Alex Agassiz

TRANSACTIONS

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TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY OF LONDON.

DESCRIPTION *of a* DIAPHRAGM EYE-PIECE *for the* MICROSCOPE. By HENRY J. SLACK, F.G.S., Hon. Sec. Mic. Soc.

(Read October 10th, 1866.)

IN viewing small objects by transmitted light, it frequently happens that distinct vision is impaired, and the eye injuriously affected by the large size of the surrounding luminous field. If we may compare the objects to an engraving, and the rest of the luminous field to a white margin, we shall find that different objects require a different portion of margin for their most pleasant and efficient display.

With a given intensity of illuminating power, it is evident that the quantity of light affecting the eye will depend upon the size of the space from which the light proceeds, and it will be frequently found that the whole aperture of an eye-piece admits far too much light when the intensity is nicely proportioned to the requirements of the object. It is therefore desirable to have a ready means of cutting off the superfluous light by reducing the size of the luminous field, and, as objects vary, not only in size, but in their relative proportions of length and breadth, it is further desirable that the field should be susceptible of corresponding changes.

Having these objects in view, the writer requested Mr. Ross to adjust four moveable shutters, so that an A eye-piece might be susceptible of all the changes in the form and size of its field that different objects would require. This has been accomplished in the eye-piece now shown to the society. The new diaphragm stops are placed immediately over the ordinary round stop of the A eye-piece, and they are worked by four milled heads conveniently situated on the flange of the eye-piece, and slightly projecting beyond it. Each of these milled heads moves one shutter, which is capable of closing half the field. By combining the movements of the four shutters in various ways, it is easy to form a series of symmetrical apertures bounded by straight lines, and of any dimensions required. Unsymmetrical apertures can also be formed, but they are usually very disagreeable to the eye, and ought therefore to be avoided.

Astronomers have long been acquainted with the advantage of restricting their field when looking at luminous objects of large size, and the solar eye-piece of Mr. Dawes is a contrivance having this end view; but so far as the writer is aware, microscopists have not been in possession of any analogous instrument.

The only objection to the general application of this diaphragm stop to A eye-pieces, in the form now shown, is that it slightly diminishes the full size of the field. This arises from the writer having required that the shutters should meet when drawn out to their full extent. To accomplish this the shutters are rather broader than the ordinary stop. If kept within the dimensions of that stop they would probably do all that is required, as experiment shows that the eye is incommoded when the field is very small.

The diaphragm stop is most needed in the examination of small objects sufficiently opaque to require a very intense light for their display by transparent illumination; but other objects, such as diatoms and butterfly scales, are improved in appearance, and have their markings made more striking when the extent of the luminous margin surrounding them is nicely adjusted to their special requirements.

The diaphragm stop may also be used as an indicator, as it affords a ready means of isolating one out of many objects that may be on a slide.

The writer believes that it will be found of much use in protecting the eyes of microscopists, which are more liable to injury from excess of light than from any other cause (bad glasses excepted) incidental to their pursuits.

On a Double Hemispherical Condenser *for the* Microscope. By the Rev. J. B. Reade, F.R.S.

The hemispherical condenser, consisting of a single lens with suitable diaphragms, was described to the Society in May, 1861; and at the Exhibition in 1862 it received "honorable mention" by the appointed jury. This condenser was proposed as a cheap and not inefficient substitute for more expensive apparatus, inasmuch as it enabled my $\frac{1}{2}$-inch object-glass to bring out with great distinctness the markings on *Pleurosigma angulatum* and other similar tests. This fact was proved by ocular demonstration to Mr. Ross, whose skill had overcome the optical difficulties in producing a large angle of aperture; but my assertion of its power was at first received with a smile of doubt.

The single hemisphere has only a small angle of illumination when the pencils converge from near the margin of the lens to the object. Hence the value of its application to deep powers was questioned by many, though, so far as my own experience goes, the $\frac{1}{8}$th and $\frac{1}{12}$th are not beyond the scope of its illumination. Still, something like *tact* may be required—to use the language of objectors unskilled in its manipulation—in order to put the single lens through all its paces with all the powers. That the work can be done, but done with difficulty, is, perhaps, somewhat less than the merit which an inventor aims at, for, like poetry of a certain kind, if the sense does not stare you in the face no one cares for it.

The felt want, then, is greater obliquity of the illuminating pencil. With the single "kettledrum," the angle of illumination is rather less than 90°, and we all allow that this is too small for the easy exhibition of the more difficult tests. In the coarser lined objects the shadows are easily obtained when the pencils of illumination have a comparatively small angle; but where the lines and markings are extremely thin the angle must be nearly doubled, that the shadows may be well defined and sufficiently intense.

I propose to obtain this greater obliquity by placing a smaller hemisphere upon the larger one, and then the two kettledrums, turned to fifths, may be made to play upon any scale. For practical purposes it is near enough the mark to say that one lens, when placed upon another, adds its own obliquity to the obliquity of the rays which fall upon it. Neglecting, therefore, the smaller effects due to thickness and density, it is certain, as a matter of fact, and proved by measurement, that the illuminating pencils, after passing through the two hemispheres, may be made to fall upon the test objects at an angle of more than 150°, and thus produce illumination on a dark field even with the $\frac{1}{12}$th. This obliquity, no doubt, increases the facility of dealing with such close fine lines as those of the Amician test and the *Macrum.* To check the latter has been described as "a most blinding and heart-rending and brain-softening test;" but by using the double hemisphere, with the $\frac{1}{12}$th and C eye-piece, the lines and dots may be counted with ease. It is also not very difficult to make the whole battery of powers, from the $\frac{1}{12}$th to the $\frac{1}{2}$-inch, available for the exposition of these tests. A $\frac{1}{2}$-inch of exquisite workmanship, now in my possession, readily checks the *Rhomboides,* and a $\frac{1}{5}$th checks both this test and the *Macrum.* These powers were presented to me by my friend Mr. Wray, a Fellow of the Astronomical Society, who has devoted many years to the difficult task of annihilating the secondary spectrum in telescopic object-glasses of large dimensions, and I have witnessed his success with the highest gratification.

The want of achromatism in the double kettledrum is not injurious; on the contrary, the dispersion is beneficial rather than otherwise when the deep powers are used. With these the illumination is virtually monochromatic, and we may use at pleasure the red, yellow, or blue ray, by slightly altering the distance of the condenser. The blue ray, being the most refracted, and therefore falling on the test lines with greater obliquity, is decidedly the most effective on *N. rhomboides.* The pure light of a bright white cloud reflected from the plain mirror shows this very clearly. Webster's condenser, somewhat similar to mine, and consisting of two lenses partially achromatized, is, in its present state, not more effective than my single hemisphere. Mr. Highley, who makes them, is now enlarging the angle of aperture, and thus extending the application of the condenser.

The diaphragm-cap, properly constructed for one, two, or three apertures, as in the case of the single hemisphere, may be removed to the top of the second hemisphere, unless the fineness of the lines under examination require the condenser to be very close to the object. In this case a diaphragm of tin-foil or of thin brass properly pierced may be placed between the two hemispheres; tin-foil has an advantage in its very easy management. By looking down the body of the microscope, when the eye-piece is removed, and examining the dimensions of the discs of light, it is seen, at a glance, whether one or other of the apertures require to be more or less deeply cut. In the one case the little lappet of tin-foil can be so doubled as to shorten the aperture, and in the other it may be cut deeper and thrown further back. To obtain these very slight but not slightly important variations, and in a moment, is an advantage which minute observers will readily recognise. It corresponds, in fact, to the gentle strengthening or diminishing the gas-lights when the pair of achromatic prisms is dexterously arranged by our friend Mr. Tomkins, in order to give to rectangular lines the force of illumination indicated by their thickness. Mr. Tomkins, to take the *Rhomboides* as an example, after placing it perpendicularly as to the major axis of the stage, proceeds to bring out the transverse lines with the one prism, and then, shutting off its light, acts on the longitudinal lines with the other. The same admirable method of working may be adopted in the case of the kettledrums by placing a bull's-eye condenser in front of the lamp. By a little alteration in the position and height of this lens, the upper aperture, or that at right angles to it, may be easily and separately used for the independent exhibition of the transverse or longitudinal lines; the two pencils of light are then worked together, as through the two prisms, for the final resolution of the valve.

In my own condenser a slit has been made in the brass-work between the lenses for the insertion of the thin brass diaphragms without the removal of the condenser, an arrangement with which the Waterhouse diaphragms in photographic combinations has made us familiar. With respect to these diaphragms, I have made a new arrangement which gives immediate and ready command over the length of the V apertures, and therefore over the power of the illuminating pencil for rectilineal tests. The method is this—on the surface of the lower hemisphere place a circular diaphragm, having apertures at right angles to each other, and extending from the circumference to within a quarter of an inch from the centre. On another circular diaphragm of the same size draw diameters at right angles to each other, also draw lines from the extremity of one diameter to the two extremities of the other, and with a pair of scissors cut off the two lunes, thus forming a right angle upon a semicircle. This rectangular diaphragm is placed in the slit of the tube between the condensers, so that the vertex of the right angle divides the space between the two long V apertures of the lower diaphragm. When pushed home it nearly shuts up the apertures of the fixed diaphragm; but by gently drawing it out, and moving it a little sideways, if necessary, we can obtain with the utmost nicety just that length of either aperture which the test lines under examination require. It is absolutely necessary to have this entire command over the length of the apertures and the strength of the illuminating rays, and this is one method, among others, which might suggest themselves to different observers, for securing this control. Two narrow strips of brass having small V apertures may also be conveniently used for the independent regulation of the two lower and larger apertures, over which they should be moved by a fine adjustment. The two hemispheres themselves are, as it were, the mere raw material; the secret of success lies in the proper management of the condensed and convergent pencils. In the diaphragm-cap the apertures are always of one and the same size, and hence arises the only practical difficulty in using it for the most delicate tests. By the present arrangement the precise amount of light from either aperture is obtained at once.

As cheapness is the order of the day, I may state that the cost of the material for these diaphragms is "three a penny." I cut the apertures with a pair of scissors, and after filing the edges, when necessary, I blacken them with oxide of copper. A few crystals of sulphate of copper must be dissolved to saturation in two measures of strong nitric acid and one measure of water. The diaphragm, raised to a temperature of about 300° over a spirit lamp, is dipped in the solution and immediately dried over the flame. On rubbing the frost-like surface with a small brush a clean and permanent black stain remains.

No light can fall upon the upper hemisphere but that which passes through the apertures of the diaphragm on the lower; and as the apertures are generally about $\frac{4}{10}$ths of an inch deep, while the diameter of the lens itself is one inch and three quarters, it is evident that the outer portion of the hemisphere is alone called into use. There is, however, a limiting circle, beyond which parallel rays of light are not transmitted to the upper hemisphere. It may be an improvement to bring this portion into play, and Mr. Ross is constructing a condenser of three lenses, in which every ray that falls upon the first lens will be available for illuminating the object.

What I have aimed at in the double kettledrum is a distinct and well-defined pencil of light, falling at right angles on the lines of the object, and at the necessary obliquity for resolution and definition; and I trust that my experiments will not be considered fruitless. I have often used the hemispherical combination with much pleasure and satisfaction, and, at the request of the Council, I now place it before this Royal Society.

Charter *and* Bye-Laws *of the* Royal Microscopical Society.

Objects of the Society.—The Royal Microscopical Society was founded in 1839, and incorporated by Royal Charter, 1866, for the promotion and diffusion of improvements in the optical and mechanical construction, and in the mode of application, of the Microscope:—

For the communication and discussion of observations and discoveries tending to such improvements, or relating to subjects of Microscopical observation:—

For the exhibition of new or interesting Microscopical objects and preparations, and for the formation of an arranged collection of such objects:—

For affording the opportunity and means of submitting difficult and obscure Microscopical phenomena to the test of instruments of different powers and constructions:—

For the establishment of a Library of standard Micrographical Works.

Royal Charter of Incorporation to the Microscopical Society of London.

Victoria, by the grace of God, of the United Kingdom of Great Britain and Ireland, Queen, Defender of the Faith, To all to whom these Presents shall come Greeting: Whereas James Scott Bowerbank, Doctor of Laws, Fellow of the Royal Society; Rev. Joseph Bancroft Reade, Master of Arts, Fellow of the Royal Society; Nathaniel Bagshaw Ward, Fellow of the Royal Society; and others of our loving subjects, did, in the year 1839, establish a Society by the name of "The Microscopical Society of London," for the advancement of Microscopical Science:

And whereas it has been represented to us that the same Society has, since its establishment, sedulously pursued such its proposed object, by the researches of its members, and the collection and discussion of observations, and by the publication of its transactions from time to time, which have contributed to the progress of Microscopical knowledge:

And whereas distinguished individuals in foreign countries, as well as British subjects, have availed themselves of the facilities offered by the same Society for communicating important discoveries, greatly extending Microscopical knowledge; and the great and general interest now felt in those branches of Science, whereof the Microscope is an important instrument of investigation, has been greatly promoted and fostered by this Society:

And whereas the same Society has, in aid of its objects, acquired a considerable and important Library of Scientific Works, a large collection of Microscopic objects, and several valuable Microscopes, to which fresh accessions are constantly being made; and the said Society has hitherto been supported by donations and annual and other subscriptions and contributions to its funds, and has therefrom purchased and is possessed of a considerable amount of stock in the public funds:

And whereas, in order to secure the property of the said Society, to extend its operations, and to give it a more permanent establishment among the scientific institutions of our kingdom, we have been besought to grant to James Glaisher, Fellow of the Royal Society, the present President of the said Society, and to those who now are or shall hereafter become members of the said Society, our Royal Charter of Incorporation for the purposes aforesaid:

Now know ye that We, being desirous of encouraging a design so laudable and salutary, of our especial grace, certain knowledge, and mere motion, have willed, granted, and declared, and do by these presents, for us, our heirs and successors, will, grant, and declare, that the said James Glaisher, and such other of our loving subjects as now are members of the said Society, or shall from time to time be elected Fellows thereof, according to such regulations or bye-laws as shall be hereafter framed or enacted, and their successors, shall for ever hereafter be by virtue of these presents one body politic and corporate, by the name of "The Microscopical Society of London;" and for the purposes aforesaid, and by the name aforesaid, shall have perpetual succession and a common seal, with full power and authority to alter, vary, break, and renew the same at their discretion, and by the same name to sue and be sued, implead and be impleaded, answer and be answered, unto and in every court of us, our heirs and successors, and be for ever able and capable in the law to purchase, receive, possess, hold and enjoy, to them and their successors, any goods and chattels whatsoever, and also to be able and capable in the law (notwithstanding the Statute of Mortmain) to take, purchase, hold, and enjoy to them and their successors a hall or house, and any such messuages, lands, tenements, or hereditaments whatsoever as may be necessary or expedient for carrying out the purposes of the Society, the yearly value of which, including the site of the said hall or house, shall not exceed in the whole the sum of £1000, computing the same respectively at the time of the purchase or acquisition thereof, and to act in all the concerns of the said body politic and corporate as effectually, to all intents and purposes, as any other of our liege subjects, or any other body politic or corporate in our said kingdom, not being under any disability, might do in their respective concerns.

And we do hereby grant our special licence and authority unto all and every person and persons, bodies politic and corporate (otherwise competent), to grant, sell, alien, and convey in mortmain unto and to the use of the said body politic and corporate and their successors any messuages, lands, tenements, or hereditaments not exceeding such annual value as aforesaid.

And our will and pleasure is, and we further grant and declare, that there shall be a General Meeting or General Meetings of the Fellows of the said Society to be held from time to time as hereinafter mentioned, and that there shall be a Council to direct and manage the concerns of the said body politic and corporate, and that the General Meetings and the Council shall have the entire direction and management of the same in the manner and subject to the regulations hereinafter mentioned.

And we do hereby also will, grant, and declare that there shall be a President, Vice-Presidents, a Treasurer, and Secretaries of the said body politic and corporate, and that the Council shall consist of the President, Vice-Presidents, Treasurer, Secretaries, and not more than twelve nor less than eight other Fellows of the said Society.

And we do hereby further will and declare that the said James Glaisher shall be the first President of the said body politic and corporate, and the other persons now being the Vice-Presidents, Treasurer, Secretaries, and Members of the Council shall be first Members of the Council, and shall continue such until the election of officers shall be made in pursuance of these presents.

And we do hereby further will and declare that it shall be lawful for the Fellows of the said body politic and corporate hereby established to hold a General Meeting once in the year or oftener, for the purposes hereinafter mentioned; namely, that the President, Vice-Presidents, the Treasurer, the Secretaries, and other Members of the Council, shall be chosen at such General Meeting, and that the General Meetings shall from time to time make and establish such bye-laws, and vary and alter or revoke the same, as they shall deem to be useful and necessary for the regulation of the said body politic and corporate, for the admission of Fellows and of Honorary and Foreign Members, and for the fixing the number of the Vice-Presidents and Officers, and for the management of the proceedings, and the estates, goods, and business of the said body politic and corporate, so that such bye-laws be not repugnant to these presents, or to the laws and statutes of this our realm; and shall and may also enter into any resolution and make any regulation respecting the affairs of the said body politic and corporate that may be necessary and proper:

And we do further will and declare that the General Meetings shall take place at such time as may be fixed by the said Council, and that the present regulations of the said Society, so far as they are not inconsistent with these presents, shall continue in force until the same shall be altered by a General Meeting.

And we further will, grant, and declare that the Council shall have the sole management of the income and funds of the said body politic and corporate, and the appointment of librarian, curator, and such other officers, attendants, and servants as the Council shall think necessary or useful, as also the entire management and superintendence of all the other affairs of the said Society, and shall and may, but not inconsistently with or contrary to the provisions of this our Charter, or any existing bye-law, or the laws and statutes of this our realm, do all such acts and deeds as shall appear to them necessary for carrying into effect the objects and views of the said body politic and corporate.

Provided always, and we do will and declare, that the Council shall, from time to time, render to a General Meeting a full account of their proceedings, and that every Fellow of the Society may at all reasonable times, to be fixed by the said Council, see and examine the accounts of the receipts and payments of the said body politic and corporate.

And we further will, grant, and declare that the whole property of the said body politic and corporate shall be vested, and we do hereby vest the same, solely and absolutely in the Fellows thereof; and that they shall have full power and authority to sell, alienate, charge, and otherwise dispose of the same as they shall think proper: but that no sale, mortgage, incumbrance, or other dispositiou of any messuages, lands, tenements, or hereditaments belonging to the said body politic and corporate shall be made except with the approbation and concurrence of a General Meeting.

And we lastly declare it to be our Royal will and pleasure that no resolution or bye-law shall, on any account or pretence whatsoever, be made by the said body politic and corporate, in opposition to the general scope, true intent, and meaning of this our Charter, or the Laws or Statutes of our Realm: And that if any such rule or bye-law shall be made, the same shall be absolutely null and void to all intents, effects, constructions, and purposes whatsoever.

IN WITNESS WHEREOF we have caused these our Letters to be made Patent.

WITNESS OURSELF, at our Palace at Westminster, this twenty-eighth day of August, in the thirtieth year of our reign.

BY HER MAJESTY'S COMMAND.

CARDEW.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY OF LONDON.

On TWO NEW SPECIES *of the Genus* ŒCISTES, *Class* ROTIFERA. By HENRY DAVIS, F.R.M.S.

(Read December 12th, 1866.)

THE hitherto undescribed species of tubiculous Rotifera which I have to introduce, furnish further proof—if such be needed—that the generally accepted classification of these animals is unsatisfactory in the extreme. In the present instance there would almost seem to be a special arrangement for the purpose of excluding some interesting creatures —possessing in every sense a "local habitation," but no "name"—from enjoying the advantages of acknowledged relationship with their greater and more famous compeers.

Mr. Gosse has recently proposed to subdivide the class in a manner not only more natural and less arbitrary than that complained of, but having the further advantage, in its comprehensiveness, of admitting as well-defined species the new rotifers in which I am particularly interested. He proposes to make a family to be called Melicertadæ, and in this he would include two genera, Melicerta and Megalotrocha, degrading some of the present genera to form species of Melicerta, and others to constitute three species of Megalotrocha. The first-named genus would embrace nearly all the solitary individuals among the tube-dwellers, and the latter those few which are aggregated by the adhesion of their gelatinous cases. To the genus Melicerta, as thus constituted, fain would I add two species—*M. longicornis* and *M. intermedius;* but unfortunately the admirable arrangement quoted has been introduced in so quiet and unobtrusive a manner, in the pages of a popular journal, that there is some reason for fearing it may not be generally adopted, at least for some time; and this fact determines me to find for the strangers the least inconvenient place—possibly a temporary one—with the family Œcistina, as propounded by Ehrenberg and indorsed by Williamson and Pritchard.

Genus Œcistes.

Œ. intermedius (n. sp.).—Sheath granulate; pale at the base, growing dark and opaque towards the open extremity; narrow; tapering slightly downwards. The simple trochal disc ovoid in outline, and its cilia interrupted in the dorsal aspect. Beneath the oral aperture a ciliated protuberance, on each side of which is a setiferous tubercle. Length of case $\frac{1}{50}''$; animal about $\frac{1}{35}''$. (Pl. I, figs. 1, 2, 3, 4.)

This species is plainly a connecting link between *Œ. crystallinus* and *Limnias ceratophilli,* having the single trochal disc of one and the tapering tube of the other; yet a strict reading of artificial characteristics would undoubtedly exclude it from either genus, and justify me in absurdly making another on purpose for it. Limnias requires the mature animal to have a "two-lobed rotary organ," and Œcistes a single lobe, but a "cylindrical case." In my difficulty I apply for advice to our highest authority in these matters, and am recommended to "call it Œcistes, but note its resemblance to Limnias."

Œ. longicornis (n. sp.).—Sheath solitary; rarely contiguous, and imperfectly conglomerate; floccose; generally unsymmetrical and opaque. Animalcule with two long antennæ terminated by retractile setæ; thickly ciliated "chin." Length of case $\frac{1}{100}''$; animal about $\frac{1}{70}''$; antennæ $\frac{1}{500}''$. (Figs. 5, 6, 7, 8.)

There are also two varieties of this species, one resembling it in every particular with the exception of the antennæ, which are replaced by setiferous tubercles, as in *Œ. intermedius* and in Limnias; the other variety has a more cylindrical case, which is slightly annulated, and transparent even when grown in turbid water.

I find these creatures in ponds near Leytonstone, growing on leaves of the water ranunculus and other aquatic plants. Even minute filaments of Confervæ are often studded with their nest-like cases. *Œ. longicornis* is by far the smallest of the tube-dwellers; its brown, fluffy, and irregularly formed sheath is scarcely noticeable under a low power, and to this circumstance I attribute the fact of its being hitherto overlooked. The body of the animal, when the disc is retracted, is somewhat oviform, gradually attenuated to a highly elastic, deeply corrugated foot-tail. Outside the integument are four fine lines indicating segments of a delicate carapace; these lines form one broad central annulation and two narrow rings near the head; to one, apparently the strongest, are attached the long antennæ. The trochal disc at its base seems hinged in each lateral aspect; the movements of these curious hinges are best seen when the animal is slowly expanding, then the ciliary wreath has a waved and oblong outline. In the ventral aspect, outside the rotary organ and beneath the ciliary frill, is an arcuate process forming the cheek of the buccal cavity or "funnel," and below this the ciliated projection, termed the "chin" when applied by Gosse to Limnias, or the "additional" and "fifth lobe" to Melicerta by Williamson.*

Atoms of carmine are greedily swallowed by healthy specimens; and the whole course of the red particles is easily watched from their entrance into the buccal funnel and the mastax, through the curved and undulating œsophagus into the stomach, to their discharge (apparently unaltered) from the everted anus.

On treating the animal with solution of potash the foot, antennæ, and rotary organ, are immediately dissolved, but the integument and the mastax remain unaltered. The latter is pretty plainly constructed on the plan of Limnias, as figured by Mr. Gosse in the 'Philosophical Transactions;' but the required number of teeth—three to each ramus—is, I think, greatly exceeded; three teeth are very distinct, and, I fancy, a fourth and fifth; but as they gradually grow fainter as they recede from the joint of the rami, it becomes exceedingly difficult to determine the exact number. Mr. Gosse's figure shows a faint striation on the surface of each ramus, parallel with the three teeth, and extending beyond them, and it is quite possible that I may have confounded a similar striation with the teeth, for the exceedingly minute size of the gizzard in *Œ. longcornis* precludes all hope of trustworthy observation on it with the moderately high powers at my command.

Whatever may be the function of the ciliated "chin" in other species, it appears to me in these to be intimately connected with the formation of the tube; for on several occasions I have noticed minute particles of the extraneous matter in suspension drawn across and from the buccal aperture, and directed by the cilia over the chin into a slight depression beneath it; the granules were not rotated nor formed into

* Mr. Slack believes that he has detected an unusually complicated ciliation of the trochal disc in *Œ. longicornis.* Certainly his skilful handling of a Beck's $\frac{1}{20}$th, with this object and a fine condenser, warrants me in accepting his opinion with the greatest respect.

pellets, but they simply collected in a spot agreeing with the position of the pellet-cup in Melicerta. There was evidently a viscid excretion at the spot which held the extraneous matters loosely together in a clot; in about half a minute the rotifer would jerk down, leave the floccose deposit on the edge of its case, then rise immediately and repeat the process. On mixing a little carmine with the water, the process became very striking; an irregular crimson edge to the tube was made under my own eyes, and, on leaving a number of specimens of both species in a zoophyte trough, charged with carmine, for forty-eight hours, I was gratified to find that a few had continued building, and made red tops of different sizes to their habitations; nearly one fourth of the entire structure in two instances were composed of the mixture of the red atoms and gelatinous excretion. One infant rotifer, whose first efforts at building I had distinctly marked, seemed to have made his entire nest of the glowing pigment. The carmine apparently stimulates the creatures to activity, but certainly kills them in a day or two. I have mounted, in Deane's gelatine, some of the red-topped cases, constructed as described, and I offer them as confirmatory evidence of the reliable character of what I advance. They tend to show, not only that Melicerta enjoys no monopoly in the building trade, but that all rotifers inhabiting opaque encrusted tubes may reasonably be suspected of constructing them piecemeal, and in the same manner.

Finally, returning for a moment to the sheath of *Œ. longicornis,* I would note its great internal elasticity, as shown especially at the aperture. It always embraces the animal, expanding or contracting in its movements in rising and retreating, and to such an extent that when the rotifer, greatly alarmed, shrinks down to a mere ball at the bottom of the sheath, there is generally a coalescence and perfect closing of the orifice.

On a Portable Slide Cabinet *and a* Form *of* Slide *for* Opaque Illumination. By Samuel Piper, Old Change Microscopical Society.

(Read January 9th, 1867.)

The Portable Horizontal Slide Cabinet is composed of any number of flat cardboard trays, divided into six or more compartments, each holding a single slide in a horizontal position.

The trays are enclosed in a strong millboard box, the front of which is made to fall down, so as to permit the trays to be readily withdrawn. When closed, an elastic band renders the whole firm and secure.

It may be made of any desired capacity. Specimens are placed on the table capable of receiving from six to two hundred and fifty slides. The smallest is well adapted to contain a "half-dozen series" of anatomical or other subjects; and its great strength, combined with lightness, makes it peculiarly available for transmission through the post.

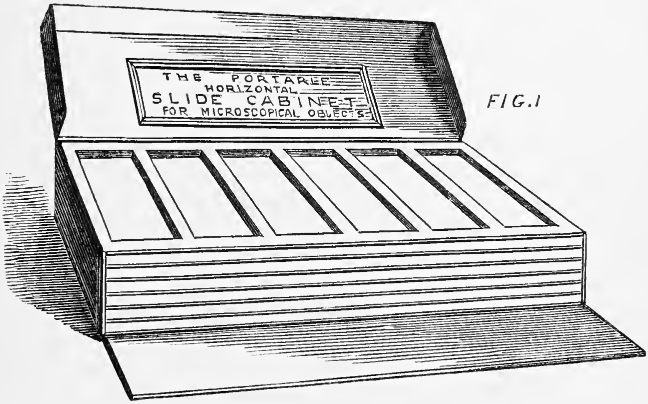


FIG. 1

The one figured above is, however, that to which I would more particularly call your attention, being of a convenient size, and suitable for carrying in the pocket. It contains six trays, and will therefore hold three dozen slides.

Amongst the advantages which may be derived from the use of these cabinets I will mention the convenience of displaying at one view the entire collection of slides, and the facility thus afforded for the selection of any required specimen without the troublesome search and difficulty of removal frequently experienced with the old form of box, in which the slides are dropped (out of sight) into perpendicular grooves. It also prevents the possibility of the covers becoming detached by shaking about in transit, which is important when it is required to convey a rare or valuable collection.

The trays, being all of uniform size, may be transferred from one cabinet to another of larger or smaller dimensions without necessitating the disturbance of the slides. In addition to its portability, it possesses the merit of cheapness, durability, and neatness of appearance.

It may be obtained in its various forms from all the leading microscope makers in London.

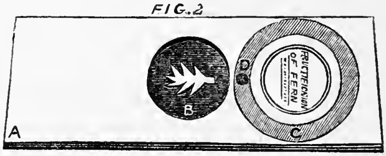
On a Form *of* Slide *for* Opaque Illumination.

I would also beg to offer to your consideration a form of slide which meets a want frequently felt in mounting opaque objects for the binocular microscope, so that they may be examined without the intervention of a glass cover, and, at the same time, to have adequate protection against the intrusion of dust or other foreign matter when not in use.

It is especially adapted for botanical or geological specimens, and for objects of considerable thickness requiring a deep cell.

It consists of the usual mahogany slide, with the addition of a thin circular disc of bone or other convenient material, which is attached on one side of the central cavity by means

FIG. 2



A, Mahogany slide; B, central cavity; C, covering disc (turned aside), bearing descriptive label; D, pivot on which the cover rotates.

of a split metal rivet, the ends of which are turned outwards, on the underside, before the black paper and cardboard bottom are applied; this rivet acts as a pivot, on which the cover rotates, so that it can be instantly turned aside for the display of the object, and as readily replaced when the slide is returned to the cabinet. The cover is also available for the application of the label bearing the name and description, and can be applied in a few minutes, at an increased cost of about twopence per dozen upon the price of the ordinary slides.

By substituting a thin glass instead of the cardboard bottom it may be used for Lieberkühn illumination.

On the Crystallization *of the* Sulphates of Iron, Cobalt, *and* Nickel. By Robert Thomas.

(Read January 9th, 1867.)

The object in view, in crystallizing the salts of the magnetic metals, being to ascertain whether there is any relation between the magnetic principle in those metals and the action which takes place in the crystallization of their salts, experiments have been made with a less number of atoms of water than are usually found in the *natural* crystals of these salts, and the results of these experiments are here submitted as indications of the possibility that some such relations exist.

Faraday has shown * that a crystal of sulphate of iron "is compounded of superposed flat crystals or plates, and that the magne-crystallic axis goes directly across these." After many trials, the writer has been able to get these "plates" to form on the "slide," which may be done as follows:—Take a concentrated solution of sulphate of iron, with a small quantity of sugar to prevent oxidation of the film of iron. Drive off the water as rapidly as possible with a "Bunsen's burner" or "spirit-lamp," and when nearly dry the "plates" will form, and, if carefully watched, their formation may be seen even by the unaided eye. Then place the slide *quickly* at a higher temperature, and further crystallization of the plates will be arrested. When perfectly dry, the slide should be kept at a temperature of about 65° Fahr.; but these processes (even when great care is taken) are influenced much by the state of the atmosphere. If it be too moist, the foliation (seen in the specimens) will proceed from *all* points of the "plates." The slide should then be placed at a *higher* temperature, when the foliations will proceed only from each pole, or from the ends of the longest diameter of the plates, and curve backwards towards the opposite pole, exhibiting the same configurations as iron filings when arranged round the magnet, the crystalline force appearing to flow in the direction of the magne-crystallic axis described by Faraday.

