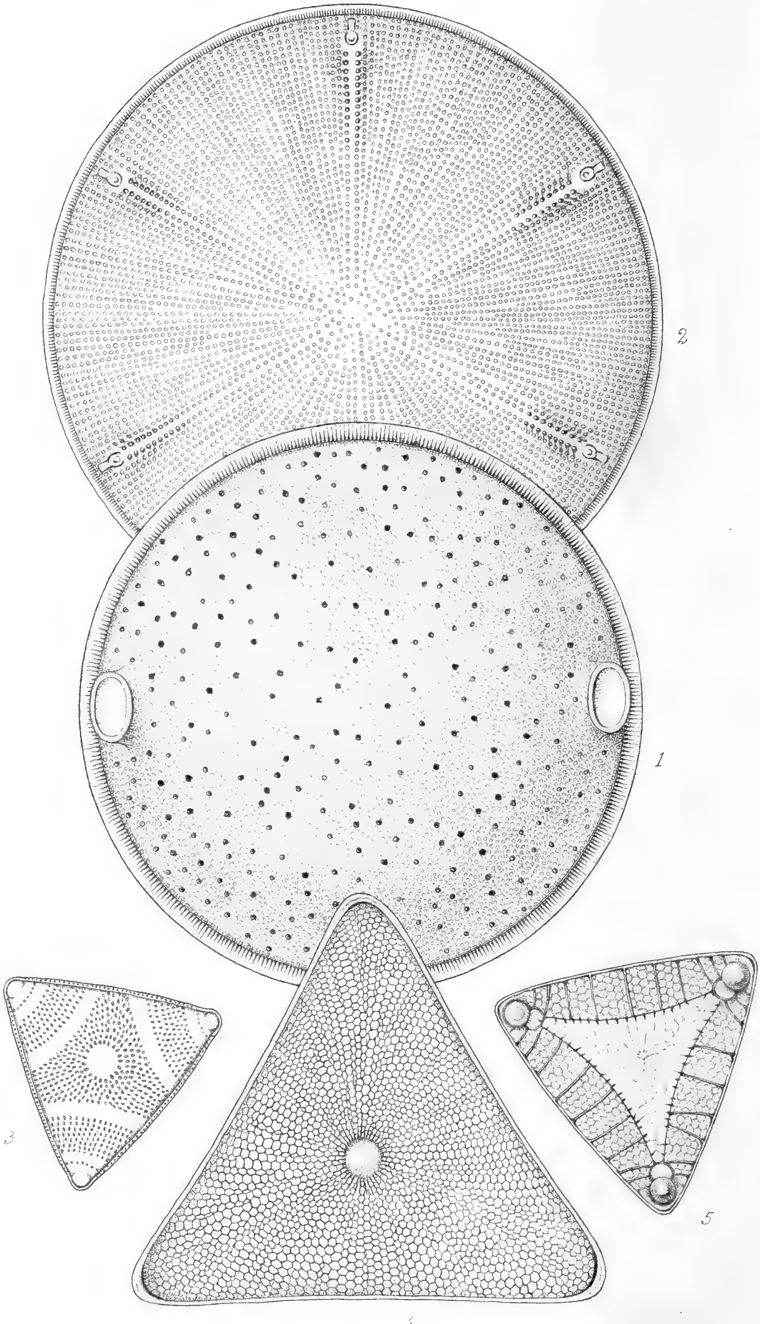
Capillary from areolar tissue. Mouse × 700.

