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THE JOURNAL

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ABBE'S TEST OF APLANATISM, AND A SIMPLE APERTOMETER DERIVED THEREFROM.

By Frederic J. Cheshire, F.R.M.S.

(*Read June 19th*, 1903.)

The Abbe-Helmholtz sine-law expresses, as is well known, the necessary and sufficient condition for the production, by the different zones of a wide-angle optical system, of equal-sized images of an indefinitely small object on the axis of the system, and in a plane at right angles to that axis.

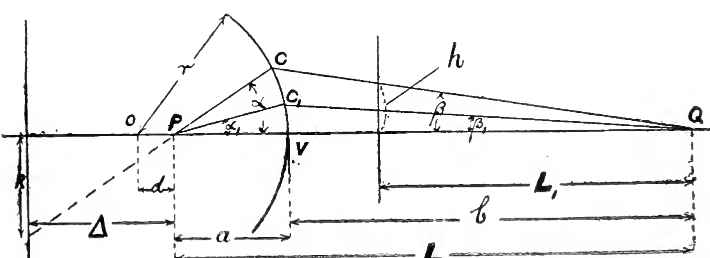


Fig. 1.—Diagram of Aplanatic System.

Let P and Q be a pair of conjugate and aplanatic foci, on the axis of a wide-angle optical system, then the sine-law states that the sine of the angle α, which any ray makes with the axis in passing from the point P, must bear a constant ratio to the sine of the angle β, which the corresponding conjugate ray makes with the axis, when passing through the point Q. If the points P and Q be immersed in media with refractive indices

μ and μ_1, respectively, and if M equal the magnification produced by the system, the sine-law fully stated takes the form—

$$\frac{\sin \alpha}{\sin \beta} = \text{M} \frac{\mu_1}{\mu} = \text{K (a constant)}^* \quad . \quad . \quad . \quad . \quad (1)$$

In general, a ray, passing from the point P to the point Q, and undergoing a total deviation equal to the sum of the angles α and β, would suffer, in any practical optical system, many refractions, which, however, it is not necessary for our purpose to consider. All that we are concerned with is the total deviation, and this may be looked upon as though produced by a single refraction only, at the point C, obtained by producing the incident ray and its conjugate ray until they meet as shown. To the point C the name *chief* point has been given by Professor S. P. Thompson.

In a similar way, let C_1 be the point of intersection of a second pair of rays, making angles α_1 and β_1, respectively, with the axis. Then from simple geometry we have—

$$\frac{\sin \alpha}{\sin \beta} = \frac{\text{C Q}}{\text{C P}},$$

and—

$$\frac{\sin \alpha_1}{\sin \beta_1} = \frac{\text{C}_1 \text{Q}}{\text{C}_1 \text{P}};$$

and, since the ratio of the sines is constant,—

$$\frac{\text{C Q}}{\text{C P}} = \frac{\text{C}_1 \text{Q}}{\text{C}_1 \text{P}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and so for any pair of rays. It follows from the constancy of this ratio and the fixed distance P Q, that the chief points must lie upon a curve, which is the locus of a triangle constructed on a given base and with a constant ratio between the lengths of its other two sides. This locus is a circle,† with its centre on the axis P Q, and cutting it, say, at V. Let P V $= a$, and V Q $= b$; then r, the radius of this circle, is obtained from—

$$r = \frac{a \, . \, b}{b - a}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and, if a be less than b, the centre O of this circle is at a point on the axis such that we have for d the distance P O:

$$d = \frac{a^2}{b - a}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

We have thus arrived at the following important result:—*In*

* See *Heath's Geometrical Optics*, 1887, p. 255.

† Briggs and Bryan, *Co-ordinate Geometry*, 3rd edition, Part I., p. 186.

*any wide-angle optical system, which satisfies the sine-condition for a pair of conjugate foci, the equivalent refracting surface for these foci is a part of a sphere.**

In the case of the microscope objective, with which we are principally concerned, the image is always formed in air, hence $\mu_1 = 1$ in equation 1, and for a pair of conjugate rays meeting in the vertex V,—

$$\frac{b}{a} = \frac{\sin \alpha}{\sin \beta} = \frac{\mu}{M} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Putting L for $a + b$, the distance P Q, and M/μ for b/a, we can write equation 3 in the form—

$$r = \frac{\mu L M}{M^2 - \mu^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

and equation 4 as—

$$d = \frac{\mu^2 L}{M^2 - \mu^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

An example will show the use and application of the last two equations. A dry lens, of a focal length of 15·8 mm., gave in a plane 205 mm. above the plane of the object, on the stage of the microscope, a magnification of 11·5. Substituting these values in equation 6, and remembering that $\mu = 1$ in this case, we have, for the value of the radius of the equivalent refracting spherical surface—

$$r = \frac{205 \times 11{\cdot}5}{(11{\cdot}5)^2 - 1} = 18 \text{ mm.}$$

And obviously, so long as $a < b$, this surface must be convex on its upper surface. By substituting in equation 7, we get for the distance d of the centre of curvature O below the aplanatic focus P,—

$$d = \frac{205}{(11{\cdot}5)^2 - 1} = 1{\cdot}6 \text{ mm.};$$

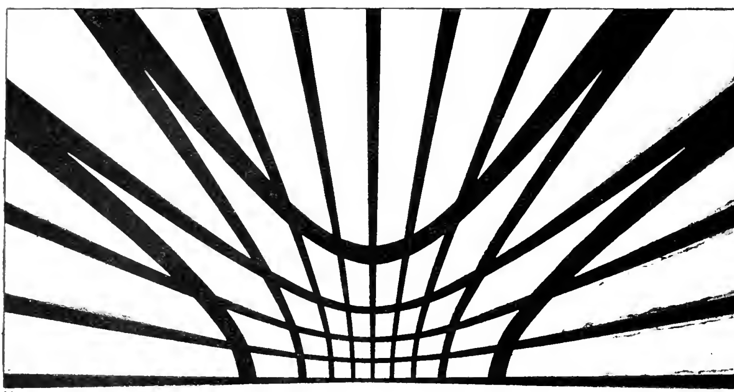
and again, so long as $a < b$, O is below P. Thus, in a very simple and practical way, it is possible to determine for any aplanatic system, from the distance between the aplanatic foci

* This proposition is well known for the particular case in which one of the aplanatic foci is at infinity, as for a telescope object-glass; but, so far as I can discover, the general proof given above, simple though it is, and important as it appears to be, does not occur in any English book on the subject. Dr. von Rohr, of Jena, has, however, since the reading of the paper, drawn my attention to an article by Mittenzwei in the *Jahrbuch für Photographie*, 1888, pp. 317-20, which clearly anticipates my proposition.

and the magnification, the radius of curvature of the equivalent refracting surface and the point at which the latter cuts the axis.

Abbe's Test of Aplanatism.—In the year 1879,* Abbe, wishing to ascertain to what extent objectives, made before the formulation of the sine-law, satisfied that law, invented the test diagram shown by Fig. 2. The problem was to find the nature of the curves, which, drawn upon a flat surface placed normal to the axis of a microscope and at a given distance below the lower focus of the objective to be tested, should project into the upper focal plane of the objective as a rectangular network of equi-thick

Fig. 2.



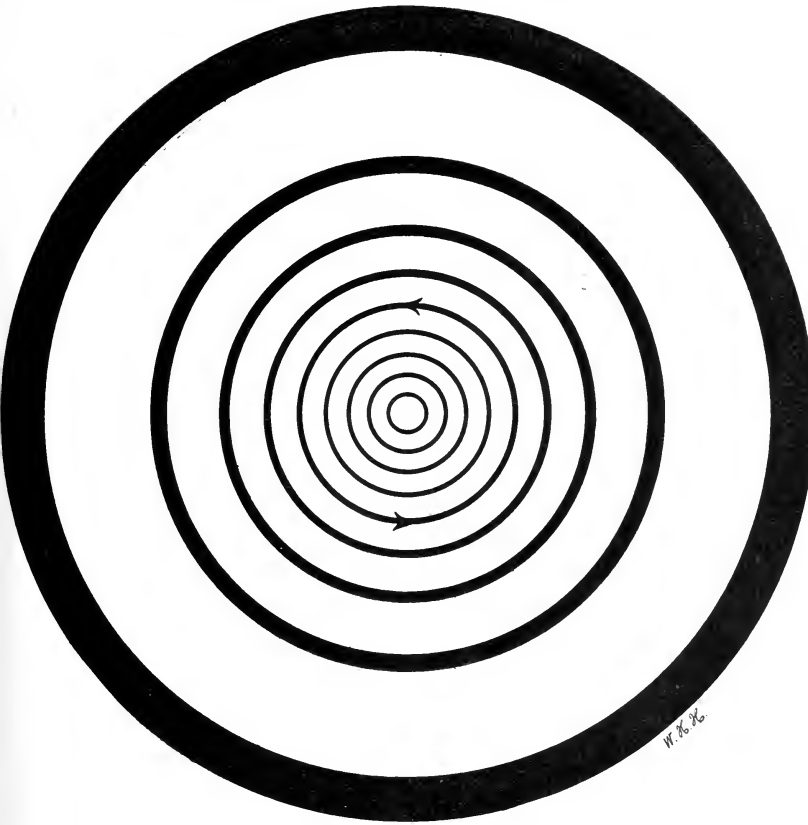
ABBE'S TEST FOR APLANATISM
($\Delta = 12{\cdot}5$ mm.)

and equi-distant parallel straight lines, in the event of the sine-law being fulfilled. These curves, by a method to be subsequently described, can be shown to be hyperbolas. To use the diagram, it should be placed upon the stage of the microscope, and the object to be tested focussed upon the middle point of the bottom line. The body of the microscope, carrying the objective with it, should then be racked back through 12·5 mm. Upon removing the eye-piece and looking down the tube, one-half of the back of the objective will be found to be occupied by an image of the diagram, in the form of the net-work referred to, if the objective is a good one.

* See *Gesammelte Abhandlungen von Ernst Abbe*, p. 226.

It occurred to the author of this paper that Abbe's test might be modified to project into the upper focal plane of an aplanatic objective to be tested for numerical aperture—*not* for aplanatism—

Fig. 3.



CHESHIRE'S APERTOMETER.

($\Delta = 25$ mm.)

a series of equi-thick equi-distant concentric circles, each of which should correspond to a definite and predetermined N.A. The result is shown by Fig. 3.

Theory of the New Apertometer.—Returning to Fig. 1, let us consider the ray PCQ intersecting the second (back) principal focal plane of the objective, at a distance h from the axis; and let the distance of this plane from the point $Q = L_1$. Then, Q being in air, we have from equation 5,—

$$\sin \beta = \frac{\mu \sin \alpha}{M} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

Since the angle β, in a microscope system, never exceeds a few degrees, its tangent may be taken as equal to its sine; hence—

$$\sin \beta = \frac{h}{L_1}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

and the magnification at Q is equal to the distance L_1, divided by the back focal length of the objective system; or—

$$M = \frac{L_1}{f} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Combining equations 9 and 10 we obtain—

$$\sin \beta = \frac{h}{Mf};$$

and substituting in equation 8—

$$\frac{h}{f} = \mu \sin \alpha = \text{N.A.}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

a well-known result which tells us that for objectives of a given focal length their N.A.'s vary directly as the effective diameters in the upper focal planes. Imagine now the point P in air ($\mu = 1$), and the ray CP produced backwards until it intersects, at a distance R from the axis, a plane normal to the axis, and at a distance $\triangle$ from the aplanatic focus P; and further, let us suppose that rays can only enter the system through a very small stop at P. Then to find the radius R of a circle which, placed normal to the axis and at a distance $\triangle$ from the aplanatic point P, shall project so as to completely fill the effective opening in the upper focal plane of an objective with a given N.A., we have only to remember that the N.A. = $\sin \alpha$, and that $R/\triangle = \tan \alpha$, to obtain the desired equation,—

$$R = \triangle \cdot \tan (\sin^{-1} \text{N.A.}) \quad . \quad . \quad . \quad . \quad . \quad (12)$$

A circle drawn with such a radius, and placed at the distance $\triangle$, will fill any objective with the given N.A., no matter what its focal length may be.

Agreeing, then, upon some convenient value for $\triangle$, it is a very simple matter to calculate the various values of R for a series of circles which shall correspond, in the way described, to N.A.'s of 0·1, 0·2, 0·3, and so on. These circles would, as is obvious from a consideration of equation 11, project into the upper focal plane of any objective as a number of equi-distant, concentric circles, but they would not, in general, be of equal thickness. To secure this object, it is necessary to calculate, for each circle on the diagram, a thickness which corresponds to an equal increment of the N.A. Thus, instead of calculating the radius of a circle to project as equivalent to a N.A. of 0·5, say, it is better to calculate for 0·49 and 0·51, draw the two circles, and blacken the space between them. The difference between the N.A. represented by the circle of the inner edge of any line and that represented by the circle of the outer edge is thus in every case equal to 0·02 N.A. The following table has been calculated in this way for a value of $\triangle = 1$, and for N.A.'s commencing at 0·1 and proceeding by steps of 0·1 to 0·9.

	R.	N.A.
1st Circle	{0·09 {0·11	0·09 0·11
2nd "	{0·19 {0·22	0·19 0·21
3rd "	{0·30 {0·33	0·29 0·31
4th "	{0·42 {0·45	0·39 0·41
5th "	{0·56 {0·59	0·49 0·51
6th "	{0·73 {0·77	0·59 0·61
7th "	{0·96 {1·01	0·69 0·71
8th "	{1·29 {1·38	0·79 0·81
9th "	{1·95 {2·19	0·89 0·91

To use this table for the calculation of the radii of the N.A. circles for any other value of $\triangle$, it is only necessary to remember that R must be read in the unit selected for $\triangle$, and must be multiplied by it. Thus if $\triangle$ be taken as 2 inches, each number under R must be multiplied by 2, to obtain the desired radii in inches. Similarly, if $\triangle$ be taken in centimetres, R must be read as centimetres. Should the apertometer, when made, be too large to be accommodated on the stage of the microscope, with its centre in the axis of the instrument, it should be cut down on one side until it is possible to do so.

In using this apertometer it is necessary to observe the image in the upper focal plane of the objective, either directly, or after it has been magnified in some way. Whatever method is adopted it is important that a small stop should be used, placed virtually at the point P, to sharply define the apex of the cone of light taken up by the objective. One of the following methods may be employed:—

1. The unassisted eye may be used, in which case the image of the eye-pupil formed by the objective serves to define the point P. Care should be taken to keep the eye fixed during the taking of a reading.

2. The observation may be made through a 2—3 mm. hole in a plate on the top of the draw-tube, replacing the ordinary eye-piece.

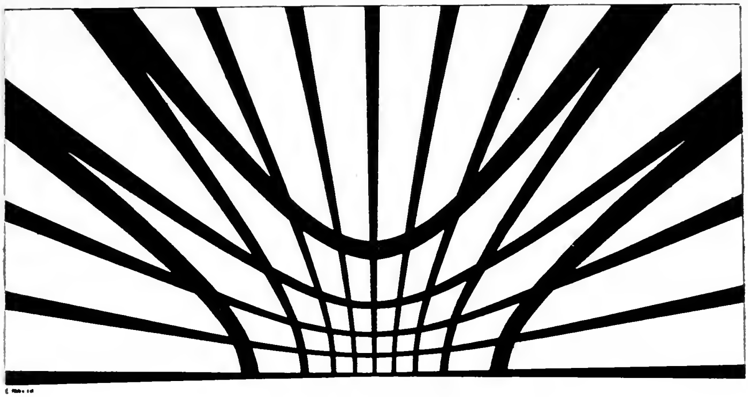
3. The bottom of the draw-tube may be fitted with a low-power lens, with a small stop near its upper focal plane—this lens forming with an eye-piece a low-power telescope.

4. By using a low-power eye-piece—the lower the better—fitted with a 2—3 mm. stop in the usual place, to form in the eye-ring an image of the image in the upper focal plane of the objective. The eye-ring may then be examined with a hand-magnifier.

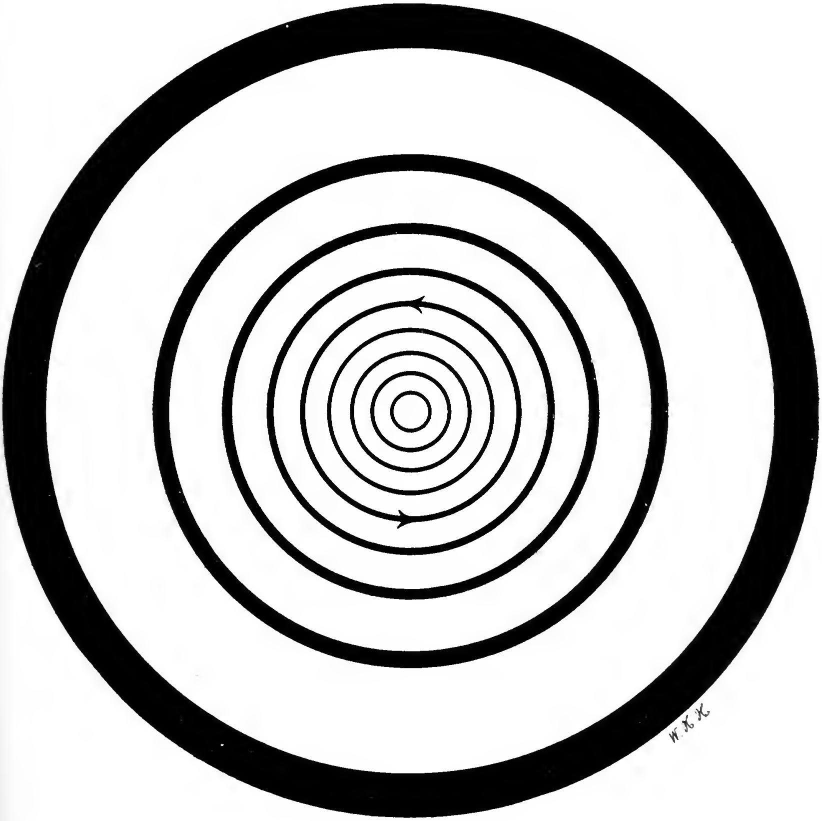
The 2nd and 4th methods will generally be found the most convenient—the first for testing low-power objectives, and the second for testing high-power ones.

[The diagrams on the loose plate accompanying this paper are intended to be cut out and used on the microscope in the way described. The apertometer disc should be placed upon the microscope stage, with its centre in the axis of the instrument, upon which the objective to be tested should be focussed. Then, upon racking back the body through 25 mm., and removing the eye-piece, the N.A. of the objective will be found projected in its upper focal plane.]

Issued with Journal Q.M.C., April 1904.



ABBE'S TEST FOR APLANATISM
($\Delta = 12{\cdot}5$ mm.)



CHESHIRE'S APERTOMETER.
($\Delta = 25$ mm.)

THE SPIDERS OF THE SUB-FAMILY ERIGONINAE.

By Frank P. Smith.

(*Read October 16th*, 1903.)

Plate 1.

A retrospective glance at the published work of the Quekett Club will be sufficient to convince one that, whereas certain classes of animals and plants have received no small amount of attention, several groups of equally interesting organisms have been for some reason or other almost completely neglected.

Notwithstanding the fact that many members of this Club are at present engaged upon special research work in other directions, I think it may be useful to bring forward a few notes upon one of these neglected groups, namely the Araneae or Spiders. It is quite possible that one or two members may be in quest of a subject upon which to bestow a portion of their leisure, and even if this be not so I think I may claim as an extenuation that there are at least many spider-slides in the possession of the Club and in private collections which might be rendered more interesting by a few remarks upon the structure and habits of the creatures from which they were prepared.

Before further discussing the study of Araneae I ought, perhaps, to justify the position I am taking up that this branch of science is one which actually falls within the province of a society devoted to microscopical investigation. It is obviously a matter of great difficulty to draw a hard and fast line between what might be termed a microscopical and a non-microscopical study, for in every branch of research work the microscope not only plays a most momentous part, but must be regarded as a *sine qua non* by the serious investigator. It appears, however, only reasonable to suggest that a group, the greater part of whose representatives absolutely defy identification by the unaided eye, must be regarded as microscopic, and, basing our observations upon this assumption, let us consider the suitability of the various creatures included in the order Araneae as candidates for microscopical investigation.

In Great Britain we have nearly 550 known species of spiders, varying in body length from 1 mm. to 20 mm., and of these certainly not more than 20 per cent. can be satisfactorily identified without microscopical aid. Moreover, several genera of large spiders, *Aranea* for example, are not by any means satisfactory as at present limited, and a complete revision of these groups is an urgent necessity. It is fairly certain that any sub-division will have to be founded upon somewhat obscure characters, and a vast field of work is here open to any enterprising student of minute nature who can boast of moderate efficiency in the manipulation of the microscope and dissecting-knife. It must be distinctly understood that I have not the slightest intention of advocating attention to the Spiders simply as a means of adding slides to our cabinets, and although I shall indicate methods by which certain portions of these creatures may be prepared as permanent objects, such preparations should be regarded only as means to an end—as marginal notes, so to speak, to the main work of the studious arachnologist.

For an explanation of the neglect of this order by students of nature, we have, to my mind, not far to seek. We are constantly being brought into contact with the expression, "a happy medium"; but there are two sides to every question, and we undoubtedly have in many cases an "unhappy medium" in the form of an object which, hovering on the boundary between two conditions, fails to find favour either upon one side or the other. Our neglected spiders must, I fear, be placed in this category. Some of them which are too large to mount upon an ordinary slide still require, as already stated, microscopical examination for their indentification, and even those forms whose small size permits of their being flattened out in balsam, at once become unrecognisable when so treated. Specimens, also, cannot be preserved by desiccation, as in the case of the lepidoptera and coleoptera, and cannot, consequently, be placed in neat series in cabinets. We might briefly summarise the so-called difficulties and drawbacks to the study of spiders as follows. The Araneae are creatures whose non-resistant integument renders "setting" upon pins or cardboard an impossibility; whose size in many cases precludes the possibility of mounting them in cells after the manner usually adopted by microscopists, thus necessitating their preservation in bottles or tubes; and yet whose minute and obscure specific and generic differences render the removal of specimens from their tubes, for purposes of microscopical examination, almost inevitable.

These drawbacks, however, are more than counter-balanced by facts, which, although at first liable to be overlooked, will appeal strongly to the embryo araneologist after a few weeks of serious work. There is no need for expensive and cumbersome appliances, no time spent (or wasted!) in setting legs at a regulation angle, no soaking or boiling in liquor potassae or corrosive acids, the whole matter being almost as simple as dealing with pond life, a class of object which has always deservedly found favour with microscopists. The advantage, too, of being able to turn a specimen under examination in different directions should never be under-estimated, the absence of such a facility being undoubtedly one of the most serious drawbacks to the orthodox mounted object.

Of course, I do not mean to assert that the theoretical portion of the subject is free from difficulties. Quite the reverse. But the obstacles which exist should be by no means insurmountable by such workers as our Club possesses; and by giving some amount of attention to these strange little creatures, we may hope to avoid any accusation of partiality based upon the fact that, whereas we have systematically studied the minute inhabitants of the deepest oceans and the fossil organisms of the sedimentary rocks from the most remote regions of the globe, many of the denizens of our own gardens, fields, and forests have been consigned to oblivion, for no other reason than that they occupy a position somewhere between the microscopical and non-microscopical spheres of research. The Dublin Microscopical Club has been responsible for some valuable araneological work; why should not we be likewise?

Before examining our spider we must catch it, and a few brief remarks upon the collection of specimens may therefore be of use. The requisite apparatus is of a most unassuming type, and all the necessary articles could no doubt be found amongst the paraphernalia of the average microscopist. An umbrella, the older the better, a newspaper, a pair of forceps, a few dry tubes of various sizes, a bottle of methylated spirit, and a note-book; these for all ordinary purposes conclude our list. I might have included a strong net for "sweeping" low herbage, but personally I deprecate this somewhat wholesale and promiscuous method of collecting; for not only are the captures exposed to considerable risk of damage by reason of the struggling mass of insects which accumulates at the bottom of the net, but any notes as to habitat or snare are entirely precluded.

The umbrella is held in an inverted position under trees, which are beaten or shaken to dislodge some, at any rate, of their tenants. A few species cling to the foliage with such pertinacity that nothing short of close search will enable the collector to obtain them. The newspaper is spread upon the ground whilst tufts of grass or low herbage are being violently shaken or torn to pieces above it. This method is, as a rule, especially productive, yielding a rich harvest of the more minute forms, chiefly of the family Linyphiidae. The dry tubes are used for obtaining species capable of rapid gradatorial progression, the specimens being hustled by means of one hand into the tube held by the other, and the opening then promptly closed. The minute species of Erigoninae, with which I wish to deal in the present paper, are most easily captured by means of a wetted finger, being thence transferred to the spirit-bottle. Further information on collecting may be obtained from the Rev. O. P.

Cambridge's *Spiders of Dorset*, or from my own papers in the *Essex Naturalist*, December 1902 and *Nature Study*, March 1904.

The most useful method, generally, of examining a spider is the following. A pomade-pot lid is nearly filled with methylated spirit, and the specimen under observation placed in it. The depth of the spirit should be sufficient to entirely submerge the object, which is then examined by reflected light. For ordinary araneological work no objectives will, as a rule, be required higher than a quarter-inch, the two-inch and one-inch being perhaps the most generally useful. It occasionally behoves the arachnologist, desirous of discerning the exact form of some obscure appendage, to distort various structures by means of potash and pressure; but this method must be treated as the exception, and not the rule. The legs and palpi of the smaller spiders are usually sufficiently transparent to be mounted in Deane's medium, after a few weeks in glycerine, without any alkaline treatment and, thus prepared, are very suitable for examination with dark-ground illumination. The form of the caput, as seen either in profile, from above, or from the front, is of great importance for purposes of identification and comparison, but for this purpose the required portion will have to be cut from the body and mounted in a cell of alcohol. In the few preparations of this kind which I have made, a loose mass of cotton wool was placed in the cell—this keeping the object in position against the cover-glass, and also preventing its moving from the centre. Several cements have been recommended for sealing spirit-mounts (*e.g.* see *Journal of the Quekett Microscopical Club*, Ser. II., Vol. VI., p. 149); and although the student of minute spiders may seldom desire to prepare permanent slides of his specimens, it is as well to be acquainted with the technical details of the process in case necessity should arise.

For the storage of specimens I think the following method is unrivalled for simplicity, neatness, compactness, and economy. A wide-mouthed bottle of about four ounces capacity is taken, a number of tubes two inches in length and about three-eighths of an inch in diameter being ranged round the inside, and kept against the glass by a central plug of cotton wool. The bottle is nearly filled with methylated spirit, so as to completely submerge the tubes, each of which is separately plugged with wool. The labels, written either with pencil or Indian ink, are dropped in the tubes with the spiders. To give some idea of how much space should be allowed, I might say that the sub-family Erigoninae, with which we are at present chiefly concerned, contains about 120 species, all of which could be satisfactorily stored in tubes of the above-mentioned size.

The spiders included in the family Linyphiidae, to which the Erigoninae belong, are all of a small or moderately small size, amongst them being the most minute representatives of the Araneae. The eyes are normally eight in number, arranged in two transverse rows; but one or more pairs may be atrophied, and even the whole of these organs may be absent. The form of the caput in the male varies to a surprising extent in different species, but, with a few exceptions, that of the female is quite normal. The legs are more or less furnished with spines, but in many cases these are very small, and often there is only one upon the tibia of each leg, the other joints being quite devoid of them. In addition to these spines and the ordinary hairs, the legs are sparsely furnished with minute organs, which I propose to denominate *sensory setae.* These peculiar structures are described and figured by F. Dahl,* who believes them to be organs of hearing. W. Wagner,† however, gives it as his opinion that they are more probably connected with some other sense, and suggests that by their aid the spider may be enabled to prognosticate atmospheric disturbances. Personally, I am inclined to ascribe to them acoustic properties, but I do not feel justified in expressing any strong opinion upon the matter until further opportunities for investigation shall have cleared up some of the difficulties with which at present the subject is beset. For the benefit, however, of any one who may be anxious to aid in the unravelling of one of the many mysteries of spider structure,

* *Arch. mikr. anat.*, xxiv., pp. 1-10. Translation in *Ann. Mag. Nat. Hist.*, Ser. V., vol. xiv., pp. 329-37.

† *Bull. Soc. Imp. Nat.*, Moscow, 1888, pp. 119-34.

I may, perhaps, be permitted to make a few remarks upon the minute organs in question, especially as their arrangement has been recently used as an important character in the separation of some of the genera of Linyphiidae.

Viewed with a two-thirds inch objective they appear as small globular bodies, from the centre of each of which usually springs a long slender bristle. The fact that these bristles are usually much longer and more nearly at right angles with the leg than are the ordinary hairs and spines, will help to distinguish them. An increased amplification will show that the basal part of the structure—which I propose to term the *pocillum*—is goblet-shaped, and that it is to the bottom of this organ that the bristle or *seta* is fixed. That these organs play some important part in the economy of the spider I think there can be no doubt. If, for example, we take a leg from a spirit-preserved specimen of the very common *Pachygnatha degeerii*, or the larger *P. clerckii*, treat it with boiling glycerine, mount it in Deane's medium, and examine it with, say, a quarter-inch objective, we shall find, as a rule, that the contents of the leg will have greatly contracted, and that the only points at which an attachment with the integument is maintained are at the bases of these sensory setae. There is, in fact, every indication of there being an important nerve connected with each of these organs, and it is, therefore, only reasonable to suppose that they are capable of transmitting impressions of some kind to the brain; but as to the exact nature of the sensations which they are instrumental in producing, there exists at present, as already stated, very considerable doubt. That spiders possess the power of distinguishing aerial vibrations—at any rate, to some extent—there can, I think, be little doubt; but that they have anything like an accurate sense of hearing is by no means certain, although one would be naturally led to this conclusion by the knowledge that many species are capable of producing sounds by means of stridulating organs. The fact that a spider will often exhibit no signs of motion when a tuning-fork is vibrating near it, must not be taken as conclusive that the creature cannot hear. Obviously, it would be to the creature's advantage, even if it heard an approaching buzz, to remain motionless until the supposed victim absolutely touched the snare. Some species of *Aranea* which are much persecuted by fossorial wasps have been seen to drop suddenly from their snares upon the approach of their tormentors; and, by mechanically imitating the buzzing of one of these insects, I have been able to produce, although by no means invariably, a similar result.

The falces of the Linyphiidae are devoid of any basal protuberance, a very constant structure in some of the spider families; but their outer surface is furnished with a number of more or less parallel ridges, which are actuated by a point upon the palpus, no doubt for the purpose of stridulation. In some species these ridges are almost obsolete and broken up into a number of short pieces; but in most cases they are quite distinct under careful illumination and accurate focussing. In some species—for example, those of the *Walckenaera* group—the ridges are widely separated and few in number, whereas in the genus *Erigone* they are excessively fine and close together. The clypeus —*i.e.* the space between the anterior row of eyes and the front edge of the caput—is hardly ever narrower than the distance between lines tangential to the fore edges of the anterior central eyes and the hinder edges of the posterior centrals.

The family Linyphiidae, as defined by the foregoing characters, may be synomymically expressed as follows :

Linyphiidae (ad partem), Blackwall, 1861.