Specimens of the crystals of the salts of cobalt and nickel are also shown, which clearly indicate that they all have the same mode of formation as, but less definitely marked than, those of iron. And if the relationship to which reference has been made should be found to exist, this less perfect crystal-

* Series xxii, § 2546.

lization of the salts named would naturally follow from the fact of the *metals* themselves being less magnetic.

Note.—My friend Mr. Thomas having having presented me with some crystallized specimens of sulphate of iron, cobalt, and nickel, of great novelty and beauty, I solicited him to write a short description of what they were intended to illustrate, and also his method of producing them, thinking it would be interesting to the Fellows of the Royal Microscopical Society.

In his letter to me he says, "If any one can offer a better explanation I shall be gratified. In trying to produce specimens there will be many failures, and it will require a considerable amount of practice and patience to produce similar results."—W. Ladd, 11 and 12, Beak Street, W.

On a Travelling Microscope.

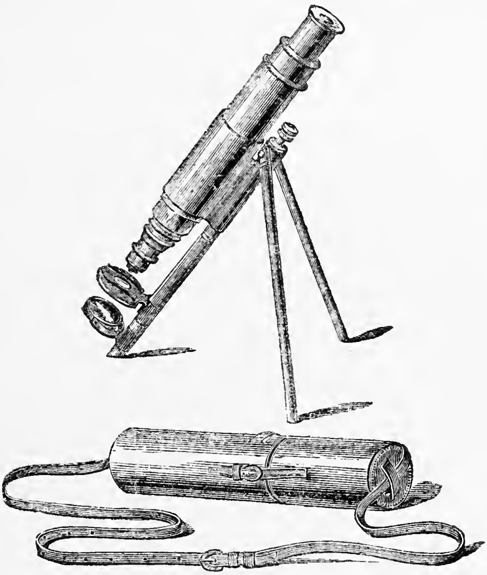
By J. Newton Tomkins, F.R.C.S., F.Z.S., F.R.M.S.

(Read January 9th, 1867.)

I am desirous of bringing before the notice of the Society a new microscope stand which possesses many points of merit, and is quite novel in some of its arrangements. The aim has been to combine lightness and extreme portability with steadiness and efficiency of work, while the essential element of cheapness has not been lost sight of. The whole apparatus is contained in a sling case, similar to that used for race-glasses, and weighs somewhat under two pounds; it has been appropriately called the "Travelling Microscope," from its manifest capabilities. The compound body is firmly attached to the front leg of the tripod stand, the two other legs are supported on capstan-bar joints (to be tightened at pleasure should they work loose), which fold up when not in use. The tripod forms an exact equilateral triangle, with the view of ensuring the greatest possible steadiness, and the feet are shod with cork in order to diminish vibration, as well as to prevent the instrument from slipping on a smooth table. The tube, which allows of elongation to an extent of eight inches, slides in a jacket lined with cloth, and the coarse adjustment is gained by this sliding motion; the fine adjustment is effected by means of a tangent screw of fifty threads to the inch, which is placed conveniently behind the body, and worked by a milled head acting on a spring contained in the upright which supports the body. This portion of the instrument works smoothly and satisfactorily.

The stage is formed of a simple brass plate, with spring clips to hold the slides; but should greater accuracy be desired, a mechanical stage capable of affording traversing movements in two directions can be added. Beneath the stage, and secured by brass pins working in slots, room is found for a Varley's live-box. The nose-piece is furnished with the Society's universal screw, thus being adapted for most modern object-glasses.

By way of utilising the limited space to the utmost, the legs permit of being detached by help of bayonet-catches, and contain, severally, dipping tube, forceps, and two dissect-



ing needles. A small case, placed near at hand, holds a glass slide with ledge, and a reserve of thin covering glasses. The optical portions of the microscope, viz. the object-glass, eye-piece, and mirror, are of the usual description. The fishing apparatus that I use with this instrument is simple, but very effective. The rod is the common landing-net rod of the angler; into this is fixed a gun-metal ring, which carries a bottle provided with a screw, and which may be obtained of any chemist. A small net, a metal spoon (indispensable when hunting for diatoms), and one or two gutta-percha bottles, preferable to glass because lighter and not liable to breakage, complete the equipment.

This microscope especially recommends itself to the attention of field-naturalists, since every one who has made the

Protophytes and Protozoa his study is aware how difficult, if not impossible, it is to bring home many of these delicate organizations from any distance in a living state. Of this class may be mentioned some of the more tender of the oceanic Hydrozoa, the free-swimming larvæ of the Crustacean family, the Antheridia and Antherozoids of the ferns, and innumerable others.

The naturalist who may be possessed of an instrument like that herein described will now be enabled to prosecute his researches under the most favorable circumstances, and to select from his gatherings of the day only those portions suitable for future examination.

The whole merit of this arrangement is due to Mr. Moginie, of Mr. Baker's establishment, a member of our Society; it is only after many trials that he has succeeded in bringing the "Travelling Microscope" to its present effective form.

I am not exactly aware of the price at which Mr. Baker will supply these instruments, but believe that it will not exceed £3, including one eye-piece, but exclusive of the object-glass.

ROYAL MICROSCOPICAL SOCIETY OF LONDON.

Anniversary Meeting.

February 13th, 1867.

James Glaisher, Esq., President, in the Chair.

After the usual routine business,

Walter Kerr, Esq., Cedar Road, Fulham Road; Oliver Codrington, Esq., Surgeon, 68th Light Infantry; John James Hamilton Humphreys, Esq., 16, Torrington Square; were balloted for and duly elected Fellows of the Society.

A report from the Auditors of the Treasurer's accounts was read.

It was resolved—"That the President's address be printed without delay."

The meeting then proceeded to ballot for Officers and Council for the year ensuing.

At the close of the ballot the scrutineers made their report, when the following gentlemen were declared duly elected:

President.—James Glaisher, Esq., F.R.S.

Vice-Presidents.

Charles Brooke, Esq., F.R.S.	Arthur Farre, M.D., F.R.S.
R. J. Farrants, Esq., F.R.C.S.	Rev. J. B. Reade, M.A., F.R.S.

Treasurer.—C. J. H. Allen, Esq., F.L.S.

Hon. Secretaries.

Jabez Hogg, Esq., F.L.S.	H. J. Slack, Esq., F.G.S.

Council.

Geo. E. Blenkins, Esq., F.R.C.S.	Ellis G. Lobb, Esq.
W. L. Freestone, Esq.	R. Mestayer, Esq.
James Hilton, Esq.	John Millar, Esq., F.L.S.
Robert Hudson, Esq., F.R.S.	Major S. R. J. Owen, F.L.S.
Wm. Henry Ince, Esq., F.L.S.	F. C. S. Roper, Esq., F.L.S.
Henry Lee, Esq., F.L.S.	F. H. Wenham, Esq.

The thanks of the meeting were then voted to the President, Secretaries, Treasurer, and Council, for their services on behalf of the Society during the past year.

Report of the Cabinet of Objects during the past year.

Number of objects in the Cabinet on February 14th, 1866	1389
Presented by Colonel Samuel Hennall, March, 1866, twelve slides of Diatomaceæ	12
Presented by Major Owen, June, 1866, one slide of Foraminifera	1
Presented by Thomas Shearman Ralph, Esq., of Melbourne, January, 1867, twelve slides of Blood-spherules	12
Total quantity of objects now in the Cabinet . .	1414

Ellis G. Lobb.

AUDITORS' REPORT. *From January 25th*, 1866, *to February 12th*, 1867.

Receipts.

	£	s.	d.	£	s.	d.
By Balance from previous year				104	14	0
Admission Fees of 48 Fellows, at £1 1s.				50	8	0
,, ,, 1 Fellow, at £2 2s.				2	2	0
Compositions of 14 Fellows				147	0	0
Two Dividends on £860 19s. 10d. Consols				25	8	0
Annual Subscriptions—						
For the year 1861	1	1	0			
,, ,, 1862	3	3	0			
,, ,, 1863	7	7	0			
,, ,, 1864	17	17	0			
,, ,, 1865	35	14	0			
,, ,, 1866	143	17	0			
,, ,, 1867	73	10	0			
,, ,, 1868	3	3	0			
				285	12	0
Screw Tools				0	14	0
List of Objects				0	1	0
				£615	19	0

Payments.

	£	s.	d.	£	s.	d.
To Salary of Assistant Secretary				21	0	0
,, Curator				10	10	0
Editors of the 'Microscopical Journal'	155	12	6			
Postage and Delivery of ditto	14	14	7			
				170	7	1
Rent of Rooms at King's College	25	0	0			
Expenses of Soirée	27	0	5			
				52	0	5
Purchase of £107 13s. 10d. Consols				94	10	0
Reporter				8	8	0
Printing and Stationery				13	9	2
Rackwork for Cabinet				1	3	0
Assistant Secretary, Petty Expenses				8	12	6
Lamp Oil, &c.				3	14	0
Balance in favour of the Society				230	4	10
				£615	19	0

We, the undersigned, have examined the Treasurer's accounts, with the documents and vouchers, and found the same to be correct. We find the balance in the Bank of England to be £230 4*s.* 10*d.*, and the amount of Stock in the Consolidated Three per Cents. to be £860 19*s.* 10*d.*

RICHARD KIPPIST,
SAML. R. J. OWEN, } *Auditors.*

February 12th, 1867.

The President's Address *for the year* 1866–1867.

By James Glaisher, Esq., F.R.S., &c.

The year 1866-7 will be memorable in the annals of the Microscopical Society, as that in which a Royal Charter was obtained for its incorporation, in which Her Most Gracious Majesty Queen Victoria was pleased to signify her distinguished appreciation of its objects, by commanding it to assume the title "Royal," and in which H.R.H. the Prince of Wales conferred upon it the honour of becoming its patron.

During the past year the general condition of the Society has been one of prosperity: its members have augmented, its meetings have been well attended. Many subjects of interest have been brought forward in the papers that have been read before it; the discussions thereupon have elicited much information of general interest and value.

The number of new Fellows elected during the year has been 51; the number lost by death and by resignation, 6.

In adverting to the loss this Society has sustained during the past year through the death of its members, I have to mention Dr. Ansell, Richard Beck, Dr. Lee, Dr. Hinxman; and the loss to Microscopy in general, though not a member of this Society, of Dr. Greville.

Thomas Ansell was a very diligent student both in London and Edinburgh. He graduated at the University of St. Andrew's, and obtained the diploma of the Royal College of Surgeons of England. After this he made a voyage to China, and on his return settled at Bow, where he steadily pursued his profession and obtained a high position. He was elected twenty-five years ago one of the Examiners of the Society of Apothecaries; and six years since he was unanimously chosen Chairman of the Board, and continued in this position till his death Under the recent Act, he was elected Officer of Health for Bow, in Middlesex; and in the performance of the duties of that office he was distinguished for his zeal, and it was whilst in their discharge, at the outbreak of cholera in his district, in July, 1866, he died of that disease.

He was an ardent lover of Natural History, and a good observer; he was not an original contributor to Microscopical

Science, though he readily comprehended, and almost instantly appropriated, everything which was new and valuable.

His fine library and microscopical museum bear testimony to his judgment and taste. He was an able practitioner, a good anatomist, and possessed an ample knowledge of general physics.

Richard Beck was born in October, 1827, at the then residence of his parents, Tokenhouse Yard, London; his father being a partner in the well-known firm of Lister and Beck, wine-merchants. As is often the case with men who distinguish themselves in particular pursuits, Richard Beck did not in his boyhood evince much aptitude for the ordinary routine of scholastic teaching. He is described as more fond of play than of books, and his manifestations of talent and ability were in the direction of mechanical pursuits. This inclination was judiciously fostered in a school at York where he finished his education. . At this time (1841) his parents perceiving that the manufacture of the microscope was likely to rise in commercial importance, made arrangements that Richard Beck should learn the business by serving for three years under Mr. Smith, an excellent workman engaged in carrying out the views of Mr. Joseph Lister and other distinguished members of this Society. Previous to this period much had been accomplished by Mr. Pritchard, Mr. Powell, and Mr. Ross; the two latter having greatly distinguished themselves by giving practical effect to the optical principles made known by Mr. Lister in 1829; but both in methods of manufacture and in many important details of construction there was still much to be desired and accomplished, and it was mainly through the skill and the exertions of Richard Beck that the well-known firm of Smith and Beck, formed in 1847, took such an important position in the microscopic world, and, by maintaing an honorable rivalry with the other great makers, effectively contributed to bring the English microscope to its present degree of optical and mechanical perfection.

Important improvements in the mechanical stage and in methods of illumination owe their origin to Richard Beck, and when Mr. Wenham devised his admirable arrangements for binocular vision, they were promptly carried out under his skilful supervision. In devising microscopic apparatus adapted for special investigations, Richard Beck exhibited great ingenuity; and when the ideas of other inventors were communicated to him, he usually endeavoured, and frequently with success, to improve upon them before giving them practical effect. As a microscopic observer he took a high place, as numerous communications to this Society abundantly show. He was slow in forming conclusions, very searching in investigation, unwilling to take anything for granted without submitting it to careful verification, and very open-hearted and generous in communicating to others the facts which he had ascertained, and the conclusions to which he had arrived. As a manufacturer, he brought a high degree of natural intelligence and a cultivated understanding to bear upon mechanical pursuits, never allowing the requirements of trade to overpower his zeal in the cause of science, or his commercial connection with the microscope to interfere with his appreciation of it as an instrument of research. In addition to the production of first-class instruments, the firm of which he was a member introduced at various times constructions devised by himself to meet the wants of a less rich class of students, such as the "Educational Microscope," the "Universal Microscope," and the "Popular Microscope." In 1865 Mr. Beck published a "Treatise on the Construction, Proper Use, and Capabilities of Smith, Beck, and Beck's Achromatic Microscope," in which many valuable suggestions are contained. This work is illustrated by some of the best plates of microscopic objects that have been produced, several being from his own drawings. The frontispiece gives representations of the Podura scale as seen with powers from 80 to 1300, and presenting those appearances which microscopists have accepted as tests of the true correction of their objectives, and of their methods of illumination. As a member of this Society, Richard Beck rendered constant and valuable service by contributing to its 'Transactions' and taking part in its discussions. Great grief and pain were felt by his numerous friends and acquaintances when his valuable life terminated, at the early age of thirty-nine, on the 20th of September last, through a disease of the heart, first contracted when suffering from rheumatic fever at school, and which had been suddenly aggravated six months previous to his decease. He was buried in the graveyard attached to the Friends' Meeting-house at Stoke Newington, and your President, accompanied by several members of the Council, attended on the occasion to manifest the respect due to him for his many excellences of character, and for his numerous services to Microscopical Science.

John Lee, LL.D, F.R.S., of Hartwell House near Aylesbury, who died on the 25th February last, was elected a member of this Society in 1841, but never took any active part in microscopical pursuits. His attention was chiefly devoted to astronomy, and he founded one of the best private observatories in the country. He was elected to the office of President of the Royal Astronomical Society a few years since. By those engaged in his favorite study, as well as by many devoted to other branches of science, he will long be remembered for the encouragement and assistance he was at all times willing to afford.

Robert Kay Greville, F.R.S.E., although not a member of this Society, has contributed so many valuable papers to our 'Transactions,' and was so well known as a distinguished cryptogamic botanist, that his loss cannot be passed over in silence. He was born at Bishop Auckland, in Durham, in 1794, and died at his house at Murrayfield, near Edinburgh, in June last, after a few days' illness. From an early age he had been devoted to botanical pursuits; and though he entered the medical profession, he devoted himself entirely to his favourite study as soon as he came into possession of independent means. In 1824 the University of Glasgow conferred on him the degree of LL.D. Uniting great energy of character with a quick discernment of the minute distinctions which characterise a large proportion of the Cryptogamic series of plants, he at the same time possessed such artistic skill, that few could rival the exquisite drawings, especially of the microscopic plants, which were procured by his pencil. His earlier well-known works, the 'Scottish Cryptogamic Flora,' and the 'Algæ Britannicæ,' published between 1823 and 1830, although containing some microscopic species, and illustrated by microscopic dissections, were chiefly devoted to a description and delineation of higher tribes of cryptogams, and are still unrivalled for the beauty and correctness of the drawings which illustrate the species. On the death, however, of his friend Dr. Gregory, he devoted himself almost entirely to the study of the beautiful siliceous frustules of the class of Diatomacea, to which he had been attracted by the illustrations of the papers at various times contributed to our own and other societies by that author; and since 1857 he has contributed twenty-nine papers on this branch of study to our 'Transactions' and 'Journal,' besides contributions to the 'Annals of Natural History,' the 'Edinburgh New Philosophical Journal,' and 'Transactions of the Botanical Society of Edinburgh.' He devoted himself more especially to the delineation and description of forms hitherto unnoticed; and though some may consider that many of these will prove on further examination mere varieties, and not entitled to rank as distinct species, and that his labours would have had more scientific value if employed in the consolidation rather than the extension of an already over-burdened nomenclature, none can fail to admire the beauty of the drawings which accompany his papers, or to wonder at the perseverance which, at threescore years and ten, enabled him to examine critically hundreds of slides to select those forms which had not previously been illustrated.

Mr. Joseph Gratton belonged to a very valuable class of men—those who, being engaged in commerce, devote their money and leisure time to scientific pursuits. He took interest in microscopical investigations, and manifested a liberal disposition by freely showing, with other objects of interest, those which his foreign transactions enabled him to obtain abroad.

Passing from subjects of painful association, it is gratifying to revert to the favorable position occupied by the Society, as the number of new Fellows added in the year, over the number lost by death and resignation, amount to no less than forty-five.

I will now briefly advert to the subjects which have been brought under our notice since my last address. An inquiry into the whole microscopic work of the past year would far exceed the limit of this address; and indeed my long illness, and consequent absence from the meetings of the Society during the last four months, places it beyond my power. I must therefore limit myself to a brief notice—to a few points only.

At the first meeting of the Society in the year, viz., on March 14, a valuable paper was read by H. C. Bastian, M.A., "On the so-called Pacchionian Bodies." In this paper those bodies were shown to be in no way glandular in their composition, as was formerly supposed, but to be composed of precisely the same elements as entered into the formation of the arachnoid, of the visceral layer of which, they were local hypertrophies, or circumscribed outgrowths. Their various forms were described, and the situations in which they were encountered in their different stages of growth were accounted for. It was maintained, in opposition to some other observers, that these growths invariably sprang from the visceral, and never from the so-called parietal layer of the arachnoid. The causes leading to their development were considered, and also the questions as to whether such growths were to be regarded as normal or pathological formations. And, lastly, it was shown that the Pacchionian bodies were not growths, absolutely peculiar in kind; that they could be classed with similar growths occurring on other organs of the body; and that their increased development was not usually a matter of much pathological significance.

With regard to matters relating to the practical adaptation to the microscope, or improvement in apparatus, we have to notice Dr. Maddox's "Slide-clip" for holding on glass covers, either at the time of mounting or during temporary observations. This contrivance is simply made from a piece of brass wire.

At a subsequent meeting, a different form was explained by Mr. J. Hogg, as manufactured at a very small cost per dozen by Mr. Baker. One of the prongs of this clip is armed with a small disc of cork, and the opposite one is turned in the form of an open ring, through which the proper position and arrangement of the object may be seen. These clips will unquestionably be found to be of great service in mounting objects, and maintaining a pressure till the object is dry or the medium properly set.

Next in order, is a form of adjustable diaphragm by Mr. S. Kincard. This consists of a very thin piece of vulcanized india-rubber tube set in a brass mounting so as to admit of its being twisted. In this operation every portion of the circumference of the tube, midway between the ends, gradually approaches towards the axis, and forms a variable aperture sufficiently uniform in outline. But the possible objection to this may be that the aperture is too far below the condensing lens, thus making it produce as much an effect of reduction of light as of diminished aperture.

Among other instrumental objects that have been brought before us is an ingenious leaf-holder and revolving disc-holder, by Mr. Smith, and an adjustable diaphragm eye-piece by our Secretary, Mr. Slack: this was devised for the purpose of limiting the extent of the luminous field, so as to suit the shape of any object through which it was desirable to transmit a strong light. By shutting out all extraneous or useless light, and admitting that only which comes from the object or part of the object under view, it is evident that we can see delicate structures far more correctly and comfortably than when surrounded with a large field of bright light that almost blinds us. This diaphragm can be arranged so as to enclose an object of irregular figure, and it will also serve as a pointer, as the aperture may contain only that portion of the object required for demonstration: the arrangement is neatly fitted into an ordinary eye-piece, and in no way interferes with its general use.

The most important improvement in the year relates to new forms of binocular microscope, by means of which the whole of the aperture of the object-glass may be obtained in each eye with the highest powers. The first plan for this purpose was brought before us by Messrs. Powell and Lealand, the second by Mr. Wenham: neither of them is intended to produce the peculiar stereoscopic effect resulting from the combination of two views of the same subject taken at different angles, but they have been devised to secure the physical convenience of using both eyes at the same time. To obtain an image by the whole aperture of the object-glass in each tube, Messrs. Powell and Lealand interposed an inclined disc of glass with parallel sides, so that one set of rays from the object are transmitted direct through it, while another portion of the light is reflected by the glass surface, and again reflected into the second tube; or, in other words, one portion of the light proceeds through the glass disc up one tube, while another portion reflected from it, suffers a second reflection from a rectangular prism, and is directed up the other tube. Considerable success is obtained by this method. Messrs. Powell and Lealand are able to display by it both sets of lines on the *Pleurosigma rhomboides* with only an infinitesimal loss of definition, yet the difference in brightness between the two images—one formed by transmitted, and the other by reflected light—is considerable. Mr. Wenham, noticing this great difference between the amount of light sent to each eye, called attention to the fact that at an angle of 45°, only 53·66 out of 1000 incident rays, or about $\frac{1}{19}$th part, could be reflected from a glass surface; and to obtain a more equal illumination, he devised the highly ingenious combination of prisms described and figured in the 'Proceedings' of the Society, as reported in the 'Quarterly Journal of Microscopic Science' for July, 1866. Mr. Wenham's remarkable manipulative skill enabled him to realise to a very important extent all the results he anticipated, but our leading professional artists consider his plan difficult of execution, and have not yet made the new combination of prisms for sale.

This is to be regretted, because there can be no doubt of the merit of his invention, and it seems to offer the best mode of avoiding the bad effects of a too exclusive use of a single eye, which, as is well known, tends to derange its power of focussing consentaneously with the other eye. It is also probable that in the prolonged examination of objects, better vision would be obtained by two eyes than one, as the organ of vision would be less fatigued.

Mr. Wenham in his paper embodied several plans in which the reflection was obtained from two contact surfaces, by which means the luminosity of the reflected image was greatly increased, and a more equal illumination transmitted to each eye.

The arrangement exhibited and recommended by the inventor does not differ materially in form and outline from his well-known form of binocular prism, and fits into the same space in the common double tube: the addition of another triangular prism in contact with the first reflecting surface allows direct rays to pass straight through into the eye-piece, while the others are reflected obliquely as usual. The plan is apparently simple; but the objection raised against it is, that the difficulties of construction are so great that the inventor only is capable of making them. It is to be hoped that this assertion is unfounded.

A somewhat different plan has been carried out by Mr. Ahrens, in which the principle of two combined reflections is still made available as in Mr. Wenham's; but as the direct rays are thrown out of the axis, two new bodies would be required for its application. The several plans for obtaining the whole aperture in each eye so quickly following upon Messrs. Powell and Lealand's arrangement, shows that an effect not depending upon a solitary condition may still afford ample scope for inventive ingenuity; but it is candidly admitted that combining an object with its own identically reflected image will give no stereoscopic relief, and consequently afford but little assistance in defining the projections and depressions of organic structure; yet it remains to be proved whether in carrying the now habitual use of two eyes in observations with the low powers, on to the more trying investigations with the highest, may not afford relief, and enable some observers to continue the use of the instrument beyond the time which sometimes compels them to lay aside the microscope, from the distress and injury to sight occasioned by employing one eye only for too long a period beyond its powers of endurance.

Mr. Piper has brought before us an economical and convenient cardboard cabinet for objects, and a mode of making a slide with a movable cover for the preservation of objects which it is desired to view, without the interposition of a covering glass. It must be admitted that it is much better, when practicable, to examine objects as nearly as possible in their natural state, and these slides may assist in the preservation of many objects without the flattening and distortion incident to the usual mode of preparation.

Mr. How has brought before us a useful and economical substitute for a mechanical stage, which he has attached to his new cheap microscope. Its action is like that of the magnetic stage, but the requisite adhesion is obtained by suitably placed springs, which oppose a convenient resistance, and do not seem likely to get out of order.

A simple adapter has been devised by Mr. Richards; it consists of a tube which passes through the stage of the microscope, and is sufficiently long to reach within focussing distance of the bottom of the stand, thus enabling an observer to view objects on a level with the base of the instrument, or to perform manipulations on the table.

A paper was read by the Rev. J. B. Reade, describing some improvements on his former "Kettledrum Illuminator." By superposing another somewhat smaller hemispherical lens, he is thus enabled to extend the angular aperture of the illuminating pencil to its utmost limits, and the large area of the lenses gives a great quantity of light. By the addition of ingeniously contrived shifting apertures and stops of various forms, he is enabled to throw light on the object from every angle, either in one or in several directions together, or to entirely obscure the central rays for viewing objects with dark-field illumination. This contrivance of Mr. Reade's affords a very slanting illumination, and its want of achromaticity is stated by him not to interfere with the particular purposes for which it was designed.

To obtain oblique illuminations in two directions for the display of the *Pleurosigma rhomboides*, Mr. Newton Tomkins has employed two prisms and two sources of light, arranged at right angles to each other, with excellent effect.

At our last meeting a new form of field microscope, constructed by Mr. Baker, was described by Mr. Newton Tomkins. This appears far to exceed, both in portability and simplicity, anything that has yet been produced. Two of the legs are jointed from a position near the eye-piece of the instrument. The body itself virtually forms the greater part of the length of the third leg, and is thus set at a very suitable angle of observation. The arrangement is remarkable for extreme steadiness, and the stage and mirror, being low, make the instrument very handy for manipulation. The legs are removable for the purpose of containing tubes and other apparatus. These advantages, together with the low price at which the microscope is manufactured, are good reasons why its employment should become universal.

This instrument seems to be an improvement on one of somewhat similar construction exhibited by Mr. Highley at the last *soirée* of this Society.

The art of making photo-micrographs with very high powers has been brought to great perfection by Captain Edward Curtis, assistant-surgeon U.S. Army. Dr. Maddox published in the 'Intellectual Observer' for July a description, accompanied with illustrations copied from the original of Captain Curtis's photographs of the *Pleurosigma angulatum*, one being taken with an American objective of $\frac{1}{8}$th focal length, and another with a $\frac{1}{50}$th of Powell and Lealand, the former being worked to an equal power with the latter by means of an achromatic concave amplifier used instead of an eye-piece. In these photographs, hexagonal markings appear with powers of 2344 and 2540 diameters, and nearly circular markings with magnification of 19050 diameters.

In the August number of the 'Intellectual Observer,' Dr. Maddox published a description of the process employed, from which it appeared that Captain Curtis used a Silbermann's heliostat, and that the light was transmitted through a cell containing a saturated solution of ammonia-sulphate of copper, and thus rendered approximately monochromatic.

At one of our recent meetings, Mr. How exhibited, by request of Dr. Maddox, a beautiful series of Captain Curtis's photo-micrographs obtained with various powers.

It is impossible not to admire the truly scientific and disinterested spirit which led Dr. Maddox to bring what might be considered rival work before the English public. But while assigning a very high degree of merit to the productions of Captain Curtis, it is only just to remark that in many cases, where his labours and those of Dr. Maddox have taken parallel lines, the high reputation of the latter has on the whole been fully maintained.

In the application of the microscope to natural history investigation during the past year, much worthy of notice has been achieved, if no very remarkable discoveries have been made. One paper, though properly belonging to an earlier period, was only made known to the English student by a translation which appeared in the 'Annals of Natural History' for March, 1866; and it is now alluded to on account of the important lesson which it teaches of the necessity of examining the delicate structures of soft creatures without disturbing their normal condition. Professor Schjödte demonstrates in this paper that the *louse* (pediculus) has a suctorial, and not a biting mouth, as was often stated. He found that the common practice of flattening the organs of this creature under glass gave rise to completely false appearances, and that it was only by surveying the parts in their natural condition that the true structure could be ascertained.

One of our Fellows, Mr. Davis, has recently brought before us some highly interesting and novel rotifiers, which he has placed provisionally in the genus Æcistes; and from the discussion that ensued when his paper was read, it is evident that there is a very useful field for microscopic work in the re-examination of the ciliary apparatus of rotifiers with the best means of illumination, and with the highest powers that can be brought to bear without necessitating a compression of the animals to such an extent as would introduce appearances as fallacious as those which Professor Schjödte has dissipated in the case of the louse.

A paper, published in Germany,* by Dr. Ferdinand Cohn, of Breslau, on a series of interesting forms of Infusoria which appeared in a marine aquarium, ought to stimulate English observers, who have excellent opportunities for adding to our knowledge of the microscopic life of our coasts.

Fresh-water infusoria have been studied much more attentively than their marine relations; but Professor Cohn's paper shows how much may be done with a marine aquarium only twelve inches high and twenty inches in diameter.

The question of illuminatory apparatus still exercises the skill of inventors and constructors. Achromatic condensers of various sizes and combinations are now before the public, and attention has been called to the different effects which result from various proportions in which the central and peripheral rays bear to each other. Combinations of larger lenses with longer focal lengths may be made to work with the same angle of aperture as smaller lenses with shorter focal lengths; and it is evident that the central rays are a constant quantity, while the peripheral rays may be increased by larger and suitably made combinations.

An achromatic condenser intended for research into unknown structures should have one stop in which the peripheral and central rays bear such proportion to each other as to facilitate the penetration of the object-glasses, and at the same time not to involve too great a sacrifice of surface vision.

The quantities known as penetration and resolution stand in necessary contrast to each other; but as a due proportion of angle of aperture to focal length secures a useful combination of the two properties in object-glasses, so a due proportion of the slanting and direct rays brought to a focus by a a condenser will help to preserve the balance required for most natural history investigations.

* 'Zeitschr. f. Wissensch. Zool.,' Bd. xvi, Heft 1866.

An achromatic condenser, made by Mr. Ross, with a large-angled $\frac{4}{10}$ths, possesses in a high degree the properties alluded to in these remarks; though Messrs. Powell and Lealand's large-angled condenser must be preferred when difficult surface markings are to be displayed.

Professor Smith, of Kenyon College, U.S., whose name is well known to English microscopists, is now in this country; and he has brought with him a series of remarkably beautiful drawings of diatoms in a live state, illustrating new views of their structure and mode of propagation. These it is hoped he will be able to show at the next meeting of this Society, and to add explanations of the curious and important results at which he has arrived. English observers have, in too many cases, confined their attention to dry and dead valves of the diatoms; but it may be expected that Professor Smith's researches will excite renewed attention to the living forms.

Professor Smith has likewise brought with him a binocular eye-piece adapted for use with a single-tube microscope, which is considered by those who have tried it in this country to give much better results than had been previously obtained by a similar construction. He has also devised a mechanical finger, which is described in 'Silliman's Journal,' No. 123. In this instrument a movable arm readily attached to the microscope carries a bristle, which can be made to touch and lift up any minute object seen under a moderate power on a glass slide. As soon as the mechanical finger has caught the object, it is raised, and a clean slide placed on the stage. The bristle carrying its minute burden is then brought into focus, and made to deposit it on the centre of the slide. With this little instrument very minute objects can be sorted and arranged with great ease.