1000th of an Inch × 700

1000th of an Inch × 1800

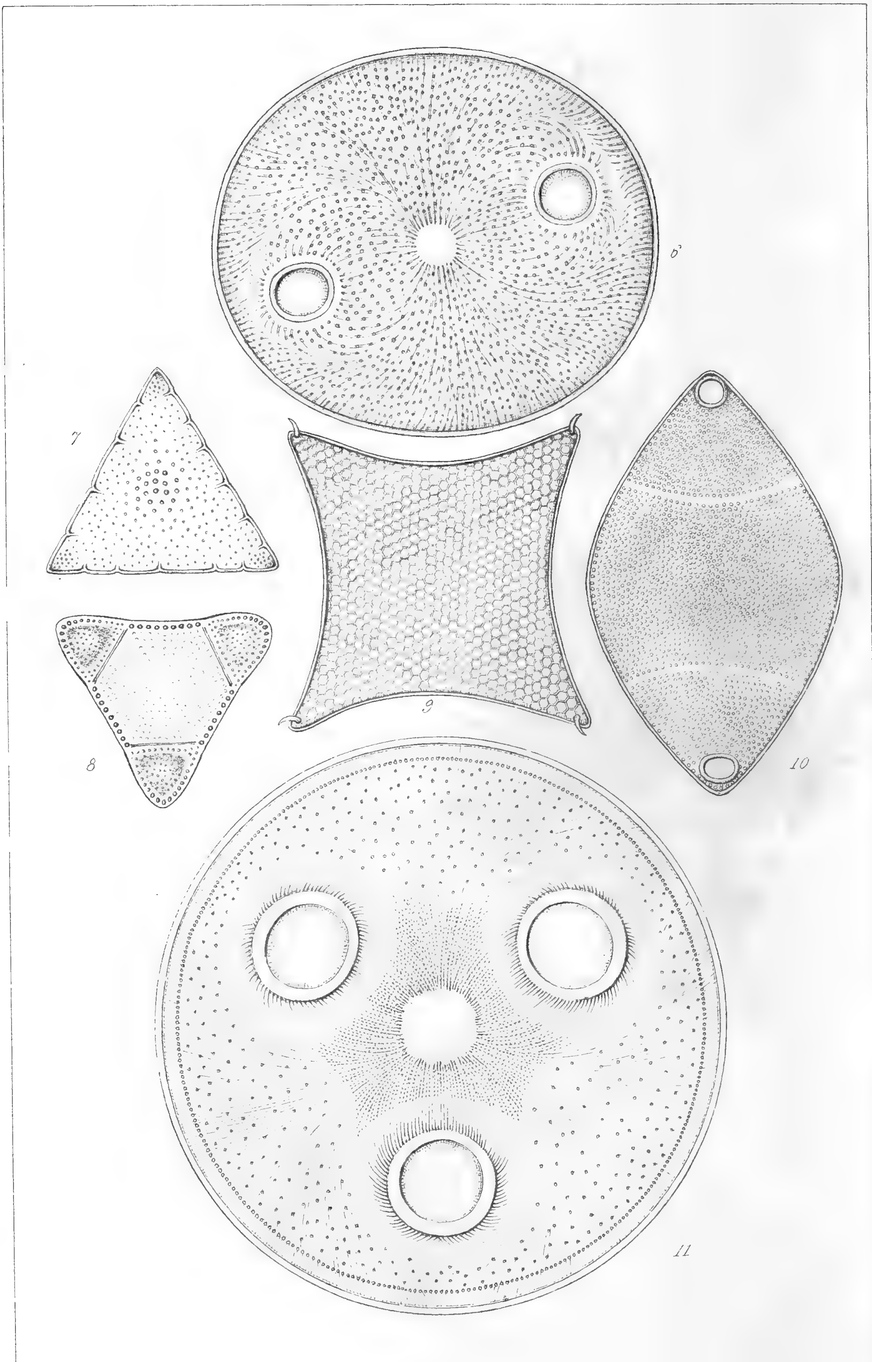
L. S. B. ad nat.]

Harrisons Imp.



R.K.Greville, delt. – F. Huth, engd

W.H.McFarlane, Lithr. Edinr.



R. K. Greville, del^t - F. Huth, eng^d

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

DESCRIPTION OF PLATES X & XI,

Illustrating Dr. Greville's paper on New Diatoms.
Series XII.