Theridiides (ad partem), O. P. Cambridge, 1878–81.

Argiopidae (ad partem), E. Simon, 1895, etc.

To be more concise, Blackwall's Linyphiidae consists of those species which are common to both Mr. Cambridge's Theridiides and Mr. Simon's Argiopidae, whilst my Linyphiidae is equivalent to Blackwall's, less the genus *Pachygnatha.*

The numerous species constituting the family Linyphiidae fall into two divisions, whose systematic separation, however, owing to the presence of many intermediate forms, is a matter of great difficulty. Having before us a vast and heterogeneous assemblage of creatures which have apparently developed along two divergent main lines from a common stock, it is, of course, only natural to suggest using such characters for a preliminary broad division as will separate these hypothetical lines of development. The difficulty becomes at once apparent when one considers that there are still in existence very many of the more primitive types, and the exact point at which the dividing line should be drawn becomes more or less a matter of speculation. As a natural consequence, the two sub-families thus formed, which I propose to term Linyphiinae and Erigoninae, might reasonably be regarded as somewhat conventional and ill-defined; but when one comprehends the vagueness of the boundaries which separate, for example, the Drassidae from the Clubionidae, the Sparassidae from the Philodromidae, or even the Agelenidae from the Pisauridae, it becomes at once evident that it is often absolutely necessary to employ minute and obscure structural details, and even a concensus of characteristics, in order to reduce certain motley assemblages of spiders into groups possessed at any rate of something like homogeneity.

Perhaps I might be permitted to draw for a moment upon my imagination, and to sketch a purely hypothetical spider which might reasonably be supposed to have enjoyed the distinction of having been the ancestral type of the numerous species of Linyphiidae.

The thorax would be normal, the eyes arranged somewhat as in *Pachygnatha*. The falces would be fairly powerful, each being provided with a rudimentary stridulating organ. The legs would be similar to those of *Pachygnatha*, but upon the tibia of each one would appear a tiny spine. From such a creature let us examine the process of evolution in the case of the Linyphiinae. From the very first a tendency to develop additional spines upon the legs becomes apparent, and continues with few exceptions throughout the whole series. The palpal organs of the male become vastly more complex as we advance, and the external branch of the tarsus assumes a variety of forms, such as would lead one to suppose that it fulfils some important function in connection with the reproductive mechanism. The genital aperture of the female in the higher forms usually possesses a clavus, which often attains a high state of development. The tibia of the male palpus is, however, with very few exceptions, devoid of any projection or apophysis, and the caput in that sex is almost invariably normal, resembling that of the female. The metatarsi exhibit a gradual elongation compared with the tibiae, and the whole spider shows a decided tendency to increase in size. Contrasting now the Erigoninae, we find no sign of increase in the number of spines, the single minute example upon each tibia being constant throughout the series. As in the case of the Linyphiinae, the palpal organs become more prominent and complex, but the external branch of the tarsus is never very conspicuous. The genital aperture of the female is almost invariably devoid of a clavus. The tibia of the male palpus is, with hardly an exception, provided with an apophysis, which, in the more specialised form, is often of surprising dimensions, and, the caput in this sex is nearly always more or less modified either by the elevation of a portion of its upper surface, or by the presence of post-ocular depressions. The metatarsi are normal, seldom exhibiting any tendency towards undue elongation.

The species constituting the sub-family Erigoninae may be arranged in three groups, which, although by no means sharply defined, will perhaps be of some assistance to the student.

The *Neriene* group contains a number of genera with the sternum at least as broad as long, and the elevation of the male caput, when present, so placed as to have practically no effect upon the position of the eyes. The spiders themselves are about the medium size of the Erigoninae. The genus *Stylothorax* [*Gongylidium*, Simon (in part)], contains some of the least specialised species of this group. In *S. fuscus* a slight gibbosity appears behind the eyes, which becomes more pronounced in several allied species—*S. apicatus*, for example, being furnished with a small conical projection, surmounted by a tuft of hairs. In *Erigone* and *Neriene* [*Gonatium*, Simon (in part)], there are no distinct cephalic eminences, but the whole caput is more or less raised. Allied to *Neriene* are the genera *Dicyphus* and *Hypomma*, with large oval protuberances behind the eyes.

The *Diplocephalus* group contains a large number of minute spiders, including the smallest known representatives of the order. It seems to be an offshoot from some of the more specialised forms of the *Neriene* group, and is characterised by the sternum being at least as broad as long, and by the elevation of the male caput, which is usually present, affecting to a greater or less extent the position of the eyes. Many of the species included in this group are of most grotesque form, and the variations in structure of the male caput and palpi are of great interest. The identification of the females, as in the *Neriene* group, is often a matter of great difficulty, and the surest and most reliable characteristic is, as a rule, the armature of the genital aperture. In some species of this group the abdominal integument becomes coriaceous, especially in the genus *Lophocarenum*.

The *Walckenaera* group contains a moderate number of spiders, which are, as a rule, rather large compared with the average size of the Erigoninae. The sternum is usually considerably longer than broad, the cephalo-thorax somewhat elongate, and the tibia of the male palpus furnished with prominent apophyses. The palpal tibia of the female is longer than the patella, and usually somewhat enlarged towards its extremity, and the tarsus of the palpus is, in this sex, more acuminate than in the majority of the Erigoninae. The form of the male caput varies to a remarkable degree. In the genus *Cornicularia* there is simply a small process, varying in form with the species, projecting from the centre of the ocular area. In *Walckenaera* the caput may be quite normal, or it may be remarkably modified. In *W. acuminata* we have, perhaps, the acme of eccentricity. The caput of the male is elevated in the form of a long slender curved prominence, which carries the entire ocular group. Four eyes are placed near the middle of this prominence, which is there somewhat dilated to accommodate them, the remaining four being at the apex, which is also somewhat expanded, and is ornamented with a number of minute hairs.

Detailed generic or specific descriptions of these minute arachnids would be quite out of place in this purely introductory communication, but I append drawings of a few species from the London district which will give some idea of what the collector may expect to find. Throughout nature we know that habit and structure are more or less interdependent, and it is consequently only reasonable to suppose that there are many points in the life-histories of these curious creatures which, when patiently worked out, will furnish us with an almost endless series of pleasant surprises. Although there are many little difficulties to be overcome in the study of the microscopic spiders, both in the matter of identification and also in the observance of habits, I think it is only fair to admit that there are few subjects more replete with possibilities which could be placed at the disposal of the student of microscopical nature.

Explanation of Plate 1.

Cephalo-thoraces of male Erigoninae, legs and palpi truncated.

Fig. 1. *Entelecara acuminata* (Wid.), profile.
,, 2. *Dicyphus cornutus* (Bl.), profile.
,, 3. *Cornicularia cuspidata* (Bl.), profile.
,, 4. *Diplocephalus fuscipes* (Bl.), profile.
,, 5. *Pocadicnemis pumilus* (Bl.), profile.
,, 6. *Wideria antica* (Wid.), profile.
,, 7. *Walckenaera acuminata* (Bl.), profile.
,, 8. ,, ,, (Bl.), viewed from the front.

Magnifications approximately 45 diameters.

AN OVERLOOKED POINT CONCERNING THE RESOLVING POWER OF THE MICROSCOPE.

By Julius Rheinberg, F.R.M.S.

(*Read December 18th*, 1903.)

The experiment I have the honour of showing you this evening is a modification of one shown to me by Dr. G. Johnstone Stoney, F.R.S., who, about nine years ago, made a most interesting discovery, which, whilst fitting in perfectly with theory, seems to have entirely escaped notice hitherto. It is this:—

If we have a number of equidistant lines or points, it is well known what the Numerical Aperture of the objective must be in order to resolve them, and it has been tacitly assumed that, whether the number of lines be two, three, four, or a large number, so long as the distance between the individual lines is the same, the same Numerical Aperture is needful for the purpose of distinguishing the lines from one another.

It has been left for Dr. Johnstone Stoney to demonstrate that when there are only two lines, they can be resolved with an N.A. sensibly less than that required to resolve a large number of lines the same distance apart.

The arrangement of the experiment on the table this evening, showing this, is as follows.

The object under the microscope is the 15,000 to the inch band on one of those beautifully ruled test plates by Grayson. of Melbourne. In this band, two adjacent lines happen to be somewhat longer than the other ten, as seen in Fig. 1. An 8 mm. apochromatic objective by Zeiss and a × 27 compensating eyepiece is used. Just above the objective I have an arrangement like the jaws of a spectroscope slit, which, actuated by the projecting wooden tongs, can be opened and closed symmetrically from the centre of the objective. The N.A. of the objective can thus be gradually increased or decreased in the direction at right angles to the lines. Immediately in front of the lamp flame there is a screen, with a slot in it of such width that, when the plane of the screen is focussed by the condenser on to the object in the usual manner, the slot just covers the width of the band of lines under observation. A disc with a very narrow slot in its centre is placed in the stop carrier of the condenser.

If now, whilst attention is fixed on that portion of the band where the whole of the twelve lines lie next to one another, the N.A. of the objective is gradually cut down to that point where

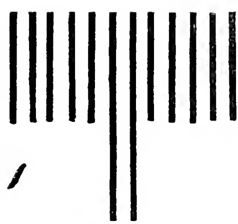


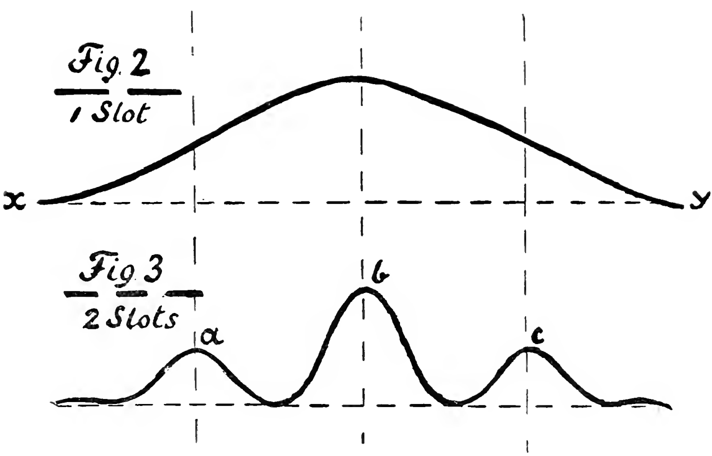
Fig 1

the band of twelve lines is just no longer visible (the lines being blurred into one another), and we then glance down at the position of the two projecting lines, we shall see that these still distinctly appear as separate lines—somewhat thickened and without sharp edges, but yet clearly resolved.

And what to many may seem remarkable is that, if we remove the eyepiece of the microscope and look down the tube, we see the direct or dioptric beam shining brightly over the centre of the objective, whereas apparently there are no flanking spectra on each side. In looking down the tube in this way, it is necessary to keep the eye perfectly central and without any shift. A simple way to do this is to hold a metal disc with a pinhole at its centre over the tube. The dummy eyepiece on the table is fitted with a metal disc like this.

Now for the explanation of the phenomenon. You all know that the condition for resolution of lines is that the angle of the objective must be sufficiently wide to grasp, besides the direct or dioptric beam of light, at least one of the beams diffracted by them. That is one of the most important generalisations of Abbe, made over thirty years ago.

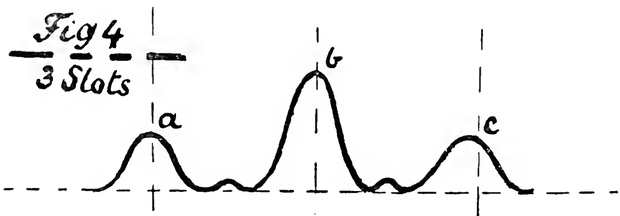
As it may not be quite clear to all as to what is meant by dioptric and diffracted beams of light, I would like, without entering into details, to point out that it simply relates to distribution of the light which has got through the object. If the object is a single narrow slot, and a parallel beam of light passes through it, it appears on the other side as a broad beam of varying intensity. The light intensity of the central part of this broad beam might be represented by the curve XY (Fig. 2).

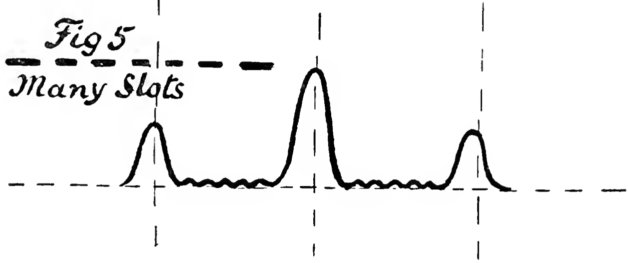


Suppose we have two slots, each as wide as the first one, and a space between them of the same width, then the distribution of the light which has passed through is different. The hump of the intensity curve we had before gets broken up into three humps, *a*, *b*, and *c* (Fig. 3), by the so-called, "interference" of light waves. The central hump *b* is known as the direct or dioptric beam, and the humps *a* and *c*, on either side of it, are called the first maxima. A better name for the central hump than either of the two above is that which Lord Rayleigh has applied to it, viz. the zero maximum.

What happens if we have three slots instead of two, and pass parallel light through them? The humps *a*, *b*, and *c* of the intensity curve will remain, but they will be steeper, and there will be a tiny negligible hump between them.

And for every extra slot we add, we get extra tiny little humps (secondary maxima) between the large humps or chief maxima *a*, *b*, and *c*. These remain in the same position whatever the number of slots, but they get steeper and steeper. After six or seven slots their sides are almost perpendicular (Fig. 5).*





Reverting to Abbe's generalisation, he showed that the condition necessary for resolution of the slots or lines was fulfilled when, and only when, the objective had a sufficiently wide angle to grasp two of these large humps or chief maxima. They bear what is known as a phase relationship to one another; in other words, the ether particles which are swinging to and fro whenever light is passing, happen to be just swinging in unison at the centre of

* Simple detailed explanations as to the formation and changes in the appearance of these maxima are given in my article, "The Common Basis of the Theories of Microscopic Vision treated without the aid of Mathematical Formulae," in the *Zeitschrift für wissenschaftliche Mikroskopie*, vol. xix. Reprints obtainable from Williams & Norgate, 14, Henrietta Street, London, W.C.

each of the humps and on corresponding portions of the same. However, into this we need not enter here, the point principally to be noted being that at least two of the light maxima must be grasped by the objective, if the lines are to be seen separately.

And now see how neatly this explains the newly observed fact. Fig. 6 shows the intensity curve (*a*) when we have the light passing through a number of lines, and (*b*) when we have it passing through two lines only; these curves are placed just below one another in the diagram. The shaded part represents the metal jaws above the objective, cutting down its N.A.

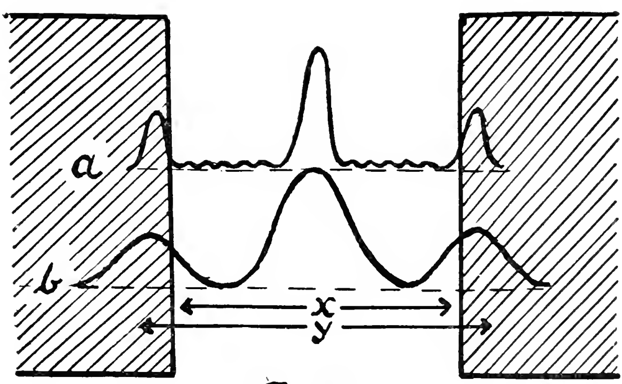


Fig 6

You will observe that when the lateral humps of the curve are quite cut off, there still remains a part of the lateral humps of the curve *b*. This it is which suffices to account for the fact that the two lines can still be seen resolved. If the reason is asked why we could not see the parts of the lateral maxima when we looked down the tube, it is simply because the light of the dioptric beam or zero maximum was so intense that it drowned the other. For we were looking at the zero maximum of twelve lines, and at but a small part of the lateral maxima of two lines. If precautions are taken so that the zero maximum observed also proceeds from two lines only, the portions of the lateral maxima can be readily seen.

The above explanations and the figures refer to the case when the resolution of the two *clear* lines is compared with the resolution of a band of *clear* lines. The explanation of the resolution of two *dark* lines as compared with a band of *dark* lines—as in the case of the Grayson ruling experiment—is analogous. The reason for treating the former case rather than the latter is that it is simpler to explain, and it illustrates the principle just as well.

It is a matter worthy of particular note that the new fact concerning resolution was not first discovered and then explained. In this case Dr. Johnstone Stoney first reasoned the matter out many years ago and then made the experiment, testing the result when Grayson's rulings became available. It is a striking example of the way in which the Abbe diffraction theory may be turned to account.

A further point is this:—According to theory, the distance apart of the lines in the image must vary inversely as the distance apart of the maxima in the intensity curve. But when we cover up the greater portion of the lateral maxima in the curve *b*, the distance between what remains (X, Fig. 6) is less than the distance between their brightest portions had they been uncovered (Y, Fig. 6). Therefore we ought to expect the lines to appear farther apart in the first case than in the last. And this may, under favourable conditions, be shown experimentally.*

There are certain interesting problems which it seems to me the newly observed fact may materially assist to clear up. Not the least of these is the question as to how far one part of an object influences the formation of the image of another part. This is a question on which differences of opinion still exist amongst those who have occupied themselves with the problems of microscopic optics, and one which is of great importance because it assists in determining to what degree of approximation the image of an object may be made to faithfully depict the structure of the object.

* It may be in place to mention that the only difference between my arrangement of the experiments and those of Dr. Johnstone Stoney is that he arranged for showing them with oblique light, using two maxima only, whilst I have preferred to make them with axial light, using three maxima.

Dr. Johnstone Stoney's experiment shows in the most conclusive manner that, *under the conditions in which the experiment is made,* —viz. with a narrow beam or cone of light—the one part of the object markedly influences the image of another part. The next question therefore is, can the effect be eliminated if we use a wide cone and critical illumination? We have to test the point experimentally to see whether under the altered conditions the resolution of the two lines will outlast that of the twelve-line band, or whether they will disappear together. I have not yet been able to satisfy myself as to the result. Some preliminary trials clearly showed the effect to be much less marked when using a wide cone of light, but it was still to be perceived. Evidence on this point from microscopists accustomed to work with critical illumination would be valuable.

In conclusion I would say that it is the usefulness of the results to which a careful study of the newly demonstrated fact may lead that must be my apology for having detained you so long in discussing and explaining an intrinsically trivial matter; it will be borne in mind, however, that it is only by close attention to little things like this that the complicated questions connected with microscopic vision can be brought a step forward.

I am sure it will interest you if I quote a few words received from Dr. Johnstone Stoney this morning. I had sent him the MS. of my paper to make sure that my statements regarding himself were correct, and he says:—

"I have suggested two corrections as to dates. It was in the end of 1893 or in 1894 that I discovered the new resolution of light into undulations of flat wavelets, and one of the first results I got out by it was that a pair of lines, or a pair of dots, should be resolved by an objective of less aperture than that required for the resolution of a ruling of lines or a row of dots equally spaced, and that, when so resolved, the spacing of the pair of lines should appear to be greater than that of the ruling. This I got out by the theorem in reversal represented graphically by your Fig. 6.

"So far as I know, until my application of this principle of reversal, aided by the new method of resolving light, to such problems, there did not exist any proof which would satisfy a physicist of the agency of diffracted light in producing images, upon which (as a matter of fact, but not as an understood thing) Abbe came by experiment.

"I find my first publication of the new method of resolving light was in December 1895, and shortly afterwards I had a conversation with Lord Rayleigh about it, and explained to him why a pair of lines or dots should be resolved by an aperture insufficient to resolve a ruling equally spaced. In his earlier papers he, like other writers on optics, had regarded them as requiring the same aperture.

"This conversation led Lord Rayleigh to look into the matter under the more familiar hypothesis that light consists of rays, and he published the result in his 1896 paper, which I understand has been recently reprinted by the R.M.S. The result comes out with ease by my method of treatment, and I told Lord Rayleigh that it ought also to come out by the older methods of treatment, if it were possible to take the phases sufficiently into account. This Lord Rayleigh succeeded in doing, which I regard as a great achievement."

SYNOPSIS OF THE KNOWN SPECIES OF BRITISH FRESH-WATER ENTOMOSTRACA.

Part III. Ostracoda, Phyllopoda, and Branchiura.

By D. J. Scourfield, F.R.M.S.

(*Read December 18th*, 1903.)

Plate 2.

In this concluding part of the Synopsis of British Fresh-water Entomostraca, it is principally the Order Ostracoda that will occupy our attention; but for the sake of completeness, the two poorly represented groups, Phyllopoda and Branchiura, must not be omitted, although it will be impossible to deal with them very satisfactorily, owing to the scanty records.*

Notwithstanding the fact that the Ostracoda possess very little attraction for the majority of collectors of Entomostraca, it is probably true that this group has received more attention in this country than either the Cladocera or the Copepoda, with the result that we possess two monographs, by Brady (56) † and by Brady and Norman (57), which between them contain figures and descriptions of nearly all our known species. It will only be necessary, therefore, in a few instances, to give references to foreign papers for information as to our native Ostracods, and but a comparatively small number of synonyms need be introduced.

With regard to the distribution of the Ostracoda in the British Isles, the same plan as before will be followed—*i.e.* the records for each species will be summarised in a table, so that its occurrence in different parts of the country can be seen at a glance. In the case of very rare forms, more definite information will also be given, under the name of each species, as to where they have been collected.

* The species new to Britain, discovered since the publication of Parts I. and II., and several important new records of rare species of Cladocera and Copepoda, will be found in an appendix.

† The numbers in brackets refer to the lists of literature at the end of this and the two previous Parts.

OSTRACODA.

Cyprididae.

Cypria Zenker.

C. exsculpta (Fischer).

Cypris striolata Brady (56).

Not a very common species, although widely distributed.

C. ophthalmica (Jurine).

Cypris compressa Baird (1), Brady (56).

A very common species. The "*lacustris*" form probably occurs in this country, although it has not been separately recorded.

Cyclocypris Brady & Norman.

C. globosa (Sars).

Cypris cinerea Brady (56).

Not yet seen in the south and east of England or in Wales.

C. serena (Koch).

Cypris laevis Brady (56).

Occurs frequently in all parts of the country.

C. laevis (O. F. Müller).

Cypris minuta Baird (1); *Cypris ovum* Brady (56).

Also common throughout the British Isles.

Scottia Brady & Norman.

S. browniana (Jones).

Only found on the shores of Loch Fadd in the Island of Bute.

Cypris O. F. Müller.

C. fuscata (Jurine).

C. fusca Baird (1), Brady (56).

A very common species in ponds and small pieces of water, but not in lakes.

C. incongruens Ramdohr.

C. aurantia Baird (1).

Somewhat rare, although widely distributed. It is said by Brady & Norman (57) to be most common in slightly brackish water, but it is by no means characteristic of such situations.

C. pubera O. F. Müller.

C. cuneata Baird (1); *C. punctillata* Brady (56).

A rare species. The only record I have of it from the south and east of England is a shallow pond at Esher, Surrey.

C. virens (Jurine).

C. tristriata Baird (1).

Very common everywhere in small pieces of water.

C. elliptica Baird.

This has only been recorded by Baird (1), and by Brady & Norman (57); three localities in all.

C. affinis Fischer.

C. tessellata (in part) Brady (56); *C. reticulata* Brady & Norman (57).

Apparently a rather rare species.

C. obliqua Brady.

A comparatively common form, not only in ponds, etc., but also in lakes. Curiously enough, it is rarely alluded to by foreign authors, although it is known to occur on the Continent.

C. ornata O. F. Müller.

There is but one published record for this species—namely, pond at Shotton Hall, co. Durham.

C. clavata Baird.

Not certainly seen in this country since Baird's record from "Copenhagen Fields, July 1836." It has, however, been found on the Continent.

C. trigonella Brady.

The only record is that referred to by Brady in his 1868 monograph (56).

C. bispinosa Lucas.

This may possibly be a brackish-water form, as it has only been found near the sea. The single British locality is "a pool in a small island at Valentia, Ireland," but it has also been found in Guernsey.

Cyprinotus Brady.

C. prasinus (Fischer).

Cypris strigata Baird (1); *Cypris salina* Brady (56).

Only found in situations where the water can be at least occasionally brackish.

Stenocypris Sars.

S. fasciata (O. F. Müller).

Herpetocypris fasciata Brady & Norman (57).

I have recently found specimens of this fine species near

Catfield, Norfolk. Although figured and described by Brady & Norman (57) it has not been previously recorded as British.

S. chevreuxii Sars [Sars (67)].

Professor G. S. Brady informs me that he took this species many years ago in a pond at Lyndhurst, in the New Forest, but that it has hitherto remained unrecorded as British.

Herpetocypris Brady & Norman.

H. reptans (Baird).

Candona reptans and *C. similis* (young) Baird (1); *Cypris reptans* Brady (56).

A very common species in most parts of the country.

H. strigata (O. F. Müller).

Not very frequently met with, and not yet recorded from Ireland and Wales.

H. tumefacta (Brady & Robertson).

Cypris tumefacta Brady & Robertson (58).

Somewhat commoner than the foregoing perhaps, but still rather rare.

Ilyodromus Sars.

I. olivaceus (Brady & Norman).

Erpetocypris olivaceus Brady & Norman (57) 1889.

Only recorded from Duddingston, Kinghorn, Black, and Forfar Lochs in Scotland, and from the River Lathkill in Derbyshire.

I. robertsoni (Brady & Norman).

Erpetocypris robertsoni Brady & Norman (57) 1889.

Mr. T. Scott (20) has found this in several localities in Scotland, and Mr. D. Robertson also collected it near Peebles and in Skye, but it has not been seen in other parts of the British Isles.

Prionocypris Brady & Norman.

P. serrata (Norman).

Cypris serrata Brady (56); *Erpetocypris serrata* Brady & Norman (57) 1889.

Apparently a rather rare species, and confined to England so far as our present records go. In addition to the localities noted by Brady & Norman, I have collected it from the East London Waterworks reservoirs at Walthamstow, and from Purfleet, both in Essex.

Cypridopsis* Brady.

C. vidua (O. F. Müller).

Cypris vidua and *C. sella* Baird (1).

Pionocypris vidua Brady & Norman (57) 1896, Scott (20), Scourfield (29).

One of the commonest of the British Ostracoda.

C. obesa Brady & Robertson.

Pionocypris obesa Brady & Norman (57) 1896.

Not yet recorded from Wales or Scotland, but this may be simply due to the fact that it is not usually regarded as anything more than a variety of *C. vidua*.

Cypridopsella* Kaufmann.

C. aculeata (Costa).

Cypridopsis aculeata Brady (56), Brady & Norman (57).

Not found as a rule far away from slightly brackish water.

C. villosa (Jurine).

Cypris westwoodii and ? *C. elongata* Baird (1).

Cypridopsis villosa Brady (56), Brady & Norman (57).

Widely distributed, but not a very common species.

C. newtoni (Brady & Robertson).

Cypridopsis newtoni Brady & Robertson (58), Brady & Norman (57), Scott (20).

One of the rarer British species.

C. variegata (Brady & Norman).

Cypridopsis variegata Brady & Norman (57).

Also a rather rare species, though widely distributed. Since the "Entomostraca of Epping Forest" (29) was issued, I have found specimens of this species in Higham Park Lake.

* Notwithstanding the opinion expressed by Brady & Norman in the Appendix to Part II. of their monograph (57), there seems no sufficient reason for removing *C. vidua* and its nearest allies from the genus *Cypridopsis* as it was originally described by Brady in 1868, and these authors themselves give *C. vidua* as the type species of this genus in the first part of their work. It follows, therefore, that the name *Pionocypris* must be dropped so far as our British species are concerned, although it will still hold for certain Australian forms. As, however, the *C. aculeata*—*C. villosa* group seems to form a distinct genus, the name *Cypridopsella*, proposed by Kaufmann, and now adopted by Sars and other authors, has been followed here.

Potamocypris Brady.

P. fulva (Brady).

Bairdia fulva Brady (56)

A fair number of records altogether from Scotland, Ireland, South Wales, and north of England, but only one from south and east of England—viz. Kew Gardens—and none from North Wales.

Notodromas Lilljeborg.

N. monacha (O. F. Müller).

Cypris monacha Baird (1).

Found in all parts of the country, with the possible exception of the extreme north of Scotland.

Cyprois Zenker.

C. marginata (Straus).

? *Cypris gibbosa* Baird (1).

Cyprois flava Brady & Norman (57), 1889.

To the single published British locality—Duddingston Loch, near Edinburgh—can now be added R. Thurne at Potter Heigham, Norfolk, where I took specimens in 1898.

Ilyocypris Brady & Norman.

I. gibba (Ramdohr).

Cypris gibba (in part) Brady (56).

The records for this are not quite satisfactory, as many of them include *I. biplicata*.

I. biplicata (Koch).

Cypris gibba (in part) Brady (56).

I. bradii Brady & Norman (57), 1896.

This seems to be a commoner form than *I. gibba*.

Candona Baird.

C. candida (O. F. Müller), as defined by Vávra (68).

C. lucens (in part) Baird (1).

An abundant and widely distributed species. The British records comprise two or three distinct forms possibly of specific rank.

C. neglecta Sars [Müller (66)].

C. candida (in part) Brady (56).

Hartwig, who has given much attention to this genus, says (62, p. 92) that one of Professor Brady's figures (56, Pl. 37, 1*e*) certainly refers to this species, and not to *C. candida*. Brady & Norman also refer to a form "very closely approaching *C. neglecta*" (57, p. 99).

C. angulata G. W. Müller [Müller (66)].

C. candida (in part) Brady (56), Pl. 25, figs. 8 and 9.

The angulation of the shell behind, and the net-like markings, separate this species from *C. candida*. The specimens figured by Brady came from Gravesend, but I know of no other definite records.

C. elongata Brady & Norman.

Only recorded from Lough Neagh, Ireland.

C. lactea Baird.

C. lactea and *C. detecta* Brady (56).

Not an uncommon form in this country, though seldom mentioned by Continental writers.

C. compressa (Koch).

C. pubescens Brady & Norman (57), 1889.

C. pubescens (Koch).

C. abbreviata Brady MS. (Scourfield, 26).

Hartwig seems to think (62, pp. 104—108) that the two foregoing species, as recorded by Brady & Norman (57), should be united under *C. compressa*. He further states, however, that the true *C. pubescens* Koch also occurs in England, as he has had from Canon Norman specimens which had been collected in Norfolk (*l.c.* p. 126).

C. stagnalis Sars.

C. ambigua Scott (20, 46).

Apparently a rare species. Only recorded from Lochgelly Loch and Loch Fitty, Fifeshire (46).

C. zenckeri Sars.

Only recorded from a pond at Ferry Hill, co. Durham (57).

C. rostrata Brady & Norman.

Not a very common species.

C. marchica Hartwig [Müller (66) = *C. rostrata*].

Specimens of this species (which very closely resembles *C. rostrata*) from Lanarkshire were sent by Canon Norman to Herr Hartwig, who has recorded the fact in (62) p. 99.

C. fabaeformis (Fischer).

C. diaphana Brady & Robertson (58).

According to Hartwig (62, pp. 112—114) the *C. fabaeformis* of Brady & Norman's monograph (57) is not really Fischer's *C. fabaeformis*, but a distinct species, which he calls *C. bradyi*.