Last year, illuminators for opaque objects under high powers were brought before the Society by Messrs. Powell and Lealand, and Richard Beck. They were both founded upon plans originally tried by Professor Smith, who did not like their performance, and he is now able to show us the form of metallic reflector which he recommends, and which affords better results. Mr. Smith, of Bow, has likewise devised an arrangement slightly differing from that of Professor Smith, which is well spoken of.

One pleasing feature of our times is the formation of scientific societies in connection with great mercantile houses. Foremost amongst these, in point of date, excellent management, and important success, is the Old 'Change Microscopical Society, formed in the establishment of Messrs. Leaf. Your President and Council, appreciating the service to science that may be rendered by societies of this description, have had much pleasure in opening friendly relations with the Old 'Change Society; and they hope, when you are better accommodated with rooms in which the instruments and collections of this Society can be made accessible, that some arrangements may be made by which a closer connection may be established with the Old 'Change Society and with similar bodies.

In inviting you to make renewed efforts for the successful application of the microscope to the vast range of questions which it is able to elucidate, I would remark that, as knowledge advances, the minute structure of every object belonging to the animal, the vegetable, or the mineral world becomes of more importance to the student, because he possesses additional means for its correct interpretation.

The bodily eye may see; but if the mental eye does not perceive, no information is gained. Hence, while improvements in the structure of the microscope and of its various appliances should be zealously promoted, it is even of greater consequence that the mind should be trained to understand the appearances which optical art is able to reveal.

Without scientific knowledge, the eye may be pleased with beauties and wonderful markings made visible by the aid of the microscope; but who is there who would not wish that the result of the devotion of his time, his money, and application to the microscope should result in an increase of knowledge?

The most common cause of failure with the microscope results from the want of sufficiently accurate and scientific knowledge to ensure the correct appreciation and interpretation of what is seen. There is no purpose of importance to which the microscope can be directed without a demand arising for several kinds of scientific knowledge.

The elements at least of physics and chemistry are indispensable in many forms of microscopic research; and if organised beings, or portions thereof, are the subjects of investigation, physiology and its kindred sciences become equally necessary. We cannot, therefore, effectually promote the use of the microscope without encouraging the study of a large group of physical sciences. I would particularly recommend that young observers make themselves acquainted with what has already been done, and acquire an elementary knowledge of physics, that microscopic researches may be advanced by their labours.

It fortunately happens that the acquisition of this knowledge, for the most part, does not need a master; the best training results from one's own industry, one's own researches, leading the observer to be self-dependent, and capable of forming an independent judgment. It is, however, a matter of the profoundest regret that the important departments of human knowledge to which I have alluded should be neglected in the majority of our schools; and it is also a matter of deep regret that, in proportion to the size of our towns and the magnitude of our population, there should be extremely few institutions in which the elements of scientific instruction can be obtained, and that there should be an equal scarcity of public libraries in which the best works can be consulted.

In conclusion, it is gratifying to revert to the favorable position occupied by the Society; and though at present the Council are unable to announce an immediate success in their efforts to obtain suitable apartments for the transaction of its business, fresh applications on its behalf will be made to the Government; and it is felt that, as Her Majesty has commanded the Society to be called Royal, and as His Royal Highness the Prince of Wales has become its patron, its claims to receive accommodation, similar to that accorded to other Societies, are of the strongest kind.

On the Gregariniform Parasite *of* Borlasia.

By W. C. McIntosh, M.D., F.L.S.

(Communicated by G. Busk, F.R.S., F.R.M.S.)
(Read March 13th, 1867.)

Kölliker, in his contributions to the genus Gregarina, L. Duf.,* described in 1848 a gregariniform parasite of his *Nemertes delineatus* (*Polia delineata,* D. Ch.) under the name of *Gregarina Nemertis,* which he had found in great numbers in the general cavity of the annelid. At least, he explains in a foot-note that his *Darm* is not the "Rüssel" of Quatrefages, but the *Darm* of Rathke; and since Quatrefages avers that Rathke considered the so-called proboscis as an organ of touch, it may be supposed the general cavity or cavities of the worm are here implied. He describes the structure of the parasite minutely, as having a spindle- or club-shaped body, furnished at its somewhat broader end with a knob

* 'Zeitschrift f. wiss. Zool.,' Bd. i, pp. 1 and 2, taf. i, fig. 4.

carried out into a blunt point, and the membranous and structureless investment containing a number of minute granules, a nucleus and nucleolus. He adds that their motion is not very vivacious, but he has seen them moving in a straight line, and undergoing certain inflexions of the body. According to the next author, Frey and Leuckart also observed similar bodies in Nemertes. Max S. Schultze* gives a drawing and description of a very similar form which he found in *Planaria torva.* He notes the greater translucency of the ends of the parasite, and says that he has not observed a copulation of two individuals to form a cyst and pseudo-naviculæ, but figures some of the latter from a cyst which he supposes to belong to this species; he makes no further remarks on their habits. The late Dr. G. Johnston mentions the occurrence of these bodies in his *Borlasia olivacea,* though he misinterpreted their nature, for he describes them as follows:†—"When pressing a portion of the body" (of the Borlasia) "between the plates of glass, I have occasionally seen some bodies escape, of a curved fusiform shape, acute at both ends, and marked towards one of them with a pale circular spot. They have shown no signs of life, nor can I say what they are, though it has occurred to me that they may be embryo young, and that the worms may, in fact, be ovo-viviparous."

Whilst examining the structure of some Nemertians at present classed as different species of Borlasia, these curious gregariniform bodies have frequently occurred. In *Borlasia octoculata* and *olivacea* (which species, however, are not to be distinguished anatomically), and in long examples transmitted alive from South Devon by the kindness of Mr. Parfitt, and called by him *Lineus lactea,* after Col. Montagu's MSS., the ova and parasites were abundant, especially in the last mentioned.

Towards the posterior end of the examples from Devon these gregariniform bodies occurred in swarms, and they were identical in all respects with those got in the Scotch specimens of the red and green varieties (Pl. II, figs. 1 and 2). They consist of elongated sacs filled with minutely granular contents, and having each a single, large, pale nucleus, measuring from $\frac{1}{1500}$th of an inch upwards, according to the bulk of the specimen. The nucleus shows slight markings when the parasite is first extruded, but a distinct nucleolus is not very apparent. In perfect specimens the snout is pale, very

* 'Beiträge zur Naturgeschichte der Turbellarien,' p. 70, tab. vii, figs. 18—22.

† 'Catalogue of British Worms,' edited by Dr. Baird, Appendix, p. 290.

faintly granular (not quite diaphanous), bluntly rounded, and marked by a slight swelling of the body at its base, from which swelling the snout gently tapers. There is no trace of rough points or other means for adhering. Sometimes, as when the investment had received injury, the surrounding water seemed to pass inwards and separate at certain parts the contained granules from the sheath, a fact which shows a certain degree of cohesion in the contents *in sitú.*

A favorable opportunity of examining the parasites was afforded by the spontaneous rupture of some of the annelids. They may then be seen projecting from the granular parenchyma throughout their entire length, with the exception of the snout, by which they adhere. Indeed, this may often be seen in the perfect annelid, as the waves of the fluid in the general cavities bend hither and thither the free bodies of the gregarinæ. After remaining for some time in the previously mentioned position (under pressure), a few separate themselves, and move through the salt water with a slow gliding motion like that of a diatome. On careful scrutiny the contour of the snout in a moving specimen is observed now and then to alter; this motion is not due to currents between the glasses, and it moves through mucus in the same manner. After remaining eight or ten hours in water (salt) all motion ceases, and in some the body becomes altered, assuming a club-shaped appearance, as seen in fig. 3. At the same time the clear portion at the snout is almost obliterated by encroachment of the granules.

Under pressure certain ova that accompany the gregariniform bodies are often extruded from the posterior end of the two first-mentioned worms. In one example of the greenish variety (*Borlasia olivacea*) they were emitted in August last in the form of an elongated cordon, held together by a slightly granular gelatinous matrix (fig. 6), the cord being rather more than the breadth of two ova, and the latter loosely scattered in the tissue. In the same specimen a mass of ova of a rounded form, enveloped in the same hyaline granular tissue, was subsequently discharged. These ova (fig. 5) measured about $\frac{1}{400}$th of an inch in diameter, and each contained an embryo that, for some time after the extrusion of the egg, made very evident movements. They have two coats, an inner, faintly (concentrically) striated under pressure, and an external, without markings. The contained embryo is finely granular, and has a large pale nucleus; its various postures are seen in the outline (fig. 6). When an ovum is ruptured between the glasses the contents spread abroad as a vast number of dancing granules.

These ova are altogether different from the ova of the Borlasia itself, which have large capsules, each with a neck ending in a long slender microscopic thread, the contents undeveloped, and otherwise totally dissimilar, and deposited in a large mass of consistent gelatinous substance, as first described by E. Désor.* It is curious, however, that the parasitic ova should be provided with a similar coating when extruded under pressure, and this coating is seen connecting the ova within the body of the worm towards its posterior end. The appearance of the contained embryo is much in favour of its identity with the gregariniform bodies, though as yet I have not seen a perfect *bonâ fide* birth. These ova, too, occurred in greatest plenty in August, whereas both Désor and I have found the ova of the Borlasia deposited towards the end of January. Kölliker does not specially mention the ova of his *G. Nemertis.* Max Schultze mentions and figures what he calls entire spheroidal forms, which differ from the ova above mentioned in being simple cells without thickened coats, and may or may not be in relation to the gregariniform bodies.

The small bodies shown in fig. 4 were extruded with the parasitic gregarinæ in great numbers; they were generally of an ovoid or pyriform shape, a few being circular, and contained many clear granules. The diameter of these structures was about $\frac{1}{1000}$th of an inch, or rather more, whereas a specimen of a stray gregariniform parasite from the same annelid measured $\frac{1}{120}$th of an inch; therefore they do not seem to be cysts formed after the conjunction of two gregarinæ.

Occasionally one of the parasites is observed in a degenerating condition, forming an ovoid body in which the bent and atrophied gregarina is scarcely distinguishable.

The large number of these gregariniform bodies, in some examples of the Borlasiæ, must give them a position of importance—whether beneficial or prejudicial—in the economy of the annelids.

* 'Müller's Archiv' for 1848, p. 511, pl. xviii, &c. I have not yet seen the American version.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY.

On the CHANGES *which accompany the* METAMORPHOSIS *of the* TADPOLE, *in reference especially to the* RESPIRATORY *and* SANGUIFEROUS SYSTEMS. By W. U. WHITNEY, Esq., M.R.C.S., &c. &c.

(Read March 13th, 1867.)

IN a paper read on the 13th June, 1861, I had the honour of submitting to the members of this Society a description of the general sanguiferous system in the tadpole, the tracing of which was rendered more complete and satisfactory with the aid of the binocular microscope, at that time a recent invention.

Those investigations, and the subsequent ones, were made with the admirable microscope possessed by my friend Mr. Fitzgerald, and to his manipulative skill, not less than to the goodness of his instrument, I am largely indebted.

A more extended inquiry has had the advantage (1) of correcting an anatomical and physiological error into which I had unconsciously fallen, the cause, nature, and correction of which were explained in a communication to 'The Intellectual Observer' for May, 1863; and (2) of directing investigation to the anatomical changes, in reference especially to the respiratory and sanguiferous systems, which accompany the metamorphosis of the tadpole from the form and functions of the fish to the shape and habitudes of the reptile.

The fact that *one* creature possesses not less than *three* sets of respiratory organs, two of which are successively developed and then annihilated, could not fail to excite curiosity, though the difficulty of tracing the steps of the process by which these transitionary changes are accomplished appears to have been generally felt. The writer of the article, "Batrachia," in the 'Encyclopædia Britannica,' says, "the change or conversion from external to internal gills is not satisfactorily described by physiological observers." And this statement, it must be confessed, appears to be applicable even to that accomplished and excellent authority, the late Dr. Thomas Williams, author of the article "Respiration" in the supplementary volume of 'Todd's Encyclopædia.'

The tadpole furnishes a remarkably interesting example of gill structure and function, because the tadpole gills *in transitu* exemplify in turn the simplest and the most elaborate forms which these organs of aquatic respiration ever present. As a general definition, a *gill* may be said to be a prolongation of surface *externally*, supplied with blood-vessels, and adapted by its form and position for exposure to an aqueous medium. On the other hand, a *lung* is a prolongation of surface *internally*, forming a pulmonary cavity or sac adapted to receive air.

The tadpole is furnished with *two* sets of gills, the external and the internal, and these are intimately connected. The vascular anatomy of this connection, upon which depends the change whereby the respiratory function is transferred from the outer to the inner gills, consequent on the atrophy of the former, simultaneously with the development of the latter organs, does not, as I have said, appear to be satisfactorily explained.

The first indication of the external gills is seen in the stage of development represented in fig. 1, Pl. III, in which a slight prominence, seen just at the junction of the head with the body, denotes the point at which the developing gill will protrude. In a few hours more the prominence grows into a tubercular like swelling, and we may even now begin to trace the motion of the blood in these incipient gills. M. Milne Edwards, in his large work on 'Physiology,' vol. ii, p. 206, quoting Rusconi, says that it is only *after birth* that the blood begins to circulate in the outer gills. But the writer has seen examples in which these gills were protruded, with a visible vigorous circulation in them, while the tadpole was still within the capsule of the egg. When hatched, the form of the gill is still more conspicuous, and in twenty-four hours after birth (fig. 2) the comb shape of the organ and the circulation within it are clearly exhibited. The outer or rather *outermost* skin at this period is a thin but opaque lamellated covering, which is gradually removed, and partly by the mechanical action of the water, which seems to wash away the thin lamellæ of scurf-like epidermic scales from the true skin beneath. Thus are revealed successively the transparent coat of the eye, of the external gills, and, by degrees, of the rest of the body. And thus the internal organs become hourly more perceptible, until in the course of two or three weeks from date of birth, the entire skin, freed from those pigmentary scales, attains its highest degree of transparency, and heart, and gills, liver, intestines, and blood-vessels, are seen in all the brilliancy of life and motion, and with as much clearness as if we were looking at them through an integument of glass.

To return to the *external gills.* On the fourth or fifth day after birth, and after the young tadpole is freed from the remnants of the gelatinous mass he has been feeding on, and has begun to live on vegetable diet, the external gills reach their highest point of development. In this condition they appear to the naked eye (fig. 3) on either side as a pair of depending, slender filaments, delicately fringed. The length of the filaments differs in different instances. The example here figured was drawn from one of a batch of tadpoles, all remarkable for the length to which these filaments had grown, and equally remarkable, therefore, for their grace and beauty. On examining with the microscope we find these gills projected through an opening or fissure, situated on either side below the head, corresponding to the *operculum* in fishes. With the aid of the glass we resolve each filament, with its fringe, into a transparent, comb-shaped case (fig. 4, *a*), containing within it an arterial and venous system, to be presently described. The fringe (to follow our simile) corresponds exactly with the teeth of a comb, and, like them, consists of processes (about six), all proceeding at right angles from one side of the filament or back of the comb. The filaments on either side are traceable inwards through the fissure, where they become immediately and closely connected with a *bed* or cluster of small digital-like processes, some of which may be seen (at an early stage) just projecting through the operculum fissure. These beds or tufts are, in fact, the *internal gills* in their incipient, undeveloped state (fig. 4, *b*).

The next perceptible change is a shortening of the filaments, with a corresponding retraction of the processes, which appear to be drawing inwards through the operculum. At the end of the first week, under favorable circumstances of temperature and light, the external gills are found to be fast disappearing, while just prior to their complete removal we may note a change in the *form* of the tadpole. The contraction below the head (fig. 3) is obliterated by a filling out in this direction, so that the tapering shape is exchanged for a square or rather rounded form (fig. 5). At this stage the body of the tadpole is daily becoming more transparent; but not until the *external gills* have nearly disappeared is the skin sufficiently clear of pigment to afford us a glimpse of the heart and other internal organs. The *motion* of the heart is detectable, but its *shape*, at present, is indefinite, and the blood-vessels are imperceptible. Hence the difficulty of tracing the *vascular connection* of the outer gills with the heart and inner gills; for upon this "the change or conversion from external to internal gills" evidently depends.

Hitherto I have not succeeded in obtaining, either by artifice or chance, a tadpole at this stage sufficiently transparent to exhibit to the eye this vascular connection. Nevertheless, by a demonstration of the vascular system of the *internal* gills, effected at a little later period, we may obtain, I think, a satisfactory key to the comprehension of that which exists, at the stage we are speaking of, in reference to the *outer* gills. But the reader will presently judge for himself of the merits of this conclusion. The *right external* gill shortens, is retracted, and disappears, sooner than the left one. The gill is not simply retracted within the fissure, but there is an absolute shrinking, withering, and ultimate absorption of its substance. When this right gill has shrunk within the fissure the latter is closed completely, so that the gill chamber on that side is shut up. The remnant of the gill, tucked in, as it were, is still perceptible, as represented in fig. 6, *c*. In a few days this remnant is reduced to a bit of shapeless substance, as seen in fig. 12, Pl. IV, *d*, which, in a few hours, is entirely removed. On the left side the process of retraction is slower. A small protrusion of *left* gill may be seen for a day or two after the right one has disappeared; and when the left is absorbed the operculum on that side is found to remain open as the aperture of exit for the water that bathes the internal gills. The permanent form of the operculum is seen in fig. 6. I have alluded to the changes of form which the body of the tadpole undergoes during the period in which the external gills shrink and disappear (figs. 3 & 5). This change accompanies the first stage of development in the *second* set of respiratory organs—the *internal* gills. Fig. 4 represents the tufts of digit-like processes composing the *inner* gills in their *first* stage, while the *outer* gills are yet in full development. This figure is composed chiefly from some dissected preparations made by my friend Mr. Archer, after immersing the tadpole for a few days in a weak solution of chromic acid. In this very early stage the opacity of the skin renders it impossible to see the incipient tufts composing the inner gills while the tadpole is alive; hence the value of Mr. Archer's preparations as exhibiting the *form* and *position* of the tufts at this period; but they cannot, of course, exhibit their vascularity. Fig. 6 represents them with the digit-like processes larger and longer, while the outer gills are shrinking and shortening.

Soon, however, we are able to find some specimens transparent enough to show these tufts in what may be considered their *second* stage of development. Fig. 12, Pl. IV, represents the *internal* gill, with the circulation in the tufts, as seen at this more advanced period. Each digit contains a single blood-vessel, which travels to the extremity on one side, loops at the end, and returns along the other. With a half-inch glass the blood-current in these loops is distinctly visible.

Tadpoles well fed and well supplied with fresh water, plenty of light and air, and kept in a warm temperature, will at this stage grow rapidly, while the skin now attains its highest degree of transparency. At this *middle period* of the metamorphosis the *internal* gills undergo a further development, enlarge, and present, under the microscope, one of the most brilliant and dazzling specimens of living vascularity that can be seen. The change from the *second* stage of development (fig. 12) to this, the perfect condition of the gill, is highly interesting and beautiful. To trace and define distinctly the anatomical nature of this change is not easy; but, when discovered, our admiration is challenged by the beautiful simplicity of the means employed.

Each cluster or tuft of the digit-like processes, seen in the *incipient* condition of the *inner* gills (fig. 4) is divisible into three double rows. In the *second* stage of their development the three double rows are not only clearly apart, but have between them red lines (fig. 12) indicating the trunks of blood-vessels, which in this stage are in process of enlargement. But on examining one of these gills a few days later, when it has reached the *third* or period of complete development, the eye is dazzled with a brilliant but confused display of dancing globules; and a maze of rapid crimson currents, running in various directions, is seen in place of the cluster or tuft of single loops of blood-vessel perceptible a day or two before. It is clear that the gill has undergone a remarkable change; and if we get rid of the dazzle and confusion caused by the maze of currents, by examining a dead tadpole (having first removed the skin that covers the gill—or what is better as a preliminary, having immersed the tadpole in chromic acid according to Mr. Archer's plan), we shall find that the three double rows of digit-like processes with their simple loops of blood-vessel, have become elaborated into three rows of *crests*, each with a cauliflower-looking surface, as seen in fig. 7, *e*. Thus we arrive at the *form*, but to understand the *vascular system* of the perfect gill we must return to the living subject.

The brilliant but perplexing maze of blood-vessels which the fully developed gill presents in the ordinary mode of looking at it is, in fact, the vascular plexus of which the *crests* are mainly composed. If we select a very transparent tadpole, and examine a portion of the crest surface with a $\frac{2}{3}$ or $\frac{1}{2}$ inch power, we find the blood-vessels assuming such shapes as are represented in fig. 8. These shapes afford an explanation of the change from *tufts* to *crests*, as far, at least, as the vessels are concerned; for it is easy to perceive that when the blood and the impetus of the heart and arteries are withdrawn from the external gills (by their destruction), and expended upon the looped vessels of the digit-like processes, how each simple loop becomes extended into the tortuous and plexiform shapes observed, thus largely multiplying the vascular surface exposed to the aerating medium. We have now to examine the course and connections of the large trunks which convey the blood to and from the *internal* gills.

It was not until it occurred to me to remove in the living subject the integument in front of the gill that I succeeded in obtaining a clear view of its vascular system. I had previously examined a large number of very transparent tadpoles by simply looking through the skin, yet found it impossible to obtain a clear and satisfactory view of the blood-vessels of the inner gill. But by removing the integument in front of the gill, so that the latter may be laid bare while the circulation is still vigorous, a most brilliant and beautiful sight is presented, and the observer is astonished that the little film he has removed (albeit apparently quite transparent) effectually obscured the simple and beautiful piece of mechanism now before him. This operation can be performed without pain. *One* drop of chloroform effectually destroys the sensibility of the tadpole without damaging the force of the circulation. I have seen the latter continue, with very little reduction of force, for two hours, under the influence of one drop of chloroform. Should any sign of sensibility return, it may be immediately quenched by touching the body with a camel-hair brush dipped in the chloroform.

This dissection, to be successful, is a delicate and difficult affair. Difficult, because, on the one hand, by incising ever so little too deep, some of the vessels are wounded, and the consequent hæmorrhage empties the arteries and obscures them; while, on the other, if we do not remove enough of the fine tissue between the skin and the vascular plexus, we cannot obtain a clear view of the latter. With much care and pains and many trials, I cannot boast of having accomplished this task perfectly more than three or four times. On these fortunate occasions, however, the vessels were completely unveiled and uninjured, and the entire plan of their distribution and connections clearly displayed.

Each *internal gill* (by which expression I mean the *entire* branchial organ on either side) may be said to consist of cartilaginous arches (fig. 13, Pl. IV, *a*), with a piece of additional framework (*b*) of a solidly triangular form, stretching beyond the arches, and composed of semitransparent, gelatinous looking material. These parts, forming the framework of the organ, support upon their upper surface the three rows of crests with their vascular network, and the main arterial and venous trunks which lie parallel with and between them. The vascular system displayed by laying bare (in the manner already mentioned) the internal gill, is seen in fig. 13. The three systemic arteries (A, B, C) arising, right and left, from the *truncus arteriosus*, enter each gill on its cardiac side, and then follow the course of the crests, lying in close proximity to them. The *upper* of these *branchial arteries* runs along on the outside of the upper crest; and if the operator has succeeded in clearly exposing the vessel without injury, he will detect a branch (*c*) leaving the trunk and passing into the network of the crest, *whence* a returning vessel (*d*) may be traced carrying back the blood *across* the branchial artery, and conveying it to another vessel lying close to and taking the *same course* as the artery itself. Carrying the eye along the latter vessel we find, at a short distance from the first of these crest branches, a second (*e*), which leaves the main trunk and enters the crest, whence a corresponding returning vessel conveys the blood across the arterial trunk into the vessel lying beside it, as in the former instance. A succession of these branches (each taking a similar course) may be traced from one end of the crest to the other. But it is now to be observed that the trunk from which these arterial branches spring *diminishes* in size as it proceeds in its course (like the gill artery in fishes), while the vessel running parallel to it and *receiving* the stream as it returns from the crest *enlarges* in the same degree.* Thus, the artery or *afferent* vessel which brings the blood *to* the gill is large at its entrance, but gradually diminishes and dwindles to a

* The latter corresponds to the branchial *vein* in the gill of the fish; only the arrangement of vessels differs in the two cases, inasmuch as in the tadpole the arterial and venous currents flow in the *same* direction, while in the fish they travel in *opposite* directions.

point at the opposite end of the crest; while the venous or *efferent* vessel, beginning as a mere radical, gradually enlarges, and thus becomes the trunk that conveys the blood out of the gill to its ultimate destination. Calling this vessel the *upper branchial vein* as long as it remains in contact with the gill, we subsequently change its name when it leaves the gill and winds upwards for distribution to the head, and then designate it *the cephalic artery.* The *middle branchial artery and vein* proceed in like manner in connection with the middle crest, and *the lower artery and vein* in connection, with the lower crest. The *middle and lower venous trunks,* having reached the extremity of the crests, curve downwards and inwards, and then leave the gill. The former trunk, converging towards the spine, meets its fellow, and with it forms the *ventral aorta.* The latter gives origin to the *pulmonary artery,* and supplies also the integuments of the neck.

We must now return to the *external gills,* for the sake of offering an explanation of the vascular change which accompanies (and apparently causes) the shrinking and ultimate disappearance of those organs, while, concurrently, we observe the progressive development of the *internal gills.*

It is evident that the three arterial trunks arising from the heart convey the blood to the *outer* gills for aeration during the period that these organs are in full development and play. It is evident, also, that during the same period the incipient *inner* gills exist in the form of small tufts (fig. 4), which at a little later period may, as I have said, be *seen* with the blood traversing the single loop of blood-vessels contained in each of the digit-like processes composing these tufts (fig. 12). As in the *tadpole* we can distinctly see the pulmonary vessels in the incipient lung of the future frog, so we cannot doubt that this loop of blood-vessel (however small) exists in the gill tuft in the first stage (fig. 4). I have already shown how the *loop* becomes the *crest,* and how the latter is connected with the large branchial vessels (page 49). For the same reason that I infer the existence of the loop in the first stage of the tuft, I infer also the existence of its *vascular connection* with the main trunks or branchial vessels which are then conveying the blood to the *outer* gills; and as, at a later period, the blood-vessel loop is visible, so, at a little later period, the vascular connection with the main trunks is also demonstrable. Hence, if it be granted that the *visible* vascular connection is but the enlarged development of the *incipient* state, I think we may understand "the change or conversion from external to internal gills" with the aid of the accompanying fig. 14. I would first observe that in the *post-mortem* preparation (fig. 4) there is an obvious continuity of structure between the bed of inner tufts and the outer gills. This observation prepares us for understanding the vascular connection between them. In accordance, then, with what soon becomes visible, we feel assured that the three systemic vessels A, B, C, in their course to the outer gills, run at the base of the three double rows into which the *inner* gill-tufts are divided (fig. 14, in which a few tufts in *one* row only are represented, for the sake of simplification). As soon as the arteries arrive at the projecting external gills, they become visible, are seen to run along on one side, and supply each division of the gill with a branch, which, having reached the extremity, forms a loop, by which the blood returns on the opposite side by a corresponding vein that travels parallel to the artery. With a $\frac{2}{3}$rds power several small communicating branches may be seen between the vessels, perhaps as a proviso in case of accidental obstruction to the main current. Now, it follows from the previous considerations that the branchial arteries, in their course to the *external* gills, become connected with the gill-tufts of the *inner* gills in the following manner :—Incipient twigs, given off from the main trunk, and represented by the dotted lines *e, f, g, h,* pass into the adjoining digit-like processes, each forming a loop by which the current returns, and then, leaving the digit, passes into the incipient upper branchial *vein* (I), which is thus filled by the aggregate of these tributaries. By close observation you may detect this vein in its early stage (before the disappearance of the *outer* gills) as a thin red line, taking the curved sweep of the future large vessel (the *cephalic artery*) into which it becomes developed. In like manner the *middle* and *lower* branchial arteries must be connected with the second and third double rows of tufts, whence the blood returns to fill the incipient trunks which, at a later stage, supply the remainder of the body.

Admitting this to be the correct explanation of the vascular connection between the *incipient inner tufts* and the full-grown *outer gills,* it follows that in proportion as the tufts develope, and derive to themselves a correspondingly larger quantity of blood, so the outer gills, being in the same degree deprived of the latter, will have their function superseded, while their delicate and feeble structure shrinks, and ultimately disappears under the gradual abstraction of the vital fluid. We may note the change of *form* with increase of size in the tadpole's body that accompany the simultaneous absorption of the *external* with the commencing development of the *internal* gills (fig. 5).

With the disappearance of the *outer* gills, those vascular changes by which the *inner* gills attain their full growth and maturity are rapidly developed. These we have already traced. It now remains to follow, as closely as we can, the vascular arrangements by which the *inner* gills, having accomplished their function as the tadpole's *second* set of respiratory organs, are, in their turn, to be removed and succeeded by the true reptilian organs of respiration—the lungs of the frog.

Each branchial artery, on entering the inner gill, communicates *directly* with the corresponding branchial vein by a very fine twig, which is, in fact, the radical of the venous trunk (fig. 13, *f*). This trunk, it must be remembered, gradually enlarges as it receives into it the newly aerated blood conveyed from the crests by the cross branches. Now, if we examine the gill in a *very* transparent subject at the period when the fore legs are about to protrude, or make a successful removal of the integument covering it, we shall find that the fine connecting twig has, in each instance, enlarged to a channel of the same calibre as the artery itself (fig. 9, Pl. III). Hence, in the case of the *upper* pair of branchial vessels, more blood begins to flow *continuously* from the gill artery into the *efferent*, or cephalic trunk, without traversing the gill-crests; in the second pair, into the trunk which forms the aorta; while in the third a large part of the current passes at once into the developing pulmonary artery and growing lungs. All this time the blood is, of course, exposed to the aerating influence of the water with which the gill is always bathed, but cannot be so thoroughly aerated as when (in the early stage of tadpole life) the entire current traverses the fine plexus of which the crests are composed. Thus, the blood begins to assume the mixed quality which distinguishes creatures of the reptilian type.

At a yet later period (when the legs are protruded) we find an obvious diminution in the size of the inner gills, for the proportion of blood which then flows continuously into the systemic circulation and pulmonary arteries hourly increases, while that which yet finds its way into the crests diminishes in the same ratio. With the advent of the extremities the creature instinctively seeks to breathe in air rather than in water; and so little of real gill function remains that, if tadpoles at this stage are confined in a bottle of water, they are very apt to die from drowning unless a piece of cork be placed on the water, whereon the tadpole can mount and breathe the air.

Curious and beautiful is the final stage of the metamorphosis, when the waning tadpole and incipient frog coexist, and are actually seen together in the same subject (fig. 10). The dwindling gills and the shrinking tail—the last remnants of the tadpole form—are yet seen, in company with the coloured, spotted skin, the newly formed and slender legs, the flat head, the wide and toothless mouth, and the crouching attitude of the all but perfect reptile.*

By the process now described, the three systemic arteries (fig. 13) become *continuous* with the corresponding *efferent* trunks that convey the blood for distribution through the body, while, simultaneously, the vital fluid is being abstracted from the *special* trunks belonging to the gill and its vascular crests. These, with the gill structure connected with and dependent upon them, being thus deprived of their blood, shrink, become absorbed, and so disappear. Such appears to be the beautifully simple mechanism by which the transition in the type of the respiratory function from fish to reptile is accomplished.