Fig.

1.—*Eupodiscus scaber.*

2.—*Aulacodiscus decorus.*

3.—*Triceratium zonatum.*

4.— „ *plumosum.*

5.—*Entogonia reticulata.*

6.—*Auliscus Moronensis.*

7.—*Triceratium pallidum.*

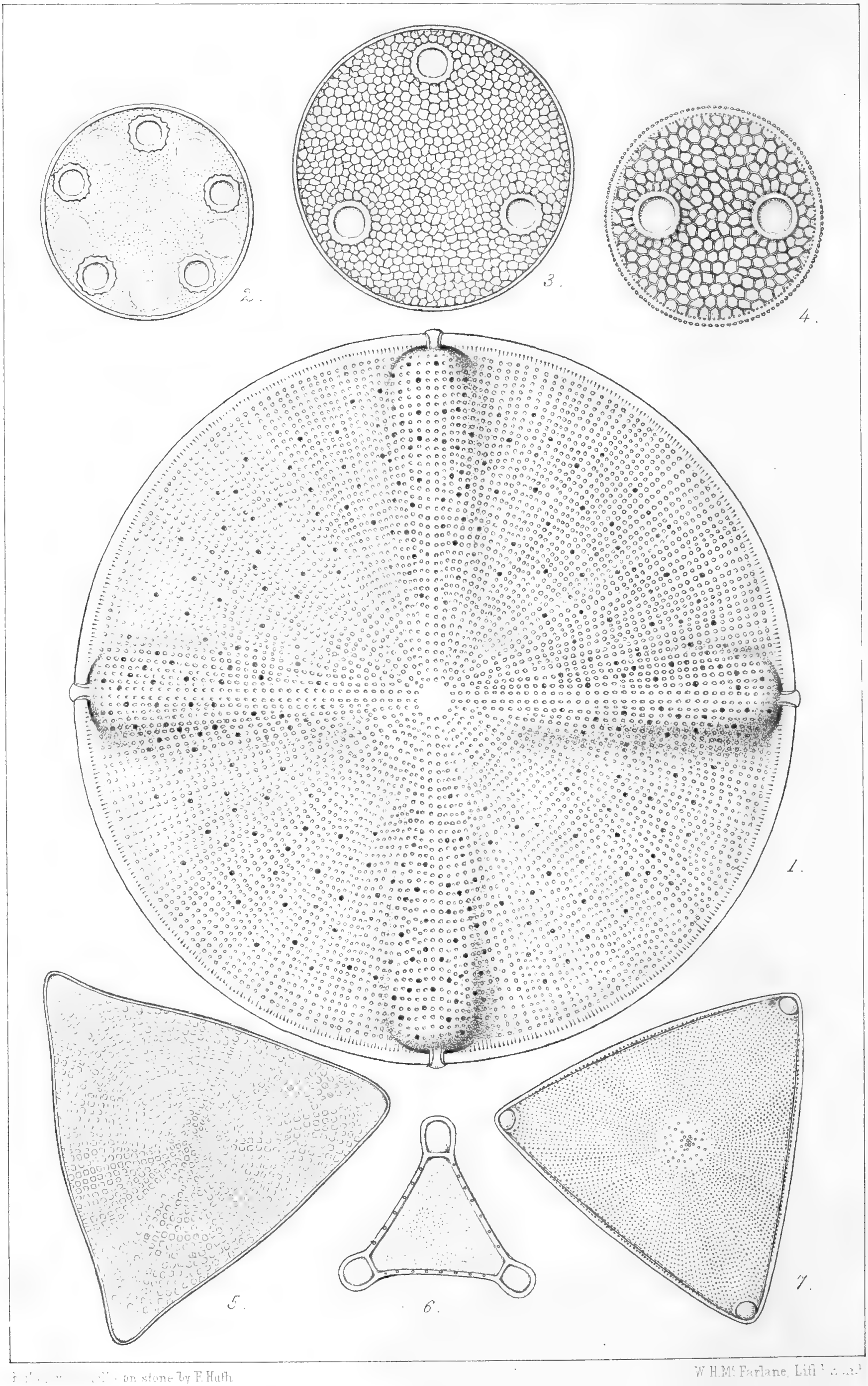
8.— „ *definitum.*

9.— „ *unguiculatum.*

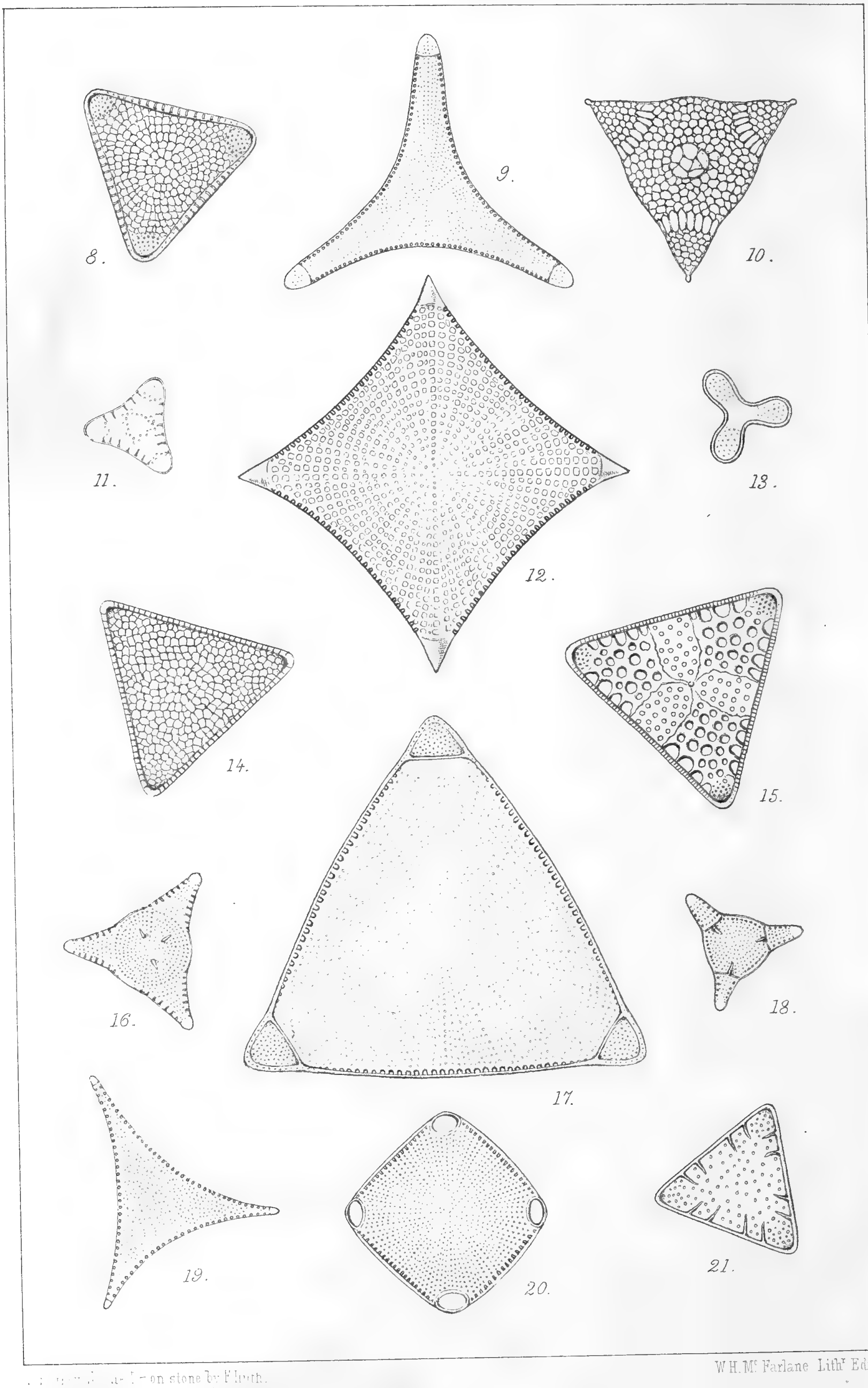
10.—*Biddulphia punctata.*

11.—*Auliscus Normanianus.*

All the figures are × 400 diameters.