C. protzi Hartwig [Müller (66)].

C. kingsleii (in part) Brady & Robertson (58), Pl. 9, figs. 11 and 12.

Prof. Brady tells me that the specimens he sent to Herr Kaufmann, as recorded in (65), p. 392, were probably from a quarry at Hairmyres, near East Kilbride.

C. hyalina Brady & Robertson.

The fairly numerous records for this species are almost entirely confined to the "Broads" district and Scotland.

C. acuminata (Fischer).

In the paper already quoted several times (62), p. 119, Hartwig does not consider Brady & Norman's *C. acuminata* to be actually that species, but suggests that it may be *C. caudata* Kaufmann.

C. euplectella Robertson.

Found in a number of localities in the south and middle of Scotland (*see* 20, 46, 57). This year (1903) I have also obtained it from the Norfolk Broads district, near Catfield.

Candonopsis Vávra.

C. kingsleii (Brady & Robertson).

Candona kingsleii Brady & Robertson (58), Brady & Norman (57), Scott (20, 46).

In some parts of the country this seems to be quite a common species, and it is also widely distributed.

Darwinulidae.

Darwinula Brady & Robertson.

D. stevensoni Brady & Robertson.

Polycheles stevensoni Brady & Robertson (58).

Darwinella stevensoni Brady & Robertson (59).

Many recorded localities in the East Anglian Fen and Broads districts; also found in the west of England, South Wales, south and middle of Scotland, and Ireland.

Cytheridae.

Metacypris Brady & Robertson.

M. cordata Brady & Robertson.

Only taken in the Fens and Broads of East Anglia, the Ellesmere district, Shropshire, and in Mayo and Galway, Ireland.

Limnicythere Brady.

L. inopinata (Baird).

Cythere inopinata Baird (1).

A fairly common species, but not yet recorded from Ireland.

L. compressa Brady & Norman.

Whitefield Loch, Wigtownshire, and Loch Aber, Kirkcudbrightshire, are the only recorded localities for this species.

L. sanctipatricii Brady & Robertson.

A rather rare species.

L. monstrifica (Norman).

Only recorded from the "Fen" and "Broads" districts, and a canal at Fleckney, Leicestershire.

Cytheridea Bosquet.

C. torosa (Jones).

Rather a brackish-water than a fresh-water species, but found occasionally in water not perceptibly brackish. The variety "*teres*" is said to be common in the Fen district, and has also been recorded from Shropshire, South Wales, Lancashire, and Firth of Clyde.

C. lacustris (Sars).

Several records from different parts of Scotland, but only three from other parts of the British Isles—namely, R. Nene and R. Thames, England, and Lough Neagh, Ireland.

As already noted, a few of the Ostracoda mentioned above are to be found more frequently in brackish than in fresh water—*e.g.* *Cyprinotus prasinus*, *Cypridopsella aculeata*, *Cytheridea torosa*, and perhaps *Cypris bispinosa*. Other more decidedly brackish-water forms, all belonging to the Cytheridae are:

Cythere pellucida Baird.
,, *porcellanea* Brady.
,, *gibbosa* Brady & Robertson.
,, *fuscata* Brady.
Loxoconcha viridis (O. F. Müller).
Cytherura gibba (O. F. Müller).

And there are several further species which, although usually marine, may be found at times in brackish water.

DISTRIBUTION OF BRITISH FRESH-WATER OSTRACODA.

Species.	England.									Scotland.			
	South and East.				North								
	Epping For.	Richmond.	Norfolk Bds.	Total S. and E.	Total N.	Lake Dist.	Total England.	Wales.	Ireland.	Total Scotland.	"Lowlands."	"Highlands."	Extreme North.
CYPRIDIDAE.													
Cypria exsculpta	×	...	×	×	×	...	×	...	×	×	×	×	×
,, *ophthalmica*	×	×	×	×	×	×	×	×	×	×	×	×	×
Cyclocypris globosa	...	...	...	...	×	×	×	...	×	×	×	×	...
,, *serena*	×	×	×	×	×	×	×	×	×	×	×	×	×
,, *laevis*	×	×	×	×	×	×	×	×	×	×	×	×	×
Scottia browniana	...	...	...	...	...	...	...	...	...	×	...	×	...
Cypris fuscata	×	...	×	×	×	...	×	...	×	×	×	×	×
,, *incongruens*	×	×	...	×	×	...	×	×	×	×	×	×	...
,, *pubera*	...	...	...	×	×	...	×	...	×	×	×	×	...
,, *virens*	×	×	×	×	×	...	×	×	×	×	×	×	×
,, *elliptica*	...	...	...	×	×	...	×	...	...	...	...	...	...
,, *affinis*	?	...	...	×	×	...	×	...	×	×	×	×	...
,, *obliqua*	×	×	×	×	×	×	×	×	...	×	×	×	...
,, *ornata*	...	...	...	...	×	...	×	...	...	...	...	...	...
,, *clavata*	...	...	...	×	...	...	×	...	...	...	...	...	...
,, *trigonella*	...	...	...	×	...	...	×	...	...	...	...	...	...
,, *bispinosa*	...	...	...	...	...	...	...	...	×	...	...	...	...
Cyprinotus prasinus	...	...	×	×	×	...	×	×	×	×	×	×	×
Stenocypris fasciata	...	...	×	×	...	...	×	...	...	...	...	...	...
,, *chevreuxii*	...	...	...	×	...	...	×	...	...	...	...	...	...
Herpetocypris reptans	×	×	×	×	×	...	×	×	×	×	×	×	×
,, *strigata*	×	...	...	×	×	...	×	...	...	×	×	×	...
,, *tumefacta*	×	...	...	×	×	...	×	...	×	×	×	×	×
Ilyodromus olivaceus	...	...	...	...	...	...	×	...	...	×	×	×	...
,, *robertsoni*	...	...	...	...	...	...	...	...	...	×	×	×	...
Prionocypris serrata.	×	...	...	×	×	...	×	...	...	...	...	...	...
Cypridopsis vidua	×	×	×	×	×	×	×	×	×	×	×	×	×
,, *obesa*	...	...	×	×	×	...	×	...	×	...	...	...	...
Cypridopsella aculeata	...	...	×	×	×	...	×	×	×	×	×	×	×
,, *villosa*	×	×	...	×	×	×	×	...	×	×	×	×	×
,, *newtoni*	...	...	×	×	...	...	×	...	×	×	×	×	...
,, *variegata*	×	...	...	×	...	...	×	...	×	×	...	×	...
Potamocypris fulva	...	×	...	×	×	...	×	×	×	×	×	×	×
Notodromas monacha	×	×	×	×	×	...	×	×	×	×	×	×	...
Cyprois marginata	...	...	×	×	...	...	×	...	...	×	×	...	...
Ilyocypris gibba	?	...	×	×	×	...	×	...	...	×	×	...	...
,, *biplicata*	×	×	...	×	?	...	×	...	...	×	×	×	×
Candona candida	×	×	×	×	×	×	×	×	×	×	×	×	×
,, *neglecta*	...	...	...	...	?	...	×	...	...	...	...	...	...
,, *angulata*	...	...	...	×	...	...	×	...	...	...	...	...	...

Species.	England.							Wales.	Ireland.	Scotland.			
	South and East.				North								
	Epping For.	Richmond.	Norfolk Bds.	Total S. and E.	Total N.	Lake Dist.	Total England.			Total Scotland.	"Lowlands."	"Highlands."	Extreme North.
CYPRIDIDAE—*continued.*													
Candona elongata	...	...	...	...	...	...	...	...	×	...	...	...	...
,, *lactea*	×	...	...	×	×	...	×	...	×	×	×	×	×
,, *compressa*	×	...	?	×	...	...	×	...	×	×	×	×	×
,, *pubescens*	×	?	?	×	...	...	×	...	...	...	...	...	...
,, *stagnalis*	...	...	...	...	...	...	...	...	...	×	×	...	...
,, *zenckeri*	...	...	...	...	×	...	×	...	...	...	...	...	...
,, *rostrata*	...	...	?	×	×	...	×	×	...	×	×	×	...
,, *marchica*	...	...	...	...	...	...	...	...	...	×	×	...	...
,, *fabaeformis*	×	×	×	×	...	...	×	×	×	×	×	×	...
,, *protzi*													
,, *hyalina*	...	...	×	×	...	...	×	...	...	×	×	×	×
,, *acuminata*	...	...	×	×	...	...	×	...	...	×	×	×	×
,, *euplectella*	...	...	×	×	...	...	×	...	...	×	×	×	...
Candonopsis kingsleii	...	...	×	×	...	...	×	×	×	×	×	×	×
DARWINULIDAE.													
Darwinula stevensoni	...	...	×	×	...	...	×	×	×	×	×	×	...
CYTHERIDAE.													
Metacypris cordata	...	...	×	×	...	...	×	...	×	...	...	...	...
Limnicythere inopinata	×	×	×	×	×	...	×	×	...	×	×	×	×
,, *compressa*	...	...	...	...	...	...	...	...	...	×	×	...	...
,, *sanctipatricii*	...	...	...	×	...	...	×	...	×	×	×	×	...
,, *monstrifica*	...	...	×	×	...	...	×	...	...	...	...	...	...
Cytheridea torosa	...	...	×	×	×	...	×	×	×	×	×	...	×
,, ,, *teres*	...	...	...	...	×	...	×	×	...	×	×	...	...
,, *lacustris*	...	...	...	×	...	...	×	...	×	×	×	×	×

PHYLLOPODA.

Apus Schaeffer.

A. cancriformis Schaeffer [Baird (1)].

It is doubtful whether this ought to be included in any modern list of British Entomostraca, as it has not been found apparently for more than half a century. The localities given by Baird (1) are Bexby (Bexley?) Common; Devonshire; and Bristol.

Chirocephalus Prevost.

C. diaphanus Prevost [Baird (1)].

This beautiful species, I am glad to say, is still to be found occasionally in this country, although very rare. In addition to the records given by Baird (1), it has been taken at Tillmire, near York, by a brother of Professor Brady in 1862; at Seaford, Sussex, by Mr. H. Maxwell Lefroy, in 1899; and near Brockenhurst, in the New Forest, in March, 1900, and October, 1901, by Mr. G. T. Harris. I am indebted to Canon Norman for the two first-mentioned records.

BRANCHIURA.

Argulus O. F. Müller.

A. foliaceus (L.) [Baird (1), Clark (60), Wilson (69)].

The records of the occurrence of this well-known fish parasite are not very satisfactory, but there is every reason to suppose that it occurs in all parts of the country. It certainly occurs in Ireland and Scotland as well as in England (*see* 1, 15, 21A, 48).

A. coregoni Thorell [Wilson (69)].

Canon Norman possesses specimens of this species which were taken by Mr. Dodds on the Barbel, in Leicestershire. It has not previously been placed on record as British.

APPENDIX.

The three following species have been added to the known British fauna since the publication of the previous parts of this Synopsis.*

CLADOCERA.

DAPHNIDAE.

Scapholeberis Schoedler.

S. aurita (Fischer).

Mr. R. Gurney has recently found this fine species in Norfolk, and has published a short account of its habit of using the surface-film of water for support, etc., in the *Annals and Magazine of Natural History* (61). It has been obtained from the following localities: Pond, at Herringfleet; Ditch, at S. Walsham; and Catfield Fen.

This species is described and figured by Lilljeborg in the *Cladocera Sueciae*.

* In a recent paper (63) Mr. W. F. de V. Kane has recorded *Bosmina dollfusi* Moniez from three Irish lakes. If this were a good species it would be an addition to our fauna, but I consider it merely as a form of *B. obtusirostris*.

Lyncodaphnidae.

Ophryoxus Sars.

O. gracilis Sars.

During a short visit to Fort Augustus last August, in connection with the "Lake Survey" organised by Sir John Murray, K.C.B., I had the good fortune to obtain this species in Loch Ness, and also in a backwater of the Caledonian Canal, at Coiltry Lock. In the former the species was living in great abundance in the shallow and sheltered bay at Inchnacardoch, near Fort Augustus, and a single specimen was also found on the protected side of the little breakwater belonging to the Monastery at Fort Augustus. I hear from Mr. J. Murray that none were to be taken after September, and that the species has not yet (March) reappeared. At Coiltry only a few specimens were seen. In all cases parthenogenetic females only were observed.

This species appears to be a characteristic northern form, at least in Europe. It has only hitherto been recorded from Norway, Sweden, Finland, the Kola Peninsula, Greenland, Minnesota, and Wisconsin. Its occurrence therefore in Scotland is particularly interesting.

Lilljeborg describes and figures it in his usual admirable manner in the *Cladocera Sueciae.*

COPEPODA.

Cyclopidae.

Cyclops O. F. Müller.

C. robustus Sars [Lilljeborg (40)].

Professor G. S. Brady tells me that he has had specimens of this species from Ennerdale Lake. They were actually taken many years ago, but it is only quite recently that he has definitely made them out to be *C. robustus.* The species has probably been often included in records of *C. vernalis*, to which it is very closely allied.

The following additional records of rare or otherwise interesting species have been made since the issue of the two previous parts.

CLADOCERA.

Diaphanosoma brachyurum (Liévin). A peculiar variety of what appears to be this species, with a strongly projecting forehead, has been recorded by Mr. Kane from Lough Mask (63, footnote, p. 214), and I have found the same form in Loch Tarff, near Fort Augustus.

Holopedium gibberum Zaddach. This species has now been recorded from a second Irish locality—Lough Mask—by Mr. Kane (63).

Daphnia atkinsoni Baird. Ponds at Happisburgh, Honing, and Brumstead, Norfolk (R. Gurney).

Simocephalus serrulatus (Koch). Swamp near Grantown-on-Spey (Dr. and Miss B. Sprague). This is the first time the species has been recorded from Scotland.

Bosmina longirostris var. *cornuta*. Mr. J. Murray obtained this last year at Crieff, in Perthshire, *i.e.* in the "Highland" region.

Bosmina mixta Lilljeborg. Mr. Kane reports the occurrence of this species from two additional Irish localities—L. Oughter and L. Conn (63).

Ilyocryptus agilis Kurz. This has been found in Scotland by Mr. J. Murray, but the exact locality cannot be given until last year's collections of the "Lake Survey" have been re-examined.

Ilyocryptus acutifrons Sars. This rare species has been found by Mr. R. Gurney in Wroxham and Sutton Broads, Norfolk.

Macrothrix laticornis (Jurine). Pond at Thorpe, and Waxham Cut, Norfolk (R. Gurney). It has not previously been recorded from the Broads district.

Macrothrix hirsuticornis Norman & Brady. Some very fine examples (one as much as $\frac{1}{15}''$ long) of this species have been found by Mr. W. A. Cunnington at Cambridge.

Alona elegans Kurz. To the single record given in Part I. may now be added, Pond at Brumstead, Norfolk, where it was taken in company with *D. atkinsoni*, by Mr. R. Gurney.

Leydigia quadrangularis (Leydig). Mr. R. Gurney finds this species fairly well distributed in the Broads district, though when Part I. was issued I knew of no records for it in that locality.

Alonella exigua (Lilljeborg). This species, as distinct from *A. excisa*, has been obtained by Mr. R. Gurney, in Sutton, and Wroxham Broads and Catfield Fen, Norfolk, and he has also collected it in North Uist.

Pleuroxus aduncus (Jurine). Although not included in Part I. in the list of Cladocera of the Norfolk Broads, owing to the absence of definite records, Mr. R. Gurney finds this species to be the commonest of the genus in that area.

Anchistropus emarginatus Sars. A single specimen of this most interesting species has been seen by Mr. R. Gurney from Sutton Broad, Norfolk.

COPEPODA.

Diaptomus laciniatus Lilljeborg. When Part II. was issued I knew of no records of this species from the extreme north of Scotland, but Mr. James Murray informs me that last year he found it in the majority of the lochs of Sutherland. It is not, therefore, such a rare species as was supposed, though restricted in its distribution.

Cyclops bicuspidatus var. *lubbockii* Brady. This form has been found in the "Muckfleet," Norfolk, by Mr. R. Gurney, who believes that its appearance is directly dependent upon a rise in the salinity of the water, only the typical form being generally found there.

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EXPLANATION OF PLATE 2.

[In accordance with the desire expressed in Part II., some details of *Cyclops nanus* Sars and *Belisarius viguieri* Maupas have been illustrated on the accompanying plate. So far as *B. viguieri* is concerned it is hoped that they will be sufficient to enable the species to be readily identified. With regard to *C. nanus*, it may be mentioned that it is closely related to *C. languidus* in that it has both branches of the first pair of feet and the inner branch of the second pair two-jointed. The first antennae are, however, as in *C. languidoides*, only eleven-jointed. It is a very small species, being only about $\frac{1}{35}$ in. in length.]

Fig. 1. *Belisarius viguieri*, ♀, ventral view × 200. *a* = spermatophore.
,, 2. ,, ,, second antenna × 400.
,, 3. ,, ,, ♀, fifth foot × 650.
,, 4. ,, ,, ♀, side view of furca × 300.
,, 5. ,, ,, ♂, furca, ventral view × 225.
,, 6. *Cyclops nanus*, ♀, fifth foot × 400.
,, 7. ,, ,, ♀, receptaculum seminis × 200.
,, 8. ,, ,, ♀, last joint of inner ramus of fourth pair of feet × 450.
,, 9. ,, ,, ♀, furca × 175.

ON A NEW FRESH-WATER POLYZOON FROM RHODESIA, *LOPHOPODELLA THOMASI*, gen. et sp. nov.

By Charles F. Rousselet, F.R.M.S.

(*Read January 15th*, 1904.)

Plate 3.

Up to quite recent times not a single species of fresh-water Polyzoa was known from the continent of Africa. To Dr. Stuhlmann is due the credit of having been the first to discover representatives of this class in Egypt, and later in German East Africa (24), between the years 1890 and 1892. These were *Fredericella* and *Plumatella*, and also some statoblasts of Hyatt's *Pectinatella carteri*, a species previously known only from India. Then in 1893 and 1897, Dr. M. Meissner (23) found sessile statoblasts of *Plumatella* on some shells of fresh-water molluscs, preserved in the Berlin Museum, which had come from East and West Africa, and this completes the whole known records of fresh-water Polyzoa in Africa to the present time.

In October last, one of our members, Mr. R. H. Thomas, of Salisbury, Rhodesia, sent me a little bottle containing a gelatinous mass which, he said, was a fresh-water Polyzoon collected early in 1900, and preserved in alcohol. The polypides were all decayed, but in a piece of the gelatinous zoarium the hollow tracts which they had occupied can well be seen (Fig. 1), and in these branching tracts, which preserve the shape of the entocyst, I found a number of peculiar statoblasts in all stages of growth. An examination of these enabled me to inform Mr. Thomas at once that a Polyzoon having such statoblasts was not known in England, but I could not at the time say if any such form had been described in any other part of the world. Since then I have looked up all the recent literature on the subject, and have also made enquiries of specialists, and am now in a position to say that this is undoubtedly a new species, for which a new genus must be created, and moreover, it is the first representative of fresh-water Polyzoa recorded from any part of Africa south of the Equator.

Before describing the characters of this new species, it may be instructive to hark back a little and see what has been done before, and what is the present state of our knowledge about these animals.

The fresh-water Polyzoa (or Bryozoa) form a very distinctive group containing only about 20 to 50 species, according to whether a number of these forms are considered good species, or merely varieties, or synonyms. Professor G. J. Allman, who in 1856 published his fine work, "A Monograph of the Fresh-water Polyzoa," seems to have almost exhausted the subject as far as Great Britain is concerned, for, with the exception of the description of two very doubtful new Plumatellas by Parfitt (8) in 1866, and one remarkable new species, Kent's *Victorella pavida* * (9), from the Victoria Docks in 1870, no work at all, or work of any importance, on this group seems to have been done or published in England. The marine Polyzoa, on the other hand, have come in for much more attention at the hands of zoologists.

During the last decades the principal descriptive work on fresh-water Polyzoa has been done in America by J. Leidy (2, 11, 12) and A. Hyatt (7), in Germany by Professor K. Kraepelin (17), and Dr. M. Meissner (22, 23, 24, 25), in France by J. Jullien (15), in Bohemia by Kafka (18), and in Japan by Oka (20). From India, Japan, South America, Australia, and Indo-China a few new species have been described, so that the total number of undisputed species does not at present exceed 20, leaving out all the more or less doubtful names which have been alternately accepted and rejected by different investigators.

I will make no attempt to give even a short description of the known species of fresh-water Polyzoa, which can readily be found in the works mentioned in the bibliography at the end of this paper; but a bare list of the recognised species, and of those named since Allman's monograph was published, may prove useful for reference.

* This was first found by Mr. W. Saville Kent at one of the earliest Quekett excursions, on September 12th, 1868. See Mr. Kent's first note in *Science Gossip* for 1868, p. 255. Later it has also been found in the Regent's and Surrey Canals, always parasitic on *Cordylophora lacustris.*

List of the Known Fresh-water Polyzoa.

British Species.

Lophophore horse-shoe shaped.

Cristatella mucedo. Cuvier. Statoblasts circular, with hooked spines.

Lophopus crystallinus. Pallas. Statoblasts elliptical, pointed at both ends, without spines.

Plumatella repens. Linnaeus. Statoblasts oval, without spines.

,, *fruticosa.* Allman ,, *coralloides* ,, ,, *emarginata* ,, ,, *elegans* ,, ,, *dumortieri* ,, ,, *jugalis* ,, ,, *allmani.* Hancock *Alcionella fungosa.* Pallas ,, *benedeni.* Allman ,, *flabellum.* Van Beneden	All these are considered to be synonyms or varieties of *Pl. repens* by continental writers.
Plumatella lineata. Parfitt ,, *limnias.* ,,	Two very doubtful species.
,, (*Hyalinella*) *punctata.* Hancock	With soft gelatinous creeping tubes.

Lophophore circular.

Fredericella sultana. Blumenthal. Statoblasts kidney-shaped, without annulus.

Paludicella ehrenbergi. Van Beneden *Victorella parida.* Kent	Statoblasts absent.

Foreign Species.

Lophophore horse-shoe shaped.

Cristatella idae. Leidy (America) ,, *ophidioidea.* Hyatt ,, ,, *lacustris.* Potts ,,	All three considered to be synonyms of *C. mucedo.*

Lophopus jheringi. Meissner (Brazil).

,, (*Hyalinella*) *lendenfeldi.* Ridley (Australia).

Lophopodella thomasi. Rousselet (Rhodesia, S. Africa).

,, (*Pectinatella*) *carteri.* Hyatt (India, East Africa).

Plumatella stricta. Allman (Belgium) „ *diffusa.* Leidy (America) „ *nitida.* „ „ „ *arethusa.* Hyatt „ „ *aplini.* Mac Gillivray (Australia) „ *lucifuga.* Vaucher, Jullien „ *hyalina.* Kafka (Bohemia) „ *polymorpha.* Kraepelin (Germany, etc.) „ *princeps.* Kraepelin (Germany, etc.)	All these are considered to be synonyms or varieties of *Pl. repens.*
„ *philippinensis.* Kraepelin (Philippine Islands).	
„ (*Hyalinella*) *vesicularis.* Leidy, Jullien (America) „ „ *vitrea.* Hyatt, Jullien (America) „ „ *lophopoida* Kafka (Bohemia)	These are considered synonyms of Hancock's *Pl. punctata.*
Pectinatella magnifica. Leidy (America, Germany). „ *gelatinosa.* Oka (Japan).	

Lophophore circular.

Fredericella regina. Leidy (America) „ *walkottii.* Hyatt „ „ *pulcherrima.* „ „	These are considered synonyms of *F. sultana.*
Paludicella mülleri. Kraepelin (Germany). „ (*Pottsiella*) *erecta.* Potts. Kraepelin (America).	
Urnatella gracilis. Leidy (America) *Hislopia lacustris.* Carter (Central India) *Norodonia cambodgiensis.* Jullien (Indo-China) „ *sinensis.* Jullien (Indo-China)	These four species are unlike the other fresh-water Polyzoa, and their affinities lie with the marine species.

As will be seen, the very variable genus *Plumatella*, having a horny, chitinous, tubular, branching ectocyst has the greatest number of species, but the claim to specific rank of nearly every one of these has been denied by one or the other eminent student of this group, who holds that they are synonyms, or at most only varieties of *Plumatella repens.* It has been stated, with much appearance of truth, that though the extreme forms differ markedly from the type, yet in every case a number of intermediate varieties have been found connecting them with *Plumatella repens.* Monsieur J. Jullien (15), in 1885, was the first to reduce all European Plumatellas to the one species *Pl. repens*; but he strangely accepted all the American species. Professor Kraepelin (17), unable to find a way out of this maze, deposed all the Plumatellas from their specific rank, and created out of them two new types, *Pl. polyforma* and *Pl. princeps*, to which he subordinated the principal varieties. These types are mainly distinguished by their statoblasts, whether broad oval or elongated oval in shape. Some more recent investigators have accepted, whilst others have rejected, this arrangement. For the creeping Plumatellas, with soft, gelatinous tubes, M. Jullien has proposed the new name *Hyalinella.* Mr. Ridley's Australian *Lophopus lendenfeldi* (19) seems to me to belong to this genus. M. Jullien (15) has also renamed the well-known *Lophopus crystallinus* into *L. trembleyi*, which is quite inadmissible according to the rules laid down by the International Congress of Zoology.

As regards their geographical distribution, most of the species have been found in England, America, Germany, France, Bohemia, Hungary, and Russia—that is, wherever they have been really looked for. Isolated species are known from India, Australia, Japan, South America, Egypt, East and West Africa, and now from Rhodesia, but it seems clear that it only requires a systematic search to find them in most countries where there are lakes, pools, canals, or slow-flowing streams.

Coming now more particularly to the species which forms the subject of this paper, I had only the statoblast to guide me in my search for its nearest allies. It is well known, however, that these resting or winter buds, produced only by the phylactolaematous* fresh-water Polyzoa, are very characteristic of the different species, and are mostly quite sufficient by themselves to establish the identity of the animals to which they belong.

The statoblast consists of a central capsule surrounded by a dark brown ring of air cells, called the annulus, which enables the structure to float on the surface of the water. In *Cristatella*

* Which means possessed of a fleshy tongue, or epistome guarding the entrance to the mouth.

mucedo the shape of the statoblasts is circular, surrounded by a number of long hooked spines. *Pectinatella magnifica* has very similar rounded statoblasts furnished with stouter hooked spines, and fewer in number (Fig. 9). In *Plumatella* the shape is a more or less elongated oval, without spines; in *Fredericella* they are kidney-shaped, and without annulus; and in *Lophopus crystallinus* the statoblasts are elliptical, and pointed at both ends (Fig. 8.)

The statoblast of the new species *Lophopodella thomasi*, from Rhodesia (Fig. 3), has some considerable affinity with that of *Lophopus crystallinus*, being elliptical in shape, and also slightly curved in the direction of its longer axis, but instead of being pointed at the ends, it is truncated, and the points are replaced normally by five spines on each side, but their number may be reduced to three or four, and sometimes increased to six. These spines consist of short flattened rods of chitin, which appear to be outgrowths of the lateral edges of the annulus. Some of these spines I have seen to be bifurcate. All round their lateral edges these rods are beset with a number of minute, closely set, and curled-up hooks (Fig. 4) which appear of little functional use. Their structure is clearly seen in immature statoblasts, where the hooklets are still thin and not so much curled (Fig. 5). Collectively the hooklets give a beaded appearance to the spines, and it was only by examining an immature statoblast with as yet very thin annulus that I became aware of their structure. I have counted twenty and twenty-two hooklets round the edge of one of the spines. I have also seen one of the spines split horizontally into two, the hooklets adhering to both halves, showing that when the young bursts open the statoblast, it splits horizontally through the edge of the capsule and annulus, leaving one half of the complete annulus adherent to each half of the central capsule.

The central capsule has a thick, dark reddish brown chitinous covering membrane of lenticular form, convex on one side and flattened on the other; it is very nearly, but not quite circular, having a longer diameter of 385 μ, and shorter diameter of 343 μ, and consists of two halves, similar to two watch-glasses, of different convexity, closely apposed round their edges. I found several of these naked capsules in the tubes of the polypides without annulus. The annulus forms a broad and thick cellular ring, not infrequently a little irregular or asymetric in shape, and is made up of two horizontal strata, each consisting of a single layer of hollow prismatic cells arranged like the two layers of cells of a honeycomb. The polygonal air cells are largest at the periphery, and become gradually smaller towards the centre. In mature statoblasts the cells cover the central capsule completely on the upper or convex side, whilst they leave a small bare central space on the concave side. The size of the statoblast of *Lophopodella thomasi* is 857 μ long by 642 μ broad; the spines attain a length of 75 μ, but of course the exact shape and size of the whole statoblast are subject to some variation.

The only Polyzoon having statoblasts approaching the characters above described is the one found in 1859 by Mr. H. J. Carter (4) in Bombay, and figured by him in *Ann. Mag. Nat. Hist.*, 1859, ser. 3, vol. iii., p. 341. The statoblast (Fig. 6) is a broad oval in shape, with fourteen short spines at each end, and each of these is provided with six curled hooklets round its edge (Fig. 6). Mr. Carter considered his animal to be a *Lophopus*, though probably different from the European *L. crystallinus*, but he gave it no name. Later, in 1866, Hyatt (7) joined this animal to Leidy's genus *Pectinatella*, and called it *P. carteri*, for insufficient reasons, it seems to me, as I shall show presently. The statoblasts of this same species have in later years (1890) been found by Dr. Stuhlmann in Ugógo, not far from the Victoria Nyanza, in German East Africa, as reported in a paper by Dr. Meissner (24), showing that the species must have a wide distribution.

Reverting to my description of *Lophopodella thomasi*, Mr. Thomas, its discoverer, informs me in a second letter that the only colony he found was attached to the upper surface of a rotten stick, floating in a pool of still water, being an overflow of a small Rhodesian stream. He remarks that the colony was exposed to the full sunshine, and not in a dark and shady place, where he had expected to find Polyzoa. The zoarium (or coenoecium of Allman)—that is, the whole colony stock—consisted of an oval patch of stiff gelatinous hyaline substance (Figs. 1 and 2), about $2\frac{1}{2}$ in. long by $1\frac{1}{4}$ in. broad, and about $\frac{1}{8}$ in. thick, with branching tubular channels radiating from the centre, which were tenanted by numerous polypides. The polypides protruded all round the edge and on the surface of the gelatinous ectocyst, leaving, however, a central oval space quite free of them. They are quite decayed in the preserved zoarium, but Mr. Thomas says that they had a horse-shoe shaped lophophore and an epistome, and the internal arrangement conformed, no doubt, to that obtaining in *Lophopus*, *Cristatella*, and *Plumatella*, in all of which there is practically no difference in this respect.

At first I felt uncertain whether to place this new species in the genus *Lophopus* or *Pectinatella*, but after a careful study of all the ascertained characters I have come to the conclusion that it must be placed in a new genus, to which I have given the name *Lophopodella*, with *Lophopus* as its nearest ally.