We have now to consider the *third* set of respiratory organs, the *lungs.* When examined in the young, newly formed frog, they are found to have arrived at organic and functional completeness; but they *coexist* (in an incipient form) with *the gills of the tadpole,* and pass through their gradations of development simultaneously with those phases of maturity, decline, and decay, in the gill organs, which have been described. If we take a tadpole a few days old, when the *outer* gills are fully developed, and immerse it for another few days in a weak solution of chromic acid (Mr. Archer's method), we may, by placing the tadpole under a dissecting microscope, and with the aid of a needle and camel-hair brush, then remove the integuments, disclose the tufts of the *inner* gills, and by carefully getting rid of a prominent roll of intestine that occupies the upper part of the abdomen, succeed in revealing the incipient lungs. These are situated behind the gut and close to the spine, and appear as a pair of minute tubular sacs, united at their upper and open extremities (fig. 4). It is much easier to describe than to perform this little operation; but that it has been achieved is amply proved

* With the loss of the *inner* gill, the teeth and fringed lip possessed by the tadpole also disappear, because the *labial* artery, which supplies these organs with blood, has its origin in the gill, and proceeds directly upwards to the mouth. Simultaneously, therefore, with the loss of the gill, the oral appendages proper to the fish are also removed.

by the several very interesting preparations which my friend Mr. Archer has successfully made. The chromic acid renders the tissues friable, so that they can be readily peeled away.

During the period of the tadpole's transparency a part of each lung is usually perceptible, and may be seen, on looking through either side of the abdomen, as a transparent, sacculated bladder of air. On one occasion I met with an example in which the tadpole exhibited the lungs, through the back, in a very beautiful and unusual manner. They were lying side by side, close to the spine, and, to the naked eye, looked like a double row of brilliant globules, glistening like quicksilver. (Fig. 11 represents them as seen under the microscope.) This singular display was due to a temporary shifting of the bowels, whereby the lungs were distinctly brought into view; for on looking at the same tadpole on the following day I found that the bowels had changed their position, and then the lungs were concealed. Fig. 7 represents the lungs in a tadpole at about the middle period of the metamorphosis, showing the progressive development and elongation of the tubular sacs.

When the last vestiges of the tadpole form—the remnants of the tail and gills—have disappeared, the lungs, though small and extremely delicate, are found to present a perfect miniature of what they afterwards become in the full-grown frog. Of all the sights to be seen in tracing the metamorphosis of the tadpole, the most splendid is that of the crimson *gill* with its vital current in vigorous circulation. Next to that, as something beautiful to see, is the appearance presented by the *lung* of the young frog with its circulation in vigorous movement. To obtain this sight the lungs should be full of air, and the heart vigorously beating. These conditions, however, are seldom easy to attain. Put the young frog into a wine-glass, and drop upon him a *single* drop of chloroform. This suffices to extinguish sensibility. Then lay him on the back on a piece of cork, and fix him with small pins passed through the web of each foot. Remove the skin of the abdomen with a fine pair of sharp scissors and forceps. Turn aside the intestines from the *left* side, and thus expose the left lung, which may now be seen as a glistening, transparent sac, containing air-bubbles. With a fine camel-hair pencil the lung may now be turned out, so as to enable the operator to see a large part of it by *transmitted* light. Unpin the frog and place him on a slip of glass, and then transmit the light through the everted portion of lung. Remember that the lung is very elastic, and is emptied and collapsed by very slight pressure. Therefore, to succeed with this experiment, the lung should be touched as little as possible, and in the lightest manner, with the brush. If the heart is acting *feebly* you will see simply a transparent sac, shaped according to the quantity of air-bubbles it may happen to contain, but void of red vascularity and circulation, as in the *left* lung of fig. 15. But should the operator succeed in getting the lung well placed, full of air, and have the heart still beating vigorously, he will see before him a brilliant picture of crimson network, alive with the dance and dazzle of blood-globules, in rapid chase of one another through this delicate and living lacework which lines the chamber of the lung (fig. 15). The trunk of the pulmonary artery is conspicuous on the one side as the channel which brings the blood to the lung, and the ramifications of which constitute the fine network aforesaid, while the pulmonary vein on the other side returns the aerated blood to the heart. The internal surface of the lung becomes, in the older frog, developed into numerous shallow cells, the boundaries of which correspond to the polygonal facets presented by the external surface.

Fig. 16 is the drawing of a dissection made to exhibit the trunks of the systemic arteries in the frog, with the origins of the pulmonary arteries and the course of the pulmonary veins, in the full-grown reptile.

Permit me, in conclusion, to thank you for the gracious and liberal manner in which you have enabled me to present the results of my humble labours on this interesting subject to the members of this society.

On the Structure *of the* Tooth *in* Ziphius Sowerbiensis (Micropteron Sowerbiensis, Eschricht), *and on some* Fossil Cetacean Teeth. By E. Ray Lankester, F.R.M.S. of Christ Church, Oxford.

(Read May 8th, 1867.)

If it be true that "differences in structural arrangement which exist without our being able to see why they should exist possess a morphological value which rises in direct proportion with their physiological obscurity,"* the teeth of the Ziphioid Cetaceans have a very considerable claim on the interest and attention of zoologists. The "reason why" a Cetacean should have two powerful teeth in its lower jaw—apparently incapable of biting, or curved over the top of its

* Professor Rolleston, 'Trans. Zool. Society,' vol. v. part 4, p. 311.

snout so as to prevent the opening of the mouth beyond a very limited extent, as in *Ziphius* (*Dolichodon*) *Layardi*, lately described by Dr. Gray, is certainly at present obscure; still more difficult is the explanation if, as it appears, the males only have these massive teeth. That these teeth, or rather one tooth of a certain Ziphioid, and probably also those of others, present marked differences in structural arrangement, distinguishing them from the teeth of other Cetacea, I hope to show in the following pages.

As far as I have been able to ascertain from the writings of Van Beneden, Gervais, Duvernoy, and others, no description has yet been published of the dental tissues of any one of the Rhynchoceti, excepting a brief notice of the small pointed denticles in a species of Hyperoödon, given by Professor Owen* in his 'Odontography,' from which it does not appear that there is any close analogy between *Hyperoödon* and *Ziphius* (*Micropteron*) in regard to the teeth; and, indeed, they have a very different position and time of appearance in the two forms.

The synonymy of genera and species in the Rhynchoceti is likely to cause some confusion, and I shall therefore make use of the generic and specific terms approved by Professor Huxley in a very concise memoir on a fossil Ziphius, published in the 'Quarterly Journal of the Geological Society,' 1864, p. 395.

The lower jaw and the larger part of the skull of the male specimen of the rare species *Ziphius* (*Micropteron*) *Sowerbiensis*, which was thrown ashore in Elginshire in 1800, and was engraved in Sowerby's 'British Miscellany,' 1806, p. 1, pl. i, is preserved in the Oxford University Museum, having been purchased by Dr. Buckland at the sale of Sowerby's museum, and presented by him to the Anatomical Museum of Christchurch, whence it was transferred with the rest of the collection to the University building.

I have been allowed to figure and describe the microscopic and other sections which have been made from the right lower-jaw tooth of this specimen, and Mr. Tuffen West has also had one of three sections entrusted to him for comparison with my drawings whilst engaged in the work of engraving them.

A history of the Oxford specimen, as also a full bibliography of the various memoirs which have appeared upon the anatomical and zoological relations of this animal, will be found in the 'British Museum Catalogue of Seals and Whales,' 1866, p. 350.

* See also Vrolik's figures in his Memoir on *Hyperoödon*. Natural History Society, Haarlem, 1848.

The lower jaw exhibits two large teeth very deeply implanted in their sockets, of a curved or somewhat claw-like form, very much compressed laterally, and fixed so that the curve is directed backwards instead of forwards, as is usual with teeth having the general form of canines.

External characters of the tooth.—In Pl. V, fig. 1, one of the teeth is drawn of the natural size; the line *a*, *b*, indicates the direction of the horizontal line of the alveolus when the tooth is in its natural position in the jaw. The lateral compression of the tooth is seen from fig. 3, which is half of a transverse section taken at *a*. The whole exterior surface, with the exception of the small conical crown, is very rough, irregular, and knotted, having a somewhat resinous lustre and a yellowish colour. This external tissue is, as in other teeth, "cement." The small conical crown which seems to rise out of the cement like a nipple is in one of the two teeth very sharply marked off from the rest of the tooth by the presence of a crack between it and the yellow noduliferous cement. Its surface has the peculiar vitreous lustre characteristic of dentine, and is white. That tooth which has not been cut is heavy for its size, and appears to be solid and compact throughout.*

Longitudinal section of the tooth.—In Pl. V, fig. 2, the longitudinal section of the tooth is drawn to a certain extent diagrammatically, the small remnant of a pulp-cavity being introduced from the opposite half of the section. The true nature of the various layers exhibited was ascertained by microscopical examination of three cross sections cut at about the point *a*, and one sixth of an inch lower (Pl. V, fig. 1, and Pl. V, fig. 3) from the other half of the specimen.

The great thickness of cement is very remarkable (*c*), completely enveloping the small cap of true dentine (*d*), with the exception of its projecting point. The cement forms the outer wall of all the rest of the tooth, being continued round the calcified pulp-cavity, into which it projects very largely in a curiously irregular manner in some places.

The small cap of dentine (*d*) is very clearly marked off from the rest of the tooth in the section by the bright vitreous lustre it has acquired in the polishing to which the specimen has been submitted. This small conical cap, hardly more than half an inch in length, appears to be all the true dentine developed in the tooth, with the exception of a very thin layer extending between the cement and calcified pulp about halfway down the tooth, which is, however, for the most part composed of a structureless "globular" mass of

* Sowerby in his description characterises the teeth as "boney."

calcareous material. The exceedingly small development of dentine is one of the most noticeable peculiarities presented by this tooth. The pulp-cavity is throughout occupied by a very dense vascular form of osteo-dentine, excepting a small elongated space which is left within the terminal cap of true dentine. This position for a residual pulp-cavity is, I believe, quite unprecedented; in other Cetacean teeth, in the tusks of *Trichechus* and *Sirenia,* which have their pulp-cavity to a large extent occupied by osteo-dentine, the residual pulp-cavity is always at the base instead of at the crown of the tooth. To the naked eye the osteo-dentine filling the pulp-cavity in the *Micropteron* tooth presents in the longitudinal section a cracked irregular structure. Fissures run longitudinally through parts of the material, and ridges of a lighter colour and denser appearance than the surrounding parts traverse the surface in irregularly longitudinal and oblique directions. The fissures appear to be caused by the canals of the osteo-dentine; the denser ridges by the lacunar but hard "globular" matter into which the tissue surrounding the canals is in many parts converted. The points to be noted in the naked-eye appearances of the tooth and its section are—the minute size of the conical cap of dentine, its being imbedded in the surrounding cement, the thickness and irregular disposition of the cement, the position of the residual pulp-cavity, and the excessive development of dense globular matter in the dentine and also in the osteo-dentine filling the pulp-cavity.

Microscopic characters of the dental tissues.—Plate VI, fig. 1, represents a portion of a transverse section of the tooth from near *a* (Pl. V, fig. 2), prepared by Mr. Topping, whilst Pl. VI, fig. 2, is a smaller portion of a section taken a very little lower down. The most striking feature in both is the very large development of opaque, apparently structureless material separating the cement from the dentine of the tooth.* It is very sharply marked off from the cement, but on the other side shades off into the dentine (or perhaps osteo-dentine in some parts of the tooth), of which it is really but a part. Both this globular matter and the cement present large circular and longitudinal fissures which were vascular canals. In fig. 1 the dentine is seen to merge into the osteo-dentine surrounding the two circular canals; in fig. 2 it is cut off from the osteo-dentine by a fissure and deposits of globular matter, and has a very much more

* The dentine of the narwhal's tusk (*Monodon*) exhibits this same opacity—due to imperfect calcification—in a striking manner. It is also observable in many other large teeth, but less markedly.

limited development, the section in fig. 2 being taken further away from the terminal cap of dentine than that in fig. 1.

Cement (Pl. VI, fig. 3).—The lacunæ of the cement are disposed in regular concentric series (figs. 1, 2, *c*), abounding more along certain planes than others, thus giving the structure a banded character. At various parts of the periphery the formation of nodular protuberances gives an irregular character to their arrangement. They are rounded and very irregular in form, with but small though very numerous diverging canaliculi: their size is very great, varying from the $\frac{1}{500}$th to the $\frac{1}{1200}$th of an inch and less. They are less numerous than in the cachalot or porpoise, and of larger size. The ultimate ramuscules of the canaliculi could be seen, by some care in the lighting and focussing of the object, to enclose square or polygonal spaces of structureless material of an average diameter of $\frac{1}{6000}$th of an inch. In some parts the canaliculi united to form small, much elongated lacunæ (fig. 3, *a*), this variation in the structure having apparently some connection with the production of the cement into a surface-ridge or tuberosity.

Globular matter and dentine.—The parts of the opaque stratum of globular matter nearest the cement presented no structure excepting an indistinct botryoidal character, visible with a low magnifying power. This was more distinct nearer the dentine (fig. 1, 2, *g*), where variations in the opacity of the layer disclosed such a disposition. The amorphous matter at length shades off into the dentine, as seen in Plate VI, fig. 4, numerous distinct, minute, "interglobular spaces" becoming more and more distinct as one recedes from the opaque stratum and their number diminishes. The "interglobular spaces," sometimes known as "dentinal cells" (not of Owen), have no very definite form, but are simply minute transverse lacunæ intercepting the light, and by their superabundance contributing to the opacity of the amorphous stratum of globular matter. They had an average breadth of $\frac{1}{2000}$th of an inch. The dentinal tubes have nothing remarkable in their character. They are rather coarse, though finer than in many Cetacean teeth, or than those of the walrus tusk, and communicate frequently with one another near their peripheral origin or rather emersion from the opaque stratum.

Osteo-dentine and globular matter.—The osteo-dentine and the globular matter which in many cases surround the periphery of an osteo-dentinal canal or cavity and its tubules, in intimate character do not differ materially from the similar parts just described. The canals of the osteo-dentine are numerous and large, appearing in section as circular, fusiform, or much elongated, narrow cavities. The dentinal tubules of one canal do not anastomose to any large extent with those of other neighbouring canals, in many cases a wall of opaque globular matter enclosing each. The tubules of some of the osteo-dentinal canals are very few in number, and have an irregular tortuous distribution, the canal, when in section in such cases, resembling a very large multiramose bone lacuna.

Comparison with other teeth.—In no other Cetacean teeth is the dentine developed to so small an extent, and the cement and osteo-dentine so largely concerned, in forming the mass of the tooth. In the large conoid teeth of the cachalot the dentine occupies a very much greater space in the tooth, the osteo-dentine is sparsely developed, and a certain amount of basal pulp-cavity is left, while the cement, though forming a thick layer on the tooth, is comparatively small in amount. In *Hyperoödon* the small pointed teeth are stated by Professor Owen to be tipped with enamel, which does not appear to be the case in *Micropteron.* In the Porpoises and Grampuses the dentine has a large development, and osteo-dentine, when present, bears but a very small proportion to it.

Purpose of the teeth.—The teeth of *Micropteron* are not worn at the crown, and are obviously not used for biting, since they are not opposed by any part of the upper jaw. They are said to be sexual characteristics, Eschricht considering the toothless *Delphinus micropterus* (Cuvier) to be the female of the bident *Micropteron Sowerbiensis.** These teeth, then, obviously have their true function aborted, degraded from the class of "functions of animal life" to that of "functions of vegetable life;" and with this we may expect a corresponding degradation in structure, resulting in the production of a tooth of less specialised character, and less differentiated from the rudimentary structure of a developing tooth. This, I think, can be shown to be the case with the tooth described above. Cement is not a structure belonging specially to teeth; it is merely bone such as exists throughout the body. Osteo-dentine is a less differentiated structure than true dentine, being formed by a conversion of the substance of the pulp instead of at its periphery, and retaining certain elements of the pulp in its canals and cavities; moreover osteo-dentine is developed in many teeth (*e. g.* human) only as the result of age and decrepitude, or as a pathological product; in others,

* The female stranded at Ostend is said to have had "a few" small denticles concealed in the anterior part of the lower jaw. It is not at all improbable that the male, when young, has many teeth, one only of which on each side is developed.

which are of large size (*e. g.* the tusks of the walrus), merely as a packing or strengthening for the hollow pulp-cavity. Osteo-dentine is therefore of low physiological importance. Dentine and enamel are the special tissues of the tooth, present the greatest amount of differentiation, and are formed under the most special conditions, and probably with the greatest expenditure of force.

The tooth of *Micropteron* has only the small terminal cap formed of this special tooth structure, resembling in this a fœtal human tooth, and, indeed, were such a tooth, minus its enamel, arrested in its development at this stage, its vascular pulp allowed to convert itself into osteo-dentine, and the surrounding tooth sac subsequently ossified into cement, we should have a miniature representative of the *Micropteron* tooth.

The large development of opaque globular matter in the dentine and osteo-dentine of the *Micropteron* tooth is also significant of low organisation. The opacity is caused by the large number of interspaces left between globular and botryoidal masses of calcareous salts deposited in the formation of the tooth, that is to say, it is due to imperfect calcification. This appearance is frequent in human embryonic teeth,* and is occasionally to be met with to a small extent in those of the adult and in very many mammalian teeth. It is, however, in the human subject corrected as development proceeds, the interspaces being filled up. In *Micropteron* it is not so; the rudimentary calcification is allowed to persist.

For these reasons, then, I think it may be urged that we have in the teeth of *Micropteron Sowerbiensis* a rudimentary structure corresponding with a degraded function.

Teeth of other recent Ziphioids (*Dolichodon*).—I had the good fortune to see the skull of the *Ziphius* (*Dolichodon*) *Layardi* described by Dr. Gray, at the British Museum, before it was packed to be returned to Cape Town, whence it came. The great curved teeth, one in each ramus of the lower jaw, as in *Micropteron*, are even more laterally compressed and flattened than in that genus; their length exceeded a foot, while their width was about two inches. The exterior surface was smoother than in the Oxford Cetacean, but of the same yellow colour characteristic of cement. I looked anxiously for a projecting tip of dentine as in *Micropteron*, and at the crown of each tooth, on the inner side, was a very small nob or nipple of brighter appearance than the surrounding surface, evidently corresponding with the dentinal cap of *Micropteron*. This protuberance is I find noticed by Dr. Gray in his catalogue of seals and whales, where a small figure of this very remarkable skull is given. Though, in the

* Tomes.

absence of any sections, certainty is impossible, there can, I think, be little doubt that the structure of the tooth of Layard's Ziphius agrees with that of Sowerby's, and assuredly the small projecting caps of dentine are identical. Some zoologists are inclined to regard the strange overlapping teeth of *Dolichodon Layardi* as deformities. Dr. Gray, however, does not incline to this opinion. The two teeth are almost exactly alike, and very regular and definite in form, and certainly have not the aspect of abnormal growths. Whether deformities or not, their function is in the highest degree obscure; and, supposing that they have grown to an abnormal size, their essential composition and form is probably unaltered.

Berardius. The figures given of the teeth of the tetrodont Ziphioid *Berardius* by Duvernoy appear to indicate a nipple-shaped termination to a broad flattened tooth—as in *Micropteron.**

A second male specimen of Sowerby's *Micropteron* has recently been cast ashore in Ireland, and the skull is preserved. It is desirable that the teeth of these specimens should be examined, as also those of the other ziphioids in various museums, both by simple and microscopic sections.

Fossil ziphioid teeth from the Red Crag. The woodcut, fig. 1, represents a remarkable compressed claw-like body

FIG. 1

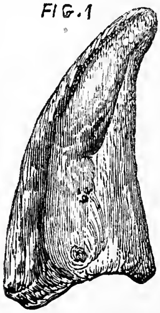
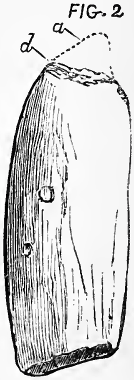


FIG. 2

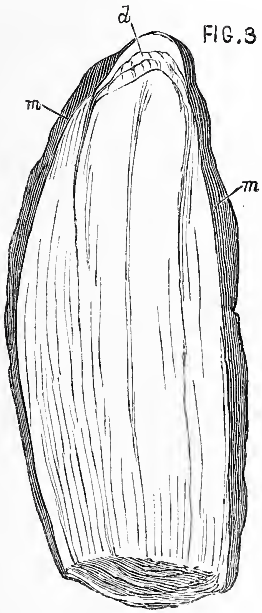


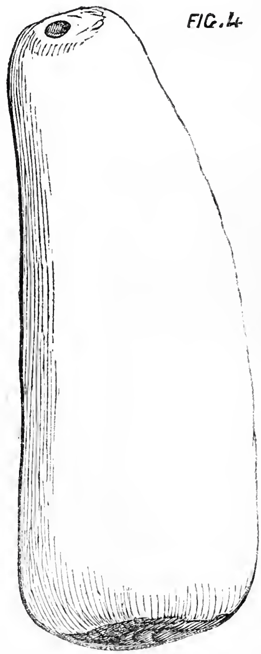
Reduced to one half the natural size.

from the Red Crag; three other specimens similar to it are in

* Since this paper was read I have seen the first part of a paper by M. Fischer in the 'Nouvelles Archives du Muséum,' 1867,' 3rd vol., "On the Cetaceans of the genus *Ziphius.*" He does not appear to have examined the structure of the tooth in any of the species he quotes, but I hope may be induced now to ascertain if the structure here described is common to the Ziphioids in his charge.

the collection of Mr. Whincop, of Woodbridge. When cut longitudinally an appearance like that of "pudding-stone" (a simile used by Cuvier when describing the osteo-dentine of the walrus) was shown, accompanied with numerous longitudinal fissures. In Pl. VI, fig. 4, a portion of this same body cut transversely and mounted for microscopic examination is drawn. Figs. 5 and 6 represent two of the multiramose canals more highly magnified. No other structure than these bodies, and a homogeneous iron-stained matrix, could be made out. The claw-like fossil is very probably the osteo-dentinal core of a tooth of some one of the Rhynchoceti, the rostra of which are so abundant in the crag.





Reduced to one half the natural size.

The structure of the ziphioid tooth, as ascertained from the *Micropteron Sowerbiensis*, throws some light on the nature of the tooth called *Balænodon*, by Professor Owen. In a paper published in the 'Quarterly Journal of the Geological Society,' 1865, p. 231, I mentioned that Professor Van Beneden had obtained specimens from the Antwerp crag, which he identifies with our crag *Balænodon*, and considers as ziphioid. The *Balænodon* teeth, such as that drawn in fig. 2, are very much rolled and truncated at each end. In section they show a core of osteo-dentine with very thick walls of cement. They are much rounder and bulkier teeth than those of the recent *Micropteron.* Some specimens show anteriorly fragments of a brighter denser substance, which I believe are the remains of the dentinal cap or nipple characteristic of ziphioid teeth. The infiltration of mineral matter in varying quantities into the differently constituted tissues of the tooth would readily cause their separation, and the *double* rolling and deposition to which these crag mammalian remains have for the most part been subjected, would be very efficient in breaking off the small tip of the tooth. Figs. 3 and 4 represent of half the natural size two very large Cetacean teeth which I obtained some time since from the Red Crag. The first (fig. 3) is in section, and appears to have preserved a small cap of dentine surmounting the osteo-dentine and cement, which form the bulk of this very large tooth.* Fig. 4 is probably not the tooth of a ziphioid at all, but is remarkable for its large size.

On an EXAMPLE *of the* PRODUCTION *of a* COLOUR *possessing* REMARKABLE QUALITIES *by the* ACTION *of* MONADS (*or some other Microscopic Organism*) *upon* ORGANISED SUBSTANCES. By J. B. SHEPPARD, M.R.C.S.E.

(Communicated by the Rev. J. B. READE, F.R.S., F.R.M.S., &c.)
(Read May 8th, 1867.)

I WILL relate, as shortly as I can, the steps by which I became acquainted with the properties of the coloured liquid in the "thousand-grain bottle."† The history is as follows:—On April 19th I went with two archæological friends for a long ramble through West Kent. Our route lay through that district where the greensand crops out from under the chalk escarpment between Ashford and Maidstone. About

* The chief interest of this specimen is in the preservation on its surface of a large amount of the fine sandy deposit in which it was imbedded, previously to its deposition in the Red Crag, it being like all the other *Rhynchoceti*, *Carcharodons*, &c., of the Red Crag—already a fossil when the Red Crag sea and mollusca were existing. This fact has been unaccountably overlooked by some geologists, who wish to show that the Red and Coralline Crag were *contemporaneous*, or nearly so, with the Lower and Middle Antwerp Crags, where similar Cetacean remains occur in an unrolled condition, the Cetacea &c., having *lived* during that period, not during the Red Crag.

† Shown at the Soirée of the Royal Microscopical Society, by the Rev. J. B. Reade, April 24th.

midway we came to a clear spring rising in a rocky basin (Kentish rag, carbonate of lime), and on all the submerged stones in the basin there was a dark olive-brown coating, covering every surface with a velvet-like film, and thick enough to be scraped off in an unbroken sheet—just such a coating, in fact, as promised oscillatoriæ and diatoms.

My companions being archæologists, and not microscopists, in deference to their tastes I had forborne to take any apparatus or receivers for collections, having on other occasions bored them by wasting time, as they thought, about pond-edges and spring-heads. Having no bottles, I begged from my friend a piece of paper—a part of the wrapper of his sandwiches—and to this piece of paper, greasy and glazed with some sort of size, is partly due the result which I am about to communicate.

The specimen in the paper was placed in an india-rubber tobacco pouch, and remained undisturbed for twenty-four hours before I opened the parcel to separate a piece for microscopical examination. As soon as the parcel was taken from the pouch, I noticed that the paper was stained here and there with hues of red, blue, and purple, and (the paper being removed) in the wet mass within I saw small clots of red jelly, exactly counterfeiting recently coagulated blood. I selected a clot and put it on a slide, whilst the rest of the mass was laid in a glass of clear water. This mass consisted of interwoven oscillatoriæ and other confervoideæ, with navicula-shaped diatoms pervading the texture, and, excepting the clots, presenting nothing that is not to be found on the stones of every wall. The specimen on the slide was remarkable. The colour, before placing the glass on the stage, was opaque red, looking like a small quantity of vermilion mixed with water; but when held up to the light the red disappeared, and a pale transparent blue took its place.

Under the microscope (1-inch, "B") the clot appeared of a pale blueish-grey, quite transparent and structureless; but entangled in this now grey-looking jelly were several bodies which I took to be ova. In form they were pointed-oval—almost kite-shaped—buff as to colour, and moderately opaque. Each example contained a small collection of reddish and brownish cells, with one, or at most two, larger spherical, colourless globules—perhaps vacuoles.

After examining two or three of the clots, and finding in each some of these ova, I concluded that in some manner they contributed to the formation of the red colour; and from farther experience I feel certain that but for the dirty piece of paper and these bodies this interesting subject would never have presented itself to me. I may mention that these egg-shaped bodies, surrounded by a gelatinous or albuminous envelope, are distinguished by the possession of an undoubtedly flexible, easily ruptured coat, and by a general dotting all over the surface, when seen by oblique light. But after the first day these bodies were absent, and with them the clots and the colour, this latter being entirely transferred to the water in which the mass was placed. In a note of the 27th ult. you say that the question, "Whence the colour?" is in every mouth. I have not been inattentive to this point, as you know. Having no doubt that the colour was due to the presence of some substance dissolved in the liquid, and not to any organisms suspended in it, I was anxious to ascertain what the liquid *did* hold in solution. Boiled in a test-tube, the colour faded, and a flocculent precipitate was produced. Bichloride of mercury destroyed the colour and procured the precipitate, as also did nitric acid. From these tests, of which you were an eye-witness, it was certain that albumen was present; and the disappearance of the colour when this albumen was thus artificially coagulated seemed to indicate that *soluble* albumen was a necessary ingredient in the process. We have not far to look for the source of this albumen, for the mass abounded with slimy clots (limpid, changing to red), each of which enveloped a number of the above ova.

The "thousand-grain" bottle exhibited at the microscopical soireé contained the solution of these albuminous clots, and the colours, both of the clots and the solution, seemed from my observations to be inseparable from the agency of the monads and the oscellatoriæ of the confervoid mass. Hence, in my first note (April 22), I expressed strongly the opinion that "the colour is due to some form of albumen under the influence of some form of life; as long as the life continues, the phenomena of the colour continue, and when it ceases they cease."

This was the upshot of my first journey, and, to make my story continuous, I will here insert your letter on the subject, which describes some facts observed by yourself, and also the very interesting spectroscope phenomena, communicated by Messrs. Sorby and Browning.

"BISHOPSBOURNE RECTORY, CANTERBURY;
"*April* 27, 1867.

"MY DEAR SHEPPARD,—Accept my best thanks for your interesting account of the coloured solution. It was carefully examined by my friends in London at our Microscopical

Soireé, and was very naturally supposed to be a new solution, either of iodine, aniline, or some curious chemical compound resembling the 'chameleon mineral.' But the beautiful lambent blue by transmitted light, and the deep carnelian red by reflected light, was an effect they were not prepared for. When I gave it a name, perhaps for the amusement of our lady visitors, who were fascinated with the play of colour, a name withal, perhaps, not very far beside the mark, and called it 'polychromatic infusorial water,' a clue was given to its origin, though its nature remained a mystery. You are, therefore, earnestly requested to continue your researches till you can 'render a reason.' I stated that at present you consider it to be some form of albumen connected with some form of life; and I gave the substance of your story to those who had not an opportunity of reading it.

"Upon examining the solution with the spectroscope, Browning said that it gave the most curious spectrum he had ever seen, and Sorby highly values it as being the only blue solution in his class C (of which the blood spectrum is the type) that gives a dark band in the red rays; and he wishes to have a sample of the confervoid mass for further experiment. You may therefore be congratulated upon having recorded a new fact of special interest to microscopists. In addition to your statement I was able to add, from my own examination of the solution, that the process of filtering left a delicate pink stain upon the paper, without materially weakening the colour or colours of the solution; and on evaporating a filtered drop to dryness, and examining it under a high power on a dark ground, I was convinced that the *life* you speak of is due to the infinitesimally minute *monad.* This supposition was, curiously enough, confirmed yesterday at Browning's, when we witnessed the voluntary motion of these atoms, 'nature's invisible police,' under the spectroscope.

"But the question was still in every mouth, 'Whence the colour?' Infusoria, which are themselves coloured, are known and described by all observers. Ehrenberg, Carpenter, Hogg, &c., describe the red protococcus, or snow plant, the *Palmella cruenta*, 'of the colour and general appearance of coagulated blood,' the *Hæmatococcus sanguineus*, and the *Astasia hæmatodes*. The latter, Hogg says, 'is a kind of crimson-coloured animalcule, $\frac{1}{318}$th of an inch in length, that exist in enormous numbers, and give the waters in which they live the appearance of their bodies.' But these do not give a permanent stain to the water, nor is there any recorded instance of the marvellous variety of colour which your solution possesses. It happens, however, curiously enough, that in a subsequent conversation with Sorby, I learnt that a German naturalist has just lately discovered a *monochromatic* solution, 'the result of decaying algæ,' and of this Sorby promises to send me the particulars.

"Your solution, at all events, is new both to him and to English observers generally; and we hope that your second visit to the scene of action will enable you to prepare a special communication for our next microscopical meeting.

"Believe, &c.,

"J. B. READE."

A week after my first visit I again visited the spring for a farther supply of the film; this, collected in bottles, was now properly cared for *secundem artem*, and great disappointment followed; the velvet film remained olive brown, and the water remained colourless, save that now and then a vermilion deposit appeared capriciously, now here, now there, at the bottom of the containing dish. This vermilion behaved very oddly; no sooner was a piece of the substance drawn to the surface than the colour, before intense red, quite disappeared, and more strangely when the vessel was shaken to diffuse the dye; the colour all vanished, and instead of the water becoming red, the red became water.