on stone by F. Huth
W. H. McFarlane, Lith.



[illegible] on stone by F. Huth.

W.H. McFarlane Lith. Edin.

DESCRIPTION OF PLATES XII & XIII,

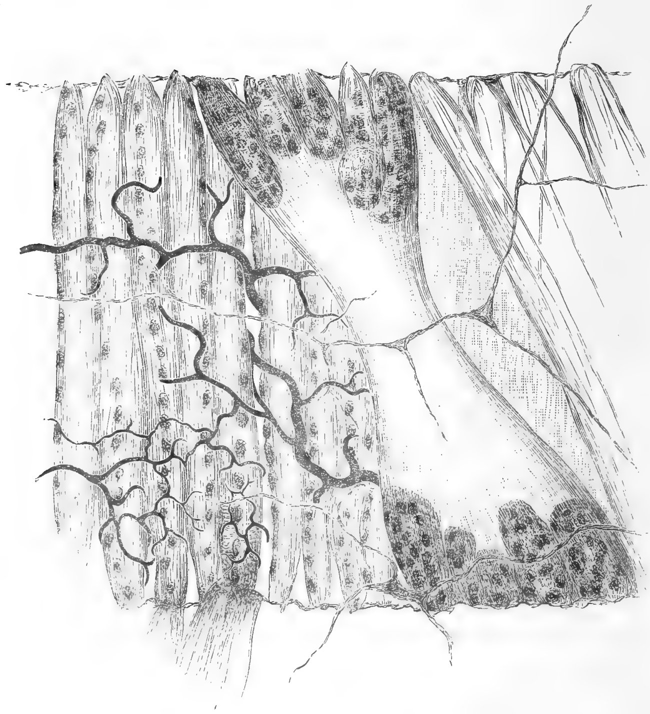
Illustrating Dr. Greville's paper on New Diatoms.
Series XIII.

Fig.

1.—*Aulacodiscus extans*
2.—*Auliscus ornatus.*
3.—*Eupodiscus trioculatus.*
4.— „ *Barbadensis.*
5.—*Triceratium irregulare.*
6.— „ *Rylandsianum.*
7.— „ *Smithianum.*
8.— „ *firmum.*
9.— „ *ligulatum.*
10.— „ *attenuatum.*
11.— „ *obesum.*
12.— „ *acutangulum.*
13.— „ *perpusillum.*
14.— „ *modestum.*
15.— „ *foveatum.*
16.— „ *prætenue.*
17.— „ *microstictum.*
18.— „ *perminutum.*
19.— „ *inæquale.*
20.— „ *oculatum.*
21.— „ *venulosum.*

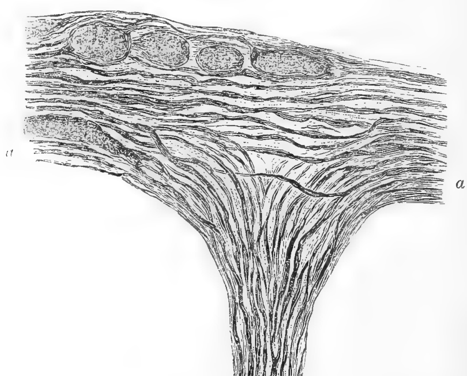
All the figures are × 400 diameters.

Fig. 1.