It cannot belong to *Pectinatella*, as *P. magnifica*, the type of this genus, first discovered by Professor Leidy in America, and since found also in Germany, near Hamburg and Berlin, forms very large agglomerated rounded masses, with a gelatinous ectocyst often several inches thick, on the surface of which the animals form closely-set irregular rosette-shaped colonies, with horizontal tubes. The mass may attain the size of a man's head on submerged timber, but has never yet been found on green water-plants. The statoblasts of this species (Fig. 9) are altogether different, being circular, resembling those of *Cristatella mucedo*, with a ring of twelve to twenty long hooked spines, projecting from the outer edge of the annulus.

The statoblasts of *Lophopodella thomasi* have, in general shape and character, a much greater resemblance to those of *Lophopus crystallinus*; but as one of the generic characters of *Lophopus* is, "statoblasts without spines," it is not possible to include this new species in this genus.

I have mentioned above that the Polyzoon which Mr. Carter discovered near Bombay in 1859, and which was named *Pectinatella carteri* by Hyatt (7), has a statoblast (Fig. 6) resembling that of the new species, with fourteen short hooked spines at each end. The following is an extract of Mr. Carter's (4) remarks on his animal (*loc. cit.*, p. 341): "The Lophopus is essentially *L. crystallinus*, but with a different form of statoblast, so that it is probably a new species; but this I leave to others who are acquainted with the fresh-water Polyzoa better than myself to determine, merely observing that, should it be considered a new species, the form of the statoblast will afford the chief distinguishing character. I have not, however, been able to trace the gelatinous envelope, which Professor Allman calls the ectocyst, beyond the base of the coenoecium, or polypidom, of this Lophopus, where it looks to me like the deciduous tunic of the first or original group, although I have had the opportunity of examining the coenoecium on bodies (the shells of *Paludina bengalensis*) from which it has never been removed. The group, no doubt, can move from place to place if necessary, but its habit is to remain fixed."

From this short and incomplete description, and considering the shape and character of its statoblast, it is clear that this animal does not belong to, and has no affinity with, the genus *Pectinatella*, and I have no hesitation to remove it to the new genus.*

In order to give a clear idea of the appearance of the statoblasts of these various species, I give a figure of those of *Lophopodella thomasi* and *Lophopus crystallinus*, drawn for me by Mr. F. R. Dixon-Nuttall, and reproduce the drawings of Kraepelin and Carter for those of *Pectinatella magnifica* and *Lophopodella carteri* respectively. I may mention here that Allman's figure of the statoblast of *Lophopus crystallinus* is not quite correct, as the polygonal cells of the annulus are very much smaller than there represented.

I have not in this paper touched upon the anatomy nor the development of the Polyzoa from buds, eggs, and statoblasts. These details can readily be studied in the works mentioned in the bibliography (1, 7, 10, 17, 20).

A few words on the preparation and preservation of Polyzoa may be acceptable. By adopting the following method, little difficulty will be found in killing these animals fully extended. A clean and healthy colony is placed in a watch-glass full of water, and when fully expanded one drop of 1 per cent. solution of cocaine or eucaine (β) is mixed with the water. After five to six minutes another drop is added, and so on until five or six drops have been added. In twenty to thirty minutes from the

* Since writing the above I have seen in the British Natural History Museum a slide of this statoblast made by Mr. Carter, from which I observe that its affinity to that of *L. thomasi* is fully confirmed. The spines are thin, with few hooklets, and vary in number from seven to fourteen on each side; the latter, shown in Mr. Carter's figure, is probably the greatest number which he observed. Would it not be possible for some microscopist living in Bombay or Bengal to rediscover this animal and send over some well-preserved specimen?

beginning, the animals will be narcotised and insensible to needle pricks, and are then to be killed and fixed with a solution of 2 per cent. formaldehyde, 1 part of the commercial solution in 15 parts of water (the solution usually sold being mostly much nearer 30 per cent. than the nominal strength of 40 per cent), to which a very little osmic acid solution has been added. After five minutes the Polyzoa are removed and washed in 1 per cent. formaldehyde, and finally preserved in the same fluid.

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Explanation of Plate 3.

Fig. 1. *Lophopodella thomasi*, gelatinous zoarium, with the branching tubes shown at one end only, natural size.

,, 2. *Lophopodella thomasi*. The branching tubes in zoarium magnified about 5 diam.

,, 3. *Lophopodella thomasi*. Statoblast, × 50.

,, 4. ,, ,, ,, the hooked spines, × 200.

,, 5. ,, ,, the hooked spines of an immature statoblast, × 200.

,, 6. *Lophopodella carteri*. Statoblast, × about 44. Copy of Mr. H. J. Carter's figure.

,, 7. *Lophopodella carteri*. Statoblast, the hooked spines, × 200. Copy of Mr. H. J. Carter's figure.

,, 8. *Lophopus crystallinus*. Statoblast, × 50.

,, 9. *Pectinatella magnifica*. Statoblast, × 36. Copy of K. Kraepelin's figure.

Figs. 1 to 5 and 8 have been drawn from nature by Mr. F. R. Dixon-Nuttall, to whom I am greatly indebted for the same; Figs. 6, 7, and 9, are copies from Carter and Kraepelin respectively.

THE PRESIDENT'S ADDRESS.

SOME PLANT DISEASES CAUSED BY FUNGI.

(*Résumé.*)

By George Massee, F.L.S.

(*Delivered February 19th*, 1904.)

Until quite recently, no logical explanation was forthcoming as to why certain fungi are parasitic on other plants. That such parasitism is the outcome of a definite law is obvious from the fact that, although the spores of parasitic fungi will germinate on the surface of any kind of plant, provided it is damp, the germ-tubes only enter the tissues and infect particular species of plants.

As a rule, a given obligate parasite is confined to one, or at most a few closely allied species, and in not a few instances a parasitic fungus is confined in its attacks to a single variety of a species.

The reason for this apparent selection of hosts on the part of parasitic fungi is now attributed to what Pfeffer, a German botanist, called chemotaxis. By chemotaxis is meant the influence exerted over the direction of growth of the germ-tubes of fungi by various substances, which may be of the nature of acids, alkalies, sugars, and various other substances present in the cell-sap of different plants. Towards certain of these substances the germ-tubes of some kinds of fungi are attracted, and pass through the stomata, or even pierce the cell-walls and enter into the tissues of plants. Such substances are said to be positively chemotactic. On the other hand, the germ-tubes of some kinds of fungi are repelled, or prevented from entering the tissues of certain plants, owing to the presence in the cell-sap of a substance which to that particular fungus is negatively chemotactic. Thus it comes to pass, that those fungi whose germ-tubes are attracted by substances present in the cell-sap of a given plant, can enter its tissues and become parasitic upon it; whereas, on the other hand, those fungi whose germ-tubes are repelled by a substance present in the cell-sap cannot enter the living tissues.

It has been shown that certain bacteria are influenced by chemotactic substances in the same manner as fungi.

It is well known that very different substances are normally present in the cell-sap of different parts of a plant. This probably accounts for the fact that certain fungus parasites are restricted to different portions of the structure. For instance, some fungi are parasitic in the anthers only, others are confined to the foliage, wood, or roots respectively.

In the distribution of fungus spores, wind must be perhaps accorded the first place, although it has been proved in the instances of several serious epidemics that insects are the main agents in carrying spores from one plant to another, and in some fungi special arrangements are present for aiding this object. The most general contrivance of this kind is where the spores of the fungus are imbedded in some sweet substance eaten by insects. In this case the spores pass uninjured through the body of the insect, and are thus distributed.

With these few remarks bearing on the general subject of parasitism, we must now pass in rapid review a few of the most frequent diseases of plants caused by fungi.

Peach Leaf-curl.

(*Exoascus deformans.*)

This parasite attacks the young shoots and foliage, and is recognised by the distorted and curled leaves, which are at first pale green and afterwards tinged red, and covered with a very delicate bloom, caused by the fruit of the fungus appearing on the surface. The young shoots also become more or less swollen. As the mycelium of the fungus is perennial in the shoots, and advances with each year's growth, from whence it passes into the young leaves, the most certain cure is to prune all diseased shoots and burn the same at once. Even with this precaution, infection may occur the following season from spores that have passed the winter in crevices of the bark, etc.; hence it is advisable to spray, just when the leaf-buds are expanding, with dilute Bordeaux mixture.

The leaves of apple-trees and plum-trees are often curled inwards, variously distorted, and reddish in colour, due to a disease which might at first be mistaken for leaf-curl. On unfolding a leaf, however, the true cause of the mischief is seen to be due to plant-lice, or aphides, which will be found in various stages of development. In this case, spraying with one of the many insecticides on the market will be necessary, and this should be done on the first symptoms of the disease, as when the leaves are compactly curled the solution does not reach the aphides.

Mildew.

This name covers diseases produced by various species of *Erysiphe* and allied forms, all of which are characterised by the formation of a white cobweb-like felt on the surface of the foliage of various plants, as hops, peas, vegetable-marrows, etc. When the disease is abundant the leaves present the appearance of having been whitewashed.

In the majority of kinds of parasitic fungi the mycelium or vegetative portion of the fungus grows in the tissues of the host-plant, the fruiting portion only bursting through to the surface for the purpose of securing the dispersion of the spores.

In the mildews, however, the whole of the mycelium lies on the surface of the part attacked, and is held in position by numerous suckers or haustoria, which pierce the epidermal cells of the leaf, where they play the double part of anchoring the fungus to the leaf and absorbing food from its cells.

The superficial nature of the mycelium enables the disease to be readily combated if preventive measures are commenced on the early appearance of the mildew. The remedy consists in dusting the plants with powdered sulphur, mixed with about one-quarter of its quantity of powdered quicklime. The dredging should be done in the early morning when the foliage is wet with dew.

Strawberries often suffer severely from one of the mildews (*Sphaerotheca castagnei*). The leaves are first attacked, and at a later stage the fungus passes on to the fruit, which becomes covered with a white bloom. Such diseased fruit is sometimes dipped in water to remove the fungus and present a saleable appearance, but the watery, insipid taste is sufficient to reveal the deception practised.

Such plants should be treated with powdered sulphur at intervals of eight days until the fruit begins to set. In places where the disease has existed the plants should be covered with a thin layer of straw or other litter, and set fire to. By this means all the old infected leaves, also fragments of diseased leaves lying on the ground, are burned, and the plants afterwards develop vigorous and healthy foliage.

Another mildew, called *Sphaerotheca pannosa*, proves very destructive to roses, the leaves and young shoots becoming covered with a white mould. Powdered sulphur, again, is a remedy if applied at intervals after the earliest appearance of the disease. Diseased leaves that have fallen should be collected and burned, otherwise the fungus will mature its fruit on such during the winter, and a fresh infection will follow the succeeding year. Diseased shoots should also be removed.

Brown Rot of Fruit.

(*Sclerotinia fructigena.*)

This is undoubtedly one of the worst of fungus diseases with which the fruit-grower has to contend, and unfortunately it is always present in more or less quantity wherever fruit is grown. It attacks apple, pear, plum, cherry, and, in fact, all orchard fruits, and is also common on many wild plants belonging to the order Rosaceae.

The young leaves are first attacked, the fungus appearing on the surface in the form of small, minute, velvety olive-brown patches, which gradually increase in size and grow into each other, until eventually the greater portion of the leaf becomes covered. The spores are carried by rain, wind, insects, etc., from one leaf to another, and at a later stage also on to the young fruit.

On the latter the first evidence of disease is the presence of small brown spots on the surface of the fruit. These spots gradually increase in size, and at a later stage become studded with small whitish downy warts, which constitute the conidial or summer form of fruit, at one time called *Monilia fructigena*, before it was discovered to be only one stage in the life-cycle of the higher form of fungus called *Sclerotinia fructigena*.

On the apple the white conidial tufts are arranged in concentric circles, being, in fact, miniature fairy-rings, due to gradual extension of the fungus on every side from the point of infection. On other fruits the tufts are irregularly scattered, and not arranged in circles.

Diseased apples do not rot, but shrivel, and remain in a dry, mummified condition throughout the winter, either hanging on the tree or lying on the ground. The following spring, just when the young leaves are expanding, these mummified apples produce another crop of conidia, which are dispersed by various agents, and infection of the young leaves results.

Those apples that become buried in the ground, or covered over with herbage, etc., produce at the end of two years, from the same mycelium that previously yielded conidia, a second kind of fruit of a much higher organisation than the conidial form, and the result of a sexual act. This second form resembles in appearance a widely open wine-glass, supported on a long slender stem, and belongs to the group of fungi called the Pezizeae. The spores of this form of fruit give origin to the conidial condition occurring on the foliage.

As to practical methods of preventing an epidemic caused by this fungus, the trees should be sprayed with a dilute solution of Bordeaux mixture, commencing at the unfolding of the leaves, and repeating at intervals until the fruit is half-grown. Of course, all diseased fruit should be collected and burned.

ON THE PHYLLOPODS *LIMNADIA LENTICULARIS* (L.) AND *LIMNETIS BRACHYURA* (O.F.M.), AND THEIR OCCURRENCE IN BOHEMIA.

By V. Vávra, Ph.D.

Communicated by D. J. Scourfield, F.R.M.S.

(*Read March 18th*, 1904.)

Plate 4.

Limnadia lenticularis (L.)

1761. *Monoculus lenticularis*, Linné, *Faun. Suec.*, 2nd ed., p. 499
1804. *Daphnia gigas*, Hermann, *Mém. Apt.*, p. 134, pl. v., f. 4-5.
1820. *Limnadia hermanni*, Brongniart, *Mém. Mus.*, vi., p. 84, pl. xiii.
1836. ,, ,, Guerin, *Mag. Zool.*, vii., 1836.
1840. ,, ,, M. Edwards, *Hist. Nat. Crust.* iii., p. 362.
1849. ,, ,, Baird, *P.Z.S. Lond.*, p. 86, pl. xi., f. 1.
1853. ,, *gigas*, Grube, *Arch.*, p. 157.
1865. ,, *hermanni*, Grube, *Arch.*, p. 270, pl. viii., f. 9-11.
1866. ,, ,, Lereboullet, *Ann. Sc. Nat.*, v., p. 383, pl. xii.
1871. ,, *gigas*, Lilljeborg, *Ofv. K. Vet. Akad. Forh.*, No. 7, p. 823, pl. xvii.-xviii., A-B.
1875. ,, *lenticularis*, Sahlberg, *Om. Finlands h. k. Phyllopoder. Not. F. Fl. Fenn. forh. N.S.*, 11, p. 310.
1877. ,, ,, Lilljeborg, *Syn. Phyll. Suec.*, p. 17.
1878. ,, ,, Spangenberg, *Zeitschrift w. Zool.*, xxx., *Suppl.*, p. 474.
1886. ,, ,, Simon, *Ann. Soc. Ent. de France*, p. 436.
1903. ,, *gigas*, Merkel, *Mitth. Bad. Zool.*, V., No. 16, p. 3.

As may be seen from the foregoing list of synonyms, this species was described as *Monoculus lenticularis* by Linné. His specimens came from Finland, and it was only because the species had not been found again in that country up to 1871 that Lilljeborg had doubts as to the propriety of retaining the name given to it by Linné. In 1875, however, Sahlberg found it again in Finland, and in 1877 Lilljeborg placed the identity of *M. lenticularis* (L.) with *D. gigas* Herm. and *L. hermanni* Brong. beyond all doubt.

Some examples of this interesting Phyllopod were received by me in June 1899 from my friend Professor F. Klapálek, and immediately afterwards I visited the spot, near Wittingau, in the south of Bohemia, where they had been found. They occurred in a quite shallow pond harbouring a rich aquatic vegetation, and I was able to collect numerous specimens and thus have the opportunity of watching the living animals. They swim upon their backs exactly in the manner of *Branchipus*, a fact about which some doubt has been expressed in recent times. When at rest the animals lie upon their sides. The bivalved shell is about 15 mm. long, 10 mm. high, and, seen from above, very narrow, only being about 4 mm. broad. It is highly polished and transparent, with seven or eight concentric lines marking stages in its growth (Figs. *a*, *c*).

The body of the animal does not fill the whole of the shell. The rounded head is bent downwards, and is furnished with a pair of large eyes, together with an eye-spot. The swimming antennae are pretty long and powerful, the shorter dorsal branch being usually ten-jointed, and the longer ventral branch eight to twelve-jointed, both being armed with long swimming bristles. On the back of the animal there is a so-called organ of attachment (Haftorgan). There are twenty-three to twenty-four body-segments, and the same number of pairs of feet, of which the first ten are equal in length, while the remaining pairs become gradually shorter. With the exception of the last, the feet carry two branchial appendages.

The ninth, tenth, and eleventh pairs of feet are provided with long thread-like processes (cirri), with which the eggs are held in position on the back (see Fig. *c*). The powerful post-abdomen or tail (Fig. *d*) is toothed on the dorsal edge, and furnished with two plumose bristles. At the end of the tail are two large movable claws, having little spines along their hinder edges.

Almost all the individuals seen carried eggs in the brood-cavity. These eggs are of a most remarkable form (Figs. *e* and *f*). Each egg is globular, with a diameter of 0·13 mm., and its surface is covered with oblique and pretty deep furrows. In addition to this it is clasped by two semicircular girdles, having a breadth of 0·8 mm., and standing at right angles to one another.

The male of *Limnadia lenticularis* is unknown, and propagation takes place parthenogenetically.

In the same pond with *Limnadia lenticularis* the following animals were found:

Littoral.	Pelagic.
Planorbis albus.	*Volvox globator* (in great numbers).
,, *nitidus.*	*Anabaena flosaquae.*
Cyclops fuscus.	*Daphnia longispina.*
,, *serrulatus.*	,, *pennata.*
Polyphemus pediculus.	*Diaptomus gracilis.*
Sida crystallina.	*Corethra plumicornis* (larvae).
Diaphanosoma brachyurum.	
Scapholeberis mucronata.	
Eurycercus lamellatus.	
Chydorus sphaericus.	
Curvipes rufus	The Hydrachnidae were determined by Dr. K. Thon.
,, *conglobatus*	
Neumania spinipes	
Prionocercus uncinatus	
Rhipidodendron splendidum.	

In similar small ponds near Wittingau *Apus productus* is also found, sometimes in great quantities in the spring, for these ponds are dried up during the greater part of the year.

Everywhere *Limnadia lenticularis* appears to be a very rare form. Linné obtained it from Finland; after 114 years it was found there again, near Helsingfors, by Sahlberg. It has also been recorded from Sweden, Norway, and Denmark; from Germany (Berlin, Breslau, Mainz, Trier, Landshut, Worms, Neustadt in Mecklenburg, Strasburg, and last year near Walldorf in Baden); and from France (near Fontainebleau).

Limnetis brachyura (O.F.M.)

1785. *Lynceus brachyurus*, O. F. Müller, *Ent. Dan.*, p. 69, pl. viii.
1847. *Limnetis brachyura*, Lovén, *Kgl. Akad. Handl.* for 1845, p. 430.
1848. *Hedessa sieboldi*, Lièvin, *Schrift. Ges. Danzig.*, p. 4.
1853. *Limnetis brachyura*, Grube, *Arch. Nat.*, p. 156.
1873. „ „ P. E. Müller, *Nat. Tid.*, p. 569.
1875. „ „ Hellich, *Vesmir*, t. iv., p. 158.
1877. „ „ Lilljeborg, *Nova. Act. Ups.*, iii., p. 18.
1886. „ „ Simon, *Crust. Phyll.*, p. 457.
1890. „ „ Sars, *Overs. Norg. Crust.*, p. 29.
1895. „ „ Wierzejski, *Sprav. Kom. Fyz.*, t. xxxi., p. 178.

The family of the Limnadiidae contains a second genus *Limnetis*. The species *L. brachyura* (O.F.M.) is comparatively small, being only 3 mm. long. The shell is almost globular, smooth and shining, and in outward appearance exactly like the shell of a *Cyclas*. The head is large; the first pair of antennae small and two-jointed. According to the investigations of Lilljeborg, there is only one pair of maxillae, as in the Cladocera, while in all the other Phyllopods there are two pairs. This species was found by B. Hellich in material collected in a little pond near Mělnik by Professor A. Fritsch, and was described by him in the Bohemian periodical *Vesmir*, in 1875. Specimens are preserved in the collection of the Prague Museum.

Up to the present time this species has been found in Denmark, Germany (Danzig), Russia (Archangel, Dorpat, Charkow), Finland, Bohemia, and Galicia (Crakow).

Explanation of Plate 4.

Fig. *a.*	*Limnadia lenticularis* ♀,		lateral view, nat. size.
„ *b.*	„	„	dorsal „ „ „
„ *c.*	„	„	lateral „ × 3.
„ *d.*	„	„	post-abdomen, × 14.
„ *e* and *f.*	„	„	egg, × 90.

NOTE ON EBONISING LABORATORY TABLES.

By W. J. Wood, F.R.M.S.

(*Read October 16th*, 1903.)

In the latter part of 1902 and the early part of this year, I fitted out two vessels for the International Sea Fisheries Investigation. The two steamships *Huxley* and *Goldseeker* are trawlers specially fitted up for biological and hydrographical research, the *Huxley* under the management of the Marine Biological Association, with Mr. Garstang as naturalist-in-charge, and the *Goldseeker* under the Scottish Fishery Board, Professor D'Arcy W. Thompson conducting the scientific work. While fitting out the *Goldseeker*, Professor Thompson sent me directions for ebonising the laboratory tables on this ship. The method was so successful that I have since ebonised my own microscope work-table at home, and I understand that Mr. Garstang has had the laboratory tables at the *Huxley's* headquarters, Lowestoft, treated in the same manner. I thought that perhaps this method of treating tables for micro and chemical work would be useful to some of our members, and have pleasure therefore in sending the recipe for publication. My own table-top is of plain teak, and the laboratory tables of the *Goldseeker* are yellow pine. Any kind of wood seems to take the stain.

(*a*) 250 grams of aniline chloride in one litre of water. This solution is applied to the wood every day for two or three days. It must be thoroughly dry before each application.

(*b*) 125 grams of copper sulphate dissolved in 80 grams of boiling water, and 125 grams of potassic chlorate dissolved by boiling with about 250 grams of water. These solutions are mixed together while quite hot, then allowed to cool. Then filter, and dilute the filtrate to one litre. This solution is applied to the wood the same as *a*, the wood being allowed to dry thoroughly after each application.

(*c*) At the end of this operation all crystals covering the surface of the wood are to be washed off with clean water.

(*d*) Once more dry the wood thoroughly and then paint over with cottonseed or raw linseed oil. Leave the oil for one day and then rub dry.

This preparation takes about six days, allowing two days for *a*, two for *b*, one for *c*, and one for *d*. I found it advisable to rub the table thoroughly with a dry absorbent duster for two or three days in succession, as the oil is not thoroughly removed with one rubbing.

I understand that the tables in the laboratory of the Danish investigation vessel *Thor* are treated in this manner. The result is a beautiful black surface which will withstand the usual reagents used in biological work.

NOTE ON THE SERTULARIIDAE OF KENT AND SUSSEX.

By Rev. H. A. Soames, M.A., F.R.M.S.

(*Read January 15th*, 1904.)

The Sertulariidae, a family of calyptoblastic hydroids, whose representatives are exclusively marine, includes about twenty-five species which occur upon our coasts. For those who live away from the sea-shore the study of the living animal is attended with considerable difficulty; but the empty receptacles are washed up by every storm, and may be obtained from the refuse of the trawl, and these, occurring as they do in such vast profusion and possessed of so many points of interest, certainly seem worthy of far more attention than they usually receive.

The specimens should be placed, as soon as collected, in methylated spirit, and in this condition will retain their characteristics, free from dust and risk of breakage, for an indefinite period. As may be gathered from the following notes, many of the Sertulariidae are commonly met with attached to Algae. Polyzoa, and even to other species of hydroids. The smaller species, especially at an early stage of growth, are easily overlooked, and may often be more readily detected if the object to which they are attached be placed in a jar of water.

The method I personally adopt for the mounting of these hydroids is as follows. The specimen is dried for a few minutes, placed in an excavated cell, covered with a large drop of Canada balsam in chloroform, and thin glass added in the usual way. The slide is then placed under an air-pump, in order to remove the bubbles from the calcycles, the air being exhausted and readmitted several times should it be found necessary. An alternative method, which obviates the necessity of using an air-pump, is as follows. The polypidom is transferred from the spirit to oil of cloves, thence to turpentine, and thence to balsam. The specimen should remain for at least one day in each fluid, and should be transferred with care and rapidity so as to prevent the air from entering the calcycles.

The following is a list of the species I have found in Kent and Sussex:—

Sertularella polyzonias, Linn.

Common on *Flustra*, etc. Deal, Sandgate, Bexhill, Dover, Folkestone, St. Leonards.

Sertularella rugosa, Linn.

Very common on *Flustra*. Deal, Sandgate, Bexhill, Folkestone, St. Leonards.

There are four other species of *Sertularella* which I have not yet found, although *S. gayi* certainly occurs.

Diphasia attenuata, Hincks.

Common on zoophytes, and sometimes on seaweed. It is the only species out of seven that I have at present found. Deal, Sandgate, Dover, Folkestone.

Sertularia pumila, Linn.

Very common, especially upon seaweed, whose fronds it often thickly covers. I have not found it upon zoophytes. Sandgate, Bexhill, Herne Bay, Whitstable, St. Leonards, Folkestone.

Sertularia gracilis, Hassall.

Not uncommon on zoophytes and seaweeds, but small and not easily seen. Sandgate, Dover, Westgate, Whitstable, Worthing.

Sertularia operculata, Linn.

Found upon zoophytes and seaweeds, often in masses of considerable size. Deal, Sandgate, Bexhill, Dover, Folkestone, St. Leonards, Margate.

Sertularia abietina, Linn.

A deep-water form, but large quantities are often cast ashore. Deal, Sandgate, Dover, Folkestone, St. Leonards.

Sertularia argentea, Ellis & Solander.

Common. Sandgate, Bexhill, Dover, Whitstable, Folkestone, St. Leonards.

Sertularia cupressina, Linn.

Not common. Whitstable, St. Leonards, Sandgate.

S. filicula and *S. fusca* I have not at present found.

Hydrallmania falcata, Linn.

Very common and characteristic. Deal, Sandgate, Bexhill, Dover, Westgate, Margate, Whitstable, Folkestone, Bognor.

Two species of *Thuiaria* occur in Britain, but I have not yet found either of them.

If any fellow-members have slides of hydroids which require identification, I shall be happy to assist them to the best of my ability.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on October 16th, 1903, Geo. Massee, Esq., F.L.S., President, in the Chair, the minutes of the meeting held on June 19th were read and confirmed, and the additions to the Library and Cabinet announced.

Professor Alexander S. Skorikow was balloted for and duly elected.

The death of Mr. Washington Teasdale, F.R.A.S., F.R.M.S., etc., at the age of seventy-three, was announced by Mr. Freeman, who furnished an obituary notice. Mr. Teasdale was a member of twenty-five years' standing, but, residing at Leeds, he was not of late years a frequent visitor to the Club meetings. In addition to his microscopical studies, he was a devotee to the camera, having taken up photography when that art was in its infancy. He had spent several years in India, and could relate many interesting experiences of Oriental life and customs. To those who were privileged to know him in private life he was a kind and sympathetic friend, ever willing to place his great knowledge at the disposal of the inexperienced. While attending a meeting of the British Association at Southport he had a severe stroke of paralysis, and on September 19th—a week later—a second attack brought to a close his eventful life.

Mr. Freeman also exhibited some exceedingly delicate and skilful microscopic rulings, the work of the late Mr. Teasdale.

Mr. Scourfield, on behalf of Mr. W. J. Wood, read a note on a method of ebonising wood for laboratory tables.

Mr. Frank P. Smith gave an address upon "The Spiders of the Sub-family Erigoninae," illustrated with blackboard sketches and specimens under microscopes.

The President said that the way in which the subject had been dealt with by Mr. Smith left no doubt that there was much more behind it, and this he hoped the Club might be able to draw upon at a future occasion.

At the meeting of the Club held on November 20th, 1903, J. G. Waller, Esq., F.S.A., Vice-President, in the Chair, the minutes of the meeting held on October 16th were read and confirmed, and the additions to the Library announced.

Messrs. G. W. Kirkaldy, William T. Waller, John L. Escudier, and Dr. Arthur B. Griffiths were balloted for and duly elected.

Mr. Karop announced that he had still a number of glass slips for distribution, and had brought them to the meeting so that members could take what they required.

Mr. Langton exhibited and described a portable microscope of his own design and manufacture.

Mr. Karop thought that Mr. Langton deserved great commendation for the ingenuity displayed in the construction of this instrument, and regretted that he had laboured under the great disadvantage of being without a lathe.

Mr. Wesché read a note "On the Mouth Organs of Dipterous Flies." The subject was illustrated by diagrams of the mouth parts of various insects, the homologies of which were very clearly pointed out.

Mr. Gleason gave an address on "Amateur Bacteriology," illustrated by lantern-slides. Many forms of bacteria were shown and explained, and also several ingenious pieces of apparatus constructed from the most homely utensils.

At the meeting of the Club held on December 18th, 1903, A. D. Michael, Esq., F.L.S., Vice-President, in the Chair, the minutes of the meeting held on November 20th were read and confirmed, and the additions to the Library announced.

Messrs. F. F. Beckett and F. J. Oxley were balloted for and duly elected.

Mr. Rheinberg exhibited and described a large number of beautiful and curious diffraction plates and gratings.

Mr. Scourfield gave a *résumé* of the third part of his "Synopsis of the British Fresh-water Entomostraca," dealing with the Ostracoda, the Branchiura, and the Phyllopoda. The structure of a typical Ostracod was described and illustrated by means of a diagram.

Mr. Rheinberg read a paper "On an Overlooked Point concerning the Resolving Power of the Microscope," illustrated by diagrams and a Grayson ruling exhibited under special apparatus. The paper was followed by a discussion, in which Messrs. Hilton, Rheinberg, Neville, and Stokes took part.

Owing to the lateness of the hour it was decided to hold over a note by the Rev. H. A. Soames "On the Sertulariidae of Kent and Sussex"; but the President drew attention to the exhibition of slides in illustration of this paper under microscopes provided by the kindness of Mr. C. L. Curties.

At the meeting of the Club held on January 15th, 1904, George Massee, Esq., F.L.S., President, in the Chair, the minutes of the meeting held on December 18th, 1903, were read and confirmed, and the additions to the Library and Cabinet announced.

Messrs. John H. Pledge, Walter Hunter, John Hopkinson, L. Bulcher, William Cox, and Dr. Thomas B. Sprague were balloted for and duly elected.

The Secretary reminded the members that the Annual Meeting would be held upon February 19th, and invited nominations to fill the vacancies upon the Committee caused by the retirement by rotation of four members and the resignation of Mr. G. T. Harris. The list of gentlemen nominated as officers for the ensuing year was also read. As an auditor on behalf of the members, Mr. Hicks was proposed and duly elected.

Mr. C. F. Rousselet read a paper "On a New Fresh-water Polyzoon from Rhodesia," illustrated by drawings and specimens.

The President remarked upon the extreme value of a paper of this kind, especially as the known species of Polyzoa were so few and the literature of such a scattered nature.

Mr. Holder exhibited a number of excellent lantern-slides of Foraminifera of his own preparation, the more interesting details being pointed out by Mr. Earland.

The Rev. H. A. Soames' note "On the Sertulariidae of Kent and Sussex," held over from the previous meeting, was taken as read.