Of course the next step was to compare the circumstances of the first and second collections in order to ascertain why the former yielded spontaneously such a rich crop of results, whilst the latter remained barren, notwithstanding my careful husbandry.

The circumstances differed in unimportant particulars; the first specimen contained the ova already described, and was wrapped in paper impregnated by organic (animal) matter; the second was kept from contact with all foreign substances—but not a single ovum, with its slimy envelope, could be found. Hoping to learn the law of the transformation of the water into blood, I imitated, as nearly as I could, the circumstances of the first collection; but neither india-rubber, ammonia, nor tobacco, was efficient to provoke the colour. I then tried glazed paper resembling that first used, but not, like it, greasy or strained. This produced a pale tinge of colour; but, pale as it was, it was sufficient to indicate that there was a something in the mass which was capable of calling forth colour when it met with a suitable vehicle.

I was proceeding to carry out experiments founded on this idea, when I saw an article in the 'Edinburgh Review' for April discussing M. Pasteur's book 'On Spontaneous Genera-tion.' In the review I found that M. Pasteur stated that certain monads and vibrious (our liquid contains them) had the property of changing the colours of nitrogenous and some other substances brought into contact with them under favorable conditions.

Now, given the monads, what evidence have we already to confirm M. Pasteur's opinion; greasy paper with some kind of size; sized paper, but without grease; and the slimy envelope of the eggs which your own nitric acid on a single drop proved to be albuminous, all developed colour when either of the above-mentioned substances was brought into contact with the confervoid mass. I should mention that on one occasion a filament of *Batrachospermum* seemed to supply the albuminous vehicle and the colour.

On the 3rd of May, having found, as above described, that soluble albumen, or some similar organic substance, was necessary to the production of the colour, I placed some of the film of my second gathering in contact with white of egg diluted with a little water; the ingredients, after remaining together for a night, developed a glassful of, as one might have believed, magenta dye, and the dye thus obtained has the peculiarities of the already exhibited solution; it possesses the same epipolar property, throwing back from its surface all the red and yellow rays, and transmitting the blue and violet.

The globular bottle, viewed by reflected light, looks like a ball of red carnelian, and the contained liquid seems totally opaque; but, by transmitted light, it is transparent and brightly tinted of a blue and violet colour.

I need only further remark that Ehrenberg Eidmann (who is quoted in the 'Edinburgh') and Pasteur seem to have overlooked the most striking quality of the new organic dye-stuff, viz., its polychromatism.

Decaying algæ, which have been mentioned as capable of staining water, cannot be considered the cause of the development of our colour, inasmuch as I find that the fresh-gathered ferment (as I may call it) is more active than the stale, and farther decay of the organic materials involves decay of the colour, so that, as soon as decomposition begins (five to seven days), this grows paler, and when it is complete the colouring agent is powerless, decay having produced only a dirty fœtid liquid, white with floating flakes.

Note.—The vile smell which belongs to the film is not the result of decomposition, it is most pungent at the moment of gathering, and even on the hill-side it is almost unbearable.

I am by no means sure that it is harmless—it certainly produces headache and sickness; to such an extent is this the case that experiments with the substance cannot be carried on in the house. I may ask, and not without reason, has the change the organisms produce in organic fluids, in their consistency as well as their colour, any relation to the alteration of the physical qualities of the blood in typhus? Here is a ferment which in a few hours is capable of producing a total disorganisation of the fluid to which it is added, and the film is composed of materials which abound in the foul undrained localities whence fever is never absent, and in the impure water of town wells. I hope before long to be able to give you more information *ad hoc.*

The solution of coloured albumen obeys all the chemical laws to which albumen itself is obedient, but it becomes much less tenaceous—ropy after it has acquired the colour.

Reaction of the film upon various organic substances.

Darkness assists the changes, and is almost necessary for the production of them.

Soluble albumen.—Albumen at the bottom of a glass, film dropped on it, and water above, action commences instantly, and colour of any intensity can be obtained.

Coagulated albumen.—No action; partially coagulated; action in inverse proportion to the completeness of the coagulation.

Starch.—Action slow, but continuous; colour has a preponderance of blue.

Gluten.—Action rapid at first, then production of colour soon ceases, but fermentation with copious evolution of gas continues.

Gelatine.—Patent gelatine swollen and softened by cold water—no action in twenty-four hours.

Cooked beef fat.—Action tardy, but a good colour; appears at last showing the different tints in different aspects very well.

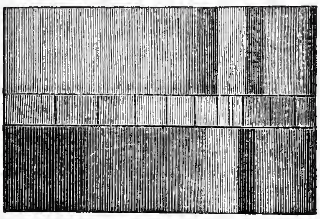
Coloured fluid poured upon soluble albumen.—The *coloured liquid* has not yet propagated the fermentation (for want of a better name) when added to fresh albumen where care has been taken to exclude all pieces of the film. The film coagulates albumen in a* partial manner; when dropped into diluted white of egg it produces threads of very opaque, very

* Not meaning incompletely, but as if selecting some parts for coagulation and avoiding them.

firm coagulum, these threads leading down from the surface where contact first begins to the film lying at the bottom of the glass. When the film is dipped into undiluted albumen it appears to become coated with an imperfect coagulum, and when this has happened I have in no instance seen any chromatic change take place.

Notes on the SPECTRA *of the* DICHROIC FLUID *described in the above paper.* By JOHN BROWNING, F.R.A.S.

THE spectrum of the fluid seen by transmitted light, which shows it as a blueish purple, is somewhat remarkable as being the only blue fluid, Mr. Sorby has found to give particular bands. The chief characteristics of this spectrum, represented in diagram 1, may be briefly described thus:—Commencing at the least refrangible or red end of the spectrum, we find it cuts pretty sharply a short piece of the extreme red. Then we have a strong absorption band also in the red, corresponding to 2½ of the twelve lines given by Sorby's standard inter-



ference spectrum.* Ten lines of this interference spectrum I have drawn underneath spectrum 1.

A second absorption band in the green commences at line 4, and tones off gradually into the spectrum just beyond line 5.

After the preceding paper had been read it occurred to me that it would be a matter of much interest if a spectrum of the fluid viewed by transmitted light could be produced.

* Mr. Sorby's scale, just referred to, is an interference spectrum, produced by a plate of quartz ·043 inch thick, cut parallel to the principal axis of the crystal, and placed between two Nicol's prisms. In this spectrum the whole visible space is divided into twelve divisions. These are counted from the red and towards the blue. The sodium line, as shown in the diagram, corresponds to three and a half. Mr. Sorby has very kindly presented me with an exact duplicate of his own standard spectrum, from which I am enabled to prepare others, which will give exactly similar results.

This proved a matter of some difficulty, but I effected it at last by filling a glass vessel three inches across, and the same depth, with the fluid, and then condensing the light on the surface of the fluid by means of a large condensing lens. The micro-spectroscope was placed at an angle of 90° to the condenser. If placed opposite to it, only a continuous spectrum of the lamp flame is perceived, the absorption spectrum, which is much fainter than the spectrum viewed by transmitted light, being masked by its intensity.

The liquid viewed by this strong reflector is of a fine carnelian red. In figure 2, I have represented the spectrum. It will be seen that it differs considerably from the first spectrum, 1. A much larger portion of the red end of the spectrum is absorbed, but not so sharply as in spectrum 1. The strong band in the red is shifted towards the more refrangible end of the spectrum, cutting out the edge of the red, some of the orange, and most of the yellow. The second absorption band is wanting, but the greater part of the light of the spectrum is absorbed from a point between the 4th and 5th lines, and all the light is absorbed at the 7th. The part of the spectrum which should be yellow has a strong tinge of olive green. Of course the diagram represents very imperfectly the beautiful and curious appearances which the spectra present in colour. The Rev. J. B. Reade was with me when I made the experiments I have described, and kindly verified the results I obtained.

On Two New Lamps *for the* Microscope.

By Ellis G. Lobb, F.R.M.S.

(Read May 8th, 1867.)

The lamp which I now bring before your notice is, I think, a great improvement upon most of its predecessors. Three things are decidedly essential in a lamp to the working microscopist: 1. A reservoir that shall not interfere with the proper use of the bull's-eye condenser. 2. A small brilliant white flame. 3. That it shall be so portable as to be carried about with ease. These three requisites are combined in the lamp now before you. The reservoir for the spirit (camphine being used), although apparently small, still holds a sufficient quantity for four hours' consumption. You will perceive it is so shaped that the bull's eye can be placed in any direction, and as near to the flame as may be desired. Microscopists know how requisite this is when a strong light is required for the black ground illumination, for the polariscope, or for opaque objects.

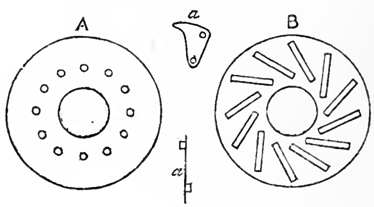
Many microscopists have complained of difficulties in obtaining and preserving good camphine. It may be purchased at Deanes', the furnishing ironmongers, King William Street, London Bridge, in half-gallon cans. If the camphine is only required for one microscope lamp, its consumption will be slow, and its deterioration may be prevented by purchasing one can at a time, bottling off three pints in pint bottles well filled, tightly corked, and kept cork downwards in a dark place. The fourth pint may be put into quarter-pint stoppered bottles, also kept in the dark, brought into successive use, and replenished from a pint bottle when all are exhausted. By this means the spirit will keep for any time, and always yield a brilliant flame. It is well not to put more spirit in the lamp than is required for immediate use; and the wick must be cut perfectly level.

Mr. Lobb then called attention to the small brilliant white flame afforded by this lamp, and pointed out the means by which a current of air was carried in the centre of the flame through the circular wick. To illustrate the portability of this lamp, he observed—"The chimney can be put in one pocket, the reservoir, which unscrews and receives a cap at the top to keep the spirit from oozing, can be placed in the waistcoat pocket, and the remaining portion of the lamp will go into the coat pocket. The lamp, being patented, can only be obtained of Mr. Young, in Queen Street.

I have also to bring to your notice another lamp, the ingenious contrivance of one of our own Fellows, Mr. Piper, the inventor of the portable horizontal slide cabinet. This lamp is contained in a small box with a sliding lid. When required for use, the stem of the lamp is screwed into the box-lid, and the lamp is affixed to the stem by a clip, which enables it to be adjusted to any height. The dimensions of the various parts, and the neat way in which they all pack into a small compass, make this an excellent travelling lamp, and it has the additional merit of very moderate price, ten shillings and sixpence.

Iris Diaphragm *proving the circular form whether expanding or contracting.* By J. H. Brown, Esq.

Although my new form of diaphragm is at first sight somewhat complex, it is in reality extremely simple. A glance at the diaphragm will give a better idea of its construction than any amount of written description. It essentially consists of a number of triangular blades (a), each furnished with two axes, one of which works in a hole in the



brass plate (a). The other works in the shot in the brass plate (b). The blades expand or contract the aperture of the diaphragm by giving a rotatory movement to either of the brass plates, whilst the other remains stationary. The blades being thus moved simultaneously, and their edges next the aperture curved, they form an opening very nearly circular.

The first diaphragm I made of this pattern contained sixteen blades, but I find twelve or even less are sufficient.

On NUTRITION, *from a* MICROSCOPICAL POINT *of* VIEW.

By LIONEL S. BEALE, M.B., F.R.S., Fellow of the Royal College of Physicians, Physician to King's College Hospital, Professor of Physiology and of General and Morbid Anatomy in King's College, London, Honorary Fellow of King's College, Fellow of the Medical Society of Sweden, &c., &c., &c.

(Read May 8th, 1867.)

There are many questions of great general interest and importance which, perhaps, from not falling exactly within the range of subjects prescribed for consideration in any one individual society, are scarcely ever discussed or alluded to, but which, nevertheless, belong to many departments of science. Of these, nutrition seems to be one. Neither the physicist, chemist, microscopist, comparative anatomist, botanist, nor medical practitioner, can proceed far in his inquiries without referring to the process of nutrition, and asking what is the exact nature of this operation by which things are enabled to grow and multiply. Strange as it may appear, this, like some other elementary matters which one would think naturally formed one of the first steps in the study of natural knowledge, is very imperfectly understood, and observers are not by any means agreed as to what nutrition is or is not. I believe that this arises in some measure from the circumstance that the subject has not yet been fairly studied from a microscopical stand-point.

As the conclusions advanced in my paper have been entirely deduced from the results of microscopical observations, many of which have been already given in detail in memoirs published in our 'Transactions' some years since*—as inferences derived from microscopical observation ought to be at least as interesting to observers as mere descriptions of observations—and as there is no Physiological Society in London, nor, considering the great number of societies, does it seem desirable that there should be one, I shall venture to ask the attention of the Fellows of our Society to an attempt to ascertain the nature of the nutritive process, and to define exactly what nutrition is.

The more I work the more strongly I become convinced

* Trans. Mic. Soc. and Journal, 1861 to 1865.

that there exists a sharp and well-defined difference between *living* and *non-living* things. And in spite of all that has been advanced to the contrary during the past ten years, it seems to me certain that matter which is alive is in a condition essentially different from non-living matter. I shall endeavour to show that living matter alone is nourished, and that no non-living thing yet discovered experiences nutrition.

We shall see that the act of nutrition involves much more than the mere addition of new particles of matter to a mass which already exists, as some have held. *Growth* resulting from nutrition is so very different in its essential nature from every kind of increase resulting from deposition or aggregation, that it seems to me wrong to apply the word "growth" to the process of increase in these two cases, and if the term is to be employed at all, I think it ought to be restricted to living things only. Here, however, at the outset, I find myself distinctly at issue with one whose opinions on such questions are entitled to our respect. At the same time I cannot help feeling that if the author had observed more for himself, and trusted less to the arbitrary dicta and inconclusive statements of others upon elementary questions of the highest importance, but which have been very imperfectly worked out, he would have been led to adopt conclusions strangely at variance with the doctrines to which he has, I venture to think, prematurely committed himself. After affirming that the increase in size of the plant, like the crystal, is effected by continuously integrating surrounding like elements with itself, Mr. Herbert Spencer says* that the food of an animal is "a portion of the environing matter that contains some compound atoms like some of the compound atoms constituting its tissues." If such be so, the peculiar substances of which white fibrous tissue, yellow elastic tissue, muscle, nerve, epithelium, &c., consist, ought to be present in the white and yolk of an egg before these have undergone conversion into the chick; but we know that not one of these things can be detected, and, in short, that development and growth are processes essentially and absolutely different from the mere deposition in a solid form of particles previously held in solution in a fluid. In *growth* the substances dissolved in the fluid pabulum are completely altered in composition and properties. Their elements are entirely re-arranged. If the elements of the dissolved crystalline matter were torn asunder and then reunited in a different way, so as to produce a new substance when deposited in a solid form, crystallisation would in this one particular accord with

* 'The Principles of Biology,' vol. i, p. 108.

growth; but there is not even this resemblance. A crystal, then, does not *grow.* The fungus-like (!) accumulation of carbon that takes place on the wick of an unsnuffed candle is not *growth.* The deposition of geological strata, the genesis of celestial bodies, are not examples of *growth.* I think that if Mr. Herbert Spencer would carefully study a growing microscopic fungus he would modify his views concerning the nature of *growth,* and admit that there is an essential difference between growth and the above physical phenomena. From what has been stated in many physiological works the student would be led to conclude that the *tissue* or *formed* matter to be nourished, selected from a mixed fluid, in consequence of some sort of affinity, certain constituents adapted for its nutrition at once, and that those substances passed from a state of solution to the condition of tissue. But no instance is known in which any lifeless substance takes up another lifeless substance differing from it in composition, and converts this last into matter like itself, as occurs for example when a simple gelatin-yielding texture increases in amount although it is surrounded only by an albuminous material in which no trace of gelatin-yielding substances can be detected.

In the hope of ascertaining the essential nature of the nutrient process we must not limit ourselves to the consideration of the phenomena occurring in the fully-formed organisms of man and vertebrate animals, in which the nutrient blood plays so important a part; but we must extend our observation to plants and the lower organisms, which consist of extremely minute independent masses of matter in a peculiar state of being. Many facts lead us to conclude that nutrition in its essential nature is the same in all cases; and whatever meaning be assigned to the term it ought to apply equally to the lowest simplest forms and the highest and most complex.

A simple living organism may take up a quantity of nutrient matter and increase in weight. Having reached a certain size portions may be detached, and each of these, after absorbing nutrient matter, grow and give rise to others. In this case the nutrient pabulum is converted into *living matter,* and as a result of nutrition there is an enormous gain in weight. But, on the other hand, living bodies may take up a considerable quantity of nutrient matter without altering in weight, and indeed some, in spite of being well supplied with nourishment, may actually lose in weight. In other words, the new matter taken up may exactly compensate for old material which is removed, or more than compensate for this: or the process of removal may proceed faster than the process of nutrition. It is, therefore, obvious that nutrition cannot be held to mean the mere *addition of new matter to a living body.*

Suppose we now consider what actually occurs when simple living matter, like an amœba, or a white blood-corpuscle, or a pus-corpuscle, is nourished. Matter either in a state of solution or capable of being readily dissolved passes into the matter of which the living body is composed. Some of the constituents become part of the living body, while others are given off. The living body then increases in size. It is nourished and *grows.* In other instances, as in many of the lower vegetable organisms, and in the cells of the higher, a coloured material or matter having some peculiar properties is formed while the process of nutrition is proceeding. Now, this matter did not exist in the pabulum, nor was it to be detected in the living matter which absorbed the pabulum, but it results from the death of the living matter under certain conditions. In this case, then, the pabulum is first changed into living matter, and the living matter into the coloured or other formed material. In some instances this formed material accumulates in the elementary part itself, as in the case of starch in vegetable cells and fat in animal cells, and there is a gain in weight. In other cases the formed material passes away from the germinal matter as fast as it is produced, dissolved in fluid or in a gaseous state, and no alteration in weight occurs, although a large quantity of nutrient matter is taken up. Usually, of the formed material produced, part accumulates on the surface of the germinal matter and part escapes. Consider what occurs in the nutrition of ordinary yeast. A layer of cellulose matter which increases by the addition of new layers to its inner surface is formed externally. Within this is the transparent living or germinal matter. When such a particle is nourished the pabulum passes through the cellulose wall into the germinal matter, and thus the substance increases; but at the same time some of the germinal matter becomes converted into new cellulose, which is added to that already existing, and alcohol, water, and carbonic acid, which escape. The germinal matter differs from the pabulum, and both differs in physical characters and chemical composition and properties from the cellulose envelope. *We cannot make the cellulose or the germinal matter from the pabulum, nor can the pabulum be obtained, as it was before, from either of the above substances.* How different are all these processes from the mere *addition* of matter previously held in solution, as occurs in the formation of a concretion, or a crystal, which increases by the superposition of layer upon layer!

I propose now to refer briefly to the process of nutrition as it occurs in man and the higher animals. It has been said that the life of the body is the blood, and it has been surmised that from this fluid the tissues derive not only the elements of their nutrition, but their *life* or the properties which we call by that name. It is, however, more probable that the blood contains only nutrient pabulum adapted for the nutrition of the tissues, which, like all nutrient matter, is *lifeless,* not *living.* The actual nutrition, the conversion of the pabulum that was in the blood into tissue, is due to actions which occur outside the vessels containing the passive nutrient blood. As little supported by facts as the opinion above alluded to is the doctrine that arterial blood takes special part in the nutrition of tissues, although a student reading any of our text books would be led to believe that the highly nutritive properties of arterial blood had been proved beyond all question, and that every tissue to be nourished must have its nutritive artery. The very active nutrition going on in the lower animals and plants under conditions not favorable to free oxidation, and the fact that in man and the higher animals during the early periods of life when nutritive activity is most remarkable, the blood is not so highly oxygenated as at a later time when the nutritive operations are comparatively slowly carried on, seem to show the fallacy of such a view.

Every one knows that food nourishes the body, and that the tissues are nourished by the blood, and it is generally believed that a high state of nutrition depends upon a liberal diet. At the same time, however, we know that the degree of nutrition exhibited by the body is not dependent merely upon the quantity or quality of the food introduced into the stomach, absorbed and converted into blood, but upon many other circumstances. In one individual much of the food may be excreted in an altered form soon after it has been introduced into the system, while in another a large proportion may be converted into tissue. This difference is determined not by the pabulum, but by the living material which is destined to take this up, and which is concerned in the formation of tissue. Some men and some animals soon become fat upon a diet which to others would be extremely low; while certain individuals cannot be made fat, although supplied with abundance of the choicest food. We must also bear in mind that every tissue does not share in the increased nutrition, and although we often talk familiarly of the increased or diminished nutritition of the body, we refer really to an increase or diminution of the adipose tissue, and, but to a less extent, of the muscular tissue. At the same time we know that every tissue in the body is nourished from the earliest period of its existence; but of all the tissues when the organism is fully developed the adipose and muscular are most influenced by altered diet. It may be said that the elementary parts of these tissues exhibit greater variation in activity than those of other textures. In some men and animals it would appear that the elementary parts of adipose tissue take up in proportion a larger share of nutrient matter than those of other tissues; while, on the other hand, the elementary parts of the glandular excretory organs are, in other individuals, the most active. The elements which in the first would become an integral part of the body, as fat and other tissues, would in the last escape as carbonic acid, water, and other substances, in the excretions. It is not possible to say why one set of tissues should be most active in one individual, and another set in another individual, any more than we can explain why a particular kind of food, which is most easily assimilated by one person or animal, would be useless or injurious to another.

As there are in the body many different tissues to be nourished, and many different substances in the blood which may nourish them, it is necessary to consider what particular constituents of the blood are principally concerned in the nutrition of the different textures. The opinion seems to have been very generally entertained that certain substances in the blood were destined for the nutrition of particular tissues, while other textures selected from the fluid constituents are of a different character; for instance, it has been supposed that the red blood-corpuscles were specially concerned in the nutrition of the nervous and muscular tissues, while the white blood-corpuscles nourished the fibrous textures—that fat selected fatty matter from the blood, muscle fibrinous material, and so on.

In a paper which I communicated to this Society in 1864, I endeavoured to show that the blood, like the tissues, might be looked upon as composed of germinal or living matter, and formed material. The white blood-corpuscles and smaller corpuscles of similar character, which could be detected in the blood, being composed of germinal matter; while the red blood-corpuscles, the albumen, and some other constituents, were to be regarded as formed material, being composed of non-living matter, possessing peculiar characters, properties, and chemical composition, but resulting from changes taking place in pre-existing germinal matter. The white blood-corpuscles, therefore, are themselves composed of living matter, which is nourished, and they cannot as white blood-corpuscles contribute to the nutrition of any tissues whatever. With regard to the red blood-corpuscles, it seems to me probable that they play a highly important part in equalising the temperature in all parts of the body, taking away heat from parts whose temperature is above the normal standard, and contributing heat to textures which are colder than they should be. At the same time it must be borne in mind that the red blood-corpuscles themselves are gradually undergoing disintegration; and although it seems most probable that the constituents resulting from their decay are eliminated from the body in the form of urinary, biliary, and other excrementitious matters, it is not unlikely that some of the products may take part in nutrition.

Upon the whole, however, it seems probable that the constituents which form the pabulum of the tissues are those which are contained in the serum of the blood; and it is impossible to conceive how minute quantities of pabulum prone to undergo rapid change could be more perfectly and equally distributed to the textures, without its composition being materially changed, than in the thin layers which each red blood-corpuscle carries upon its surface, and smears, as it were, upon the walls of the capillary vessel distributed to the tissue. The arrangement is such as to reduce to a minimum the chances of alteration in the composition of the nutrient fluid as it traverses the vessels in different parts of the body.

From a careful consideration of the facts, I cannot help drawing the inference that the serum is the pabulum; that the red-blood corpuscles are concerned in its distribution, and in preventing changes in the composition of the great mass of the blood, as certain constituents are removed from it or poured into it; and that the white blood-corpuscles are masses of germinal matter concerned in the formation of the serum, as well as of the red blood-corpuscles. In support of this view, I would venture to call attention to the following points:

1st. That fibrous tissue, bone, cartilage, muscular and nervous textures—the two last as perfect and, as far as we can make out, far more delicate, elaborate, and beautiful than any of the tissues of vertebrate animals—are formed, and with wonderful rapidity, in many of the lower creatures quite destitute of a nutrient fluid containing bodies corresponding to the red blood-corpuscles of the vertebrate blood; and that in all these cases the nutrient fluid is clear, transparent, colourless, and contains a substance closely allied to the albumen of serum, if not identical with it. Different plants and animals produce from the very same fluid, and apparently under similar conditions, very different substances; and the different kinds of germinal matter in the body of one of the higher animals produce formed matters differing widely in structure, chemical composition, and properties.

2nd. That in man and the higher animals the development of the tissues corresponds to the period of life when the blood is not remarkable for the number or perfection of its red blood-corpuscles.

3rd. That certain morbid growths appear and increase rapidly in cases in which the blood has for some time contained a small proportion of red blood-corpuscles.

It seems, therefore, probable that the substances taking part in the nutrition of all the different textures of the body are furnished by the albuminous matter of the serum, and that the production of muscle, nerve, fibrous tissue, &c., depends not so much upon the characters of the pabulum as upon the *converting powers* of the germinal or living matter which appropriates this. The substances formed by germinal matter depend upon its *vital powers* and the conditions under which these *cease to be manifested*, rather than upon the presence of particular substances in the pabulum itself. Different kinds of germinal matter have power to rearrange the elements of the pabulum supplied to them in different ways, so that one kind of germinal matter produces muscle, another nerve, another fibrous tissue, and so on; each of these tissues, and, of course, the pabulum itself, containing oxygen, hydrogen, nitrogen, carbon, and some other elements,—but combined in a different manner.

Although the opinion is still entertained by many anatomists that tissue—as, for example, the intercellular substance of cartilage—is deposited directly from the blood, no one has explained by what means the composition of the pabulum becomes so altered as it passes through the walls of the vessels to be distributed between the masses of germinal matter. On the other hand, the facts advanced by me several years ago in favour of the view that every kind of formed material passes through the state or stage of germinal matter have not been overthrown. The existence of germinal matter before the production of formed material; the continuity of the germinal matter with the formed material in tissues in process of development; the circumstance of no case being known in which formed material is produced without germinal matter; and the demonstration that fluids will pass through a comparatively thick layer of formed material, and reach the germinal matter in the course of a few seconds, forced upon me the conviction that pabulum invariably passes to the germinal matter, and it, or at least some of its constituents, undergo conversion into this living substance, and acquire its properties and powers,—portions of the germinal matter from time to time losing their properties, and undergoing conversion into formed material. So that pabulum invariably becomes germinal matter, and the germinal matter, not the pabulum, is converted into formed material. I have been accustomed to state these facts in the following simple manner:—Calling the germinal matter which was derived from pre-existing germinal matter *a*, the pabulum *b*, and the formed material resulting from changes in the germinal matter *c*, I say *b* becomes *a*, and *a* becomes converted into *c*, but *b* can never be converted into *c* except by the agency, and, in fact, by passing through the condition, of *a*.

So far, then, it would seem that in the process of nutrition pabulum passes into living germinal matter, and is converted into this substance. The formed material or tissue which, in many cases, constitutes the chief increase in weight and bulk, has all passed through the state of germinal matter. The formation of this germinal matter from the pabulum is therefore the important part of the process.

It is most interesting to inquire by what means the soluble pabulum is caused to pass into the germinal matter. It is, I think, impossible, in the present state of our knowledge, to explain the facts by physics or chemistry. And no form of attraction or affinity that we are acquainted with accounts for the passage of pabulum towards and into the germinal matter. The question is one upon which I have ventured to speculate. The tendency which every mass of germinal matter exhibits to divide into smaller portions, each part appearing to move away from other portions, suggests the idea of there being some centrifugal force in operation. This moving away of particles from a centre will necessarily create a tendency of particles around to move towards the centre; I think, therefore, that the nutrient pabulum is, as it were, drawn in by centripetal currents, excited by the centrifugal movements of the particles of the living germinal matter. How it is that vitality gives to matter the power of moving away from centres I cannot even attempt to speculate upon. That this is so, general facts, open to the observation of all, as well as the wonderful phenomena seen with the aid of the highest powers of our microscopes, abundantly testify.

The point in which every nutritive operation differs essentially from every other known change is this: the composition and properties of the nutrient matter are completely altered, its elements are entirely rearranged, so that compounds which may be detected in the nutrient matter are no longer present when this has been taken up by the matter to be nourished. The only matter capable of effecting such changes as these is living matter, and it is very remarkable that when this matter ceases to live, we do not detect amongst the compounds formed at its death substances previously present in the pabulum, but new bodies altogether, and these often vary according to the circumstances under which the matter dies.

Desirous as I am to yield all that can be yielded to those who maintain that there are no vital powers distinct from ordinary force, I might say that a particle of soft transparent matter, called by some living, which came from a pre-existing particle, effected, silently and in a moment, without apparatus, with little loss of material, at a temperature of 60° or lower, changes in matter, some of which can be imitated in the laboratory in the course of days or weeks by the aid of a highly skilled chemist, furnished with complex apparatus and the means of producing a very high temperature and intense chemical action, with an enormous waste of material. It is, therefore, quite obvious that an independent, scientific man must, for the present, hold that the operations by which changes are effected in substances by living matter, are in their nature essentially different from those which man is obliged to employ to bring about changes of a similar kind out of the body; and until we are taught what the agent or operator in the living matter really is, it is better to call it vital power than to deny its existence altogether.

It seems to me childish, rather than philosophical, on the part of any one to reassert in these days that nutrition is merely a chemical operation, unless he can imitate by chemical means the essential phenomena which take place when any living thing is nourished. The passage of a fluid through a tissue by which its structure is preserved is not nutrition, or the introduction of preservative fluids into dead tissues would be a nutritive operation. A fluid may hold in solution certain substances which are separated from it as it traverses the tissue, thus adding to its weight and altering its properties, as occurs when calcareous and other slightly soluble substances are deposited in the soft matrix of bone, teeth, shell, and other textures. This is a process which can be made to take place in lifeless matter, and has been adduced in support of the doctrine that the tissues of plants and animals are formed by physical and chemical agencies only; but it is not nutrition. Those who advance such arguments confuse the process of deposition of insoluble salts in a material previously formed, with the actual *formation* of the material itself out of substances of a totally different composition.

Nutrition then, I think, involves the conversion of lifeless pabulum into living germinal matter, and comprises these distinct phenomena:

1. The contact of the soluble pabulum with the germinal matter.
2. The separation of the elements of the nutrient substance from their state of combination.
3. The rearrangement of the elements, and the conversion of some of these into new germinal matter.

Nutrition is impossible unless living germinal matter be present, and in every case in which it is known to occur new germinal matter is produced. Nutrition is a *vital* process, its occurrence is positive evidence of *vitality*, and nothing like it has ever yet been effected by human ingenuity.

On the GERMINAL MATTER *of the* OVARIAN OVA *of the* STICKLEBACK. By Dr. LIONEL S. BEALE, F.R.S., Fellow of the Royal College of Physicians, Physician to King's College Hospital, &c.

Plate VII.

IN a paper "On the Structure and Growth of the Ovarian Ova of the Stickleback," read before the British Association, and published in the January number of the 'Microscopical Journal,' Dr. Ransom states that "the plan of staining tissues by carmine, as suggested by Dr. Beale, is not to be recommended; for the ammonia rapidly dissolves the germinal vesicle and its contents." This remark made me feel very anxious to study ova prepared by the process of investigation condemned by my friend; and I take the earliest opportunity of communicating the results to the Society. It is a source of regret to me that I had not prepared some ova for Dr. Ransom's examination before he expressed himself so decidedly against the mode of investigation from which I have derived great advantages. I feel sure from his remarks that the process has not been properly carried out by him.