Arrangement of muscular fibres, nerves, and tracheæ of the common maggot. The muscles represented are concerned in shortening the body. They are connected at each extremity with one of the segments. The contractile tissue of the muscular fibre in the centre of the drawing has been ruptured, and has contracted within the tube of the sarcolemma. A fine branch of the nerve trunk is seen to cross the sarcolemma and give off a still finer branch, which, after being followed for a short distance, appears lost upon the sarcolemma. If the nerve trunk be traced, many other branches distributed in a similar manner will be observed. The tracheæ, represented only in one part of the drawing, are black. × 40.

Fig. 2.



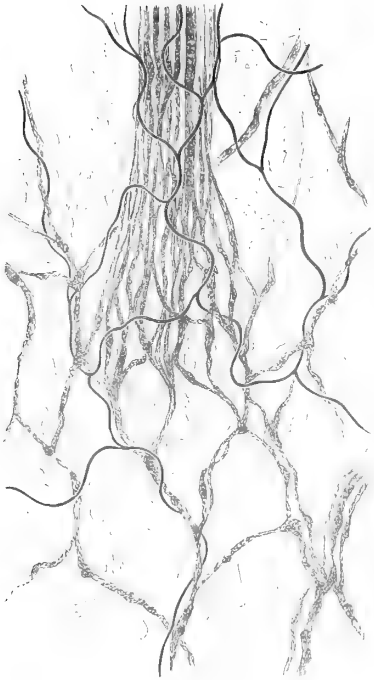
The point where the fine nerve trunk, which seems to be lost upon the surface of the sarcolemma in Fig. 1, leaves the larger trunk which crosses the muscle. Observe that the fibres of the fine branch divide into two bundles, which proceed in opposite directions in the nerve trunk. × 1100.

L. S. B. ad nat.

March, 1864.

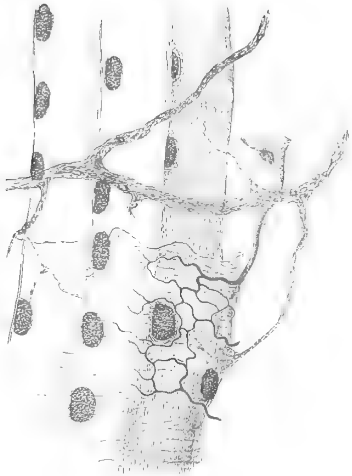
[Harrison's Impt.

Fig. 3.

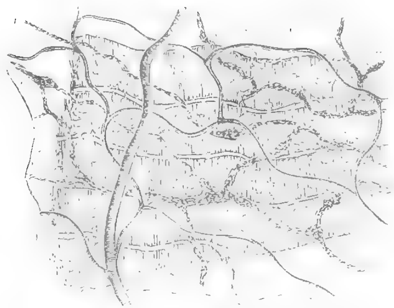


The lower part of the fine fibre which seems to be lost upon the surface of the sarcolemma in Fig 1 The fine nerve fibres are seen to divide and subdivide forming a network or plexus upon the surface of the sarcolemma The finest tracheæ are also seen to form a network × nearly 3000

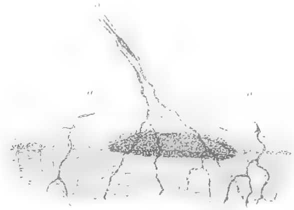
Fig. 7.



Sarcolemma partly torn away from the muscular fibre shewing how the tracheæ and finest nerve fibres reach this membrane and ramify upon its external surface The large nerve trunk with several of its branches and the fine fibres distributed to the sarcolemma are well seen Also observe the network of tracheæ Maggot × 215

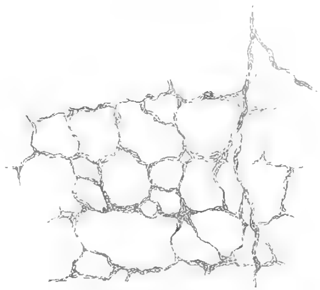


portion of the sarc[illegible] ramifying upon its s[illegible] a portion of the mu[illegible] fig[illegible] is seen beneath it [illegible]