At the Annual Meeting of the Club held on February 19th, 1904, George Massee, Esq., F.L.S., President, in the Chair, the minutes of the meeting held on January 15th, were read and confirmed, and the additions to the Library and Cabinet announced

Messrs. J. Burton, L. W. Allardice, C. Graham, A. C. Butterworth, D. Finlayson, J. W. Page, and R. Gurney were balloted for and duly elected.

The Officers and Council for the ensuing year were balloted for and the result announced.

The 38th Annual Report was read by the Secretary, and the Statement of Accounts by the Treasurer.

The President delivered his Annual Address upon the subject of "Plant Diseases caused by Fungi," the chair being meanwhile occupied by Mr. A. D. Michael.

A hearty vote of thanks was accorded the President, who then introduced his successor, Dr. Edmund J. Spitta. In a short address. Dr. Spitta expressed his intention of doing all within his power for the welfare of the Club, and the meeting terminated with the usual conversazione.

THIRTY-EIGHTH ANNUAL REPORT.

Your Committee is again able to report favourably upon the Club's progress during the past year.

During the twelve months ending December 31st, 1903, thirty-three new members were elected. This may be considered a very satisfactory total, as it represents the average number elected during the last ten years, which include the two remarkably prosperous years, 1901 and 1902, during which the large number of ninety-nine new members were elected. Twenty-six members have been lost owing to resignation or removal, and four have died. Three of these were old members of the Club, Mr. J. W. May having joined so far back as May 1871, and Mr. W. Stuart Smith in August 1872; while the third, and perhaps the best known, Mr. Washington Teasdale, had been a member since August 1878. The total number on the books of the Club on December 31st was 379, as compared with 370 in the previous year.

The attendance, both on "gossip" nights, and at the ordinary meetings, has been quite up to the average of previous years, and the Club is probably favoured with larger gatherings than any other society of its kind in London. The number and quality of the exhibits also show no signs of falling off.

The chief communications read at the meetings of the year are as follows:—

Jan.	The Male Organs of *Scatophaga lutaria* and *S. stercoraria* .	Mr. Wesché.
,,	Some points in the Structure and Life-history of Diatoms.	Mr. Rowley.
,,	Synopsis of the Known Species of British Fresh-water Entomostraca.—Part I. Cladocera	Mr. Scourfield.
,,	On the Larva of an Hydrachnid found in the Stomach of a Trout	Mr. Soar.
Feb.	President's Address on Fermentation and Putrefaction .	Mr. Massee.

March	Pocket Magnifiers . . .	Mr. Karop.
April	Further Observations on Male Rotifers	Messrs. Marks and Wesché.
,,	Remarks on the Emission of Musical Notes by *Eristalis tenax*	Mr. W. H. Harris.
May	On a method of taking Internal Casts of Foraminifera . .	Mr. Quilter.
June	Two new Commensal Bdelloida.	Signor Piovanelli.
,,	Two new species of *Philodina*.	Mr. Bryce.
,,	On Abbe's test of Aplanatism and a simple Apertometer derived therefrom . .	Mr. Cheshire.
,,	Synopsis of the Known Species of British Fresh-water Entomostraca.—Part II. Copepoda	Mr. Scourfield.
Oct.	Spiders of the Sub-family Erigoninae	Mr. F. P. Smith.
Nov.	Amateur Bacteriology . .	Mr. Gleason.
Dec.	Synopsis of the Known Species of British Fresh-water Entomostraca.—Part III. Ostracoda, Branchiura, and Phyllopoda	Mr. Scourfield.
,,	On an Overlooked Point concerning the Resolving Power of the Microscope .	Mr. Rheinberg.

The Committee begs to thank the members who have communicated their investigations to the Club.

The following books, periodicals, and transactions of learned societies have been added to the Library during the past year:—

Cross & Cole's *Modern Microscopy*. 3rd edition.
Dr. Braithwaite's *British Moss Flora*. Part 22.
Missouri Botanical Garden Report, 1903.
Smithsonian Annual Reports.
American Botanical Gazette.

Proceedings of Academy of Natural Science of Philadelphia.
Journal of Applied Microscopy.
Journal of the Royal Microscopical Society.
Proceedings of the Royal Society.
Journal and Proceedings of the Royal Society of New South Wales.
Newstead's *British Coccidae*, Vol. 2. Ray Society.
Michael's *British Tyroglyphidae*, Vol. 2. Ray Society.
Quarterly Journal of Microscopical Science.
Annals and Magazine of Natural History.
British Museum Handbook of Instructions for Collectors.
Proceedings of the Geologists' Association.
Sundry other Proceedings and Transactions, and various pamphlets.

The Committee have much pleasure in announcing that the Honorary Librarian has completed a new Catalogue of the works in the Club's Library in three sections—Authors, Titles, and Journals of Scientific Societies. The Catalogue has been printed, and is now on sale at the price of 1*s.* The publication of this Catalogue will undoubtedly greatly enhance the value of their Library to the members, and the Committee do not doubt that members will cordially appreciate the completion of their Librarian's task, the labour of which has been greatly increased by the inadequate accommodation at his disposal.

The Journal has been issued with the usual regularity, and the October number marks the completion of the eighth volume of the Second Series. The Committee regret to announce that Mr. Scourfield finds himself unable to continue the office of Editor, owing to pressure of other work, and in accepting his resignation the Committee desire to place upon record their cordial appreciation of his services, and of the uniformly high standard maintained by the Journal during his four years of office.

It is, however, most desirable that the members should realise that the present high standard of the Journal is attended by a correspondingly high expenditure, and even under the existing conditions, could only be maintained so long as the membership remained at its present figure. A reference to the Balance Sheet will show that the Club's income is practically absorbed by two items, rent and the expenses of the Journal. In view of a probable increase in the Club's rental, it may be necessary to diminish the expenditure upon the Journal, unless the income of the Club can be correspondingly increased. The Committee therefore trust that all the members will take an active interest in a matter so vital to the welfare of the Club, and endeavour to increase the membership by bringing the Club under the notice of their acquaintances. The advantages offered to the amateur microscopist in return for a very moderate subscription are so obvious that a large influx of new members would undoubtedly result from such advertisement, and this would render it possible to meet the increased expenditure without diminishing the present high standard of the Journal.

The Honorary Curator reports an increased demand for the loan of slides from the Club's cabinets. During the past year over 2,000 slides have been borrowed, and the number would doubtless have been still larger but for the cramped conditions under which the Curator is unfortunately compelled to work. One hundred and twenty-four slides have been presented, and seventy-six purchased out of proceeds realised by the sales of Catalogues. With the object of further extending the usefulness of the Cabinets, five series of slides on Botanical Histology have been prepared. A key to each series, explaining the chief points of interest, and illustrated by diagrams, has been written by Mr. R. Paulson. The best thanks of the Club are due to this gentleman for the careful and instructive way in which these notes have been compiled.

The number of members who have attended the Excursions during the past year is higher than in any previous year since 1893. In 1893 the total number of attendances was 124; in the past year the total number was 117, or an average number of 13 for each of the nine excursions. The excursion to the Royal Botanical Gardens was, as usual, the best supported; in spite of the weather no less than 32 members attended. A new locality, viz. Wallington, Surrey, was visited in the excursion of July 11th, which was attended by 9 members, who spent an enjoyable afternoon collecting in the private grounds of Mr. Christy and Mr. Maitland. The thanks of the Club are due to these gentlemen for the privilege thus afforded. The excursions were well patronised by the new members, to whom the experience thus obtainable should be specially valuable.

The finances of the Club are in a sound condition, and there is very little in the Balance Sheet requiring comment. The amounts received from subscriptions and from the sales of Catalogues show a slight increase, which is nearly balanced by a slight decrease in the receipts from advertisements. The balance in hand—viz. £190 9*s.* 3*d.*—shows an increase of £22 4*s.* 5*d.* on the balance at the end of last year, but as the greater part of this increase may be considered as already earmarked for the cost of printing the Catalogue of Books, the balance may be regarded as nearly the same as last year.

The Committee desires to express its thanks to the officers for their individual and collective services, on which the efficiency of the Club so largely depends. In this connection they desire especially to draw the attention of all members to the loss which the Club is sustaining in the retirement of their Honorary Secretary, Mr. G. C. Karop, who, after more than twenty years of devoted service to the Club, is now resigning his office.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1903.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1902	168	4	10	By Rent of Rooms and Bookcases	51	12	0
,, Subscriptions received during 1903 ...	186	0	2	,, Expenses of Journal	125	2	2
,, Dividends, etc., on Investments	8	18	2	,, Postage	6	8	2
,, Sales of Journal	11	7	11	,, Printing and Stationery	7	6	4
,, Sales of Reprints	0	6	6	,, Attendance	6	0	0
,, Sales of Catalogues, etc.	2	0	9	,, Petty Expenses	1	15	9
,, Receipts for Advertisements	19	13	0	,, Books and Slides	7	17	8
				,, Balance in hand, £100 of which is at Deposit Account at Bank	190	9	3
	£399	11	4		£399	11	4

INVESTMENTS.

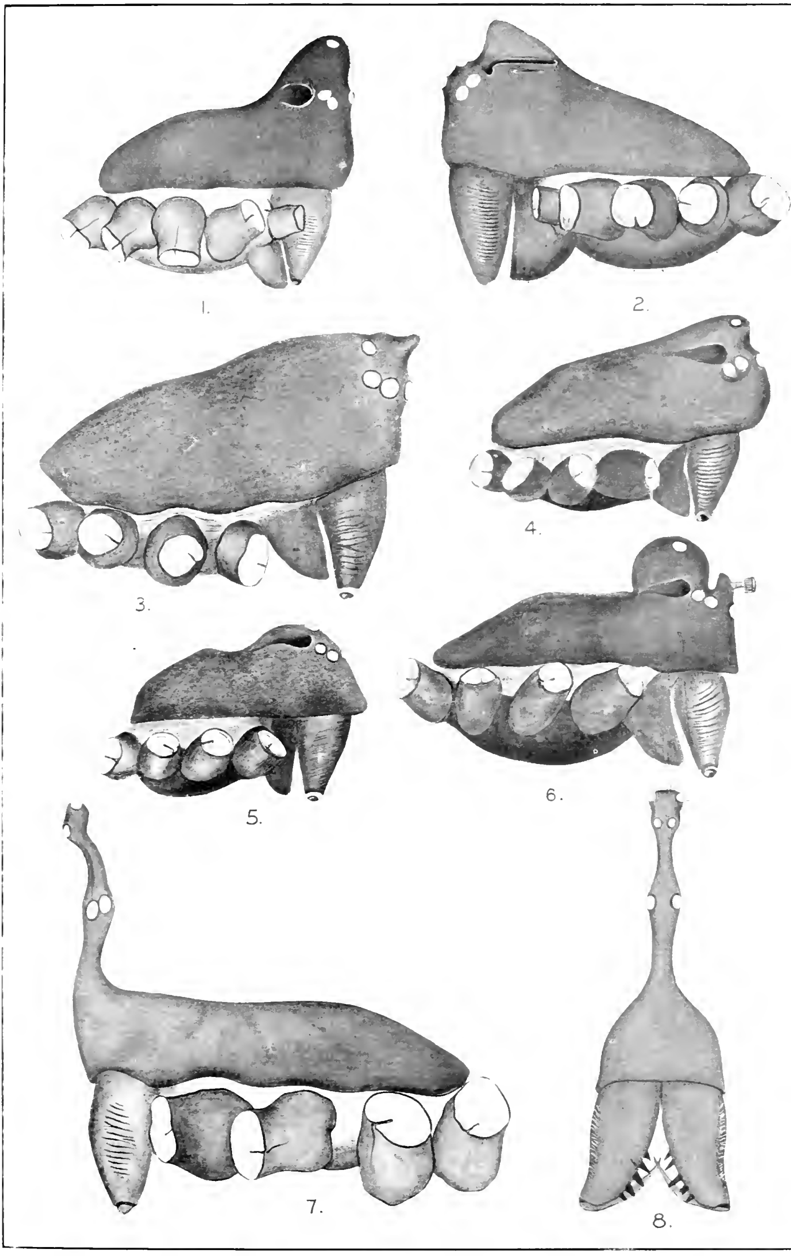
	£	s.	d.
$2\frac{1}{2}$ per cent. Consols	200	0	0
$2\frac{1}{2}$ per cent. Metropolitan Stock	49	5	2
$2\frac{1}{2}$ per cent. Annuities, 1905	100	0	0
	£349	5	2

We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and have verified the investments at the Bank of England, and find the same correct.

January 28th, 1904.

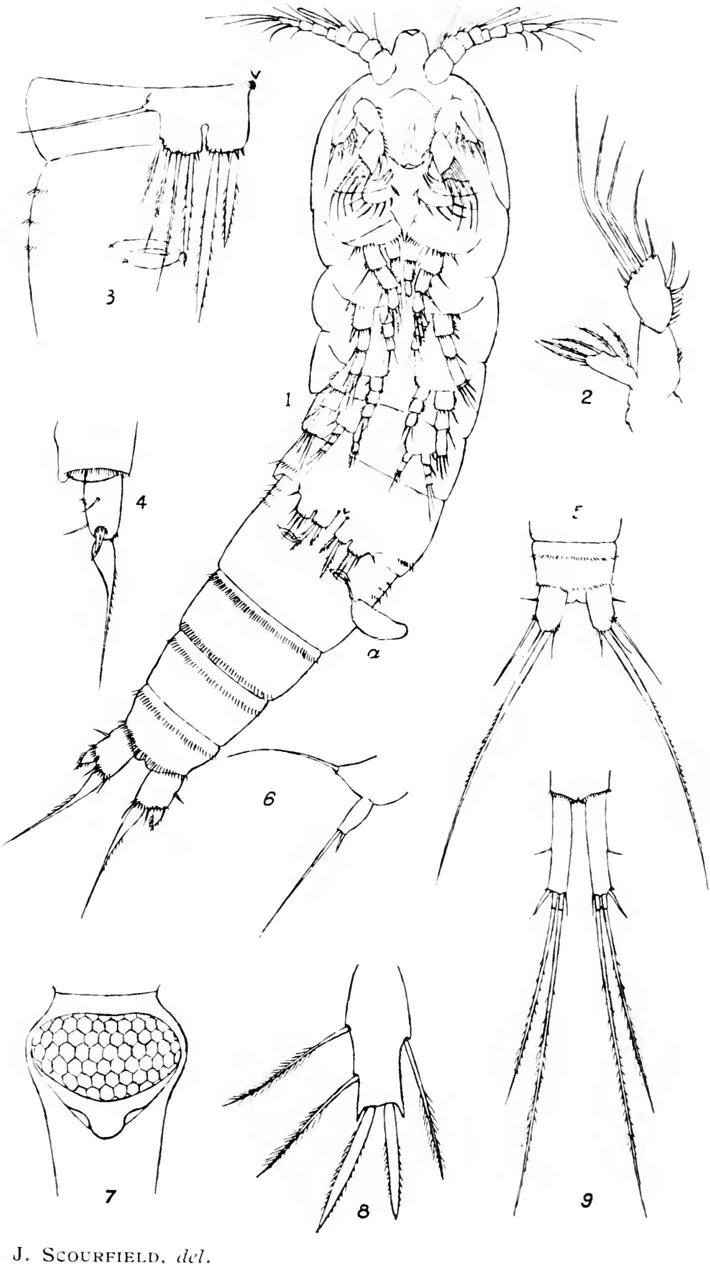
H. MORLAND, *Hon. Treasurer.*

F. HUGHES }
F. H. HICKS } *Auditors.*



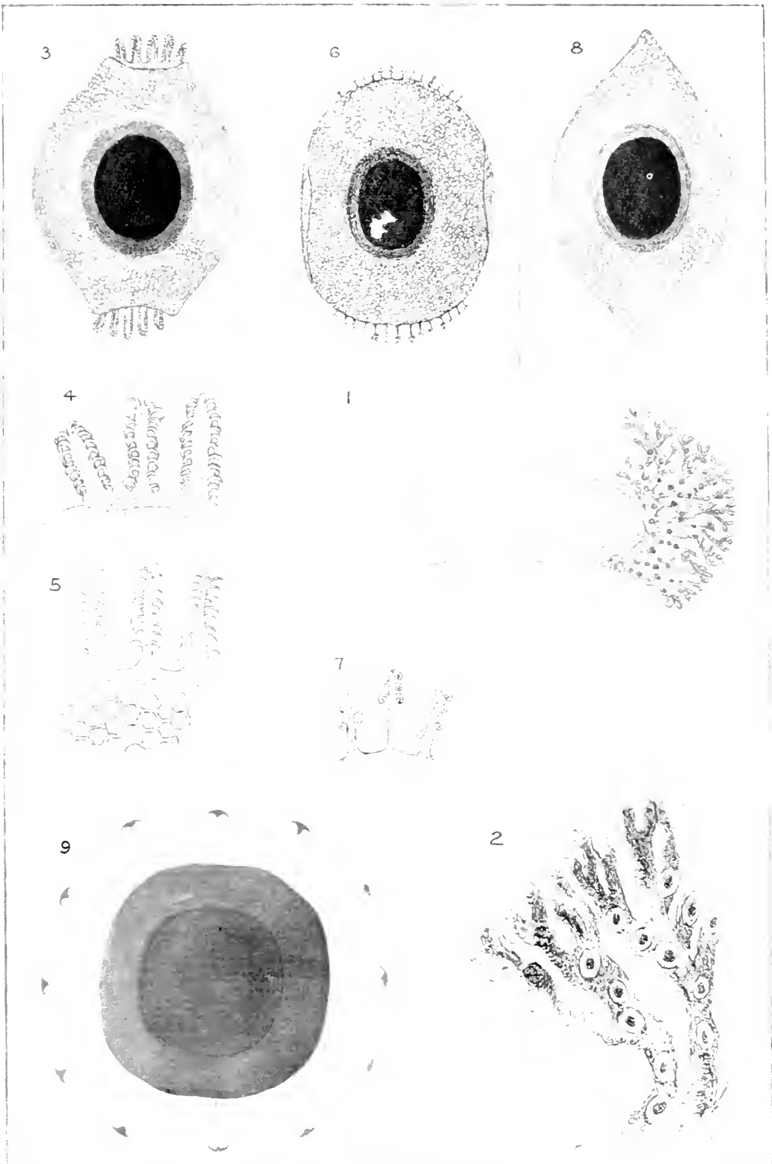
Frank P. Smith, *del. ad nat.*

Cephalo-thoraces of Male Erigoninae.



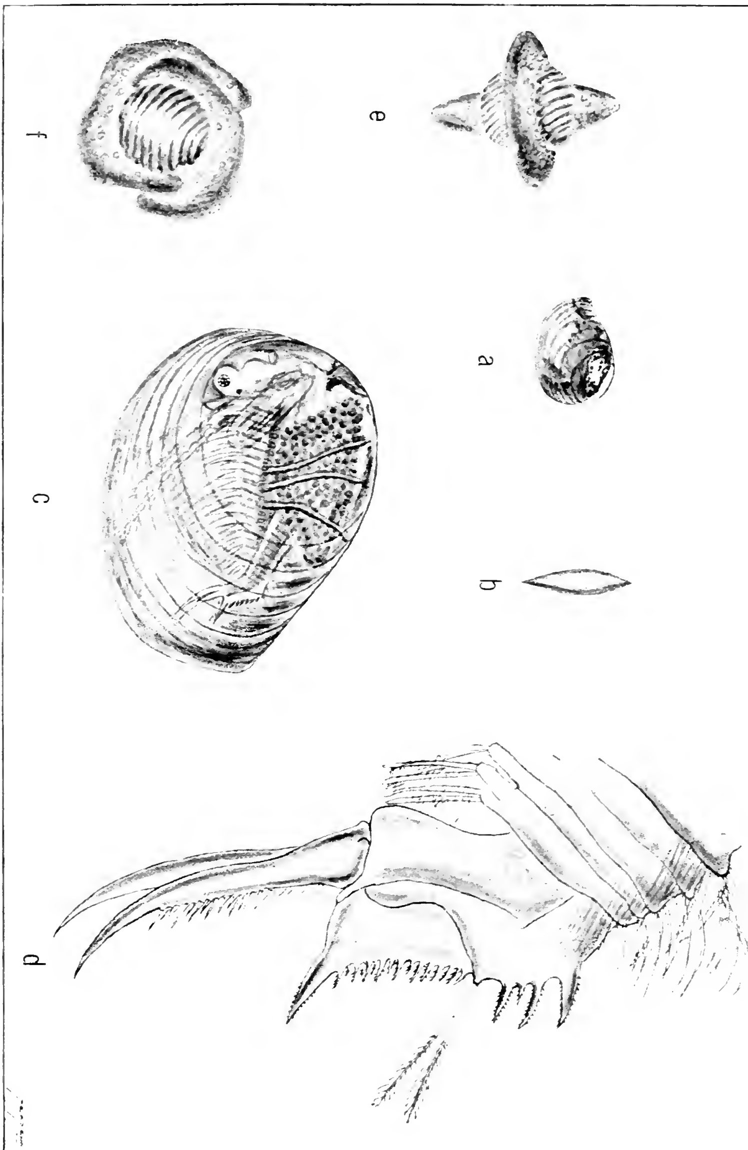
D. J. Scourfield, *del.*

Belisarius viguieri.
Cyclops nanus.



F. R. Dixon-Nuttall, *del ad nat.*

Lophopodella thomasi. gen. & sp. nov.



V. Vávra, *del.*

Limnadia lenticularis.

THE GENITAL ORGANS OF *TAENIA SINUOSA*

By T. B. Rosseter, F.R.M.S.

(*Read March 18th*, 1904.)

Plate 5.

Taenia sinuosa, Zeder (Dujardin).

1782. *Taenia collari-nigro*, Block.
1782. ,, *infundibuliformis*, Goeze.
1786. ,, *collaris*. Batsch.
1790. ,, *torquata*, Gmelin.
1800. *Alyselminthus sinuosus*, Zeder.
1800. *Taenia breviarticulata*, Goeze.
1803. *Halysis sinuosa*, Zeder.
1803. *Halysis torquata* (Gmelin, 1790). Zeder, vide Rud, 1810.
1845. *Taenia sinuosa*, Dujardin.
1858. *Hymenolepis sinuosa*, Weinland.
1869. *Taenia sinuosa*, Krabbe.
1893. *Drepanidotaenia sinuosa*, Railliet
1903. *Taenia sinuosa*, Rosseter.

From the time that Block (1782) found this worm parasitic in the intestine of *Anas boschas fera*, until Krabbe (1866) took it from *Anas boschas dom.*, much uncertainty seems to have existed as to the true character and identity of this avian helminth. Krabbe, following Dujardin's determination of Zeder's *Taenia sinuosa*, adopted the same, and this basis is likewise adopted by the author of this memoir.

Dujardin's description is as follows :—

"Long de 50 à 160 mm. (à 330 mm , Rud), capillaire en avant, large de 2·25 mm. en arrière ; tête presque globuleuse avec un prolongement conique tubuleux, plus ou moins saillant qui contient la trompe ; trompe retractile, aussi longue que la tête, mince, renflée à l'extrémité, et armée de dix crochets très-longs (de 0·040 à 0·042 mm.), très saillants, presque droits; cou très-long; les articles mâles trapézoïdaux; derniers articles (androgynes ou femelles) plus ou moins arrondis; orifices génitaux unilatéraux; appareil mâle formé d'un testicule blanc ou jaunâtre opaque, situé transversalement au milieu de chaque article, avec une tige cornée mince, contenue dans un tube hérissé de poils et dirigé transversalement vers l'orifice genital: à côtè de cet orifice se trouve un sac intérieur globuleux, tout hérissé de poils ou de petites épines, et paraissant comme un point noir sur le côté de chaque article (d'où resulte une ligne de points noirs très régulière). Je l'ai trouvé assez communément à Rennes dans l'oie et le canard" (Duj. *Hist. des Helm.*, p. 573, No. 35, *T. sinueux*).

The specimens upon which I have been working were taken from the intestine of a duck (*Anas boschas dom.*) fed artificially by me on cysticercoids (*Cysticercus sinuosa*) taken from the Beverley dairy-farm pond in the parish of St. Stephen's, near Canterbury. The result of feeding was not so successful from the point of view of growth as was anticipated; nevertheless, the object in view—namely, the production of the mature worm from the cysticercoids for the study of the organs of generation—was obtained. This sets at rest in connection with this avian tape-worm the views expressed at different times by O. von Haman, Von Linstow, Mrázek, and myself, that the cysticercoids found in Copepods by the former, and by myself in Ostracods, were the cystic scolices of Krabbe's *T. sinuosa*, and of which Stiles, in his work on *The Tape-worms of Poultry*, said, "For the want of experimental infection is problematical and not positive."

Although this platyhelminth has been known for the past century and a quarter, and studied by various eminent helminthologists, yet, hitherto, the organs of generation have been very inaccurately described and imperfectly portrayed.

Respecting the external form of this tape-worm, I am in accordance with Krabbe in accepting Dujardin's determination of Zeder's *T. sinuosa*; but the description of the internal anatomy will be taken from notes and observations made from my own prepared and mounted specimens. Dujardin gives the length of this tape-worm as from 50 mm. to 160 mm. The Zeder-Rudolphi specimen was 330 mm. My longest specimen produced by infection was 18 mm. Thus it will be seen that it has no pretensions to the length of the Zeder-Rudolphi or even the Dujardin specimen; but it is a perfect worm, minus the uterine sac with the uterine eggs.

Male Organs.

The male genital pore (Fig. 1, *d*)—I use it in the singular—is unilateral, and is situated on the anterior lateral border of the segment. It is cup-shaped; its orifice has a diameter of ·026 mm., and the diaphanous cup has a depth of about ·065 mm., and is easily overlooked. The male organs are situated well up in the anterior portion of the segment, being overlapped somewhat considerably by the posterior transverse border of the preceding segment. They consist of a cirrus, with its sheath, a vesicula seminalis, a vas-deferens, a monoecious testis, and paired prostate glands. In a mature specimen the proglottis is ·325 mm. long, and in width 1·747 mm. anteriorly, and 1·976 mm. posteriorly.

The testis (Fig. 1, *a*) is a subglobular organ, having an approximate diameter of ·162 mm. In those young segments which are approaching maturity it appears to be situated in the centre, or nearly so, of the anterior portion of the proglottis; but as the segment develops, and with it the generative organs, the testis gradually moves backwards towards the anterior distal lateral border, on its dorsal side immediately over the distal end of the receptaculum seminis. The growth of the spermatozoa within the spermatic sac is analogous to—in fact, is a counterpart of—the development of the spermatozoa of *T. coronula*, with this exception, that the bundles of spermatozoa do not form coils or strands, but are passed on individually through the vasa-efferentia to the vesicula seminalis. The head of the spermatozoon is a spatulate cell containing a cellule or nucleus of plastic substance easily stained by either haemalum or haematoxylin, whilst the cell itself, being structureless, remains in a perfectly hyaline condition. Ordinarily this spatulate head of the spermatozoon wraps itself round until if forms a blunt-pointed spathe (Fig. 2, *b*), and this no doubt is its normal condition when it meets and penetrates the ovum in the fructifying canal.

On leaving the testis the vasa-efferentia curves sharply but gracefully upwards, and becomes a sinuous vas-deferens (Fig. 1, *b*), running distally and proximally in the segment, and ultimately becomes a sac within the vesicula seminalis. In young specimens this sac is very pronounced, and may be beautifully demonstrated by the aid of haemalum.

The vesicula seminalis (Fig. 1, *c*) is situated in the dorso-anterior portion of the proglottis. Its distal end is rounded, whilst its proximal end elongates itself to form the cirrus-sheath. It is an elongated pyriform sac, ·35 mm. in length and ·065 in breadth.

The cirrus-sheath is, normally, ·13 mm. in length, but during the act of coition it exserts itself to ·212 mm. Its mean width is ·016 mm. Externally it is hispid, but internally it is smooth. The cirrus (Fig 1, *e*) is a long, hollow, smooth, diaphanous, flexible tube, and, when exserted for the purpose of coition, has a length of ·23 mm., and is 2 μ wide.

Below the male genital pore, somewhat anterior of the plane of the cirrus-pouch, is what, under a low power, appears to be a dark punctate spot or point. This is not seen in the early or young proglottides, but makes its appearance as the male organ approaches maturity, and continues to increase in size until the male organ has attained its perfection. Seen under a $\frac{1}{4}$-inch objective it is a globular spinous sac (Fig. 1, *f*), with a round, smooth, diaphanous collar, somewhat similar to a collared monad. It is hollow, and the endoderm is smooth, although punctate. These punctuations are at the bases of the spines. In some proglottides it appears as if the cirrus with the proximal end of its sheath passes through its centre. Such, however, is not the case, for it lies dorsal of that organ, and is easily dissociated, by teasing, from the cellular tissue in which it is embedded.

One cannot refer with any certainty farther back than Dujardin respecting the knowledge of the existence of this spinous body in the structure of this particular platyhelminth, and we have only one other instance of it occurring in the Cestoidae—viz. in Krabbe's *Taenia fragilis*, which he took from *Anas crecca*. No mention is made of this dark point by Rudolphi, in his synopsis, and Zeder's drawings of the generative organs do not contain it (Fig. 4). From the days of Dujardin and Stiles no explanation has been given as to what part this spinous body plays in the structural economy of this particular helminth. The hispid (spinous?) cirrus-sheath is of common occurrence, and armed suckers occur in *Daraniae echinobothridae* and *Echinocotylus rosseteri*, each having their uses—the former to assist in the act of coition, and the latter to anchor the scolex in the mucous membrane of the intestine; but this globular spinous sac performs no such function. How, then, are we to explain its presence, and what inferences are we to draw as to its utility in the structural economy of tape-worms? In my opinion we must look backwards for a solution of the problem.

The more one studies and considers the class Cestoidae from a taxonomist's point of view, the more one is brought face to face with the question, "Have the Cestoidae advanced or retrograded in the law of evolution?" I cannot think, as some eminent histologists have thought and at the present day do think, "that nature, having once made a step forward by the creation of cell tissue, reverts under circumstances inimical to its environment to the original form." If we advocate and concede this theory in the lower forms of life, we must admit the same causation in the other orders of nature, for one law governs the whole, and the law of adaptability, in no matter what form, or under what circumstances, is but an empty theory. For instance, *Trichodina pediculus*, considered essentially an ectoparasite on the tentacles of the fresh-water polypes *Hydra fusca* and *H. viridis*, and sometimes on the branchial appendages of the larvae of *Triton cristatus*, loses none of its ectoparasitic characteristics on becoming an endoparasite on the urinary organs of the adult *Triton cristatus*, having migrated there through the gill slits during the act of absorption of the branchiae (see Rosseter on "*Trichodina* as an Endoparasite," *Journ. R.M.S.*, Ser. 2, Vol. VI., 1886, p. 929). The fact of these platyhelminths being endowed with organs of generation which, although hermaphroditic, are comparable favourably with the bisexuality of the higher orders of nature, and are yet *anenterous*, does not necessarily imply that they previously were *enteritic*, but having by disusage, caused possibly by their surrounding environments, lost the organs of nutrition, from this cause had thus retrograded in the scale of life. Far from it: I maintain that these platyhelminths never possessed an enteron. No matter what stage of segmentation in the strobila you examine, no trace of such a tract can be found existing, or as having existed, in their cellular tissue. I have looked in vain in prepared and stained sections, and have never been able to resolve Pagenstecher's narrow space within the muscular layers (*Taenia critica*) which he would represent as the body cavity; neither can the "anlage" of the digestive apparatus (?) be traced in the embryo or hexacanth stage. Nor is the saccular cavity of the cyst (*Cysticercus*) to be looked upon as an enterocoele; it is merely the blastomeric cavity of the forming strobila. Thus we are forced to consider this cavity as a blastocoele; consequently, it has never arrived at, much less passed through, in the law of development, the gastrula stage. Looking at it from this point of view I arrive at the conclusion that a close affinity exists between the Cestoidae (*Taenia sinuosa*) and the Porifera-Spongidae. One can trace this affinity backwards through *Turbellaria convoluta*, which, like the Cestoidae, ingests its sustenance through the endodermal parenchyma; likewise in the Discophora, in which is foreshadowed by the agamogenetic multiplication of the colonies by fission, into eight-lobed discoidal medusoids (*Medusa bifida*), the future strobila of the Taenidae; and finally in the lowest groups of the Metazoa, the Porifera, the cellular tissue of the one is structurally the counterpart of the other. That which I wish chiefly to draw attention to, however, is the spiculiferous character of the Porifera and its relationship, or affinity, in this respect, with the Cestoidae, more particularly as regards *Taenia sinuosa*.