I shall not occupy time by recounting in detail the new facts in connection with the structure of the germinal vesicle and the development of the ovarian ova learnt by the process of investigation I have pursued, but content myself with referring to the drawings in Plate VII, and the descriptions underneath them.

In conclusion, I will only observe that the ammonia does *not* dissolve either the germinal vesicle or its contents; and I fear that when my friend sees the drawings he will be inclined to reply that, so far from exhibiting solvent properties, the fluid has precipitated particles from the contents of the germinal vesicle, and has actually formed things which do not exist in the natural state. I will not, however, now discuss this matter.

The best results are obtained by diluting the carmine fluid I have recommended with a little water and spirit of wine. I have already stated that, for special inquiries, the staining fluids will be improved by slight modifications, which will suggest themselves to any observer after a few careful experiments. So, also, some things are stained most easily at ordinary temperatures, others at a temperature of 100°; but it would be tedious beyond measure to give detailed directions for each individual object. If the experimenter considers the principles upon which the success of the process depends, I think he will find little difficulty in carrying it out. Like many other operations, practice is required before the best results are obtained, and most who anticipate complete success upon the first trial will, I fear, be disappointed in this as in most other scientific investigations.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY.

Some Remarks *on the* Parasites *found in the* Nerves, *&c., of the* Common Haddock, *Morrhua æglefinus.* By R. L. Maddox, M.D.

(Communicated by G. Busk, Esq., F.R.S., F.R.M.S., &c.)
(Read June 12th, 1867.)

Although the "spheroidal bodies," the subject of the present communication, were discovered and partially described by Monro secundus, much more fully investigated by Professor Sharpey in 1836, who was in the habit of mentioning them in his lectures at the University College, and subsequently by Mr. H. Goodsir, whose paper "On the Anatomy and Development of the Cystic Entozoa," read before the York meeting of the British Association, 1844, was published in 'Goodsir's Anatomical and Pathological Observations, 1845;' still, from the interest that attaches to all knowledge of Parasitic life, whether vegetable or animal, from the scarcity of the last-named work, as well as from the difficulty attending the correct investigation of the structure and relationship of these peculiar creatures, I am induced to offer the accompanying notice as a further elucidation of their organization, with some general remarks. To my friend Professor Aitken, of the Victoria Hospital, Netley, I am indebted for calling my attention more particularly to these bodies, as a subject worth more extended examination.

Dr. Monro, secundus, found peculiar "spheroidal bodies" existing on the surfaces of the brain and nerves of the Gadidæ, which are known to be encysted entozoa containing a living parasite, similar to Distoma. I have noticed them chiefly on the nerves, and more particularly on the caudal nerves, extending in some fish of about fourteen inches long, to two and a half inches upwards from the tail. On making an incision along the caudal extremity over the spinal column of the common haddock, and carefully dissecting back the muscles, the series of nerves as they pass out from the spinal cord are found studded with flattened bead-shaped bodies plainly visible to the unaided eye. Removing a portion of one of these nodulated nerves, placing it in water under the microscope if the fish have not been too long dead, these "spheroidal bodies" of Monro are seen to be cysts, generally imbedded in and displacing the nerve structure, and containing a spinous parasite bent up, which in many cases can be seen to execute partial movements of revolution on an axis at right angles to its length. After removing the surrounding nerve fibres and exposing the cyst to more complete view, it is seen to contain besides the animal, a grumous fluid and numerous oily-looking globules, set in motion by the movements of the parasite.

The cyst seems to be composed of a more or less compact substance, brownish in colour, especially by transmitted light, and lined by a softer but somewhat brittle substance, internally having, as seen through the walls of the cyst, fissures in every direction. The cysts are of a very variable size; some of the smaller not more than the $\frac{1}{100}$th of an inch, others much larger, but the average may be taken as $\frac{3}{100}$ths of an inch, more or less ovoid and flattened; some are, as in Pl. VIII, fig. 6, double; that is to say, when two cysts by the growth of the creature and expansion of the walls have met, the adjoining walls are removed, and the two cysts form but one cavity, and, as in the sketch, contain two parasites. This appearance is not very common. I have met with it twice. On careful examination of the cysts, both *in situ* and removed, I could find no aperture, nor under compression did the cysts rupture more easily in one direction than in another. These cysts are described by Mr. Goodsir as similar to the cysts of *Cysticercus,* as also to the cysts of *Trichina spiralis Gymnorrhyncus horridus* and a small *Filaria* inhabiting the livers of some fish. "The cysts of all these worms have similar structures to those of Cysticercus, namely, an external membrane composed of compressed cellular tissue, and an internal membrane containing absorbing cells, through which the contained animal obtains nourishment." Mr. Goodsir cites the encysted *Gymnorrhyncus* found in the liver of the sunfish as an example,—the "inner membrane of the cyst containing absorbent cells is covered anteriorly with a very thin layer only of the external membrane, so that it is enabled to absorb the nourishment from the external textures in great abundance, which thus enables the animal to move forward as well as obtain a supply of food." Mr. Goodsir states that "Professor Owen, in the description of a microscopic entozoon infesting the muscles of the human body, considered the cysts to be only 'condensed textures of the infested being.'" Dr. Knox, "that it belongs especially to the parasite." Mr. Goodsir's brother, as regards the parasite in the liver of the sunfish, says, "May we not suppose them to be part of the original ovum, within which the animal was formed, and within which it passes its term of existence." The special cyst of the Distoma in the nerves of the haddock, is described in the article from which the above remarks are quoted, as consisting of "three tunics: an external, which appears to be derived from the areolar texture of the infested animal, a middle and internal belonging to the parasite;" "the second tunic is a fine transparent membrane which lines the first, and has in its turn its internal surface covered by an epithelial layer, which is the third tunic of the cyst. The epithelia are flat, irregular in shape, and somewhat opaque. The third or internal layer, formed by them, breaks up under the glass plates, so as to present rents or fissures passing in various directions over it."

I have not been able to satisfy myself of the correctness of these particulars, but rather regard the cysts as the results of a secretion from the surface of the parasite, in fact as Von Siebold describes for the Cercariæ. "After a Cercaria has been for some time in the water, first creeping and then swimming about with manifest restlessness, it gathers itself up into a ball and emits from its whole surface a mucous secretion, which soon hardens, and since inside of this mucous mass the worm, coiled up into a little ball, turns round without stopping, invests it as it were in an eggshell."* The secretion in the present case I believe to arise chiefly from the lower part of the body, for I have found in several specimens removed from the cysts a grumous granular matter exuded and adherent to this portion, and forming a layer at the surface of the body of some thickness; also on wiping over the surface of the animal in water with a fine camel-hair pencil under the erecting microscope, a considerable amount of finely granular substance can sometimes be remarked. Moreover, I cannot detect any distinct tunics in the cyst, nor any epithelial structure as such, with nuclei coloured by carmine, or by maceration, liquor potassæ, &c. &c.

The outer portion seems to be of a condensed mucous or almost chitinous material, of a variable thickness and lined by a more or less transparent friable substance which, on the growth of the parasite in its expansion, splits up into irregular plates of some substance, having fissures that reach to the inner surface of the external or more condensed part.

* Von Siebold on Worms, 1856-7. Pub. by The Sydenham Society, p. 20.

I should regard the cyst as passive, *not endowed with growth or conversion of material,* but sufficiently porous to admit pabulum through its surfaces; and it seems probable the creature is also capable of reabsorbing this deposited matter, as in the case of the removal of the walls of closely adjoining cysts, figure 6, which, we could hardly expect without some trace, if the cysts contained an external tunic of the fibrous and elastic tissues of the infested animal. Although the larger number of these cysts is placed in the very structure of the nerve, the component fibres and vessels, &c., seem to be uninjured, the expansion and growth of the parasite appear to have been most gradual. I could find no change pathologically, nor can we say if there had been any effect in the physiological relations of the surrounding parts. I saw no wasting of the structures, and the only difference noticed was in some of the neighbouring muscles; they appeared here and there to be somewhat discoloured, yellower than the rest, a fine granular substance investing the fibres and fasciculi, though the intimate structure was quite as perfect as in the normal tissue. I cannot say whether any portion of the interior of the cyst should be regarded as the remains of ecdysis. In some, loose particles are found, which may be excreta.

On rupturing the largest of the cysts, containing the entozoon alive, with the dissecting needles, a small quantity of viscid fluid with variable sized oily-looking globules escapes, and with it the parasite; almost immediately if this be done in water or any saline liquid, or weak glycerine, I have noticed the creatures retain much of the form in which they emerged, and remain more or less permanently contracted: but in warm saliva, for the intimation of which I am indebted to my friend Professor Aitken, the animal often moves somewhat freely about with a slow graceful motion, and the internal textures are very much less obscured than in other media, which do not render them too transparent for distinction. I have watched one specimen alive in this medium for seven hours, how much longer it remained living I can't say, as I left it to retire for the night, but the next morning at eight o'clock there were no signs of life. The general aspect of the creature is elongated, roundish, rather narrower posteriorly and somewhat leech-like, about $\frac{14}{100}$th to $\frac{15}{100}$th of an inch in length, the entire surface of the body covered with minute spines set backwards, but more particularly, as pointed out by Mr. Goodsir, evident on the entire dorsal aspect. It is provided with an anterior or oval disc, and a central one situated about the junction of the first and second third of the body.

In the interior is noticed a large, dark-looking sac, occupying a great portion of the inside of the creature, extending along the two lower thirds in a sigmoid or partially curved direction, and terminating at a distinct posterior outlet; looking almost black by transmitted light, and by reflected light of a dead white; the contents of this sac are made up of minute globules of a highly refractive character, and I believe of an also albuminous matter enclosing air. Within the sac, in the living creature, these minute globules may be seen in irregular motion, and occasionally a portion is emitted at the outlet. Whether this is to be regarded by some as a respiratory sac or urinary apparatus, or whether it belongs to the digestive system I am not certain, or whether it is not convertible at some future stage of the creatures existence into some important and defined organ, is doubtful. It exists more or less in all, though in the most minute examined it is exceedingly trivial. The large circular disc at the anterior extremity of the creature has numerous fibres or folds, circular and radiating, with an aperture that varies from a circle to a sharp elipsoid, which, from analogy in the other distoma, we may regard as a mouth,—though, from the density of the superposed structures, I have never fairly seen an œsophageal tube,—I have noticed only, as in the fig. 4, indications of such being present. Below the anterior disc on either side of the body, are small irregularly placed cellular bodies; I have counted sixteen on one side, but could not make out the same number distinctly on the other side, made up of nucleated cells, or if we regard the cell as a single structure, with about eight or more nuclei. These were not noticed in any specimen before staining some of the creatures by Dr. Beale's plan, when they were quickly recognised and are figured in fig. 4, those the lowest in the body are the most distinct, the largest and most nucleated in their structure. Are they unimpregnated ova, or yelk glands? These bodies are best seen on the dorsal aspect, though in no single case have I found them symmetrical, the parasite dying in some contrary position, though placed as such in the figure, which is made up in one or two of its internal organs from an extended series of observations on various examples. (My best specimen I lost from slightly warming the mounted slide, the glycerine appearing to act on the delicate sarcode structure of these bodies as a solvent. This is named as a caution to others.) Situated more centrally are two tubes which appear to be united below the anterior disc by a cross branch, of which, however, I am not absolutely certain, the parts being much obscured; as they extend downwards, they are distinctly nucleated (like the biliary tubes of some insects), as figured, and at the lower parts join and apparently end by one tube posteriorly, but whether in a blind extremity or in conjunction with the large sac, I will not assert, though disposed to believe the latter. Are these tubes a portion of the digestive canal, or hereafter to become ovaries? At the centre of the upper part of the middle third is a second disc, which on tracing inwards appears to have an aperture with a short tortuous canal, or an oblique passage, that terminates in a strong pouch, regarded as the uterus, which generally contains several large globules and some very minute; its walls are rugose, thick, cellular when seen on end, and have both circular (which are very marked) and elongated fibres in its walls. On a side view it often appears divided by these into little square areas. I could not find any satisfactory connection of the sacculated end of this organ with any other, nor indeed of its mouth or neck. The walls of the disc have circular and radiating folds or fibres, the radiating in some cases very distinct, *vide* fig. 4.

Mr. Goodsir described and figured a small anterior pore in front of the acetabulum. May this pore not be the mouth of an erected short tube, which, when drawn back into the neck of the sac would give the appearance corresponding to Mr. Goodsir's description, but in other dispositions of the parts, to a small orifice beneath the disc. I could not satisfy myself on these points, though am inclined to view it as now stated (fig. 8).

Slightly below this organ and *to one side* are seen, in large specimens, five other bodies, two small, two large, and one intermediate, but more resembling the former; they appear to me as connected. The intermediate one is circular, somewhat different in aspect from the others, and contains highly refracting bodies; the next smaller in size is a cell with a segmented arrangement of about five nucleated structures. I could not trace in any specimens the exact attachment of this organ to the lowest of the sixteen nucleated cells before described, but think such exists; below this, the next small circular body is more solid, the divisions are broken up into a greater number, and evidently some change appears to have been effected in it;—beneath this are two much larger and more compact oval or roundish bodies, very distinct, the upper one generally the larger of the two: they are connected together by bands, whether ducts or not I could not determine. Speaking of these bodies, Mr. Goodsir writes, "The two larger globular masses are very constant, and as well as the two smaller contain a mass of particles apparently nucleated. From the two larger I have only been able to see faint traces of what appeared to be ducts, passing in the direction of the smaller masses and towards the neck of the pyriform sac. Whether these convoluted bodies be ovaries or convoluted oviducts, and the pyriform sac a uterus, or whether the former be testes and the latter the female organ, as in the arrangement discovered in the other distomas, or whether they be reproductive organs at all, I have failed in satisfying myself, in consequence of the delicacy of their texture and the comparatively dense integument of this part of the animal." Thus it appears he did not notice the double row of small globular bodies. We have now the large oblong albuminous (?) sac crossing the body and terminating below, whilst at the lower third, situated rather to one side, is a curious and constant organ much denser in the larger than in the smaller animals. It is an elongated body slightly curved on itself at its upper part, containing a central canal, in which in living specimens can be seen minute particles in motion; the sides of the upper half consist of highly refractive parts, apparently set at an angle to the canal, the upper end being united by a cord or duct to the two large circular bodies; the lower part of the organ is surrounded by circular fibres, a few longitudinal also being visible. At this part is a peculiar twisted arrangement, of which I could not determine the real nature; traced further downwards the widened contorted portion appears to terminate in a funnel-shaped cavity, this having a distinct exit to the side and near the outlet of the large dark sac,—*vide* fig. 4. In some positions I noticed a small projecting body near its centre, which I am led to suppose connects this at about its middle, with either the tubes of the globular bodies, or of the terminal duct of the convoluted nucleated tubes. Is this both a male organ and oviduct combined,—the minute particles seminal matter, the upper part of it the testis, the medium size circular body a seminiferous receptacle, the two large globular bodies ovisacs, containing fecundated ova, and the two smaller globular bodies as receptacles of the sixteen, more or less, yelk masses, preparatory to impregnation? There are still to be described four rapidly vibrating or pulsating points, at the lower third of the body, as in the fig. 4, indicated by the letters p. o, they are seen as narrow, bright, rapidly quivering lines in one position. When examined with a power of 445 diameters they appear $\frac{1}{12}$th of an inch in length, and in another aspect as a small circular spot. The pulsations were not equal, some being quicker at one than at the other spot—p. o′. pulsating much faster than the opposite p. o′. I am not aware of these being noticed by former observers. They were shown to others. I expect they are valvular folds, and connected with some arrangement of vessels, of which I could only find faint indications here and there, and which may belong to the vascular system, the trunks of which, Mr. Goodsir states, are most apparent at the lower third of the body.

The large oval or globular masses removed from the interior of the animal by the dissecting needles, and placed in the compressorium showed a distinctly cellular or segmented structure. The lower or male (?) organ removed, gave under compression little more than mere outline. The twisted condition the creatures often die in, and the apparently disturbed position of the internal organs with their delicate structure, add a considerable difficulty in distinctly ascertaining the exact relations of the various parts. It is by examining a large number of specimens, which I have done, that we shall possibly arrive at anything like a correct description. In the integument, both circular and longitudinal fibres and very numerous nuclei are evident, and throughout the whole interior of the body, in many cases, a kind of loculated appearance, probably from sarcode bands passing in various directions presented itself.

In the glutinous textures covering the brain I found only two parasites, none in the brain or spinal cord or canal, none in the textures of the eye, one on the optic nerve; and between the optic lobes, forming a depression in one of them, was a small brownish-looking spot, which, when examined, showed groups of, and single, yellowish-looking bodies of variable size, but no distinct structure: they appeared to be scattered in the nerve substance.

According to the opinion of many the encysted entozoa are regarded as immature parasites, or in their pupa condition, and doubtless this may be the case; but how far the peculiar creature under consideration has deviated or passed to a higher grade, and become partially sexually mature, I cannot say, but venture to hazard the following suggestion:—That we have here, as in other Distoma, a hermaphrodite creature, which, in its progress towards a reciprocal sexual maturity, yet carries on self-impregnation, so that, at the death of its host, and thus within a moderate time, (I have seen them alive in fish more than forty-eight hours dead, probably three days,) of its own death, impregnated ova may be set free to again become, perhaps, Monostomum embryos to pass through a Cercarial stage, or the lowest phase of a Trematode life.

Whether these ovoid globular bodies should be regarded as "sporularia," in which "sporulæ" are developed, using these terms, as Von Siebold, to mean germs, which are not only devoid of the ordinary constituents of an ovum, as vitelline membrane, yelk, germinal vesicle, and the so-called germinal spot, but in which the further development of the germ-body is not preceded by those conditions, (I mean that of "impregnation" by means of special seminal matter produced in a testis,) which are essential to the development of true ova developed within an ovarium, I cannot decide. In a paper translated by Mr. Dallas, in 'Annals and Magazine of Nat. Hist.,' No. cii, 1866, there occurs this passage from Professor R. Leuckart, in speaking of the trematode worms: "There are trematoda, *the embryos of which even attain sexual maturity in their* Rhabditist-*form, and only become parasitic again in their progeny*—trematoda, consequently the history of which presents us with no simple alternation of the conditions of life, but with an alternate sequence of free and parasitic generations. And, what is more wonderful, *both these generations are sexually developed,* both are produced from ova. There, therefore, we have nothing to do with an ordinary alternation of generations such as occurs, for example, in the Distomeæ, but with a process hitherto almost unheard of in the animal kingdom, and which calls for our consideration the more, because we are accustomed to regard the sexual development of an animal not merely as the sign of its perfect maturity, but also as the criterion of specific individuality."

The view of self-impregnation has been held by some, but Dr. Cobbold thinks erroneously, for he says—"Having found two of the flukes (*Distoma conjunctum,* Cobbold) sexually combined, a fact of great significance in relation to the probably erroneous notion entertained by some, that the hermaphrodite flukes are capable of self-impregnation;" still, as this only proves the one form of congress, to my own mind it does not present any serious difficulty, seeing that almost every day fresh ideas, through increased knowledge, are adding to the peculiarities of the "ways and means" by which the deviations from the ordinary paths of development are effected, to yet carry forward the one grand end—the continuation of the species. Indeed, to me it almost seems less extraordinary that in the hermaphrodite, which is itself a deviation, we should have the power of direct development up to at least a certain form, if not to the full nature of the highest phase of the creature's existence; thus might it not be that the type for self-impregnation, allowing it to exist, rather carries forward the animal under some lower form of being (according to the admitted view, that the present form has to pass to a higher stage before reciprocal congregation), provided it cannot, under its present circumstances, reach the higher mode of maturity than that it should perish. Singular, indeed, is the progressive series of stages in the "alternation of generations" or of "germination," "agamogenesis," when the offspring is to deviate, both by its appearance and its progeny, from its parents, and at last, after such transitional forms, arrive at that perfection when the result of reciprocal sexual impact is the genuine ovum of the specific type,—or that the young should be like to great-grandparents at one period, and at other stages have no relationship by similarity of external figure. Is this singularity not greater than hermaphroditic self-impregnation? No one may have outwardly witnessed the act of self-impregnation, but, if the means of passage for the male influence exist internally, we have no more than an inward self-impression which exists in a reciprocal external condition in other creatures, and which can be effectually practised by artificial methods, as in fish-hatching. The question is, do we really know the import or exact nature of the organs we figure as existing in the interior of many small beings? How various the terms employed, how questionable if strictly correct. We have our yelk-forming glands, our testes, our gemmarium, our ovaries, our oviducts, our excretory, urinary, or respiratory, or, in fact, any other apparatus that suits our views; therefore we may err, however much we may strive in truth, "for wisdom will always have a microscope in her hand;" still, when we look "into the life of things," we cannot limit the rules or restrict the powers impressed on certain animals by the Great Originator, or contrast His creative powers, however much they offend or oppose our accommodating hypotheses; our ignorance is here the boundary, and certainly must not be a substitute for our imaginary knowledge.

It is doubtful if we are even now able to state correctly all the generic relations of this genus, of the order Sterelmintha, family Trematoda, found in the cod, haddock, and whiting. I at first looked on these ovoid bodies as proceeds of digestion, retained to be expelled eventually, and this through the alteration produced in their appearance in various media in which they were examined, the same acting in a similar manner on the little quantity of granular material found in the middle pyriform sac of some; but by using saliva I obtained a better mode of examining these bodies.

On turning to Dr. Cobbold's valuable work on Entozoa, at p. 36 is figured a Distoma, the "*Gasterostoma gracilescens* (Wagener), from the intestines of the angler, *Lophius piscatorius*, magnified 60 diam.," very like the subject of the present article, in a more advanced condition. Indeed, I think, as we shall presently see, it is more than probable that this is one of the higher phases of *Distoma neuronaia Monroii* in its free state of *Gasterostoma*—Dr. Cobbold writes, "In this singular genus the ventral sucker seems to have taken the position usually assigned to the oval opening, whilst the latter is placed lower down, towards the centre of the body. The digestive cæca also disappear, leaving only a short stomachal cavity, which reminds one of the same viscus in the imperfectly organised sporocysts or rediæ. The yelk-forming glands exhibit conspicuous, round, secreting cells, the testes also being largely developed. I have also noticed two other small bodies, one of which probably represents the ovary or germ stock, whilst the other may be referred to the *receptaculum seminis*, or posterior seminal vesicle of Von Siebold. This connection between these several organs is not seen in this specimen, but their relative position is well shown. When the species first came under my observation I naturally followed Rudolphi, who described this Trematode as a Distoma (*Distoma gracilescens*, Rudolphi). I remember seeking most diligently for the digestive tubes, being greatly puzzled, not merely by their absence, but also by the character and position of an organ which we now well know to be the sheath of the intromittent appendage. The uterus also terminates in its immediate vicinity, opening externally by a common outlet. The anatomy of this genus has been pretty fully illustrated by Von Siebold. According to Molin, the excretory, water-vascular organ (or respiratory apparatus, as he interrogatively puts it) consists (in *Gasterostoma fimbriatum*) of a broad central tube, occupying the entire length of the body. In connection with this tube he did not discern any branches, but he represents it as a simple sac, opening externally at the caudal extremity."

Now, referring to Couch's excellent work on 'Fishes,' vol. ii, 1863, p. 129, art. "Lophius piscatorius," he says, "the angler sometimes seeks its prey at mid-water,—a fisherman had hooked a codfish, and while drawing it up he felt a heavier weight had attached itself to his line; this proved to be an angler. How indiscriminately these fishes feed on each other appears from the fact that, in the stomach of an angler which measured two feet and a half in length, was found a codfish that measured two feet; and in the latter were the skeletons of two whitings, within which again were other small fish." As similar parasites, as previously noticed, are found in the cod, haddock, and whiting, it is possible that in the angler the *Distoma neuronaia Monroii* finds its perfect habitat, unless again through the angler it still passes to some larger predatory fish—I hardly think to the seal or birds. The food of the haddock is chiefly shell-fish. Couch recommends naturalists to search in them for interesting species—he having found twelve separate species among a multitude of univalve and bivalve shells. Perhaps here begins the earliest stage of the parasite, so imperfectly noticed in this article, but which I hope to have shown presents much interesting matter for future research.

NOTE.—From Dr. Sharpey's letter to Mr. Goodsir, as published in the 'Anatomical and Pathological Observations:' "When in Berlin some years ago, the late Professor Rudolphi remarked to me in conversation, that he thought it not unlikely the little bodies discovered by Dr. Monro (second) on the nerves of the cod, haddock, and other allied fish, would turn out on examination to be entozoa: and he suggested that I should take an opportunity of inquiring into the point, on my return to Scotland. Accordingly, in the autumn of 1836, I examined these bodies in the haddock or whiting, I really forget which, but I think it was the former, and found that each of them was a little cyst, containing a distoma, which could be easily turned out from its enclosure alive. The specimens I examined were from the membranes of the brain. This observation was made in Edinburgh, and, on going to London soon after, I mentioned the fact to Mr. Owen; and I have been accustomed to take notice of it in my lectures ever since, suggesting at the same time that it would be well to search for these or for analogous parasites in the nerves of other animals, as it was not likely that the Gadus tribe of fishes should be the only example." * * * * "Rudolphi, as far as I know, never examined the structure of the spheroidal bodies of Monro; and the only notice of them I have met with in his writings (to which he did not refer me) is in his 'Historia Naturalis Entozoorum,' vol. ii. Part 2, page 227, where, under the head of "Dubious Entozoa," he enumerates an object described and figured by J. Rathke, under the name of "Hydatula Gadorum," which that observer found in the *pia mater* of the *Gadus morrhua* and *G. virens*, often in great numbers, and which appeared to be a vesicle containing a worm. The nature of the parasite was doubtful, but supposed in some degree to resemble that of a cysticercus, and hence the name applied to it by Rathke; but Rudolphi denies that it is a cysticercus, though he does not know to what genus to refer it, he adds 'an Cucullanus.' (?)"

On the STRUCTURE *and* METAMORPHOSIS *of the* LARVA *of* CORETHRA PLUMICORNIS. By Professor T. RYMER JONES, F.R.S., F.R.M.S., &c.

(Read June 12th, 1867.)

HAVING towards the close of last summer met with a pond in my vicinity well stocked with the larvæ of the *Corethra plumicormis,* objects so tempting to the microscopist, both on account of their marvellous transparency and the facility with which they may be obtained for observation, I was induced, preparatory to a more minute investigation of their structure, to map out, as it were, the grosser features of their anatomy, and thus obtain a kind of chart, the minor details of which could be filled up as opportunities presented themselves, and for this purpose sketched under the camera the main outlines of their economy. As the season again approaches when these larvæ are procurable, from the study of which so much information may be reasonably expected relative to the economy and metamorphoses of the Culicidæ. I have thought that it might possibly facilitate the exploration of other observers in this interesting field of study were I to place the drawings thus made at the disposal of any members of the Society who may feel an interest in the subject.

There are indeed many points of high physiological importance susceptible of solution, by a careful examination of this insect in its different stages of growth, which in other species would seem hopelessly beyond research, owing to their dark hue and the general opacity of their integuments, whereas the glass larva, as it is not unfrequently called, seems eminently constructed for the purpose of courting our observation, insomuch that it might almost be regarded as purposely intended for inspection; one of those peep-holes left by Providence, through which a glimpse may be obtained of the elaborate machinery of creation.

It would be a waste of time, before an audience, to every member of which the larva in question is no doubt a familiar object, to dwell upon the general form and appearance of this elegant but ferocious creature,—the symmetry of its shape, the vivacity of its movements, the fan-shaped plume beneath its armed tail, which, like a fin, propels it through the water, its pike-like voracity, or the ruthlessness with which it makes an onslaught on its prey; and yet the descriptions of it, given even by modern entomologists, are lamentably meagre, and give but a feeble idea either of its carnivorous propensities or its formidable armature. Its mouth presents a terrible apparatus, composed of numerous pieces, the homologies of which might furnish interesting subject for discussion. In their disposition they remind us of the foot-jaws of some of the Branchiopod Crustaceans (such as *Chirocephalus*), and in like manner are equally instruments of progression, and weapons for the capture of prey. The anterior pair, articulated to the apex of the snout, are of great strength, and are moved by powerful muscles, distinctly seen through the transparent covering of the head. At their extremities they bear fan-like tufts of stiff setæ, that, when expanded, form powerful oars, the downward strokes of which, when energetically made, have a marked effect in aiding the progress of the animal through the water. More frequently, however, their movements are of a gentler character, and only serve to cause the influx of a constant stream towards the mouth, the effect of which extends to a considerable distance, attracting, like a little Maelström, the smaller animals that come within its vortex.

The second pair of these oral appendages presents a very different structure. They are composed of numerous narrow laminæ, much resembling, in their arrangement, the plates of whalebone in a whale's mouth, and indeed they perform a very similar office. These plates, represented in the drawing (Pl. IX) in a collapsed condition, can be spread out like the walls of a tent, so as to enclose as in a net whatever small animals may be brought within their expanse by the intrant current above alluded to.

The third pair consists of two elegantly-shaped instruments wherewith the creature adjusts, as with a pair of hands, the position of the imprisoned victim, so as to pass it easily along the fatal road, and hand it to the embrace of

The fourth pair, which in function at least must be compared to palpi. These pieces are of large dimensions, furnished at their extremities with sentient vibrissæ, that remind us of the whiskers of a cat, and with a terminal tuft of greater strength and thickness, whereby the prey is seized and passed backward to the gaping jaws.

These last consist of two pairs of crushers, the maxillæ and the mandibles, both armed with formidable fangs, while, to complete the deadly apparatus, spikes of different shapes surround the immediate margin of the mouth.

The internal digestive organs are not less remarkable than the complicated machinery described above.

The commencement of the alimentary canal presents a spacious crop, the walls of which are very strong and muscular; to this succeeds a gizzard, armed internally with teeth, arranged in densely-crowded phalanx—from this a tube of remarkable slenderness and of considerable length leads to the true ventriculus, the walls of which are glandular and minutely sacculated. To the pyloric extremity are attached four (so called) hepatic vessels, while the intestine is simple and slightly dilated towards its extremity. On placing one of these larvæ between the plates of the compressor, and pressing it moderately, a very curious phenomenon presents itself. The muscular walls of the crop, thrown into violent action, tear away the gizzard and its slender tubular prolongation, and becoming suddenly everted, protrude from the mouth, having, in this condition, very much the appearance of the unfolded proboscis of an Annelidan; a resemblance much enhanced by the denuded teeth of the gizzard, that protrude from the extremity of the everted crop, which latter continues for a long while to exhibit peristaltic movements; while the crushed and mangled bodies of the swallowed monoculi, upon which these larvæ principally subsist, are cast into the surrounding water, and testify to the efficiency of the curiously-formed apparatus.

In these diaphanous larvæ, the action of the heart is very beautifully exhibited: the contractions of its various chambers succeed each other consecutively, with an apparent energy of purpose that reminds the observer rather of the untiring pumping of a steam-engine, than of those rythmical undulating movements which we should expect to witness in a viscus having walls so thin and transparent, and at the same time so isolated. It is therefore by no means surprising that the dorsal vessel should be provided with a largely-developed system of ganglionic nervous centres, the existence and distribution of which are plainly traceable when using the higher powers of the microscope. These consist of numerous minute corpuscles, closely resembling in their appearance Paccionean bodies, and are distinctly perceptible in the vicinity of each compartment of the dorsal vessel, to which they are connected by slender filaments. These minute ganglia are usually disposed in groups, varying from three to five in number, suspended in the cellulosity surrounding the heart.