Point where a fine bundle of nerve fibres B, becomes connected with the sarcolemma C, and divides into finer fibres which ramify upon its surface The membraneous sarcolemma is connected with the nerve fibre and when the latter is stretched a portion of sarcolemma is drawn up in a conical form as represented in this drawing and also in fig 7 A fine trachea A A seen upon each side This is one of the nerves fibres of ant[illegible] × 700

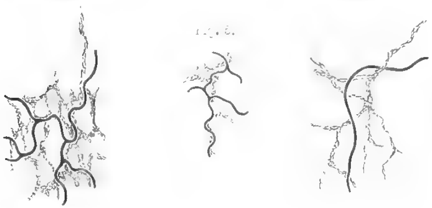
Fig. 6



A very fine nerve fibre at the point where it divides upon the surface of the sarcolemma into numerous branches which form a network or plexus Maggot × 1800

Fig. 11

A part of a muscular fibre, with nerve fibres, capillary vessels and vascular nerves × 700 Phil Trans 1860



Network of finest branches of the nerve fibres and their relation to tracheæ × 1000

1000th of an Inch × 700.

1000th of an Inch × 1800

L S B ad nat.

March 1864

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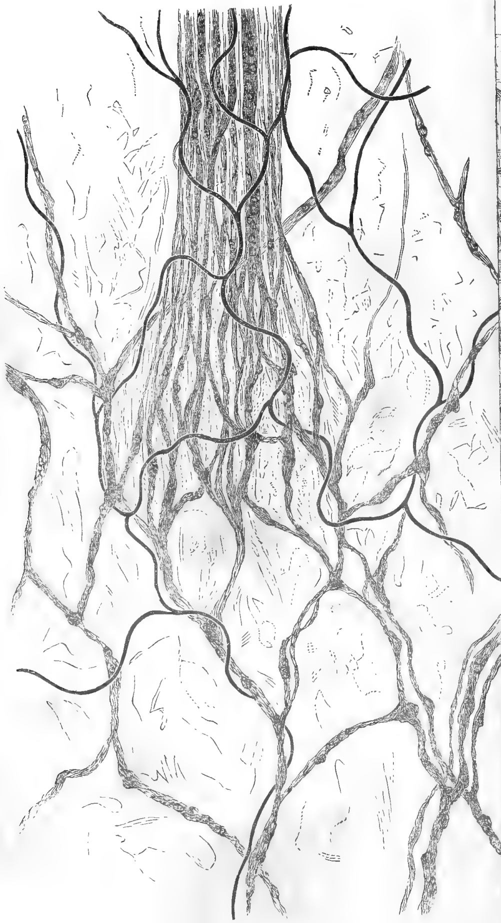
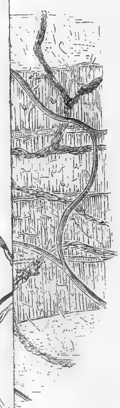
PLATE XV.

Fig. 3.





nerve fibres
sue, with its
1800.

onnected
s, which
a is con-
etched a
as repre-
a, A A, is
authors.

The lower part of the fine fibre which seems to be lost upon the surface sarcolemma in Fig. 1. The fine nerve fibres are seen to divide and subd forming a network or plexus upon the surface of the sarcolemma. The tracheæ are also seen to form a network. × nearly 3000.

Fig. 4.

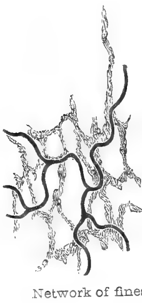


Fig. 5.

Fig. 6.

Network of finest branches of the nerve fibres and their relation to trac vessels, × 1000

L. S. B. ad nat.

March, 1864.

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DESCRIPTION OF PLATES XIV & XV,

Illustrating Dr. Beale's observations on the Distribution of Nerves to Insect-Muscle (page 94).