The skeleton of the calcareous sponges consists, as is well known, of an aggregation of separate spiculae which are developed exclusively in the ectoderm, and is not, according to Huxley, supported by any framework of animal matter. This statement is equally applicable to the Taenidae, for these spiculae of *T. sinuosa*, although appearing, when viewed by a 1-in. objective, *en masse*, yet when they are examined with a $\frac{1}{6}$-in. objective and separated by pressure from the globular mass, are seen to be totally distinct from each other. The globulous mass of spiculae is formed between the ectodermal structure or cortical layer and the middle layer. It is easily detached, and then does not carry adhering to it any of the surrounding cellular tissue, thus showing that it is not supported by the same. Thus I look upon this globulous dark point of Dujardin—seeing that it plays no known part in the structural economy of the creature—as a spiculiferous relic, pointing out to us that the Cestoidae are closely allied to the Porifera. This may in some measure explain the views of Von Siebold as to the calcareous corpuscles which are present in such abundance in the proglottides of some species of *Taenia* more than in others, being skeletal, and not, as Claparede thought, "the result of an excretion." This affinity is more emphasised and strengthened when we consider and contrast the origin and formation of the spermatozoa and ova in the Porifera and Cestoidae, for the calcareous sponges, like the Cestoidae, are hermaphroditic, and their reproductive elements are spermatozoa and ova; and whilst it is assumed, for the want of positive evidence, that the former in the calcareous sponges originate in metamorphosed cells in the endoderm, it is a demonstrable fact that such is their origin and development from the endoderm of the middle layer of the proglottis in the Cestoidae, whilst the ciliated embryo of *Bothriocephalus latus*, minus its six embryonic hooks, is but the counterpart of that of *Ascetta mirabilis*. Thus I am inclined to the opinion that the Cestoidae have not undergone retrogression, but that they have always been, in conformity with their environment, as we now find them, "a nenterous."

Female Organs.

Of the 115 to 120 species of avian tape-worms figured and described by Krabbe in his *Bidrag til Kundskab om Fuglenes Baendelorme*, 1869, there are only four in which he foreshadows the female genital organs—viz. *T. microcantha*, *T. capito*, *T. villosa*, and *T. sinuosa*—and even then in a very imperfect manner. If we refer, in the case of *T. sinuosa*, to his sketch of these organs, Tab. 7, fig. 153 (Fig. 5), we find merely the outline of certain bodies, but nothing to indicate their individuality or functions. I take them to represent the receptaculum seminis, paired ovaries, and the shell and yelk glands. An undulating filiform streak is seen passing dorsally of the vesicula seminalis, but there is nothing to lead us to infer that it has any connection with or plays any part structurally in the genital apparatus; yet, on close examination, we find that the contra is the case, and that it does play a most important part and is an essential portion of the female genital organs. In fairness to Krabbe it must be admitted that these organs, however obscurely sketched and unexplained by him, are to some extent accurately placed in the outline of the sketched segment.

In this species the female genital pore (Fig. 1, *h*) is quite distinct from that of the male. It is situated in the same plane, dorsally, but not on the lateral border. Its position is in the median line, 0·163 mm. from the lateral border. Thus it is some distance down the segment, and it is instructive to note the manner in which the whip-like cirrus, when exserted from the male pore for the purpose of coition, glides from the lateral border down the segment to the female genital pore. The vulva has a diameter of ·026 mm. The vagina is diaphanous and smooth both externally and internally. The vaginal canal (Fig. 1, *i*)—which the thin undulating line drawn by Krabbe across the vesicula seminalis in his sketch of the genital organs evidentally is meant to represent, although not described by him as such—runs obliquely, not undulatingly, dorsally over the vesicula seminalis far up under the lappet of the preceding segment, and is thus very much obscured and difficult to trace. It is then suddenly diverted, and returns ventrally under the distal end of the vesicula seminalis and joins the receptaculum seminis.

The receptaculum seminis (Fig. 1, *j*) is a triangular sac with rounded corners at its base. The vaginal canal enters it at its apex. It has a length of ·227 mm., and its base is ·097 mm., its basal angle being thus more contracted than the lateral angles. It is situated in the anterior distal portion of the proglottis, ventral to and immediately under the moniliform testis, and under such circumstances it is somewhat difficult to discriminate between them. Its efferent canal leaves it on the ventral side, runs backwards, then sharply curves round and passes on to join the ovarian ducts.

The ovaries (Fig. 1, *l′*-*l″*) are two orbicular lobed glands, situated proximally and distally in the ventral posterior portion of the segment, and have a mean diameter individually of ·211 mm. Their ducts coalesce with the duct of the receptaculum seminis, and thus form the fructifying canal, which descends into the yelk gland.

The yelk gland (Fig. 1, *m*) is situated anterior to, and the shell gland (Fig. 1, *n*) posterior to, the ovaries, in the median line of the proglottis. The former is globular, and the latter, being pyriform, runs distally, and is partially obscured by the posterior portion of the distal ovary.

I have not had the opportunity to study the uterus with its uterine ova, in consequence, as so often happens in experimentally bred platyhelminths, of the segments not having arrived at the uterine stage of development.

Explanation of Plate 5.

Fig. 1. Male and female genital organs *in situ*, × 155 : *a*, testis ; *b*, vas-deferens ; *c*, vesicula seminalis ; *d*, male genital pore ; *e′*, cirrus extruded ; *e″*, cirrus-pouch ; *f*, spiculiferous globule ; *g′*-*g″*, prostate glands with their ducts ; *h*, female genital pore with vagina ; *i*, vaginal canal (Krabbe's thin undulating streak) ; *j*, receptaculum seminis ; *k*, efferent duct of receptaculum seminis or fructifying canal, making a junction

with oviducts 1 and 2; *l'*, proximal, *l''*, distal ovaries; *m*, yelk gland; *n*, pyriform shell gland; *o*, uterine canal.

Fig. 2. *a* and *b*, spermatozoa.

„ 3. Transverse section through spiculiferous globule, × 350.

„ 4. Two segments enlarged; *aa*, *bb*, the vermiform sacs; *cc*, cirri; *d*, posterior corners of segments. (After Zeder, 1800, Tab. 3, fig. 10.)

„ 5. Segment with genital organs and extruded cirrus; the thin undulating line *a* (the vaginal canal, Rosseter) is seen crossing obliquely the vesicula seminalis (after Krabbe, Tab. 7, fig. 153); × 35.

„ 6. Cirrus, × 210, Dujardin, *Hist. des Helminthes*, 1845, Plate 9, fig. D.

SOME NEW SENSE-ORGANS IN DIPTERA.

By W. Wesché, F.R.M.S.

(*Read April 15th*, 1904.)

Plates 6 and 7.

Investigations into the sensations of creatures so far removed from the mammalia as insects are hampered by the possibility that these animals may possess (in the words of Lord Avebury) "senses and perceptions of which at present we have no conception." *

It is true that in man we have something in the extreme cultivation of particular senses which may help us to imagine other perceptions in insects. For example, the man who is only a little musical has no conception of the joy, pleasure, or rapture (words or combinations of words cannot express the feeling) that can be experienced on hearing a fine orchestra perform, in an ideal manner, the masterpieces of Beethoven or Wagner. The trained eye sees colour and beauties in nature which the untrained eye cannot discern, and the masterpieces of painting probably afford pleasure to those who have a highly cultivated colour sense as much as the great tone poems afford to those who have a highly cultivated musical understanding. There is an anecdote of the great painter Turner which well illustrates this. A critic remarked that he could not see in a landscape the blues and greens, the scarlets and yellows, that Turner had sketched upon a canvas. "But don't you wish you could?" was the answer of the artist. In matters in which cultivation plays no part, also, we have analogies. The call or cry of the bat, being a most acute sound, is beyond the capacity of the normal human ear, which can only appreciate a little more than 35,000 vibrations in a second of time; but there are persons who can hear this shrill sound without effort, and it is only by reason of the existence of such abnormal persons that the majority of human beings know the bat has a voice.

Through the anatomical and experimental investigations of many entomologists, it seems clear that we can localise the seats

* *Senses of Animals*, p. 193.

of touch, or feeling, and vision with exactness, as all imaginal insects can feel through the hairs and bristles embedded in their chitinous coverings, and nearly all can see by means of their eyes, simple or compound; while there is little doubt but that most, if not all, can smell. What is the exact seat of the organ of scent, however, is not determined, as while the antennae have been proved in some species to be the chief centre of excitation of the olfactory nerves, the palpi, and even parts of the body, may support organs sensitive to smell.

Professor Packard has found sense-pits on the palpi of *Perla* * which he thinks may be organs of taste, though he quotes Platen, Will, and Forel as having proved that in the Wasps and Ants the palpi have no gustatory function. Little is known as to these organs of taste, but it is evident that they exist in those insects which feed in the imaginal state, and must be situated in the mouth, or in its immediate neighbourhood. In Diptera they are said to be seated in the labella (paraglossae), and as far as my observations go this seems probable, except in those genera such as *Chironomus*, *Psychoda*, and *Oestrus*, in which many species do not feed in the imaginal state, but whose mouth-parts, except in the Oestridae, seem quite adapted for use.

Lord Avebury † quotes Kraepelin as finding certain peculiar club-shaped hairs at the end of the proboscis of the humble-bee (*Bombus*), which he considers to be taste hairs; F. Will as thinking certain pits on the maxillae of a wasp (*Vespa vulgaris*) to have the same use—these he calls taste cups; and Leydig, Meinert, Lowne, Kraepelin and others as considering as taste hairs two rows of minute pits, with a central papilla, situated on the proboscis of the hive bee (*Apis melifica*).

I have examined these structures with modern objectives, and I remain very sceptical as to the uses of one of the parts. The humble-bees of which I have preparations in my cabinet only show Kraepelin's club-shaped hairs in one species; but the mere fact that they are not present in all the species of a genus militates against regarding them as characteristic sense-organs. Further, all these insects, including the possessor of Kraepelin's "club-shaped hairs," have the taste hairs on the labium exactly similar to, and obviously homologous with, those of the hive bee,

* *Textbook of Entomology*, 1898, p. 272.

† *Senses of Animals*, p. 28, 29.

which, as I said before, Leydig, Meinert, Lowne and Kraepelin consider to be taste hairs.

As to Will's "taste cups" on the maxillae of wasps, I consider them as modified taste hairs. This is obvious in the maxillae of the hornet, where are found structures similar to Will's, and others, more modified, showing the gradations between this and a structure which is considered by Kraepelin as a "taste organ" in the Muscidae (Pl. 6, Figs. 4, 5). On the ligulae and paraglossae of *Vespa vulgaris* and *V. crabro* I have found chitinous discs, one on each part.

In the worker of *V. vulgaris* there is a peculiar structure consisting of a series of papillae connected at their bases, and having hollow hairs or pegs inserted at their apices (Pl. 6, Fig. 1). These are on the basal sides of the discs, which are on the extremities of the ligulae and paraglossae. In the queen-wasp and the hornet the same structure is found, but on the anterior side of the discs (Pl. 6, Fig. 3). These are most characteristic structures, and if they could be found in several families and orders they might be considered as typical taste organs. I think I can fulfil these conditions if the papillae are separated.

I have found a single, somewhat similar structure on the maxillary palpus of *A. melifica* (Pl. 6, Fig. 6), on the paraglossae of *Blatta orientalis*, cockroach (Pl. 6, Fig. 9), and on the labium of *Panorpa communis*, scorpion-fly (Pl. 6, Fig. 10); these have been combined with similar structures smaller in size (Figs. 7, 8). If Pl. 6 be examined, gradations will be found from the papilla and hair on the disc in *Vespa*, to the very short papilla and hair situated in rows between the pseudotracheae in *Musca*. Kraepelin * distinguishes four kinds of hairs on the proboscis of *Musca*.

1. Ordinary hairs, which are not hollow and are not in connection with a nerve.

2. Hairs of touch, connected with a nerve.

3. Glandular hairs, whose existence has been called in question.

4. Taste organs, which lie in a row between the trachea-like channels, and correspond to the similar organs in the bee.

* "Zur Anat. und Phys. des Russels von Musca," *Zeit. für Wiss. Zool.*, 1883.

I therefore conclude that all these structures in *Blatta, Apis, Vespa, Panorpa,* and *Musca* are "taste hairs" and homologous, and that Will's "taste cups" are misnamed, being only modifications of the characteristic hair.

One can now say that the sense of taste in insects is conveyed by a blunt, hollow, rather characteristic peg or hair, which may be (1) scarcely showing, as in Will's organ; (2) longer, as in the structures on the maxillae of *V. crabro* and the labium of some Diptera; (3) nearly double the length of the socket, as on the discs of the labium of *V. vulgaris* and *V. crabro.* This hair is loosely fixed in the socket and rather long when on the labium of the Hymenoptera, but shorter when on other parts, and in Diptera. The socket may be quite long, as in the labium of *Vespa*, shorter but still evident, as in the Muscidae, or only perceptible, or even sunk to the level of the epidermis, as on the maxilla of *Vespa.* This is but an amplification of Lord Avebury's able generalisation when he concludes, "that the organs of taste in insects are certain modified hairs, situated either in the mouth itself, or on the organs immediately surrounding it." *

There is a conflict of opinion on the subject of hearing, for though some tympanic organs in stridulating insects, such as locusts or crickets, have been thought to be auditory organs, Forel,† whose opinion has much weight, denies that these tympanic organs are necessarily ears, and thinks that all insects, possess no special organ of hearing, but that sounds are perceived by their tactile organs, just as deaf mutes can detect at a distance the rumbling of a carriage. If this opinion is correct, all insects would hear, as all can feel, and it has been demonstrated that some insects, if not the majority, are, as far as can be ascertained by experiment, quite deaf.

What we know about the Culicidae (Gnats) agrees with M. Forel's idea. The hairs on the antennae of the males vibrate sympathetically if a tuning fork, giving a note near to that of the "pipe" of the female, is sounded near them. On the other hand, a number of experienced entomologists, have separately come to the conclusion that auditory organs exist in the antennae of many species, and the deep pits or cavities in the antennae

* *Senses of Animals*, p. 31.

† *Recueil Zoologique Suisse*, 1887.

of the Muscidae are thought to be such. This part, then, may be a tactile, an auditory, or an olfactory organ in different species, and it is probable that in many instances all three senses are located, perhaps not exclusively, but in part, in the antennae. Professor Packard * says that, "the ears of the locusts are situated one on each side, on the basal joint of the abdomen just behind the first abdominal spiracle. In *Meconema* a European grasshopper, the auditory organs are on the fore-tibiae." I shall show that I have found in several Empidae, an organ in the same situation, the use of which I shall discuss later.

Without in any way calling in question Packard's conclusion as to *Meconema*, I would observe that in one case, where a structure on the fore-leg was thought to be an auditory organ, this explanation was quite wrong. The combed process, fringing a concavity of the fore-tibia of very many Hymenoptera, is the instance alluded to. Mr. Frank Cheshire found that it was used to clean the antennae, and it seems absolutely clear that this is its proper function.

Lieut.-Col. Yerbury, to whom I am indebted for several specimens of the insect, has drawn my attention to the very marked powers of smell of *Gastrophilus equi*, L., one of the Oestridae, or bot-flies. He tells me that his method of capturing the insect was, on a sunny day, to take up a position on the windward side of a cart-horse; generally after a short time a bot-fly would come up on his *leeward side*; often both Col. Yerbury and the horse would hear the fly before they saw it, and invariably the fly came *up the wind*, and was seen first on the opposite side of the horse. This shows a very highly developed sense of smell, equal to that of many of the mammalia, or even greater if we compare the surfaces exposed. I therefore made preparations of this insect, and examined every part of the external anatomy with a view of finding special olfactory organs. I used an excellent $\frac{1}{7}$-in. objective, which, working at an unusual distance, affords great assistance to an entomologist.

The result was negative for all parts except the antennae. I then examined these, comparing them with those on flies of about the same size. They were very distinctly larger than those of *Helophilus pendulus*, L., *Thelaira nigripes*, F., and

* *Textbook of Entomology*. pp. 288, 289.

Calliphora erythrocephala, Mg., and about the same size as *Echinomyia fera*, L. I have made an exact comparative measurement, by drawing these antennae with squares in the eye-piece of the microscope, and the result will be seen on Fig. 1, below. Further, I found on the third joint of the antennae of *G. equi* a larger number of sense-pits than on any of the flies mentioned, and of a different structure. When I say sense-pits I do not mean the minute perforations, 17,000 of which are said to be on the antennae of the blow-fly, but a much larger and more evident structure. This, which I have illustrated on Plate 7, Figs. 4, 6, 7, is, owing to the diffraction produced by

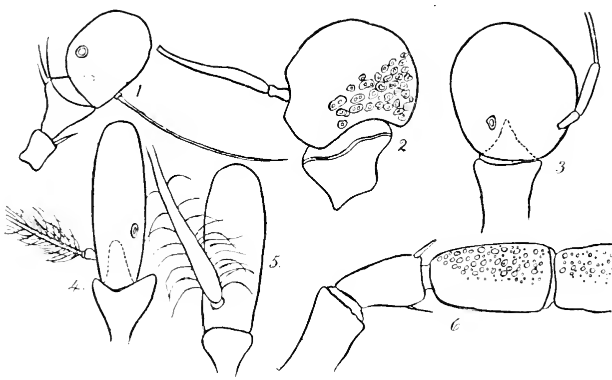


Fig. 1.—Antennae of Diptera.

1. *Helophilus pendulus*, L.
2. *Gastrophilus equi*, F.
3. *Echinomyia fera*, L.
4. *Thelaira nigripes*, F.
5. *Calliphora erythrocephala*, Mg.
6. *Stratiomys chameleon*, L.

the different layers, very difficult to make out; without a powerful sub-stage condenser, and strong illumination, the details are invisible, and even with them the short rods or pegs on the membrane do not show, but take the appearance show in Fig. 6. Owing to one of the larger pits being on a fractured edge, I was able to see these short rods and indicate them in my diagram. The structure then consists (*a*) of a large number of hairs which are on the outer surface; (*b*) under these are pits, a few larger than the others, the larger being $\frac{1}{600}$ to $\frac{1}{900}$ of an inch at their widest part, their shape being oval, but more irregular than that shown in the diagram; (*c*) these pits are covered with a delicate transparent membrane and appear to be enclosed in a thicker or darker ring than the surrounding chitin. This darkness, however, is possibly an optical illusion produced by the angle at which the object is seen; (*d*) on the larger pits are from six to ten short styles or pegs.

On Pl. 7, Fig. 7, I have drawn a diagram of the structure as I imagine it to be when seen in section. This has analogies with Kraepelin's diagram of the organs of smell on *Melonatha* as given in Packard,* except that in the latter there is only one style on the membrane, whereas in *G. equi* we find many. The pits when seen from the opposite or inner side showed the appearance drawn in Plate 7, Fig. 6, and some of the holes for the insertion of the styles were distinctly rectangular.

At the base of the arista I discovered a sense-organ (Pl. 7, Fig. 5), somewhat different in detail, which may not be of the same function as those on the third joint. This had five styles on the membrane, and was $\frac{1}{1500}$ of an inch in diameter; it was surrounded by a chitinous ring, but had no fine hairs round it. I looked for similar structures on the Muscidae, but failed to see any.

On the third and fourth joints of the antennae of *Stratiomys chameleon*, L., I found an analogous structure, with a layer of rather more chitinised rods covering the pits, which were disposed as shown in the diagram (Fig. 1, No. 6). The larger pits are $\frac{1}{1500}$ of an inch in diameter, and contain a varying number of styles. Why *S. chameleon* has this remarkable structure on the antennae is not obvious. I am told it spends a rather sluggish existence in the neighbourhood of the water, where its larval state was passed. The mouth-parts are suctorial, with the maxillae in a very atrophied condition. If the organs described are olfactory, and we cannot be sure that they are such, probably the high development of this sense enables the fly more readily to find its mate. As these flies are not particularly abundant, such a character would be of value. Apart from the special case of *S. chameleon*, the whole family of the Stratiomydae has very marked antennae, with numerous and

* *Textbook of Entomology*, p. 275.

very visible sense-pits, but not exactly similar in structure to those on *S. chameleon*. Mr. E. E. Austen has described some on *Pachygaster meromeloena*, Duf.,* and I have found similar sense-pits in *Chloromyia formosa*, Scop., *Pachygaster leachii*, Curt., *Microshrysa polita*, L., and *M. flavicornis*, Mg.

To sum up the matter, we find in *G. equi* an insect with a highly developed sense of smell, large antennae, with sense-organs larger than those in *S. chameleon* and other flies, some of these latter being known to possess a keen olfactory sense. On the other hand, we have a somewhat similar structure in *S. chameleon*, of which we have no record that it has a sense of smell, but of which I show that it would be of advantage to possess such a sense; we now see that the balance is in favour of the affirmative proposition. If we add to this the large amount of evidence recorded by Lord Avebury in *Senses of Animals*, and Professor Packard in the *Textbook of Entomology*, we get something which is not far from reasonable proof that the antennae carry olfactory organs. The palpi have been regarded as tactile organs, and there is little doubt but that they, in common with the antennae, share this sense. Being so intimately connected with the mouth, they have been thought to be the seat of the sense of taste. This has been disproved in the case of ants and wasps. These insects, after being deprived of their palpi, still rejected meal mixed with quinine and morphia, though readily feeding on unadulterated meal. I have already shown that in the wasps the taste hairs are on the labium and maxillae, and it is an interesting confirmation of Forel's experiment that I can find none of these organs on the labial or maxillary palpi. As Lord Avebury has continually emphasised in his *Senses of Animals*, what applies to one genus will not always apply to another, and I have, as already stated, found taste hairs on the labial palpi of *A. melifica*.

On the second joints of the palpi of *Bibio hortulanus*, L., are sense-organs of a very marked type, pits surrounded by ciliated rings of chitin, and on the membrane, stretched across the pits, what appear to be styles or pegs. These I regard as olfactory organs for the following reasons:—

1. The structure is similar to, or has analogies with, that which we find on *G. equi*.

* *Entomological Magazine*, 1901, p. 242.

2. Similar organs are to be found in a large number of the Nemocera, *Simulium reptans*, *Rhyphus fenestralis*, and many others. These insects have not highly developed sense-pits on the antennae.

3. *Pipunculus zonatus*, Z., which has small and characterless third joints of the antennae, has a well-marked sense-organ on the tip of each palpus.

4. *Ocidromia glabricula*, Fln., has large sense-organs on the palpi, $\frac{1}{900}$ of an inch in diameter. The antennae are pilose, having no sense-organs or pits larger than $\frac{1}{9000}$ of an inch in diameter; the third joint is only $\frac{1}{450}$ of an inch in width and $\frac{1}{225}$ of an inch in length.

Weighing these facts, I think that where the antennae are not particularly sensitive, the palpi have this structure to compensate. We thus see that the palpi, like the antennae, can bear organs of three senses—touch, taste, and smell; but I do not think that any one palpus has more than two of these senses developed at the same time.

I now come to certain sense-organs which I have found on the legs of many species, but of whose function I can form no idea.

These consist of a membrane enclosed by a chitinous ring; on the membrane are a number of smaller rings, each supporting a delicate, sharply pointed hair. The enclosing ring of the specimen figured in Pl. 6, Figs. 15, 19, is $\frac{1}{600}$ of an inch in diameter. For the sake of convenient reference I shall call this "Structure A." It is situated on the inner side of the trochanter of the middle leg of *Aphrosilus raptor*, Hal., and on the same place in *Poecilobothrus nobilitatus*, L., is a homologous organ. These are exceedingly delicate structures, placed in well-protected spots, and probably capable of recording very slight impressions.

On the opposite side of the trochanter is a cluster of pits without setae, and having below it a semicircular thickening of the chitin (Pl. 6, Fig. 18). This I will call "Structure B."

I have also found Structure A in two places at the base of the second joint of the antenna of *A. melifica*, on workers and drones, $\frac{1}{450}$ by $\frac{1}{600}$ of an inch in size; on the same place on the queen, but not arranged in ovals; and also in front of the fore-coxae of *Ocidromia glabricula*, Fln. and on the trochanters of the following Diptera:—

Bibio pomonoe, F.
Dilophus febrilis, ♂ ♀.
Haematopota pluvialis, L., ♀.
H. crassicornis, Wklbg., ♀.
Leptis scolopacea, L., ♀.
Rhamphomyia pennata, Mg., ♀.
Empis vitripennis, Mg., ♂.
Dolichopus plumipes, Scop., ♂.
D. greiseipennis, Stan., ♂ ♀.
Siccus ferrugineus, L., ♂.
Conops quadrifasciata, Seg., ♂.
Lonchoptera flavicauda, Mg., ♀.
Pipunculus campestris, Ltv., ♂.
Spilogaster communis, Dsv., ♂ ♀.
Hidrotea dentipes, F., ♂ ♀.
Parhydra coarctata, Fln., ♂ ♀.
Borborus equinus, Fln., ♂ .
Sphaerocera subsultans, F., ♀.
Limosina sylvatica, Mg., ♂ ♀.
Phora incrassata, Mg., ♀.

Structure B I have seen on the maxillae and labial palpi of *Vespa vulgaris*, on the first and second joints, and it will be very often met with if it is looked for. It is also to be found on many Diptera, particularly on the femora and adjacent parts. Whether it has any connection or correlation with Structure A I am unable to say, but as Structure B is so often found without Structure A I should think not.

These organs being found in so many different families, and on species with such different habits, it is not possible to consider them as specialisations, and no clue can be obtained as to their use by the study of life-histories. Adopting the negative method I arrive at the conclusion that:—(1) They cannot be organs of sight or taste, taste hairs as we have seen being blunt and generally hollow. (2) They are most unlikely to be tactile organs, as their situation under the abdomen would render A useless, and B has no hairs or setae to convey an impression. (3) The same objection prevents A being considered as an auditory organ, but does not apply to B, which is on situations where it would well receive impressions, though the very small surface of the membranes might not be a favouring character. (4) That leaves smell as the remaining sense. As regards both A and B, though A has analogies in detail, yet the whole organ is so much unlike the structures which so far we have been able to connect with that sense; and as B has no analogies, we must reject the hypothesis that they are olfactory organs. (5) They are not secondary sexual organs, as I find them in both sexes. (6) We then see that Structure B is possibly an auditory organ, but in the case of A we are driven back on Lord Avebury's idea, as to a sense of which we have no conception, and there the inquiry necessarily comes to an end.

In certain minute flies in the Empidae, apparently but distantly connected, as they are each in different sub-families, I have found sense-organs on the fore-legs which are obviously homologous. They are situated in much the same place as the auditory organs of *Meconema*, already alluded to as illustrated by Packard.

In *Hybos femoratus*, Müll. (Pl. 6, Figs. 14, 17, 22), I find a ciliated process $\frac{1}{450}$ of an inch long, and underneath the hair a central pit; this is situated in that part of the tibia which is directly opposite the femur, and close to the knee-joint. In *Ocidromia glabricula*, Fln., the organ is situated lower down the tibia, is $\frac{1}{600}$ of an inch long, and is bounded on three sides by a chitinous ridge. In *Chersodromia cursitans*, Z., it is in much the same place as in *Hybos*, and is $\frac{1}{900}$ of an inch long. In this species I can trace a long tube which opens into the circular pit. This can readily be distinguished from the trachea, as its structure is without annulations (Pl. 6, Figs. 13, 16, 20).

Now whether these are auditory organs is difficult to determine. The question at once arises, What particular advantage would the sense of hearing be to these very minute insects? Certainly *H. femoratus* and *C. cursitans* are uncompromisingly raptorial in their habits; they frequent damp herbage, and it may be of service as a means of informing them of the approach of prey or danger. That being so, why are the nearly related Empinae without the process, and why is not the possession of this sense a general raptorial character? They are not secondary sexual organs, as they are found on both sexes in an equal state of development.

A curious point is that these organs seem correlated with a change in the mouth-parts. The majority of the Empidae, *Empis*, *Hilara*, *Rhamphomyia*, have strong maxillae, or rather the blades (laciniae) of that organ, carrying near their bases the maxillary palpi. In *Hybos* the laciniae are absent or adhering to the labium; the cardines are present as in Muscidae, and the palpi are labial; and the other two species are but little modified from this type. None of these facts throw any light on the subject under discussion, and I am again obliged to leave the function of these organs without explanation. Before arriving at this result I made the following experiments. I found that with reflected light, focussed by means of a "bull's-eye" condenser, ½-in. objective, and a 10-in. tube, I could just see the cilia on the tibia of *Hybos*. The insect was pinned and had been in my cabinet for at least three years, which was probably a serious defect in the experiment. I sounded tuning forks giving 518, 530, and 540 vibrations a second, but could see no sympathetic movement in the cilia. I then separately sounded all the notes of the chromatic scale through several octaves of a powerful grand pianoforte, fully open, the fifth octave C giving 540 vibrations, but with no better success. As a confirmatory experiment I tried *Culex annulatus*, ♂, but with a like negative result. In Meyer's experiment a live insect was used, and his fork gave 512 vibrations in a second.*

Summary: (1) Both the antennae and palpi of insects are capable of receiving the stimulus of several senses.

(2) Their capacities differ greatly in different species, and consequently a general rule is an impossibility.

(3) Taste hairs, homologous with Kraepelin's taste hairs in the Muscidae, are found in different orders of insects: in the Orthoptera, *Blatta orientalis*; Mecaptera, *Panorpa communis*; Coleoptera, *Philonthus varius*, *Coprophilus striatulus*; Diptera, *Calliphora erythrocephala*, and a large number of families; Hymenoptera, *Vespa vulgaris*, *V. crabro*, *Apis melifica*, *Bombus*.

* *Senses of Animals*, p. 116.

(4) Organs are described on *G. equi*, *S. chameleon*, and *B. hortulanus*, which are thought to be typical olfactory organs.

(5) Three new organs, probably sense-organs, are described whose function is not known.

Explanation of Plates 6 and 7.

Plate 6.