But perhaps the most characteristic feature in the economy of these larvæ is the existence of four remarkable organs, situated—two of them in the thoracic region and two near the centre of the posterior half of the body. These strange-looking masses, conspicuous from their jet-black colour, are placed in pairs, and uniformly occupy the same situations corresponding with the centre of gravity, or rather of flotation of the two halves of the animal to which they respectively belong. In form they are more or less kidney-shaped, and are to all appearance completely isolated and unattached to the surrounding structures. On crushing these kidney-shaped bodies beneath the compressorium, they are found to be filled with air, by the compression or rarefaction of which the creature is enabled to rise or sink in the surrounding water, without apparent effort, just as a Gold-fish rises or descends by means of its swimming-bladder. There is no visible outlet for the air thus confined in their interior, and the most rigid scrutiny only shows a few delicate air-vessels of extreme tenuity, in their immediate vicinity. Each of these air-sacs consists of several coats; of these the outermost, when feebly magnified, seems of a uniform hue of jet-black; but appears under higher powers to be made up of numerous distinct spots of black pigment, separated by considerable interspaces, so as to give the organ a reticulated appearance; and it is only when this black pigment has been removed, together with a dull opaque membrane, whereon the black patches rest, that the real air-sac is displayed. When thus denuded, the true wall of the air-sac appears to be composed of a dense membrane, possessing great refractive power; the effect of which upon transmitted light is extraordinary. When highly magnified, it is found to be entirely composed of numerous coils of a delicate fibre, similar to that which maintains the permeability of the tracheæ of ordinary insects, arranged in several superimposed layers, and having the appearance of being closed on all sides. It is not until the larva thus constituted has arrived at its full size that the appearances described become complicated, by intermixture with organs belonging to the pupa condition of the insect. At this period, however, the rudiments of future limbs begin to show themselves under the form of transparent vesicles, which, as they enlarge, crowd the thoracic region of the body.

The change from the larva to the pupa condition involves several remarkable phenomena. The air-sacs, situated both in the thoracic region and in the hinder portion, burst and unfold themselves into an elaborate tracheal system; and a pair of ear-shaped tubes, of which not the slightest trace could hitherto be discerned, make their appearance upon the dorsal aspect of the thorax; two long tracheæ seem to be thus simultaneously produced, occupying the two sides of the body and constituting the main trunks, from which large branches are given off, to supply in front the head, the eyes, and the nascent limbs; while posteriorly they spread in rich profusion over the now conspicuous ovaries, and terminate by ramifying largely through the thin lamellæ that constitute the caudal appendages. The very act of this strange metamorphosis I have not been able to witness under the microscope, owing to the impossibility of predicating the exact period of its occurrence—but there is reason to believe that it takes place suddenly, and occupies but a short time in its completion. In individuals subjected to microscopic examination within a very brief period after their assumption of the pupa state, the places originally filled by the air-sacs of the larva are found to be occupied by the tattered remnants of their external coats, clearly indicated by ragged membranes, covered with patches of black pigment, in the immediate vicinity of which I have invariably met with numerous air-bubbles, extravasated as it were into the cellular tissue, as though forced out by some leakage during the violent disruption of the air-sac.

I hope on a future occasion to lay before the Society a series of drawings, illustrative of the minuter details connected with this interesting process; and, in case any of our members should be induced to devote a portion of their time to an investigation fraught with many difficulties, will at present merely say a few words which may probably serve to facilitate their operations, and save them much probation in the expensive school of experience. In their fresh condition these larvæ are, from their very transparency, almost invisible; and such is the translucency of their tissues, that these latter are with great difficulty distinguishable. To remedy this inconvenience, I have tried the effect of dyeing them with carmine and magenta, and of preserving them in a variety of solutions, but with no satisfactory result. So impatient are they of endosmotic action, that they will not bear the slightest increase or diminution in the density of the surrounding fluid—at the touch of glycerine or syrup (however much diluted) they shrink up into a shapeless heap, and by the weakest spirit are converted into masses of distortion. At last, driven almost to despair by their perversity under every mode of treatment, I was tempted to enclose them, while still alive, in cells filled with their native element—

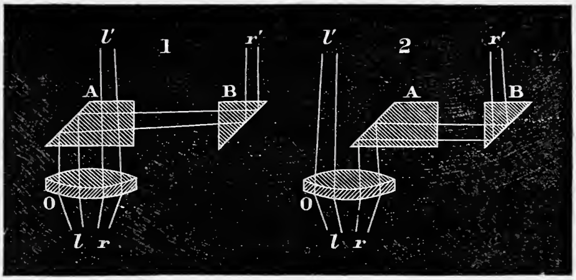
pure water—and at once seal them up with a margin of gold-size. In this condition I found that they would live for several hours, and thus exhibit in perfection the action of the heart, and the ganglionic bodies appended to its walls. When this had ceased, I was enabled to study them for days together, and found, to my great gratification, that they only improve by keeping. Slowly their muscles assume a slight degree of opacity, and shrinking, as by a sort of *rigor mortis,* leave spaces through which the minutest details of their anatomy are distinctly perceptible. The most delicate membranes, by a similar process, are rendered sufficiently opaque to be plainly visible, and the vesicles of the nascent limbs, in specimens approaching the pupa condition, become clear and distinct. The nervous apparatus, constituting the ventral series of ganglia, forms a very beautiful object: in specimens thus preserved—the outer sheath, the structure of the ganglia, the composition of the internodal cords, together with the origin and course of the nerves, are all displayed in a most satisfactory manner, even the cross-markings of the muscular fibres are recognisable with the utmost distinctness. I have here one or two specimens of these larvæ thus prepared, *au naturel,* which, although they have been upwards of a year in their present condition, will, I doubt not, when placed beneath the microscope, fully serve to recommend the process I have adopted. There is one precaution necessary in making these preparations, which, trivial as it may seem, will be found of much practical importance. In order to delineate specimens thus put up, while in the microscope, by means of the camera lucida, it is essential that the depth of the cells in which they are placed should be just such as to press sufficiently upon the enclosed larva to hold it steady while in a vertical position, otherwise it sinks in the surrounding fluid, and is continually subject to displacement. The manner in which I have succeeded in overcoming this difficulty is very simple. The cells that I employ are discs of thin sheet-lead, cut out with a circular punch, and perforated in the centre by another punch of smaller diameter. These discs, when cemented to a glass slide with gold-size, are easily rubbed upon a wet hone to the exact thickness required, and the object so mounted retained in its place by the pressure of the glass, will be found to be as steady and manageable as if placed in Canada balsam.

On Nachet's Stereo-pseudoscopic Binocular Microscope, *and on* Nachet's Stereoscopic Magnifier; *with Remarks on the* Angle *of* Aperture *best adapted to* Stereoscopic Vision. By W. B. Carpenter, Esq., M.D., F.R.S., &c.

(Read June 12th, 1867.)

Nachet's Stereo-Pseudoscopio Binocular Microscope.—An ingenious modification of Mr. Wenham's arrangement has been introduced by MM. Nachet, which has the attri-

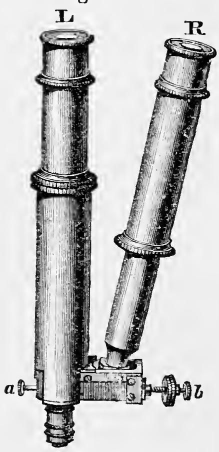
Fig. 1.



Arrangement of Prisms in Nachet's Stereo-pseudoscopic Binocular:—1, for Stereoscopic; 2, for Pseudoscopic, effect.

bute, altogether peculiar to itself, of giving to the image either its true Steoreoscopic projection, or a Pseudoscopic "conversion of relief," at the will of the observer. This is accomplished by the use of two prisms, one of them (Fig. 1, A) placed over the cone of rays proceeding upwards from the objective, and the other (B) at the base of the secondary or additional body, which is here placed on the right (Fig. 2). The prism A has its upper and lower surfaces parallel; one of its lateral faces inclines at an angle of 45°, whilst the other is vertical. When this is placed in the position 1, so that its inclined surface lies over the *left half* (*l*) of the cone of rays, these rays, entering the prism perpendicularly (or nearly so) to its inferior plane surface, undergo total reflection at its oblique face, and, being thus turned into the horizontal direction, emerge through the vertical surface at right angles to it. They then enter the vertical face of the second prism B; and

Fig. 2.



Nachet's Stereo-pseudoscopic Microscope.

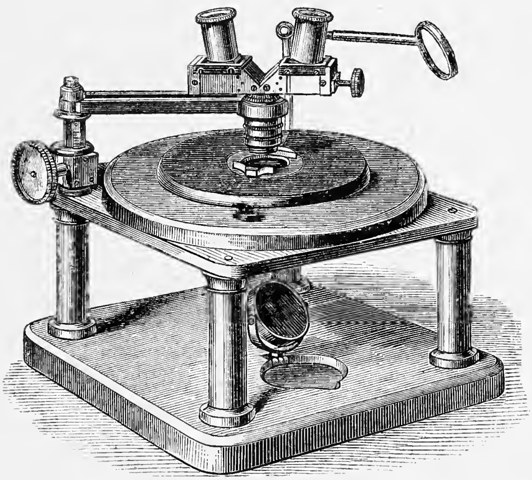
after suffering reflexion within it, are transmitted upwards into the *right*-hand body, r', passing out of the prism perpendicularly to the plane of emersion, which has such an inclination that the right-hand or secondary body (R, Fig. 2) may diverge from the left or principal body at a suitable angle. On the other hand, the *right* half (r) of the cone of rays passes upwards, without essential interruption, through the two parallel surfaces of the prism A, into the left-hand body (l'), and is thus crossed by the others in the interior of the prism. But if the prism A be pushed over towards the right (by pressing the button a, Fig. 2), so as to leave the *left* half of the objective uncovered, as shown in position 2, Fig. 1, that half (l) of the cone of rays will go on without any interruption into the *left*-hand body (l'), whilst the *right* half (r) will be reflected by the oblique face of the prism into the horizontal direction, will emerge at its vertical face, and, being received by the second prism, B, will be directed by it into the *right*-hand body (r'). The adjustment for the distance between the axes of the eyes is made by turning the milled-head b (Fig. 2), which, by means of a screw-movement, acts upon a movable chariot that carries the prism B and the secondary body R, the base of which is implanted upon it. Now, in the *first* position, the two halves of the cone of rays being made to cross into the opposite bodies, true Stereoscopic relief is given to the image formed by their recombination, just as in the ordinary arrangement. But when, in the *second* position, each half of the cone passes into the body of its own side, so that the reversal of the images produced by the Microscope itself is no longer corrected by the crossing of the two pencils separated by the prism A, a Pseudoscopic effect, or "conversion of relief," is produced, the projections of the surface of the object being represented as hollows, and its concavities turned into convexities. The suddenness with which this conversion is brought about, without any alteration in the position either of the object or of the observer, is a phenomenon which no intelligent person can witness without interest, whilst it has a very special value for those who study the Physiology and Psychology of Binocular vision.*

* The result of the numerous applications which the Author has made of this instrument to a great variety of Microscopic objects, has led to a confirmation of the principle of Pseudoscopic vision which he has stated elsewhere—viz. that the readiness with which the conversion is effected depends on *the readiness of the mind to apprehend the converted form*. Where, as in the case of the saucer-like discs of the *Arachnoidiscus*, the real and the converted forms are equally familiar, the "conversion" either of the convex exterior or of the concave interior into the semblance of the other

As an ordinary working instrument, however, this improved Nachet Binocular can scarcely be said to possess any point of superiority to the Wenham; whilst it must be regarded as inferior in the following particulars:—*First,* that as the uninterrupted half of the cone of rays (when the interposed prism is adjusted for Stereoscopic vision) has to pass through the two plane surfaces of the prism, a certain loss of light and deterioration of the picture are necessarily involved; whilst, as the interrupted half of the cone of rays has to pass through *four* surfaces, the picture formed by it is yet more unfavorably affected; and *second,* that as power of motion must be given to both prisms—to A, for the reversal of the images, and to B for the adjustment of the distance between the two bodies—a greater liability to derangement results than in the simpler construction of Mr. Wenham.*

Nachet's Binocular Magnifier.—Though the Author can testify to the fidelity of the effect of relief obtainable by

Nachet's Binocular Magnifier, adapted to Beck's Dissecting Microscope.



the Binocular arrangement adapted by Mr. R. Beck

is made both suddenly and completely. In more complex and less familiar forms, on the other hand, the conversion frequently requires time; being often partial in the first instance, and only gradually becoming complete. And there are some objects which resist conversion altogether, the only effect being a confusion of the two images.

* This arrangement, like Mr. Wenham's, can be adapted to any existing Microscope; and it seems peculiarly suitable to those of French or German construction, in which the body is much shorter than in the ordinary English models. For in the application of the Wenham arrangement to a *short* Microscope, the requisite distance between the eye-glasses of its two bodies

to his Dissecting Microscope,* he has found its utility to be practically limited by the narrowness of its field of view, by its deficiency of light and of magnifying power, and by the inconvenience of the manner in which the eyes have to be applied to it. An arrangement greatly superior in all these particulars having been recently worked out by MM. Nachet, the Author has combined the Optical part of their Dissecting Microscope with Mr. R. Beck's Stand, and finds every reason to be satisfied with the result; the solidity of the Stand giving great firmness, whilst the size of the stage-plate affords ample room for the hands to rest upon it. The Objective in Nachet's arrangement is an Achromatic combination of three pairs, having a clear aperture of nearly 3-4ths of an inch, and a power about equal to that of a single lens of one-inch focus; and immediately over this is a pair of prisms, each resembling A, Fig. 1_2, having their inclined surfaces opposed to each other, so as to divide the pencil of rays passing upwards from the Objective into two halves. These are reflected horizontally, the one to the right and the other to the left; each to be received by a lateral prism corresponding to B, and to be reflected upwards to its own Eye, at such a slight divergence from the perpendiculars as to give a natural convergence to the axes when the eyes are applied to the Eye-tubes, superposed on the lateral prisms—the distance between these and the central prisms being made capable of variation, as in the Compound Binocular of the same makers. The magnifying power of this instrument may be augmented to 35 or 40 diameters, by inserting a *concave* lens into each Eye-piece, which converts the combination into the likeness (as originally suggested by Professor Brücke, of Vienna) of a Galilean Telescope (or Opera-glass); and this arrangement has the additional advantage of increasing the distance between the object and the object-glass, so as to give more room for the use of dissecting instruments.

To all who are engaged in investigations requiring very minute and delicate Dissection, the author can most strongly recommend MM. Nachet's instrument. No one who has not had experience of it can estimate the immense advantage given by the Stereoscopic view, not merely in appreciating the solid form of the object under dissection, but also in precisely estimating the relation of the instrument to it in

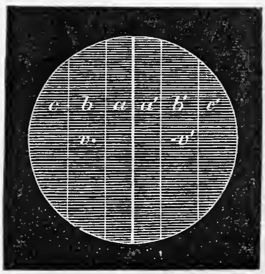
can only be obtained by making those bodies diverge at an angle so wide as to produce great discomfort in the use of the instrument, from the necessity of maintaining an unusual degree of convergence between the axes o. the eyes.

* 'Transactions of the Microscopical Society,' N. S., vol. xii, p. 3.

the *vertical* direction. This is especially important when horizontal sections are being made with fine scissors; since the course of the section can thus be so regulated to pass through the plane desired, with an exactness totally unattainable by the use of any Monocular Magnifier.

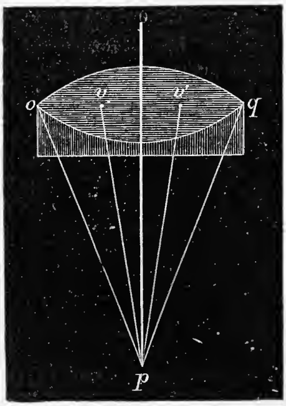
On the Angle of Aperture best suited for Stereoscopic Vision.—The Stereoscopic Binocular is put to its most advantageous use when applied either to *opaque* objects of whose solid forms we are desirous of gaining an exact appreciation, or to *transparent* objects which have such a thickness as to make the accurate distinction between their nearer and their more remote planes a matter of importance. That its best and truest effects can only be attained by Objectives not exceeding 40° of angular aperture, may be shown both theoretically and practically. Taking the average distance between the pupils of the two Eyes as the base of a triangle, and any point of an Object placed at the ordinary reading-distance as its apex, the vertical angle enclosed between its two sides will be from 12° to 15°; which, in other words, is the angle of divergence between the rays proceeding from any point of an Object at the ordinary reading-distance to the two Eyes respectively. This angle, therefore, represents that at which the two pictures of an object should be taken in the Photographic Camera, in order to produce the effect of ordinary Binocular vision without exaggeration; and it is the one which is adopted by Portrait-photographers, who have found by experience that a *smaller* angle makes the image formed by the combination of the pictures appear too *flat*, whilst a *larger* angle *exaggerates* its projection. Now, in applying this principle to the Microscope, we have to treat the two lateral halves (L, R, fig. 4) of the Objective as the two separate lenses of a double Portrait Camera, and to consider at what angle each half should be entered by the rays passing through it to form its picture. To any one acquainted with the principles of Optics, it must be obvious that the picture formed by each half of the Objective must be (so to speak) an average or general resultant of the dissimilar pictures formed by its different parts. Thus, if we could divide the lateral halves or Semi-lenses L, R, of the Objective by vertical lines into the three bands *a b c* and *a′ b′ c′*, and could stop off the two corresponding bands on either side, so as only to allow

Fig. 4.



the light to pass through the remaining pair, we should find that the two pictures we should receive of the object would vary sensibly, according as they are formed by the bands $a\,a'$, $b\,b'$, or $c\,c'$. For, supposing the pictures taken through the bands $b\,b'$ to be sufficiently dissimilar in their perspective projections to give, when combined in the Microscope, a sufficient but unexaggerated Stereoscopic relief, those taken through the bands $a\,a'$ on either side of the centre would be no more dissimilar than two portraits taken at a very small angle between the Cameras, and their combination would very inadequately bring out the effect of relief; whilst, on the other hand, the two pictures taken through the extreme lateral slips $c\,c'$ would differ as widely as portraits taken at too great an angle of divergence between the Cameras, and their combination would exaggerate the actual relief of the object. Now, in each of the bands $b\,b'$, a spot $v\,v'$ may be found by mathematical computation, which may be designated the *visual centre* of the whole Semi-lens; that is, the spot which, if all the rest of the Semi-lens were stopped off, would form a picture most nearly corresponding to that given by the whole of it. This having been determined, it is easy to ascertain what should be the angle of aperture ($o\,p\,q$, fig. 5) of the entire Lens, in order that the angles $v\,p\,v'$ between the "visual centres" of its two halves should be 15°. The investigation of this question having been kindly undertaken for the Author by his friend Prof. Hirst, the conclusion at which he has arrived is, that the angle of aperture of the entire Lens should be about 36·6°. This, which he gives as an *approximate* result only (the requisite data for a complete Mathematical solution of the question not having yet been obtained), harmonises most remarkably with the result of experimental observations made upon objects of known shape, with Objectives of different angular apertures.

Fig. 5.



When spherical objects, such as the globular forms of *Polycystina* or the pollen-grains of the *Malvaceæ*, are placed under a Stereoscopic Binocular, provided with an Objective of *one half* or *four-tenths* of an inch focus, having an angular aperture of 80° or 90°, the effect of projection is so greatly exaggerated, that the side next the eye, instead of resembling a hemisphere, looks like the small end of an egg. If, then, the aperture of such an Objective be reduced to 60° by a diaphragm placed behind its back lens, the exaggeration is diminished, though not removed; the hemispherical surface now looking like the large end of an egg. But if the aperture be further reduced to 40° by the same means, it is at once seen that the hemispheres turned towards the eye are truly represented; the effect of projection being quite adequate, without being in the least exaggerated.—Hence it may be confidently affirmed—alike on theoretical and on practical grounds—that when an Objective of wider angle than 40° is used with the Stereoscopic Binocular, the object viewed by it is represented in exaggerated relief, so that its apparent form must be more or less distorted.

There are other substantial reasons, moreover, why Objectives of limited angle of aperture should be preferred (save in particular cases) for use with the Stereoscopic Binocular. As the special value of this instrument is to convey to the mind a notion of the *solid forms* of objects, and of the relations of their parts to each other, not merely on the same but on different planes, it is obvious that those Objectives are most suitable to produce this effect, which possess the greatest amount of *penetration* or *focal depth;* that is, which show most distinctly, not merely what is precisely in the focal plane, but what lies nearer to or more remote from the Objective. Now, as increase of the angle of aperture is necessarily attended with diminution of penetrating power, an Objective of 60° or 80° of aperture, though exhibiting minute surface-details which an Objective of 40° cannot show, is much inferior in suitability to convey a true conception of the general form of any object, the parts of which project considerably above the focal plane or recede below it.*

The Author would further draw attention to two important advantages he has found the Stereoscopic Binocular to possess, his own experience on these points being fully

* In accordance with these principles, the Author has caused Messrs. Powell and Lealand to construct for him an Objective of half-inch focus with an angular aperture of 40°; and he has found it to answer most admirably for the purpose for which it was intended—the examination of Opaque objects with the Stereoscopic Binocular. For not only are these represented in their true forms, but the relations of their different parts are seen with a completeness not otherwise attainable. And an Objective so constructed has this great advantage over one whose originally larger aperture has been reduced by a diaphragm—that the distance between its front lens and the object is so much greater, as to admit far more conveniently of *side* illumination.

confirmed by that of others. In the *first* place, the *penetrating power* or *focal depth* of the Binocular is greatly superior to that of the Monocular Microscope; so that an object whose surface presents considerable inequalities, is very much more *distinctly* seen with the former than with the latter. The difference may in part be attributed to the practical reduction in the Angle of aperture of the Objective, which is produced by the division of the cone of rays transmitted through it into two halves; so that the picture received through each half of an Objective of 60° is formed by rays diverging at an angle of only 30°. But that this Optical explanation does not go far to account for the fact, is easily proved by the simple experiment of looking at the object in the first instance through each eye separately (the prism being in place), and then with both eyes together; the distinctness of the parts which lie above and beneath the focal plane being found to be much greater when the two pictures are combined, than it is in either of them separately.

In the absence of any Optical explanation of the greater range of focal depth thus showed to be possessed by the Stereoscopic Binocular, the Author is inclined to attribute it to an allowance for the relative distances of the parts which seems to be unconsciously made by the *Mind* of the observer, when the solid image is shaped out in it by the combination of the two pictures. This seems the more likely from the *second* fact to be now mentioned, namely, that when the Binocular is employed upon objects suited to its powers, the prolonged use of it is attended with *very much less fatigue* than is that of the Monocular Microscope. This, again, may be in some degree attributed to the division of the work between the two eyes; but the Author is satisfied that unless there is a feeling of discomfort in the eye itself, the sense of fatigue is rather *mental* than *visual*, and that it proceeds from the constructive effort which the Observer has to make, who aims at realising the solid form of the object he is examining, by an interpretation based on the *flat picture* of it presented by his vision, aided only by the use of the Focal Adjustment, which enables him to determine what are its near and what its remote parts, and to form an estimate of their difference of distance. Now, a great part of this constructive effort is saved by the use of the Binocular, which at once brings before the Mind's eye the *solid image* of the object, and thus gives to the Observer a conception of its form usually more complete and accurate than he could derive from any amount of study of a Monocular picture.*

* It has happened to the Author to be frequently called on to explain

the advantages of the Binocular to the Continental (especially German) *savans* who have not made themselves acquainted with the instrument. And he has been struck with finding that when he exhibited to them objects with which they had previously become familiar by careful study, and of whose solid forms they had already attained an accurate conception, they perceived no advantage in the Stereoscopic combination; seeing such objects with it (visually) just as they had been previously accustomed to see them (mentally) without it. But when he has exhibited to them suitable objects with which they had *not* been previously familiarised, and has caused them to look at these in the first instance *monocularly*, and then *stereoscopically*, he has never failed to satisfy them of the value of the latter method, except when some visual imperfection has prevented them from properly appreciating it. He may mention that he has found the wing of a small Butterfly, having an undulating surface, on which the scales are set at various angles instead of having the usual imbricated arrangement, a peculiarly appropriate object for this demonstration; the general inequality of its surface, and the individual obliquities of its scales, being at once shown by the Binocular, with a force and completeness which could not be obtained by the most prolonged and careful Monocular study.

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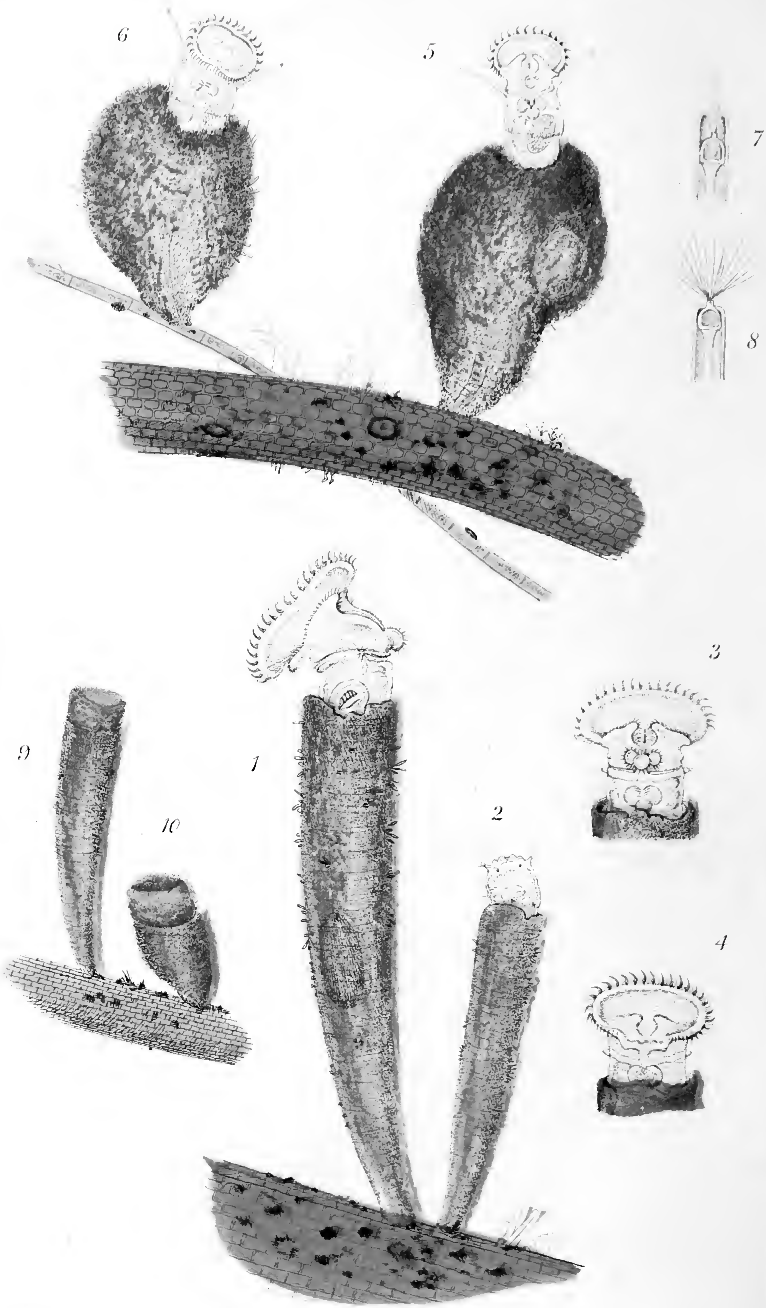


Tuffen West sc.

W. West imp.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY OF LONDON.

DESCRIPTION OF PLATE I,

Illustrating Mr. Davis's paper on Two New Species of the Genus *Œcistes*, Class *Rotifera*.

Fig.			
1.—	*Œcistes intermedius*,		lateral aspect. × 130.
2.—	"	"	young specimen, with disc retracted.
3.—	"	"	ventral aspect.
4.—	"	"	dorsal aspect.
5.—	"	*longicornis*,	ventral aspect. × 210.
6.—	"	"	dorsal aspect.
7 & 8.—	"	"	extremities of antennæ, showing setæ attached to the pistons. More highly magnified.

9.—Sheath of *Œ. intermedius*, the upper part constructed with carmine.

10.— " *Œ. longicornis*, " "

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY OF LONDON.

DESCRIPTION OF PLATE II,

Illustrating Dr. McIntosh's paper on the Gregariniform Parasite of Borlasia.

Fig.

1.—The gregariniform parasite from *Borlasia octoculata.* × 200 diam.

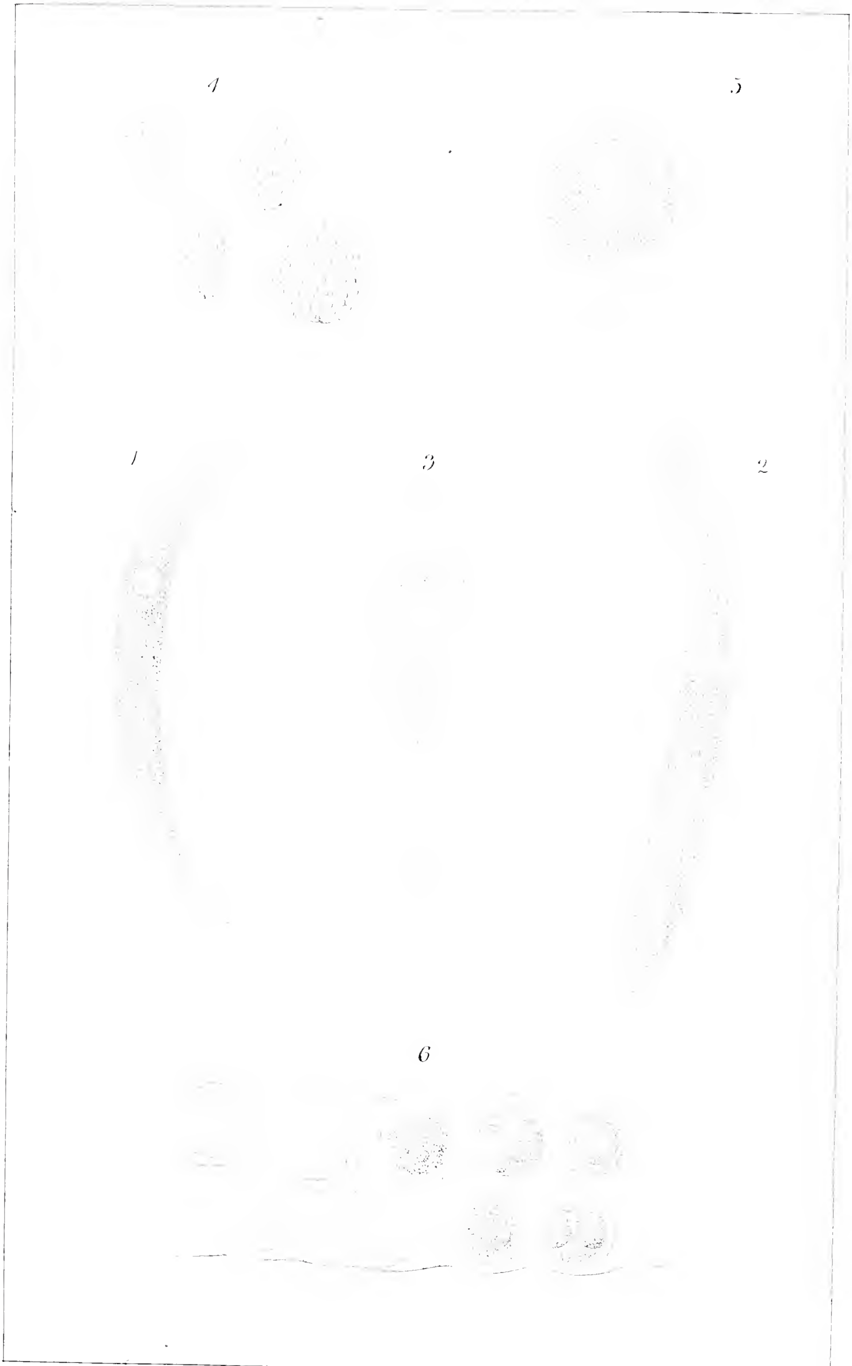
2.—Do. do. from one of the long examples from Devon. × 350 diam.