The elementary muscular fibres represented in fig. 1 are of large size, and consist, for the most part, of five subdivisions, all included within the tube of the sarcolemma. But, in some cases, tracheæ and nerve-fibres dip down in the intervals between the subdivisions. Sometimes the subdivision is distinct at the two extremities of the muscle without existing at the central part, in which case fine nerve-fibres and tracheæ pass around the subdivided portions, but do not perforate the central part of the muscle. In all cases branches of nerve-fibres and tracheæ pass over the entire surface of the muscle. The appearances described are observed in fully developed muscles, not in young ones. It would appear as if there was first the tube of the sarcolemma, which formed subdivisions, and exhibited a tendency to the formation of subordinate tubes; or the sarcolemma of these muscles of the maggot might be regarded as a transparent matrix, in which fine elementary muscular fibres, connected together in the central part, were imbedded, just as the so-called tubular membrane of nerve-fibre often appears as a fine transparent matrix, in which *several* dark-bordered nerve-fibres are imbedded.*

The general course of the nerve-trunks is well seen in this figure. They cross the muscles at right angles, and give off branches which may be traced to the surface of the sarcolemma. The trunks do not divide and subdivide into branches, each of which is distributed to a muscle, as has been represented; but they pass completely over several muscles, receiving several branches in their course, and these seem to be composed of the ultimate ramifications of numerous finer bundles, which are distributed to contiguous muscles.

The arrangement and number of the "nuclei," or masses of germinal matter of the muscle, are well seen in the part of this fig. 1 to the left of the observer. The nerve-nuclei are much smaller than those of the muscle. Some are represented in fig. 2, which is very highly magnified.

Fig. 2 shows that the very fine fibre, which may be considered as terminal, and which seems lost upon the surface of the sarcolemma in fig. 1, really consists of exceedingly fine nerve-fibres, which, as they approach the larger trunk, divide into two bundles (*a*, *a*) which take *opposite courses in the trunk.* This is fact of the utmost importance, and, as it is constantly observed, forms a strong argument against the view which supposes that nerve-fibres terminate in free *ends*, while it is in favour of the conclusions to which I have been led from many different inquiries as to the existence of complete *circuits.* My observations all point to one conclusion—that a nerve never ends, and that nerve-fibres invariably form complete circuits.

The further ramifications of the nerve, and its subdivision into extremely fine fibres, which ramify upon the surface of the sarcolemma, are represented

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* See 'New Observations on the Structure of Nervous Centres,' &c. Churchill and Sons, 1864. Also a paper in No. XIV of my 'Archives.'

n the figures in Plate XV, which will be readily understood from the description under each figure. The ultimate ramifications of the nerve, which form a plexus or network, must be considered as consisting of still finer fibres, perhaps not anatomically distinct, but still composed of matter which is traversed by nerve-force in many different lines.

The arrangement of the tracheæ in these drawings is also worthy of examination.

In figs. 7 and 10 the manner in which the finest nerve-fibres pass to the surface of the sarcolemma is represented. The appearance has been interpreted by Kühne in a very different manner. He considers that the nerve *penetrates* the sarcolemma at the summit of the conical portion, and forms within a little terminal elevation, consisting of its subdivisions and nuclei (*nerven-hügel*). Kühne has described as a single terminal nerve-fibre what really consists of a bundle of fine fibres. These, however, could not be demonstrated by the process of investigation employed by him. Nor was it possible that either of the fine nerve-fibres or tracheæ ramifying over the sarcolemma, and figured in the drawings accompanying this paper, could be seen in his specimens. Those who have recently written upon this subject in Germany have, in fact, made the nerves end or cease at the point where they commence to ramify over the surface of the sarcolemma.

*** The nuclei in the nerve-trunks represented in fig. 7 as pale spots, should have been coloured like the other nuclei in the figure.

INDEX TO TRANSACTIONS.

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