TASTE HAIRS AND OTHER SENSE-ORGANS OF INSECTS.

Fig. 1. Taste hairs on the ligula of *Vespa vulgaris*.
,, 2. Taste hairs on the maxilla of *Vespa vulgaris* (Will's taste cups).
,, 3. Taste hairs on the ligula of *V. crabro*.
,, 4. Taste hairs on the maxilla of *V. crabro*.
,, 5. Taste hairs on the maxilla of *V. crabro*.
,, 6. Long taste hair on the tip of the maxillary palpus of the honey bee (*Apis melifica*).
,, 7. Short taste hairs on the same part.
,, 8. Short taste hairs on the maxillary palpus of the cockroach (*Blatta orientalis*). Similar structures are found on the labial palpi.
,, 9. Long taste hairs on the paraglossa of *Blatta orientalis*.
,, 10. Long taste hairs on the labium of *Panorpa communis*.
,, 11. Taste hairs on the paraglossa of *Phora incrassata*.
,, 12. Taste hairs on the paraglossa of *Calliphora erythrocephala*.
,, 13. Right fore-tibia of *Chersodromia cursitans*, ♂. The sense-organ is on the inner or left side.
,, 14. A portion of the left fore-tibia of *H. femoratus*, ♀, showing the sense-organ.
,, 15. Left middle femur, trochanter, and coxa of *Aphrosylus raptor*, showing the right or inner side; *a* indicates the position of the sense-organ (Structure A).
,, 16. Right fore-tibia of *C. cursitans*, ♀, showing the left side.
,, 17. Upper part of left fore-tibia of *H. femoratus*, ♂, seen at another angle.
,, 18. Right middle trochanter of *A. raptor*. The right or outer side is seen, bearing the second sense-organ (Structure B).
,, 19. The sense-organ shown in Fig. 15, enlarged (Structure A).

Fig. 20. Left fore-tibia of *C. cursitans*, ♀, showing a longer tube than that in Fig. 13.

,, 21. Left fore-tibia of *Ocidromia glabricula*, ♂, showing the right or inner side.

,, 22. Right fore-tibia of *Hybos femoratus*, ♂, showing another view of the situation of the ciliated sense-organ.

Plate 7.

OLFACTORY ORGANS OF DIPTERA.

Fig. 1. Diagram of the structure on the third joint of the antenna of *Stratiomys chameleon*, L.

,, 2. One of the larger pits.

,, 3. One of the larger pits which has lost some of the pegs or styles.

,, 4. Diagram of the structure of one of the larger pits on the third joint of the antenna of *Gastrophilus equi*, F.

,, 5. Sense-organ at the base of the arista of *G. equi*.

,, 6. Appearance of the pits on the third joint of the antenna of *G. equi*, as they generally appear.

,, 7. Diagram giving the supposed appearance of the structure shown in Fig. 4, when seen in section.

,, 8. Olfactory organ on the second joint of the palpus of *Bibio hortulanus*.

TWO NEW BRITISH WATER-MITES.

By C. D. Soar, F.R.M.S.

(*Read June 17th.* 1904.)

When collecting in North Wales with Mr. Scourfield in September, 1896, I found a small orange-coloured crawling Hydrachnid in some moss taken from a little trickling stream in Cwm Glas, Snowdon. It was quite unlike any other mite I had previously seen. Nevertheless I put it on one side, thinking I should come across it again, or find it had been already recorded by some other writer on the Continent. It was, however, not as I thought. I have never found another, neither have I discovered any record from abroad. I also sent a tracing and description to one of the well-known writers on Water-mites in Germany, and he did not know the creature, but suggested it was not only a new species, but required a new genus. I propose, therefore, to describe it as follows:—

Pseudofeltria, n. g.

The characteristics of this genus are: body, soft skinned; epimera in four groups, but pushed up close together; legs without swimming hairs; claws to all feet; genital field large, with wing-shaped plates and numerous acetabula on each plate; palpus with a small peg on the inner edge of fourth segment at the joint close to fifth segment.

All these characters we find in the genus *Feltria*, except that in *Feltria* we have a chitinous dorsal plate, small or large in different species, and the palpus is without the peg mentioned above. As this mite possesses all the characters of *Feltria* except the two points to which I have just drawn attention, I propose to call this genus *Pseudofeltria*.

Pseudofeltria scourfieldi, n. sp.

Fig. 1.

The measurements are: length, 0·56 mm.; breadth. 0·46; palpus, 0·24; first leg, 0·40; fourth leg, 0·68. The first, second, and third pairs of legs are very strong and thick, with strong bristles at each joint. The claws are large, and the cleft at the distal end of each leg into which they sink when at rest is large and pointed at its junction with the claws. The legs of the fourth pair are longer and slighter, but the joints are well protected by strong bristles similar in structure to those we find on the other legs. The palpus is strong, and, as usual, composed of five segments. The width of the palpus is about the same as the second segment of the first pair of legs. On the

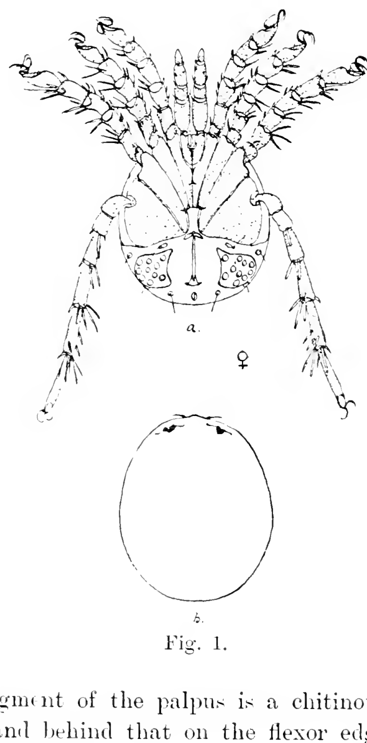


Fig. 1.

penultimate segment of the palpus is a chitinous peg near the fifth segment, and behind that on the flexor edge are two very small papillae with setae.

The dorsal surface is quite smooth without any plates. The ventral surface is nearly two-thirds covered with the epimera, which are pushed up close together as shown in the drawing. The genital cleft is long, with a tongue-shaped plate on each side. Each plate has ten acetabula.

Only one female was taken. I propose to name this species after Mr. Scourfield, who was with me at the time that the specimen was obtained, and who has been of very great assistance to me in my study of the Hydrachnidae.

Mideopsis crassipes, n. sp.

FIG. 2.

In 1900 Mr. Taverner, while collecting in the New River, took

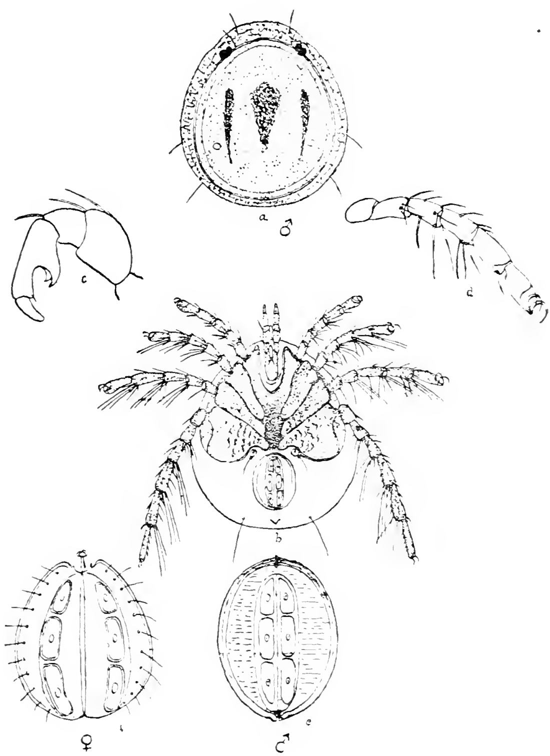


Fig. 2.

several specimens of *Mideopsis*, which he put on one side thinking they were all of the same species. On looking over them again this year, Mr. Taverner noticed that two were quite different from the others. These he forwarded to me for examination. I found they were not *Mideopsis orbicularis*, Müller, which until now was the only species known of this genus, but a new species of the same genus. As regards measurements, it is a little less than *Mideopsis orbicularis*, being as follows: length of body, 0·80 mm.; breadth, 0·72; first leg, 0.48; genital cleft, 0·22 mm. in length. The great points of difference are in the thickness of the legs and the thickness and shape of the palpi. The legs in *Mideopsis orbicularis* are very thin and slight; in this mite they are strong and thick, as will be seen by comparing the drawings of the two species.

The fourth segment of the palpus is very strong, with two curved, strongly formed spurs on the flexor side of the palpus. The two specimens taken proved, fortunately, to be male and female, so I am able to give a drawing of the genital plates of each. The male is more oval in outline than the female, but in all other respects the structure is the same. On account of the great thickness of the legs compared to the other species I propose to call it *Mideopsis crassipes*.

Explanation of Figs. 1 and 2.

Fig. 1.

a. *Pseudofeltria scourfieldi*, female, ventral surface.
b. ,, ,, ,, dorsal surface.

Fig. 2.

a. *Mideopsis crassipes*, dorsal surface of male.
b. ,, ,, ventral surface of male.
c. ,, ,, palpus of male.
d. ,, ,, first leg of male.
e. ,, ,, genital plate of male.
f. ,, ,, genital plate of female.

THE SPIDERS OF THE *ERIGONE* GROUP.

By Frank P. Smith.

(*Read October 21st*, 1904.)

In my last communication * I proposed the division of the sub-family Erigoninae into the *Neriene*, *Diplocephalus*, and *Walckenaera* groups. Mr. F. O. Pickard-Cambridge has pointed out † that the genus *Neriene* originally included three species, of which two have been removed as the types of other genera. The remaining species, *N. marginata*, Bl. (= *clathrata*, Sund.), therefore remains as the type, and as long as this species is considered to fall within the genus *Linyphia*, *Neriene* will sink as a synonym of that genus. In any case, the species *Linyphia clathrata*, Sund., from a structural standpoint, could never be included in the sub-family Erigoninae as previously characterised. I therefore propose to substitute the term "*Erigone* Group" for "*Neriene* Group."

The following list will indicate the extent and constitution of this group as far as British species are concerned. In the arrangement here adopted I make no pretension to anything like finality, the whole family Linyphiidae being so painfully involved, and the classification so chaotic, that a considerable time must elapse ere the existing confusion shall have disappeared.

Genus **Oedothorax**, Bertkau, 1884.

1833. *Neriene*, Bl. (*ad partem*).
1861. *Erigone*, Westr. (*ad partem*).
1864. *Neriene*, Bl. (*ad partem*).
1868. *Tmeticus*, Menge (*ad partem*).
1869. *Walckenaera*, Thor. (*ad partem*).
1879–81. *Neriene*, Cambr. (*ad partem*).
1884. *Gongylidium*, Sim. (*ad partem*).
1886. *Neriene*, Dahl (*ad partem*).

Type: *O. gibbosus* (Bl.).

* *Journal of the Quekett Microscopical Club*, ser. 2, vol. ix., No. 54, p. 9.
† *Annals and Mag. N. H.*, ser. 7. vol. ix.

O. agreste (Bl.), 1853.

1864. *Neriene agrestis*, Bl. (description, *not* figs.).
1879–81. „ „ Cambr., *Spid. Dorset*, p. 486, *not* p. 115.

O. fuscus (Bl.), 1834.

1861. *Erigone simplex*, Westr.
1864. *Neriene fusca*, Bl.
„ „ *agrestis* Bl. (figs., *not* description).
1879–81. „ „ Cambr., *Spid. Dorset*, p. 115.
„ „ *fusca*, „ „ „ p. 486.
1884. *Gongylidium retusum*, Sim.

O. retusus (Westr.), 1851.

1851. *Erigone retusa*, Westr.
1861. „ „ „
1862. *Neriene elevata*, Cambr.
1868. *Tmeticus foveolatus*, Menge.
1879–81. *Neriene retusa*, Cambr.
1884. *Gongylidium fuscum*, Sim.

O. gibbosus (Bl.), 1841.

1864. *Neriene gibbosa*, Bl.
1879–81. „ „ Cambr.
1884. *Gongylidium gibbosum*, Sim.

O. tuberosus (Bl.), 1841.

1864. *Neriene tuberosa*, Bl.
1879–81. „ „ Cambr.
1884. *Gongylidium tuberosum*, Sim.

O. gibbus (Cambr.), 1900.

1900. *Gongylidium gibbum*, Cambr.

O. (?) morus (Cambr.), 1894.

1894. *Gongylidium morum*, Cambr.

Genus **Stylothorax**, Bertkau, 1884.

1861. *Erigone*, Westr. (*ad partem*).
1864. *Neriene*, Bl. (*ad partem*).
1879–81. „ Cambr. (*ad partem*).

1884. *Gongylidium*, Sim. (*ad partem*).
1886. *Neriene*, Dahl. (*ad partem*).
Type: *S. apicatus* (Bl.).

S. apicatus (Bl.), 1850.

1861. *Erigone gibbicollis*, Westr.
1864. *Neriene apicata*, Bl.
1879–81. ,, ,, Cambr.
1884. *Gongylidium apicatum*, Sim.

Genus **Coryphaeus**, F. Cambr., 1894.

1884. *Gongylidium*, Sim. (*ad partem*).
Type: *C. distinctus* (Sim.).

C. distinctus (Sim.), 1884.

1884. *Gongylidium distinctum*, Sim.
1894. *Coryphaeus glabriceps*, F. Cambr.

Genus **Gongylidium**, Menge, 1868.

1861. *Erigone*, Westr. (*ad partem*).
1864. *Neriene*, Bl. (*ad partem*).
1879–81. ,, Cambr. (*ad partem*).
1884. *Gongylidium*, Sim. (*ad partem*).
Type: *G. rufipes* (Linn.).

G. rufipes (Linn.), 1758.

1758. *Aranea rufipes*, Linn.
1864. *Neriene munda*, Bl.
1868. *Gongylidium nigricans*, Menge.
1879–81. *Neriene rufipes*, Cambr.
1884. *Gongylidium rufipes*, Sim.

Genus **Gongylidiellum**, Sim., 1884.

1879–81. *Neriene*, Cambr. (*ad partem*).

G. vivum (Cambr.), 1875.

1875. *Erigone viva*, Cambr.
1879–81. *Neriene viva*, Cambr.
1884. *Gongylidiellum vivum*, Sim.

G. latebricolum (Cambr.), 1870.

1870. *Neriene latebricola*, Cambr.
1879–81. „ „ „
1884. *Gongylidiellum latebricolum*, Sim.

G. murcidum, Sim., 1884.

1895. *Gongylidiellum murcidum*, Cambr.

G. dolosum (Cambr.), 1879.

1879–81. *Neriene dolosa*, Cambr.

G. paganum, Sim., 1884.

1903. *Gongylidiellum paganum*, Cambr.

Genus **Trachygnatha**, Kulcz., 1891.

1861. *Erigone*, Westr. (*ad partem*).
1864. *Neriene*, Bl. (*ad partem*).
1868. *Tmeticus*, Menge (*ad partem*).
1879–81. „ Cambr. (*ad partem*).
1884. *Gongylidium*, Sim. (*ad partem*).
Type: *T. dentata* (Wid.).

T. dentata (Wid.), 1834.

1861. *Erigone dentata*, Westr.
1864. *Neriene dentata*, Bl.
1868. *Tmeticus dentatus*, Menge.
1879–81. *Neriene dentata*, Cambr.
1884. *Gongylidium dentatum*, Sim.

Genus **Erigonidium**, n. g.

1832. *Linyphia*, Sund. (*ad partem*).
1864. *Neriene*, Bl. (*ad partem*).
1879–81. „ Cambr. (*ad partem*).
1884. *Gongylidium*, Sim. (*ad partem*).
Erigone auct. (*ad partem*).

Erigone graminicolum, Sund., has been included in *Gongylidium* and in *Erigone* (*sensu stricto*) by various authors; but whilst it seems to possess characters which justify its separation from *Erigone*, it does not seem possible to include it in any of the genera into which *Gongylidium* has been divided. I therefore propose a new genus, *Erigonidium*, for its reception. The most obvious character by means of which it may be separated from allied genera is the process at the anterior end of the patella. This is practically non-existent in *Stylothorax* and allied genera; but in *Erigone* it is much more highly developed than in *E. graminicolum.* The structure of the reproductive organs in *E. graminicolum* is very different from that of any allied species. The tibia, and the general build of the male palpus in this species, are Erigoniform, but much less highly developed than in the true Erigones. The palpal organs are moderately developed, and their apical process is conspicuous and shaped very much like a screw. The falces are strong, furnished upon the outer surface with numerous strong granulations, and, in front, with a prominent denticule.

E. graminicolum (Sund.), 1832.

1832. *Linyphia graminicola*, Sund.
1864. *Neriene graminicola*, Bl.
1879–81. ,, ,, Cambr.
1884. *Gongylidium graminicolum*, Sim.
1896. *Erigone graminicola*, Hull.

Genus **Erigone**, Sav. et Aud. 1825–27.

1864. *Neriene*, Bl. (*ad partem*).
1879–81. ,, Cambr. (*ad partem*).
1884. *Erigone*, Sim. (*ad partem*).
1886. ,, Dahl (*ad partem*).

E. dentipalpis (Wid.), 1834.

1861. *Erigone dentipalpis*, Westr.
1864. *Neriene longipalpis*, Bl. (*ad partem*).
1879–81. *Neriene dentipalpis*, Cambr.
1884. *Erigone dentipalpis*, Sim.
1886. ,, ,, Dahl.

E. atra, Bl., 1833.

1861. *Erigone vagabunda*, Westr.
1864. *Neriene longipalpis*, Bl. (*ad partem*).
1879–81. ,, *atra*, Cambr.
1884. *Erigone atra*, Sim.
1886. ,, ,, Dahl.

E. longipalpis (Sund.), 1830.

1861. *Erigone longipalpis*, Westr.
1879–81. *Neriene* ,, Cambr.
1884. *Erigone* ,, Sim.

E. promiscua (Cambr.), 1871.

1871. *Neriene promiscua*, Cambr.
1879–81. ,, ,, ,,
1884. *Erigone* ,, Sim.

E. (?) pascalis (Cambr.), 1872.

The generic position of this species is doubtful. In all probability it requires a new genus for its reception.

Genus **Gonatium**, Menge, 1868.

1834. *Theridium*, Wid. (*ad partem*).
1841. *Micryphantes*, C. L. Koch (*ad partem*).
1861. *Erigone*, Westr. (*ad partem*).
1864. *Neriene*, Bl. (*ad partem*).
1868. *Gonatium*, Menge (*ad partem*).
1879–81. *Neriene*, Cambr. (*ad partem*).
1884. *Gonatium*, Sim. (*ad partem*).
1886. ,, Dahl (*ad partem*).

Type: *G. rubens* (Bl.).

G. rubens (Bl.), 1833.

1834. *Theridium cheliferum*, Wid.
1861. *Erigone chelifera*, Westr.
1864. *Neriene rubens*, Bl.
1868. *Gonatium cheliferum*, Menge.
1879–81. *Neriene rubens*, Cambr.
1884. *Gonatium* ,, Sim.
1886. ,, ,, Dahl.

G. rubellum (Bl.).

1841. *Micryphantes isabellinus*, C. L. Koch.
1861. *Erigone isabellina*, Westr.
1864. *Neriene rubella*, Bl.
1879–81. ,, *isabellina*, Cambr.
1884. *Gonatium rubellum*, Sim.
1886. ,, *isabellinum*, Dahl.

Genus **Enidia** (new name to replace *Dicyphus*, preoccupied).

1834. *Theridium*, Wid. (*ad partem*).
1864. *Neriene*, Bl. (*ad partem*).
1869. *Dicyphus*, Menge (*ad partem*).
1879–81. *Neriene*, Cambr. (*ad partem*).
1884. *Gonatium*, Sim. (*ad partem*).
1886. *Hypomma*, Dahl (*ad partem*).

Dicyphus, Menge, originally included *D. bituberculatus* (Wid.) (= *D. timidus*, M.); *D. cornutus* (Bl.) (= *D. cilunculus*, M.); and *D. elevatus* (Koch) (= *D. bicuspidatus*, M.).

Simon, in 1884, removed *D. elevatus* to the genus *Dismodicus*, which also included *D. bifrons* (Bl.). Dahl, in 1886, substituted *Hypomma* for *Dicyphus*, but included another species, *Dismodicus bifrons* (Bl.), which was not originally in the genus *Dicyphus*. Of the two species included in *Hypomma*, therefore, one, *H. bifrons*, had been added, and the other, *H. bituberculata*, had already been cited by Menge and by Simon (1884) as the type of the genus *Dicyphus*. The added species, *H. bifrons*, therefore, becomes the type of *Hypomma*; and *Dismodicus elevatus*, being the only species left in the genus *Dismodicus*, Sim., after the removal of *D. bifrons* in 1886, becomes the type of that genus.

D. bituberculatus is the type of the genus *Dicyphus*; but this generic name being preoccupied, I propose the name *Enidia* to replace it.

Type: *Enidia bituberculata* (Wid.).

E. bituberculata (Wid.), 1834.

1864. *Neriene bituberculata*, Bl.
1869. *Dicyphus timidus*, Menge.
1879–81. *Neriene bituberculata*, Cambr.
1884. *Gonatium bituberculatum*, Sim.

Genus **Falconeria**, n. g.

1864. *Neriene*, Bl. (*ad partem*).
1869. *Dicyphus*, Menge (*ad partem*).
1879–81. *Neriene*, Cambr. (*ad partem*).
1884. *Gonatium*, Sim. (*ad partem*).

Differs from *Enidia* in the absence of sensory setae upon the metatarsi of the fourth pair of legs.

Type : *F. cornuta* (Bl.).

F. cornuta, Bl.

1864. *Neriene cornuta*, Bl.
1869. *Dicyphus cilunculus*, Menge.
1879–81. *Neriene cornuta*, Cambr.
1884. *Gonatium cornutum*, Sim.

Genus **Dismodicus**, Sim., 1884.

1864. *Walckenaera*, Bl. (*ad partem*).
1879–81. ,, Cambr. (*ad partem*).
1886. *Hypomma*, Dahl (*ad partem*).

Type : *D. elevatus*, C. L. Koch.

D. bifrons (Bl.), 1841.

1864. *Walckenaera bifrons*, Bl.
1879–81. ,, ,, Cambr.
1884. *Dismodicus bifrons*, Sim.
1886. *Hypomma bifrons*, Dahl.

Genus **Typhochraestus**, Sim., 1884.

1879–81. *Walckenaera*, Cambr. (*ad partem*).

T. digitatus (Cambr.), 1872.

1872. *Erigone digitata*, Cambr.
1875. ,, *dorsuosa*, Cambr.
1884. *Typhochrestus digitatus*, Sim.
,, ,, *dorsuosus*, Sim.

NOTE ON A NEW METHOD OF CONSTRUCTING SMALL GLASS TANKS.

By T. G. Kingsford.

(*Read March 18th*, 1904.)

Those who have had occasion to use any of the various kinds of cemented glass tanks or troughs usually sold for microscopical and other purposes, have, I think, generally found them far from satisfactory. They are difficult to clean, and, especially in the commoner forms, very often develop leaks. I have also found that when placed close to a lamp they will occasionally crack.

The form of tank to which I wish to draw your attention has, in my hands at least, proved itself entirely free from the above defects. I therefore feel much pleasure in introducing it, hoping that others may find it as satisfactory as I have done.

Its construction is extremely simple, and within the range of any amateur mechanic. It consists essentially of two glass discs forming the sides of the tank, a band of thin sheet metal (Figs. 1 and 2, A), lined with rubber (B), forming the edge of the tank, and a metal clip or small bolt (C) to draw the ends of the band toward each other at the top of the tank, the band being of such a length as to not quite meet at the top, thereby leaving an opening for the introduction of liquid, etc. Short strips of rubber (D) are solutioned on to the rubber lining of the above band to form distance pieces, keeping the glass sides the desired distance apart. Fig. 1 will, I think, make this quite clear. It shows a tank ready for use, and intended to be attached to an ordinary bull's-eye condenser stand.

In the construction of these tanks it will be seen at once that

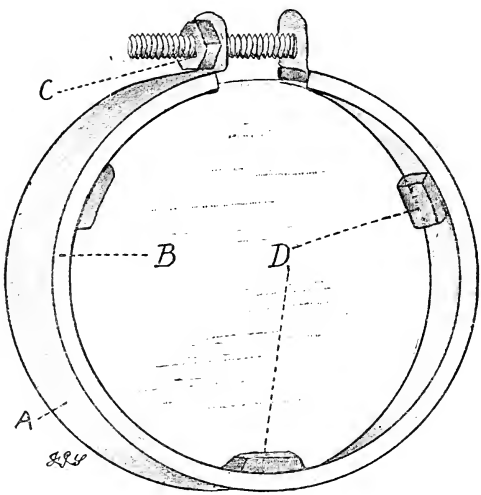


Fig. 1.

the most important thing is to be able to obtain glass discs with fairly true edges, as the water-tightness depends entirely on the glass sides making a good joint with the rubber-lined metal band. This apparent difficulty is easily overcome, as there are already on the market the very articles that we require in the form of bevel-edged clock-glasses. These can be obtained in sizes from about $\frac{3}{4}$-in. diameter to about 8-in. diameter through any clockmaker, and if the best quality is specified they will be found to have perfectly true edges, nearly as sharp as a knife, and therefore they will, with a very moderate amount of pressure, make a water-tight joint with the rubber lining on the edge of the tank. The metal band should not be too stiff; in fact, I have done away with it altogether in a rough form of tank I use for the examination of water when out collecting. This particular tank has at least one great merit—*i.e.* it can be dropped with very little chance of damage.

The form of clip used to draw together the ends of the

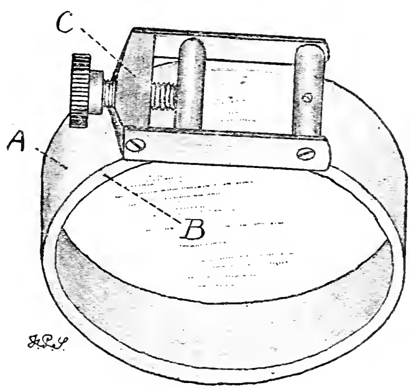


Fig. 2.

band, forming the edge of the tank, will depend to some extent on the use to which the tank is to be put. If it is not necessary to have a clear opening at the top, the ends of the band may be simply turned up at right angles, and a small bolt passed through them (Fig. 1). This is a very simple and effective fastening. If, on the other hand, the tank is to be used for the rough examination of material when out collecting, or for any purpose where a clear opening is more convenient, some form of clip as shown in Fig. 2 (c) should be used.

I may say, in conclusion, that I have had a tank of the above description, containing a solution of acetate of copper, in use as a light filter for nearly two years, and although of very rough construction, it has never developed the slightest defect, notwithstanding the fact that I have frequently had it so near to the lamp that it has become quite hot.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

PLATE 8.

AT the meeting of the Club held on March 18th, 1904, Dr. E. J. Spitta, V.P.R.A.S., etc., President, in the Chair, the minutes of the meeting held on February 19th were read and confirmed, and the additions to the Library announced.

Messrs. Max Staehler, N. W. Brushfield, Alfred C. Ballard, and William Pinkerton were balloted for, and duly elected members of the Club.

The Secretary announced that the new catalogue of the Library of the Club was now ready, and could be obtained in the room at the close of the meeting, price 1*s.*

The President said that the compilation of a new catalogue always involved a very large amount of trouble, and the thanks of the Club were due to Mr. Smith for undertaking it in this instance. A vote of thanks was accordingly put to the meeting, and carried unanimously.

Mr. Kingsford read a note "On a Method of Constructing Small Glass Tanks," specimens of which were exhibited in the room.

A note "On the Resolution of *Amphipleura pellucida*," by Lieut.-Colonel John Thompson, of Brisbane, was read by the Secretary.

Mr. Scourfield read a paper by Dr. Vávra "On the Phyllopods *Limnadia lenticularis* (L.) and *Limnetis brachyura* (O.F.M.), and their occurrence in Bohemia."

A paper by Mr. T. B. Rosseter, "On the Genital Organs of *Taenia sinuosa*," was taken as read.

The thanks of the Club were unanimously voted to the respective authors for their communications.

Announcements of excursions, etc., for the ensuing month were made, and the proceedings closed with the usual conversazione.

At the meeting of the Club held on April 15th, 1904, Dr. E. J. Spitta, V.P.R.A.S., etc., President, in the Chair, the minutes of the meeting held on March 18th were read and confirmed, and the additions to the Library and Cabinet announced.

Messrs. H. L. Woolley, C. H. Caffyn, W. L. Stephens, and V. C. Martin were balloted for, and duly elected members of the Club.

The President pointed out that the Club had received a number of slides of very great interest from Mr. Rousselet, which would be of such great value that he thought this donation called for a very special vote of thanks. There were ten slides of Polyzoa, four of Infusoria, and one of Entomostraca.

A special vote of thanks to Mr. Rousselet was voted accordingly.

The Secretary said that a further supply of Library catalogues had now been received, and could be obtained from the Librarian by any members who were unable to get them at the last meeting.

Mr. W. Wesché read a paper "On some New Sense-organs in Diptera," the subject being illustrated by diagrams drawn upon the bcard, and by numerous figures prepared by the author.

On the motion of the President a cordial vote of thanks was given to Mr. Wesché for his paper.

Announcements of the meetings and excursions for the ensuing month were then made, and the usual conversazione concluded the proceedings.

At the meeting of the Club held on May 20th, 1904, Dr. E. J. Spitta, V.P.R.A.S., etc., President, in the Chair, the minutes of the meeting held on April 15th were read and confirmed, and the additions to the Library and Cabinet announced.

Messrs. E. W. H. Kennedy and F. J. Perks were balloted for, and duly elected.

Mr. Wallis Kew, F.Z.S., read a paper "On Pseudoscorpions," illustrated by means of the lantern; and, in reply to questions from members, stated that the young chelifers possessed eight legs, and that only the adults were found attached to insects.

The President remarked upon the value of papers of this kind, and a vote of thanks to Mr. Kew for his communication was unanimously passed.

Mr. D. J. Scourfield exhibited and described Apstein's form of net for quantitative plankton work in lakes and still waters.

At the meeting of the Club held on June 17th, 1904, Dr. E. J. Spitta, V.P.R.A.S., etc., President, in the Chair, the minutes of the meeting held on May 20th were read and confirmed, and the additions to the Library announced.

Messrs. F. J. W. Plaskitt, L. O. Newton, F. G. Lawrence, J. Laws, A. N. V. Waterhouse, and M. W. Ward were balloted for, and duly elected members of the Club.

Mr. C. D. Soar read a paper descriptive of two new species of Hydrachnida, specimens of which were exhibited in the room.