3.—Outline of one of the parasites after prolonged immersion in water.

4.—Curious structures extruded with the parasites under pressure from *B. octoculata.* × 350 diam.

5.—Parasitic ovum. × 350 diam.

6.—Gelatinous cord, with ova *in sitû.* × 180 diam.



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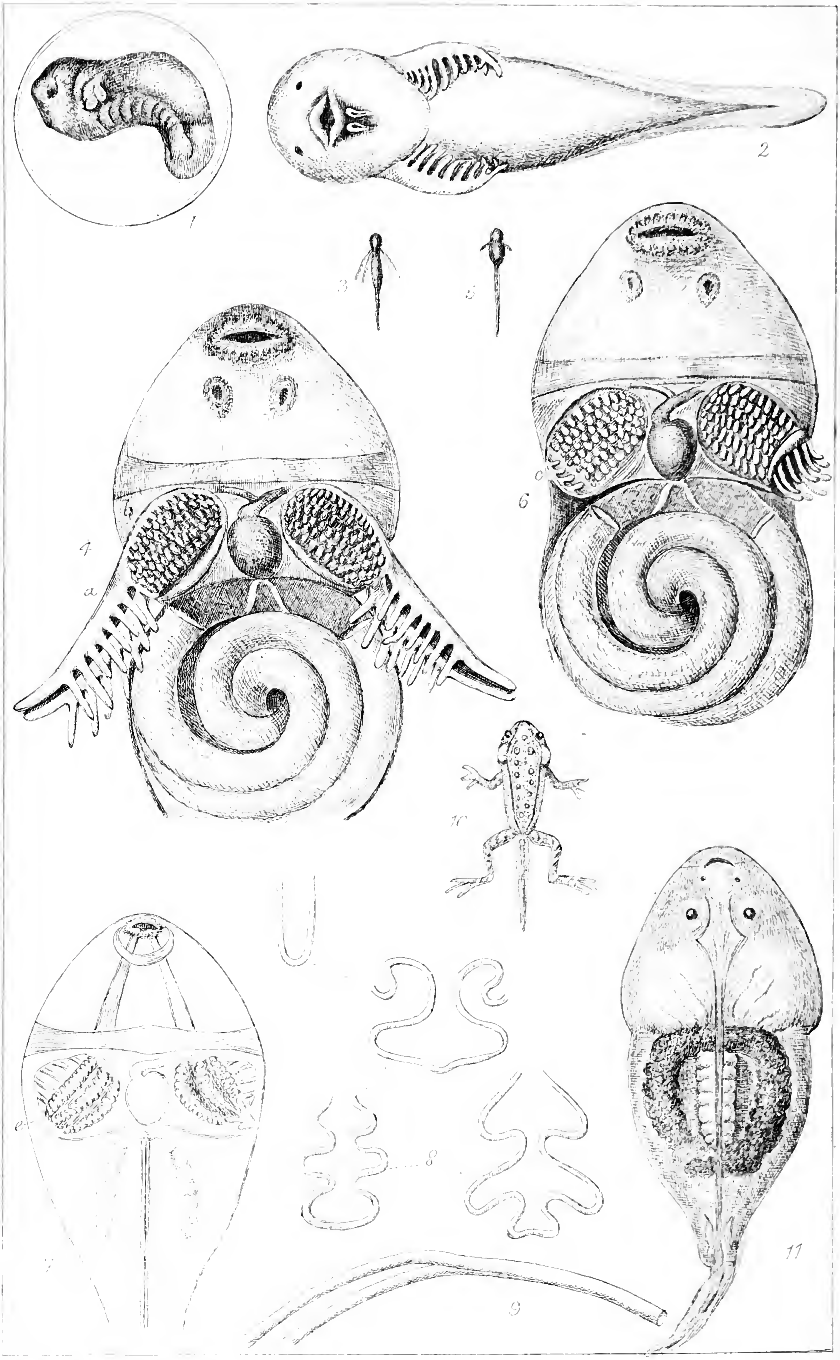
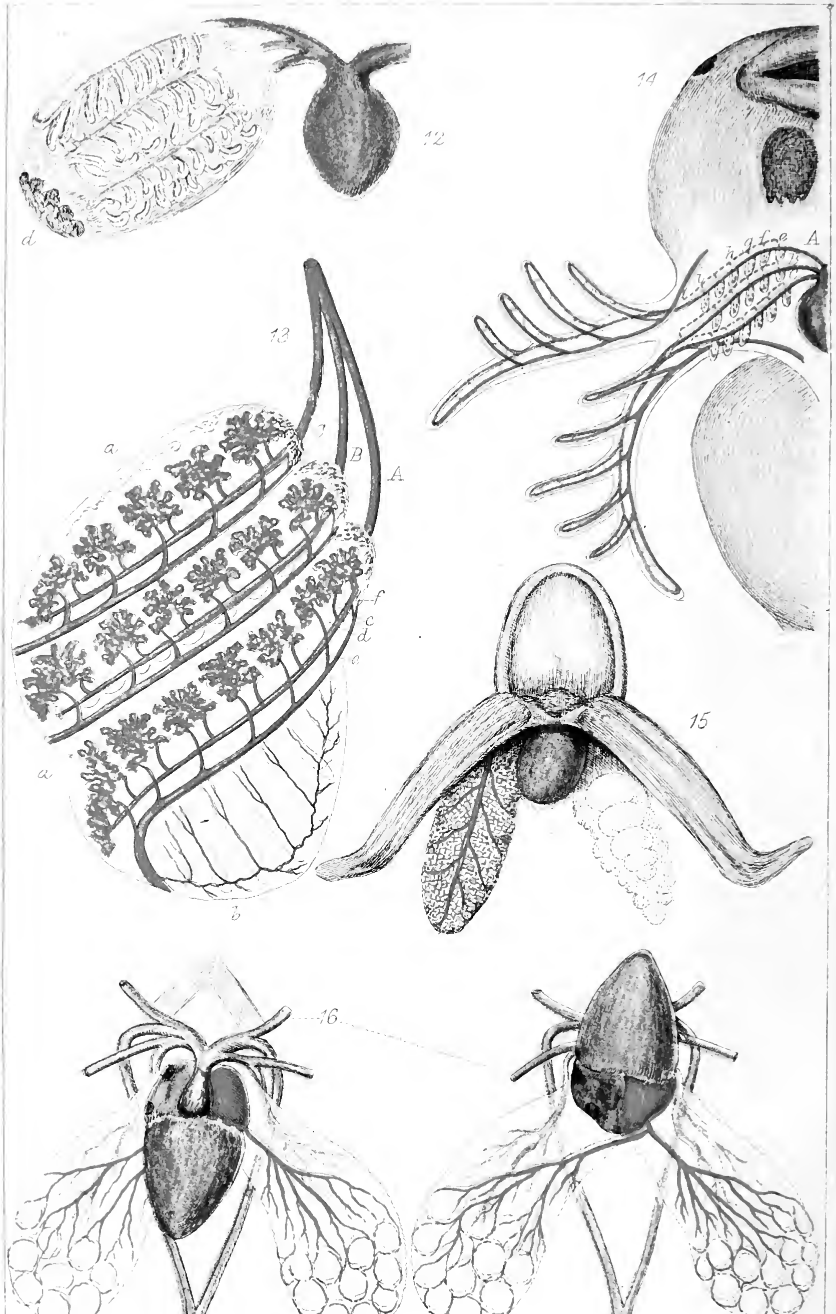


W. West imp.



W H Whitney del. T West sc

W West ch imp.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY.

DESCRIPTION OF PLATES III & IV,

Illustrating Mr. Whitney's paper on the Metamorphosis of the Tadpole.

PLATE III.

Fig.

1.—The young tadpole (enlarged view) within the capsule of the egg.

2.—The tadpole (enlarged view) twenty-four hours after birth, exhibiting nostrils, mouth, suckers, and external gills.

3.—The tadpole, life size, as seen by the naked eye, on the fourth or fifth day after birth, with the outer gills in full development.

4.—The young tadpole (enlarged view), exhibiting the *outer* gills, with the digital-like tufts of the incipient *inner* gills, and the pair of minute tubes below the heart, which are the *incipient lungs* of the future frog.

5.—The tadpole, life size, as seen by the naked eye, when the outer gills are disappearing.

6.—The tadpole (enlarged view) with the outer gills nearly removed; the operculum closed on the right side, but permanently open on the left; the digital tufts enlarging.

7.—Exhibits the *crests* of the *inner* gills in the more advanced stage, and the progressive development of the *lungs* at the same period.

8.—Simple loop of blood-vessel as seen in the *second* stage of the inner gill (fig. 12), and the tortuous shapes afterwards seen in the *crests* of the *third* stage.

9.—Enlargement of the vessel connecting the afferent and efferent trunks of the inner gill.

10.—"The waning tadpole and incipient frog."

11.—View of the lungs as seen on one occasion through the back of a tadpole.

PLATE IV.

12.—Internal gill of the tadpole, in its *second* stage.

13.—Internal gill, fully developed, exhibiting the crests and vascular system.

14.—The vascular connection of the external with the incipient internal gills.

15.—Exhibits the lungs of the young frog, with the *right* lung in a state of vascular injection.

16.—The heart, systemic arteries, pulmonary arteries and veins, and lungs in the full-grown frog. In the right hand figure the heart is turned up to show the junction of the pulmonary veins, and their point of entrance into the left auricle.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY.

DESCRIPTION OF PLATES V & VI,

Illustrating E. Ray Lankester's paper on the Structure of the Tooth in *Ziphius Sowerbiensis* (*Micropteron Sowerbiensis*, Eschricht), and on some Fossil Cetacean Teeth.

PLATE V.

Fig.

1.—Part of a transverse section of the upper part of the tooth of *Micropteron Sowerbiensis*, in the University Museum, Oxford. *c*, Cement; *g*, globular matter, with interglobular spaces; *d*, dentine; *o-d*, osteo-dentine.

2.—Portion of another section, a little nearer the base; letters as before.

3.—Cement of the same tooth; natural size of lacunæ, $\frac{1}{500}$th—$\frac{1}{1200}$th of an inch. *a*, Small longitudinal lacunæ.

4.—Dentinal tubules emerging from the opaque globular mass, with its interglobular spaces or dentinal cells.

PLATE VI.

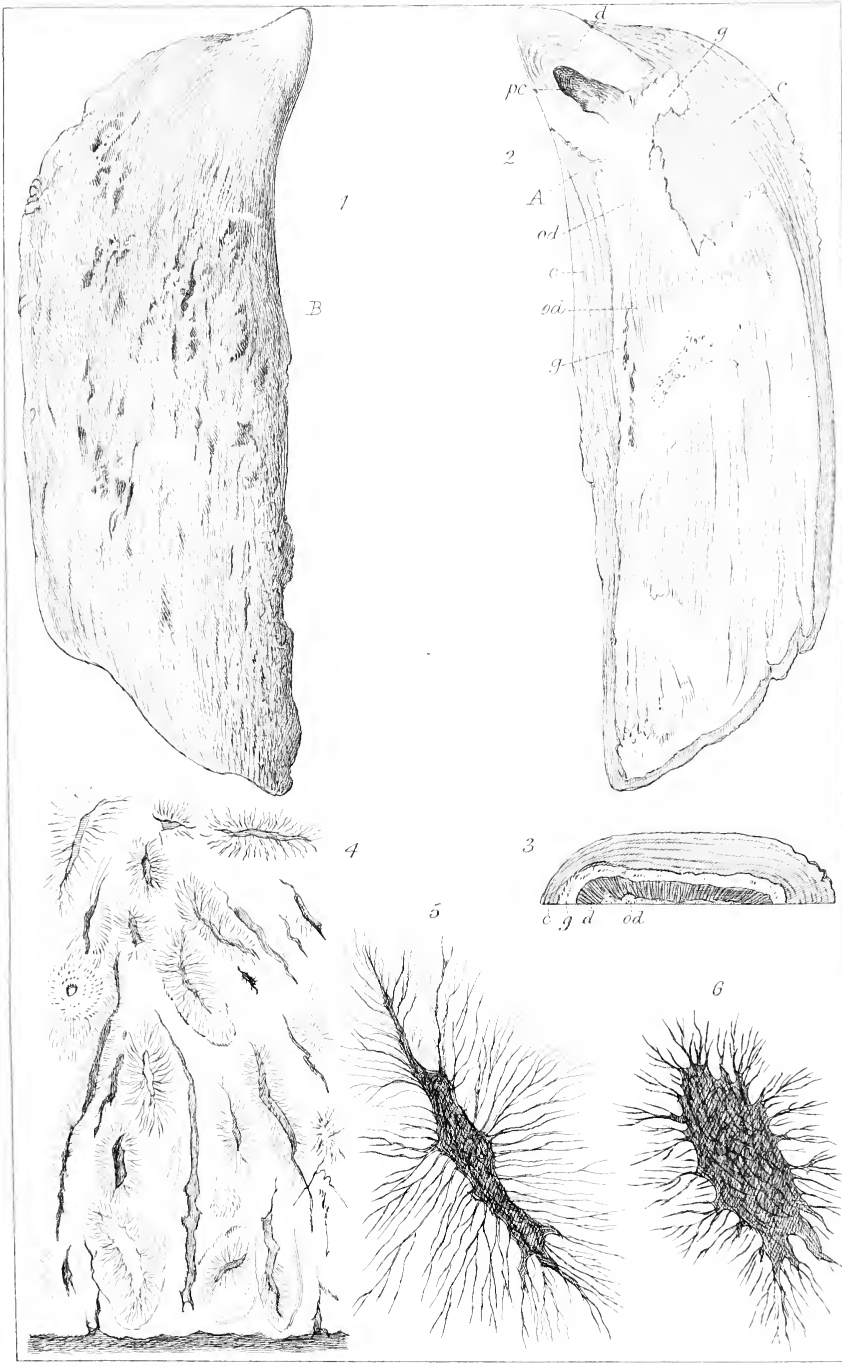
1.—Tooth of *Micropteron Sowerbiensis*, natural size. A B, Line of the alveolus.

2.—Longitudinal section of the same. A, Line of microscopic sections; *d*, dentine; *o-d*, osteo-dentine; *g*, globular matter; *c*, cement.

3.—Half of a transverse section; letters as before.

4.—Osteo-dentine of a fossil tooth.

5, 6.—Osteo-dentinal cavities of fig. 4 in section; natural size, $\frac{1}{25}$th—$\frac{1}{120}$th inch.



E.R. Lankester del. Tuffen West sc.

W West imp.

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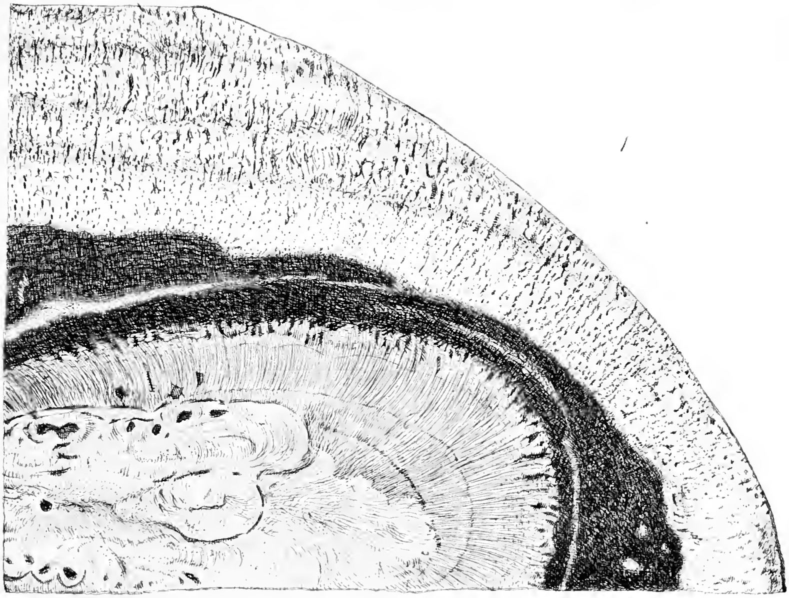

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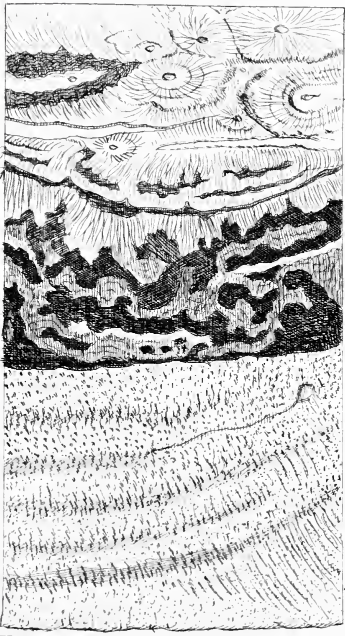

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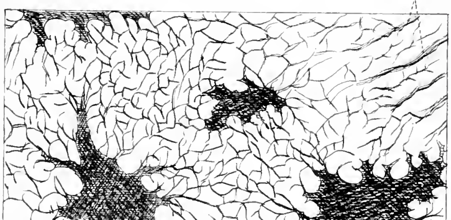

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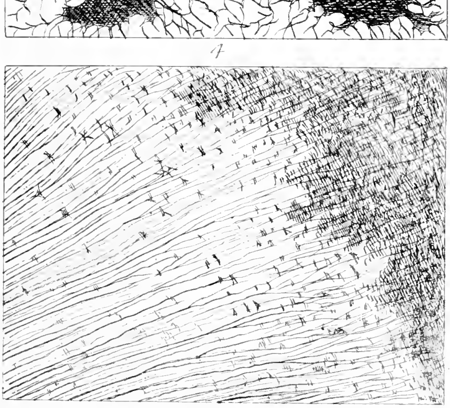


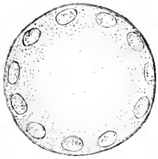
E.R.L. & T.W. del. T. West sc.

W. West imp.

OVARIAN OVA.—STICKLEBACK.

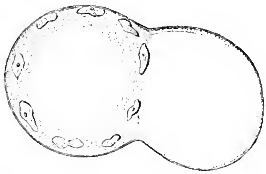
SHOWING GERMINAL MATTER COLOURED WITH CARMINE.

Fig. 1.



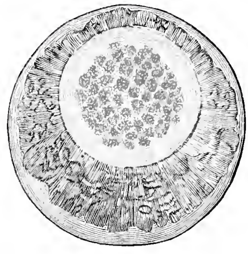
Free germinal vesicle, its spots unchanged. After Dr. Ransom.

Fig. 2.



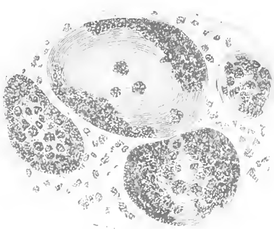
Free germinal vesicle, of which the wall is raised at one part, showing the 'colloid mass.' After Dr Ransom.

Fig. 3.



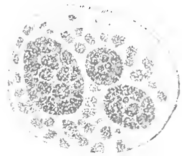
Ovarian ovum, with large germinal vesicle. The yolk cracked and forming fissures radiating outwards. × 100.

Fig. 4.



Germinal spots from a ruptured germinal vesicle. × 550. The ovum was $\frac{1}{25}$ inch in diameter, and the germinal vesicle $\frac{1}{250}$.

Fig. 5.

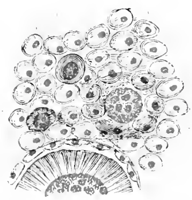


Germinal spots, with new centres (nucleoli) within them, and more minute germinal spots in the intervals between them. × 550.

Fig. 6.

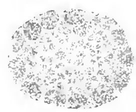
Germinal vesicle, showing germinal spots all over the surface. × 215.

Fig. 7.



Most minute ovarian ova undergoing development, in the midst of a delicate tissue with cells. × 550.

Fig. 8.

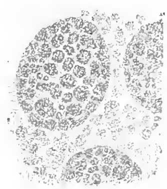


Supposed section of germinal vesicle, showing germinal matter throughout.

Fig. 9.

Globules of yolk, with germinal matter (nuclei). Advanced ovarian ovum × 215.

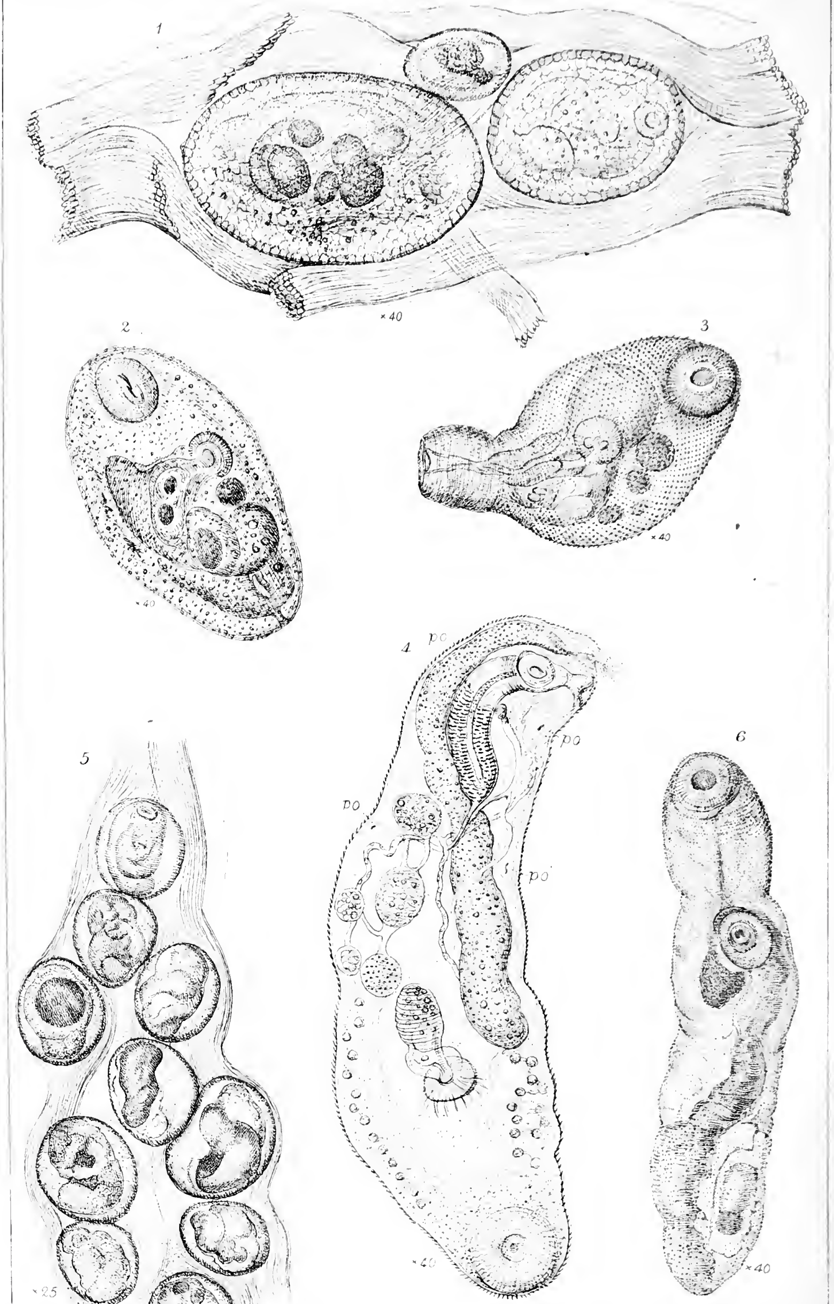
Fig. 10.



Extremely small germinal spots. × 1700.

1000th inch |___| × 215.
,, ,, |___________| × 550.
,, ,, |______________________________| × 1700.

L. S. B., April, 1867.]



Dr Maddox del. ad phot. Tuffen West sc.

W. West imp.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY.

DESCRIPTION OF PLATE VIII,

Illustrating Mr. Maddox's paper on a Parasite from Caudal Nerves of the Haddock.

Fig.

1.—A portion of nerve with cysts; the displacement of the nerve-fibres is well shown.

2.—One of the parasites contracted and partially covered with cyst contents.

3.—Parasite released from a cyst and in a state of progression; the integument is seen to be covered with short spines, beautifully arranged.

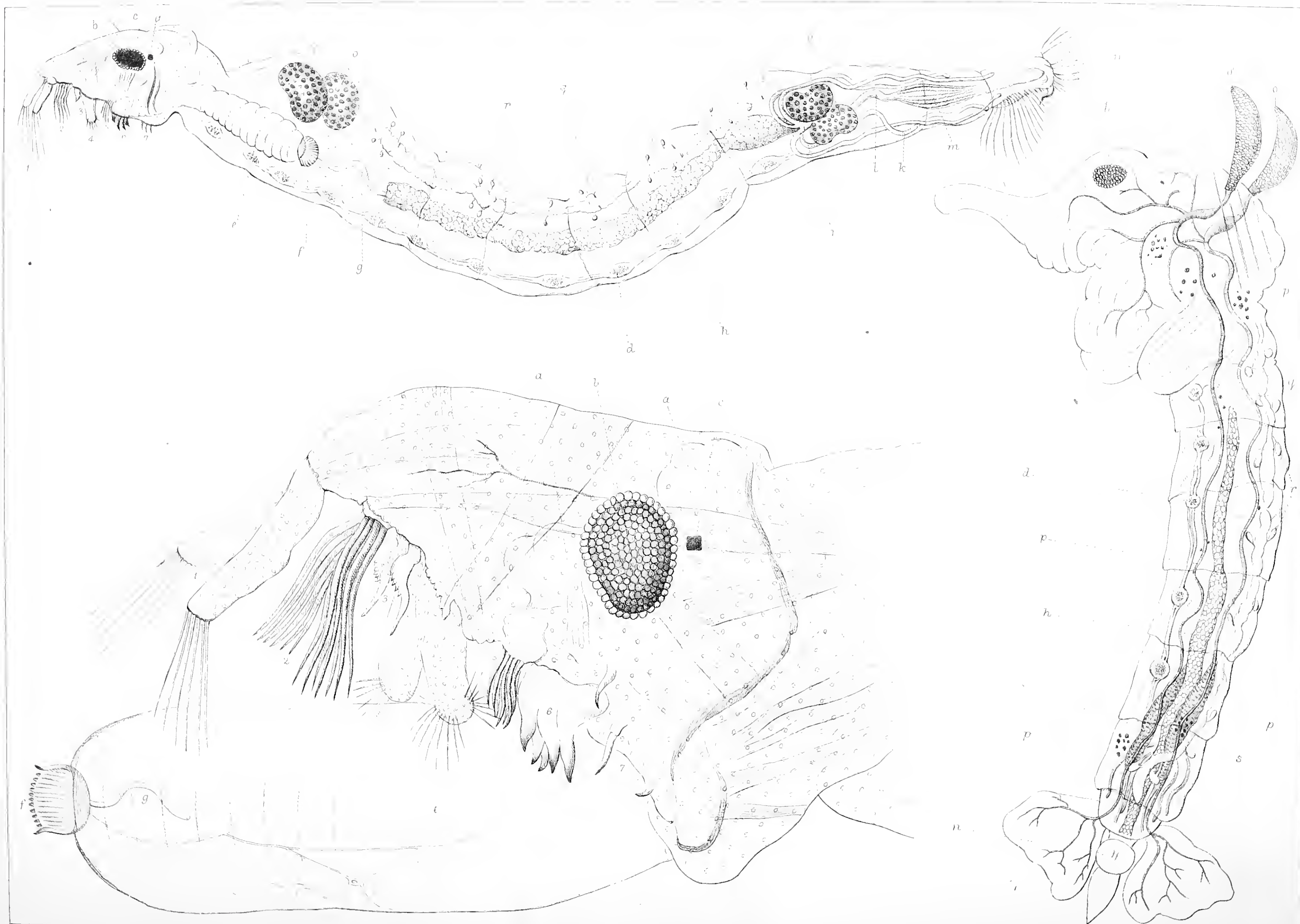
4.—Parasite, dorsal aspect. P O, P O′, p o, p o′ = vibratile organs, probably connected with a water-vascular system.

These four figures × 40 diameters.

5.—Portion of caudal nerve packed with cysts. × 25 diameters.

6.—Parasite released from a cyst. × 40 diameters.

Figs. 5, 6, from photographs; the former obtained in seven seconds by artificial illumination with magnesium wire, the latter in fifteen minutes by paraffin lamp-light.



T. Rymer Jones del. Tuffen West sc. W. West, imp.

TRANSACTIONS OF THE ROYAL MICROSCOPICAL SOCIETY.

DESCRIPTION OF PLATE IX,

Illustrating Professor Rymer Jones's paper on the Structure and Metamorphosis of the Larva of *Corethra plumicornis*.

Fig.

1.—Larva of *Corethra plumicornis* representing the general arrangement of the viscera, and the position of the air-vesicles, sketched under the compressor, and magnified sixty diameters.

2.—Pupa of *Corethra plumicornis* as seen under the compressor shortly after its change from the larva condition. The air-vesicles have disappeared, the anterior pair having been converted into the respiratory tubes—0′ 0′. The now largely developed tracheal system seems to be entirely derived from the disruption of the two pairs of air-vesicles, the lacerated remains of which may be seen scattered throughout the cavity of the body and adhering in the shape of small patches of black pigment to the walls of the lateral tracheæ. The ganglionic nervous system of the dorsal vessel is largely developed, and the masses composing the ventral series of ganglia of great proportionate dimensions. From the opacity of the thoracic region it was impossible to see whether any changes had occurred in the condition of the proventriculus and muscular gizzard.

3.—Represents the head and apparatus of jaws of the larva of *Corethra plumicornis* as seen under the compressor, magnified about 200 diameters. The proventriculus is inverted and protruded from the mouth together with the muscular gizzard *f*, and the narrow tube *g*, whereby the latter viscus originally communicated with the ventricular portion of the alimentary canal; a nervous plexus, and a few ganglionic centres are seen in the muscular walls of the proventriculus. The same letters of reference indicate corresponding parts in all the three figures.

1.—1st pair of oral appendages.

2.—2nd pair of ditto

3 —3rd pair of ditto

4.—4th pair of ditto

5.—5th pair of ditto

6.—6th pair of oral appendages.

7.—Auxiliary spikes, situated beneath the mouth.

a.—Encephalic masses of the nervous system.

b.—Conglomeration of eyes.

c.—Ocellus detached from the principal organs of vision.

d.—Ventral chain of nervous ganglia.

e.—Proventriculus.

f.—Gizzard.

g.—Slender canal leading from the gizzard to

h.—Ventricular portion of alimentary canal.

i.—Pylorus and insertion of

k.—Hepatic cæcal tubes.

l.—Small intestine.

m.—Large intestine.

n.—Anal aperture.

o.—Air-vesicles, subsequently converted into O′ dorsal respiratory tubes, and

p.—Tracheal system.

q.—Dorsal vessel, to the different compartments of which are appended

r.—Nervous ganglia of the heart.

s.—Rudimentary ovaries.

t.—Nerves and ganglionic masses in the muscular walls of the proventriculus.

Date Due