The President delivered an extremely interesting lecture "On a Method of Suiting Screens for the Photomicrography of Stained Bacteria." He commenced by saying that as photography had become the handmaid to microscopy, anything which assisted the photographer in the better and more truthful rendering of microscopical objects really benefited the microscopist. It was on this ground that he ventured to occupy the attention of the Club with the subject in question. He added that he wished it to be distinctly understood that he did not bring before them the use of screens for increasing contrast between coloured objects as anything new, but as the method for ascertaining scientifically the correct antithetical dye to use, by employing the spectroscope in conjunction with the photographic plate, might not be familiar to some of the photomicrographers present, he deemed the subject worthy of a few minutes' attention. Screens were used in photography for two purposes—to improve definition and to increase contrast. He should deal with the latter only. To make what followed better understood, Dr. Spitta carefully called attention to the difference between the human eye and the photographic plate, in their methods of perceiving contrast in coloured objects. The eye recognised the difference by contrasting the coloured objects themselves, whereas the photographic emulsion merely recognised differences in intensity of the light from each. For example, red light was merely the name given to the physiological recognition of about 460 millions of millions of taps on the retina in a second of time; whereas if the number of such vibratory shocks increased to about 678 millions of millions, we called the light violet; the photographic plate, however, "cared not for these things," and only showed contrast as an indication of different exhibitions of light intensity; at least, that was what it practically amounted to. Hence, if the photographer wanted to increase contrast when photographing stained bacteria—say a blue bacillus on a white ground—he must reduce the intensity of the blue to make it become as dark as possible. Dr. Spitta then showed how this could be done by using a certain yellow screen which turned the image of the blue bacillus black, the field becoming of the same yellow as the screen. If, then, a photographic plate was chosen which was sensitive to the same yellow tint as the screen, a photograph could easily be taken. Illustrations were given by means of the lantern. Dr. Spitta next showed how necessary it was, after what he had just said, to know the sensitive properties of most kinds of orthochromatic plates on the market, the peculiarities of each being designated by him as its "eye." A lantern slide was here thrown on the screen, showing the audience the "eye" of most of the orthochromatic plates to be procured, using both short and long exposures (Plate 8). It was very instructive, for it showed at what wave-length the sensitiveness commenced and finished for all varieties of emulsion. Step by step the audience were taken through the subject, and shown in detail how they might study these peculiarities for themselves. Dr. Spitta also exhibited and briefly described the form of spectroscope which he had employed in his researches. It was made by Zeiss, and its special feature lay in the projection, by means of a scale, of the wave-lengths of all the different colours in the spectrum upon the plate, at the same time as the spectrum was being photographed. This was a great convenience, and placed the method of comparison upon a scientific basis, for it had often been pointed out how useless remarks were, when employed by a lecturer who spoke of effects "somewhere in the blue" or "near the end of the yellow," instead of in terms of the wave-length of the colour at the situation to which reference was made. Real spectra were now thrown on the screen by means of a second lantern fitted with a large bisulphide prism. These, while adding largely to the interest of the subject, also gave the lecturer an opportunity of explaining various details, such as the use of screens, the meaning of absorption bands, and how the eye perceived these effects differently from the photographic plate. Dr. Spitta went on to explain that in the case of bacteria the photographer had mostly to deal with three dyes or stains—viz. Löffler's blue, gentian violet, and carbol fuchsin. Lantern slides showing the method of selecting suitable screens for each of these stains were thrown upon the screen, and the details carefully gone into, and finally photographs of anthrax bacilli, magnified 1,000 diameters, stained with each of the three dyes, were in succession exhibited, illustrating the effect of photography with and without the contrasting screens. It was unanimously admitted that the improvement in detail and definition was most marked.

The President concluded by thanking Mr. Conrady for his assistance in managing the great spectroscope, and his son, Dr. Harold Spitta, for the manipulation of the lantern.

Mr. J. Rheinberg, F.R.M.S., said that he had listened to Dr. Spitta's paper with the greatest interest. The contrast between the photographs taken with and without a screen was very remarkable; but it occurred to him that the contrast between stained bacteria and their background was very great compared with most other microscopic objects, and he would like to ask whether the method employed was adapted to such preparations as sections, where the contrast was less marked and the colour deeper.

Dr. Spitta said that the question was a most logical one, and not unexpected. In such cases the density of the compensating screen would have to be diminished, and he could assure Mr. Rheinberg that his method had given very satisfactory results with difficult subjects.

Dr. Harold Spitta said that he should like to be allowed to confirm the remarks made by the President, his father, from results obtained in his own work. He had recently been engaged in photographing a series of sections of spleen showing bacteria *in situ*. The members would recognise the difficulty of obtaining contrast in such an object, but by means of some experimenting with screens of varying density, he had obtained very satisfactory results.

Dr. Spitta's lecture, although dealing with an extremely technical subject, was so clearly put that it was followed by the audience with marked interest, and at its close votes of thanks were unanimously accorded to the President, and to Mr. Conrady and Dr. Harold Spitta.

Note.—By the special desire of the President, and in order that those engaged upon photomicrographical work might be possessed of the details of his lecture at the earliest possible date, it was printed *in extenso* in *Photography* for June 25th. The block used in Plate 8 was kindly lent by the Editor of *Photography*.

OBITUARY NOTICES

EDWARD DADSWELL, F.R.M.S.

THE Club has lost a greatly respected member, and many of us an old and valued friend, in the person of Edward Dadswell, who died on October 6th at the age of seventy-five. Until the last year or two, when increasing age and ill-health began to make attendance difficult, there was no more familiar figure at the meetings, and none more popular.

Mr. Dadswell was born on November 14th, 1828, and during his early life his business, with a firm of a Mincing Lane brokers, occupied nearly all his energy; but he found time for the pursuit of knowledge at the Southwark Institution. It was not, however, until after the death of his wife, some fifteen years after his marriage, that he began to devote himself to microscopy, under the direction of the late Thomas Rogers, an early member of the Club. In 1871 he became one of the founders of the now defunct South London Microscopical Club, of which from the very start he was one of the most energetic members; during the last years of its existence he was practically its "mainspring."

Mr. Dadswell was elected a member of the Quekett Microscopical Club on January 22nd, 1875, and became a member of the Committee in July, 1879. With the exception of the year 1882, he served continuously on the Committee until his retirement in 1903. He was a Vice-President of the Club in 1881, and again in 1897.

Only those who have worked intimately with him can form any idea of the services which he rendered to the Quekett and to other clubs with which he was connected. His great business capacity and tact rendered him especially useful on committees, and his indefatigable zeal and genial manner brought him to the front in connection with the excursions, the soirées, and the social life of the Club. He will be long remembered in connection with the Club's excursions, in which he always took a particular interest and a leading part. Yet withal he was of a characteristically retiring disposition, preferring always to help others rather than to take the prominent position to which his experience entitled him. By his will he leaves a legacy of £50, free of duty, to the Quekett Microscopical Club, and a similar sum to the Royal Microscopical Society, of which he became a Fellow in 1887, and all who knew him will regard the bequest as a gratifying proof of the affection which he had for the Club of which he was for so many years an honoured member.

C. G. DUNNING.

Owing to indifferent health Mr. Dunning had, for some years prior to his death, ceased to be a frequent attendant at the Club, but he will be well remembered by all the senior members. He was elected on October 25th, 1872, and became a member of the Committee in July, 1876, but retired on the completion of three years' service, and did not again take office. He was, however, for many years subsequent to this date, a prominent member of the Club, and a familiar figure at the meetings

Mr. Dunning was by profession a surveyor, and being of a mechanical turn of mind, he devoted his attention to the improvement of the microscopist's accessories, many of which were in those days of the crudest kind. His improved form of turntable, his portable microscope lamp—which he recently improved—and his cleverly contrived live box or trough, were all useful pieces of apparatus.

Mr. Dunning died at Shrewsbury on September 29th, aged seventy-one.

OFFICERS AND COMMITTEE.

(*Elected February 1904.*)

PRESIDENT:

EDMUND J. SPITTA, L.R.C.P., M.R.C.S., V.P.R.A.S.

VICE-PRESIDENTS:

GEORGE MASSEE, F.L.S.
J. G. WALLER, F.S.A.
A. D. MICHAEL, F.L.S., F.R.M.S.
RT. HON. SIR FORD NORTH, F.R.S.

COMMITTEE:

D. BRYCE.
A. E. HILTON.
J. J. VEZEY, F.R.M.S.
W. B. STOKES.
C. TURNER.
W. WESCHÉ, F.R.M.S.
F. HUGHES.
G. C. KAROP, M.R.C.S., F.R.M.S.
W. J. MARSHALL, F.R.M.S.
J. RHEINBERG, F.R.M.S.
D. J. SCOURFIELD, F.R.M.S.
C. D. SOAR, F.R.M.S.

HON. TREASURER:

H. MORLAND, Cranford, near Hounslow.

HON. SECRETARY:

A. EARLAND, Esq., Reading Villa, Denmark Street, Watford.

HON. SEC. FOR FOREIGN CORRESPONDENCE:

C. F. ROUSSELET, Curator, R.M.S., 2, Pembridge Crescent, Bayswater, W.

HON. REPORTER:

R. T. LEWIS, F.R.M.S., 41, The Park, Ealing, W.

HON. LIBRARIAN:

ALPHEUS SMITH,
14, Leigham Vale, Streatham, S.W.

HON. CURATOR:

C. J. H. SIDWELL, F.R.M.S.,
46, Ashbourne Grove, Dulwich, S.E.

HON. EDITOR:

FRANK P. SMITH, 15, Cloudesley Place, Islington, London, N.

PAST PRESIDENTS.

		Elected
*EDWIN LANKESTER, M.D., F.R.S.	.	July 1865.
*ERNEST HART	.	,, 1866.
*ARTHUR E. DURHAM, F.R.C.S., F.L.S., etc.		,, 1867-8.
*PETER LE NEVE FOSTER, M.A.	.	,, 1869.
LIONEL S. BEALE, M.B., F.R.S., etc.	.	,, 1870-1.
ROBERT BRAITHWAITE, M.D., F.L.S., etc.		,, 1872-3.
*JOHN MATTHEWS, M.D., F.R.M.S.	.	,, 1874-5.
*HENRY LEE, F.L.S., F.G.S., F.R.M.S., F.Z.S.		,, 1876-7.
*THOS. H. HUXLEY, LL.D., F.R.S., etc.	.	,, 1878.
*T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., etc.	.	,, 1879.
T. CHARTERS WHITE, M.R.C.S., L.D.S., F.R.M.S.	.	,, 1880 1.
M. C. COOKE, M.A., LL.D., A.L.S.	.	,, 1882-3.
*W. B. CARPENTER, C.B., F.R.S., etc., etc.		,, 1884.
A. D. MICHAEL, F.L.S., F.R.M.S., etc.	.	,, 1885-6-7.
B. T. LOWNE, F.R.C.S., F.L.S., etc.	.	Feb. 1888-9.
Rev. W. H. DALLINGER, LL.D., F.R.S., F.R.M.S., etc., etc.	.	,, 1890-1-2.
EDWARD MILLES NELSON, F.R.M.S.	.	,, 1893-4-5.
J. G. WALLER, F.S.A.	.	,, 1896-7.
JOHN TATHAM, M.A., M.D., F.R.M.S.	.	,, 1898-9.
GEORGE MASSEE, F.L.S.	.	Feb. 1900-1-2-3.

* Deceased.

HONORARY MEMBERS.

Date of Election.

Jan. 24, 1868. Arthur Mead Edwards, M.D., 423, Fourth Avenue, Newark, New Jersey, U.S.A.

July 26, 1872. Professor Hamilton L. Smith, President of Hobart College, Geneva, New York, U.S.A.

July 23, 1875. Lionel S. Beale, M.B., F.R.S., F.R.M.S., etc. (*Past President*), 6, Bentinck Street, Manchester Square, W.

July 25, 1879. Dr. E. Abbe, Hon. F.R.M.S., Jena, Saxe Weimar, Germany.

July 23, 1880. F. H. Wenham, C.E., The Beacon, Goldsworth, near Woking.

Nov. 24, 1882. Dr. Veit B. Wittrock, Professor at the Royal Academy of Sciences, and Director of the Museum of Natural History, Stockholm, Sweden.

Feb. 17, 1893. Robert Braithwaite, M.D., F.L.S., F.R.M.S., (*Past President*), 26, Endymion Road, Brixton Hill, S.W.

Feb. 17, 1893. M. C. Cooke, M.A., LL.D., A.L.S. (*Past President*), 53, Castle Road, Kentish Town, N.W.

Feb. 17, 1893. T. Charters White, M.R.C.S., L.D.S., F.R.M.S. (*Past President*), 26, Belgrave Road, S.W.

Mar. 19, 1897. B. T. Lowne, M.D., F.R.C.S., F.L.S., etc. (*Past President*), The Cedars, Crondall, near Farnham, Surrey.

LIST OF MEMBERS.

Date of Election.	
Feb. 19, 1904.	Allardice, Lieut. Wm. McDiarmid, 2nd Essex Regiment, 98, Talbot Road, W.
Nov. 16, 1900.	Allcock, J. F., "Brambletighe," Cambridge Road, Wanstead, Essex.
April 18, 1890.	Allen, J. M., F.R.M.S., 11, Gray's Inn Square, W.C.
Dec. 15, 1899.	Angus, H. F., 28, Barclay Road, Leytonstone, E.
Jan. 18, 1901.	Appleton, T. A., M.R.C.S., L.S.A., "Ferndale," Britannia Road, Fulham, S.W.
Feb. 22, 1889.	Ashe, A., Roman Villa, Laurie Square, Romford, Essex.
June 16, 1899.	Austin, Henry, 13, Blakeley Cottages, East Greenwich, S.E.
Dec. 15, 1899.	Ayrton, William, "The Cliff," Beccles, Suffolk.
April 17, 1903.	Bagshaw, Walter, J.P., Batley, Yorks.
Sept. 26, 1884.	Baker, F. W. W., F.R.M.S., 313, High Holborn, W.C.
Mar. 18, 1904.	Ballard, Alfred Charles, Laxfield, Woodcote Road, Wallington, Surrey.
Mar. 21, 1902.	Barker, John W., B.Sc., A.R.C.S., 8, Balcaskie Road, Eltham Park, Kent.
Mar. 19, 1897.	Barnes, W., 24, Shaftesbury Road, Hornsey Rise, N.
May 25, 1883.	Barratt, Thomas J., F.R.M.S., Bell Moor House, Upper Heath, Hampstead, N.W.
Feb. 16, 1900.	Barrett, R. H., The Homestead, Berkhamsted.
Sept. 27, 1872.	Bartlett, Edward, L.D.S., M.R.C.S.E., 38, Connaught Square, W.
Dec. 19, 1902.	Barton, G. S., F.R.M.S., 114, Harris Street, Camberwell, S.E.

Date of Election.	
June 17, 1892.	Bates, C., 1, Windsor Road, Denmark Hill, S.E.
Oct. 18, 1895.	Baugh, J. H. A., 63, Cambridge Road, Hammersmith, W.
Dec. 19, 1902.	Bawtree, W. H., Camborne House, Grange Road, Sutton, Surrey.
Jan. 16, 1891.	Baxter, W. E., F.R.M.S., 170, Church Street, Stoke Newington, N.
Dec. 21, 1900.	Beardsmore, T. S., 41, Hill Street, Hinckley.
Nov. 26, 1875.	Beaulah, John, Raventhorpe, Brigg.
July 25, 1884.	Beck, C., F.R.M.S., 68, Cornhill, E.C.
June 19, 1891.	Beck, Horace C., F.R.M.S., 233, Albion Road, Stoke Newington, N.
Dec. 18, 1903.	Beckett, F. F., 73, Court Hill Road, Lewisham, S.E.
Mar. 28, 1884.	Beetham, A., The Warren Lodge, Old Shirley, Southampton.
Oct. 23, 1868.	Bevington, W. A., F.R.M.S., "Avondale," Coleraine Road, Blackheath, S.E.
Mar. 16, 1894.	Bird, Archibald W., 8, Halfmoon Lane, Herne Hill, S.E.
Jan. 20, 1899.	Bird, Richard, 15, Woodstock Street, W.
May 19, 1899.	Blood, Maurice, M.A., F.C.S., F.R.M.S., 16, Alexandra Road, Kingston Hill, Surrey.
Oct. 20, 1893.	Boyes, William Benjamin, F.R.M.S., P.O. Box 1923, Johannesburg, Transvaal.
April 15, 1898.	Braine, Woodhouse, F.R.C.S., 67, Wimpole Street, Cavendish Square, W.
Feb. 19, 1892.	Brooke, W. R., 13, Warwick Road, Upper Clapton, N.E.
Mar. 21, 1902.	Brook-Fox, F. G., Ringmore Vean, Kingsbridge, South Devon.
Dec. 19, 1890.	Brough, J. R., 29, Alexandra Villas, Finsbury Park, N.
Jan. 28, 1887.	Browne, E. T., B.A., F.R.M.S., 141, Uxbridge Road, W.
Mar. 18, 1904.	Brushfield, N. W., 60, Deodar Road, Putney, S.W.
Jan. 15, 1892.	Bryce, D., 37, Brooke Road, Stoke Newington Common, N.

Date of Election.	
Jan. 15, 1904.	Bulcher, Lewis, 82, Barn Mead Road, Beckenham, Kent.
Feb. 19, 1904.	Burton, James, 20, Fortune Green Road, West Hampstead, N.W.
Feb. 19, 1904.	Butterworth, Arthur Cyrus, 137, Fordwych Road, West Hampstead, N.W.
June 21, 1901.	Buttifant, George H., 17, South Vale, Blackheath, S.E.
June 14, 1865.	Bywater, W. M., F.R.M.S., "Invicta," 33, Telford Avenue, Streatham Hill, S.W.
April 15, 1904.	Caffyn, Charles Henry, 32, Falkland Road, Hornsey, N.
June 18, 1897.	Campbell, Colney, 234a, Wightman Road, Hornsey, N.
Dec. 21, 1900.	Campbell, William, Cossimbazar P.O., Moorshedabad District, Bengal.
Mar. 20, 1903.	Casebourne, T. H. "Troas," Ramsden Road, Friern Barnet, N.
June 17, 1892.	Chaloner, G., F.C.S., 30, Weston Park, Crouch End, N.
Mar. 16, 1900.	Cheshire, F. J., F.R.M.S., H.M. Patent Office, Staple's Inn, W.C.
Mar. 22, 1878.	Chester, The Very Rev. the Dean of, The Deanery, Chester.
Dec. 18. 1891.	Cheyne, A. M., 16, Coleman Street, E.C.
Nov. 27, 1874.	Chippendale, George.
Dec. 18, 1896.	Chipps, F. W., 201, Castelnau, Barnes, S.W.
Feb. 20, 1903.	Clarke, Thomas E., "The Laurels," 12, Ravenslea Road, Wandsworth Common, S.W.
May 15, 1903.	Cleave, A. H. W., 54, Enmore Road, South Norwood, S.E.
Oct. 19, 1900.	Colls, Arthur, Priory Lodge, Barnes, Surrey.
Oct. 21, 1904.	Conrady, Alexander Eugen, F.R.A.S., F.R.M.S., 89, St. Alban's Avenue, Bedford Park, W.
May 28, 1869.	Cottam, Arthur, F.R.A.S., "Eldercroft," Essex Road, Watford.
Jan. 18, 1901.	Cox, Thomas N., jun., 104, Tressillian Road, Brockley, S.E.
Jan. 15, 1904.	Cox, William, 113, Manor Road, Brockley, S.E.

Date of Election.

June 19, 1903.	Coxhead, G. W., c/o G. Stevenson, 12, High Road, South Tottenham, N.
Dec. 20, 1901.	Craig, Thomas, F.R.M.S., 1013, Sherbrooke Street, Montreal, Canada.
Nov. 21, 1902.	Cressey, Dr. G. H., "Timaru," Cockington, Torquay.
Aug. 28, 1868.	Crisp, Frank, LL.B., B.A., F.R.M.S., *V.P. and Treas. Linnean Society;* 5, Lansdowne Road, Notting Hill, W.
May 15, 1891.	Croger, T. R., 114, Wood Street, E.C.
Feb. 16, 1900.	Crossland, R. E., A.R.I.B.A., "Lyndhurst," Elsinore Road, Forest Hill, S.E.
Mar. 16, 1894.	Culshaw, Rev. George H., M.A., The Rectory, Iver Heath, Bucks.
April 18, 1902.	Cumming, John, 29, Ella Road, Crouch End, N.
June 25, 1880.	Curties, C. Lees, F.R.M.S., 244, High Holborn, W.C.
Jan. 16, 1903.	Curties, C. L., jun., 244, High Holborn, W.C.
Feb. 23, 1883.	Dallinger, Rev. W. H., LL.D., F.R.S., F.R.M.S., etc. (*Past President*), "Ingleside," Newstead Road, Lee, S.E.
Jan. 16, 1903.	Damant, Lieut. Guybon, R.N., H.M.S. *Ocean*, China Station.
Mar. 22, 1878.	Darke, Edward, 46, Hilldrop Crescent, Holloway, N.
Mar. 15, 1895.	Daunou, F., 1, Shirley Villas, Westbrook, Margate.
Nov. 23, 1888.	Davis, H. R., Thistleton House, 1, Clissold Road, Stoke Newington.
Jan. 18, 1901.	Davis, Thomas John, F.R.M.S., 62, Sale Street, Rose Hill, Derby.
Feb. 15, 1895.	Davis, T. Sebastian, F.R.M.S., 199, South Lambeth Road, S.W.
May 23, 1879.	Dawson, W., Mustow House, Bury St. Edmunds, Suffolk.
May 17, 1901.	Deeley, George P., Moushall, Amblecote, Brierley Hill, Staffordshire.

Date of Election.

April 19, 1895. Delcomyn, Theo. A., F.R.M.S., "Feldheim," Wimbledon Common.

Nov. 17, 1893 Dennis, A. W., 12, Brownlow Road, Dalston, N.E.

Mar. 22, 1889 Dick, J., 39, Lowman Road, Holloway, N.

June 17, 1892. Dixon-Nuttall, F. R., F.R.M.S., "Ingleholme," Eccleston Park, near Prescot, Lancashire.

Mar. 17, 1899. Downs, Arthur, 2, Woodside Villas, Ulverston Road, Walthamstow.

Nov. 15, 1901. Druett, C. R., 302, Uxbridge Road, W.

June 19, 1891. Earland, Arthur (*Hon. Secretary*), Reading Villa, Denmark Street, Watford.

Jan. 15, 1897. East, Edwin T., 15, Westover Road, Wandsworth Common, S.W.

Jan. 16, 1903. Ebbage, H. E., 3, Duncan Road, Richmond, Surrey.

Sept. 25, 1868. Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.

Feb. 21, 1902. Edwards, Thomas Jarvis, 9, St. Lawrence Road, Brixton, S.W.

June 19, 1903. Eisenberg, Herman B., "Rathcote," Pattison Road, Finchley Road, Hampstead, N.W.

May 26, 1876. Emery, Charles, 10, Barrington Road, Crouch End, N.

April 17, 1896. Enock, F., F.L.S., F.R.M.S., F.E.S., 42, Salisbury Road, Bexley, Kent.

Feb. 28, 1879. Epps, Hahnemann, 95, Upper Tulse Hill, Brixton, S.W.

Nov. 20, 1903. Escudier, John L., 8, Woodstock Road, Chiswick, W.

Feb. 17, 1899. Evans, Henry, 34, Fellows Road, Hampstead, N.W.

Feb. 15, 1901 Eyre, Frederick W., Inland Revenue, Somerset House, W.C.

Feb. 17, 1899. Fairholme, H. W., 24, Wetherby Mansions, Earl's Court Square, S.W.

Date of Election.

July 25, 1873. Fase, Rev. H. J., M.A., "Broadview," 37, Beechcroft Road, Upper Tooting, S.W.

June 16, 1893. Filer, Frank E., 122, Stockwell Park Road, Brixton, S.W.

Feb. 19, 1904. Finlayson, David, 11, Trinity Road, Wood Green, N.

Mar. 21, 1902. Firman, Rev. Septimus, 115, Great Mersey Street, Liverpool.

July 26, 1867. Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh House, Highbury New Park, N.

Mar. 20, 1896. Fletcher, S. W., M.D., Pepperill, Massachusetts, U.S.A.

Nov. 23, 1888. Flood, W. C., 55, Aubert Park, Highbury, N.

Jan. 20, 1899. Foucar, Alexander L., "Beaulieu," 20, St. John's Park, Blackheath, S.E.

June 23, 1871. Freeman, H. E., Walcot, Limes Avenue, New Southgate, N.

Jan. 18, 1901. Freeman, Rev. Richard, M.A., Prescot, Lancashire.

Oct. 21, 1904. Freeman, Walter Bell, 200, Brecknock Road, N.

Dec. 16, 1898. French, Archibald J., 6, Fordyce Road, Lewisham, S.E.

June 20, 1902. Fullard, Alfred F., 23, Mundania Road, Honor Oak, S.E.

May 20, 1898. Fuller, Frederick, M.A., LL.D., 9, Palace Road, Surbiton.

Nov. 21, 1902. Fuller, William, 24, St. Ann's Road, East Hill, Wandsworth, S.W.

May 15, 1903. Gabb, G. H., F.C.S., 43, Charlotte Street, Fitzroy Square, W.

Mar. 21, 1902. Gale, George, 79, Lombard Street, E.C.

Jan. 20, 1899. Gardner, William, F.R.M.S., 292, Holloway Road, N.

May 19, 1899. Garnar, John H., F.R.M.S., "Fair View," Knighton Drive, Leicester.

May 17, 1901. Gladding, Harold, Birmingham House, Richmond Hill, Port Elizabeth, Cape Colony.

Date of Election.

Jan. 17. 1902. Gleason, Louis R., F.R.M.S., 420, Uxbridge Road, Shepherd's Bush, W.

April 26, 1872. Goodinge, J. W., F.R.G.S., 10, Gower Street, Bedford Square, W.

Jan. 16, 1903. Gordon, Rev. W. H., "Woodcroft," Fareham, Hants.

June 21, 1901. Goulton, Ernest Cecil, Stanmore House, Benhill Street, Sutton, Surrey.

Nov. 17, 1899. Green, E. E., Royal Botanic Gardens, Peradeniya, Ceylon.

Jan. 16, 1903. Green, H. O., 13, Sunnyside Road, Ilford.

April 17, 1903. Grey, R. H., 53, Gascony Avenue, West Hampstead, N.W.

Nov. 20, 1903. Griffiths, A. B., Ph.D., 171, Brixton Road, S.W.

Nov. 18, 1898. Grocock, L. O., 142, Oakfield Road, Penge, S.E.

May 17, 1895. Groves, H., F.L.S., 65, Chelsham Road, Clapham, S.W.

Feb. 19, 1904. Gurney, Robert, Longmoor Point, Catfield, Great Yarmouth.

Sept. 28, 1888. Hall, T.F., 39, Gloucester Square, Hyde Park, W.

Feb. 20, 1903. Hall, W. D., 25, Burbage Road, Herne Hill, S.E.

Dec. 28, 1866. Hallett, R. J., 120, Churchill Road, Brighton Road, South Croydon.

Feb. 21, 1902. Halsey, John, 15, Carlisle Street, Soho Square, W.

Feb. 22, 1869. Hammond, A., F.L.S., 30, Versailles Road, Anerley, S.E.

Oct. 22, 1886. Hampton, W., 38, Lichfield Street, Hanley, Staffordshire.

Feb. 15, 1895. Harris, George T., 21, Victoria Mansions, Willesden Green, N.W.

Jan. 18, 1895. Harrison, A., F.R.M.S., "Delamere," Grove Road, South Woodford, Essex.

May 17, 1901. Harvey, Sidney, F.I.C., F.C.S., Watling House, Canterbury.

Date of Election.

Mar. 28, 1879. Hawkins, C. E., 23, Dalebury Road, Upper Tooting, S.W.
Feb. 15, 1901. Headley, F. W., Haileybury College, Hertford.
Nov. 21, 1902. Heal, F. W., 116, Chapter Road, Willesden, N.W.
Oct. 21, 1904. Rev. Septimus Hebert, Leafland, Harrow.
Aug. 23, 1872. Hembry, F. W., F.R.M.S., Langford, Sidcup, Kent.
Feb. 26, 1886. Hewlett, R. T., Lyddon House, Avenue Road, Southfields, S.W.
Dec. 20, 1901. Hicks, Frederick H., Belmont Villas, Wallington, Surrey.
Feb. 17, 1899. Hill, Edward J., Ladyfield, Dumfries, N.B.
Nov. 17, 1893. Hill, Edwin Ernest, F.R.M.S., 3, Trevor Villas, Horn Lane, Woodford Green, Essex.
Nov. 15, 1895. Hilton, A. E., 21, Ashmount Road, Upper Holloway, N.
Jan. 18, 1895. Hinton, E., 12, Vorley Road, Upper Holloway, N.
Nov. 18, 1898. Hofmann, O., c/o Carl Zeiss, Nos. 1 & 2, Kasanski Platz, St. Petersburg, Russia.
Dec. 15, 1893. Holder, J. T., 72, Bousfield Road, St. Catherine's Park, S.E.
Feb. 26, 1875. Holford, Christopher, 5, Northumberland Avenue, Upper Richmond Road, Putney, S.W.
Nov. 17, 1899. Holloway, Rev. E. J., Clehonger Vicarage, Hereford.
Nov. 17, 1899. Hoole, Chas., F.R.M.S., 46, Westbourne Road, Sheffield.
Nov. 26, 1880. Hopkins, Robert, Shern Villa, Walthamstow, Essex.
Jan. 15, 1904. Hopkinson, John, F.L.S., F.G.S., F.R.M.S., Weetwood, Watford.
Oct. 26, 1866. Horncastle, Henry, "Lindisaye," Woodham Road, Woking.
April 21, 1893. Hornsby, E. W., jun., 25, Old Change, E.C.
April 15, 1898. Hounsome, John, 4, York Street, Stepney, E.
May 22, 1874. Hovenden, C. W., F.R.M.S., Chester House, Mount Ephraim Road, Streatham, S.W.
April 26, 1867. Hovenden, Frederick, F.R.M.S., "Glenlea," Thurlow Park Road, West Dulwich, S.E.

Date of Election.

Nov. 19, 1897. Howard, Arthur, 60, Palace Gardens Terrace, W.

Oct. 19, 1894. Howard, R. N., M.R.C.S., F.R.M.S., The Cape Copper Co., Port Nolloth, Namaqualand, Cape Colony, South Africa.

April 21, 1899. Howard, William H., 513, Caledonian Road, N.

Oct. 19, 1894. Hughes, F., "Fairleigh", Wray Park Road, Reigate.

May 28, 1886. Hughes, W., 32, Heathland Road, Stoke Newington, N.

Jan. 15, 1904. Hunter, Walter, 31, Maygrove Road, Kilburn, N.W.

Dec. 20, 1901. Hurrell, Harry Edward, 25, Regent Street, Great Yarmouth.

April 18, 1902. Imboden, Walter, "Grasmere," Moss Lane, Pinner.

May 24, 1867. Ingpen, J. E., F.R.M.S., St. John's, Wrotham Road, Broadstairs.

Mar. 19, 1897. Isenberg, A. L., 39, Cadogan Place, S.W.

June 14, 1865. Jaques, Edward, B.A., 27, Fairfax Road, Bedford Park, Chiswick, W.

Sept. 18, 1891. Johnson, W., F.R.M.S., 188, Tottenham Court Road, W.C.

May 23, 1873. Karop, G. C., M.R.C.S., F.R.M.S., etc., 198, Holland Road, Kensington, W.

Feb. 20, 1903. Kent, F. J., 8, Crescent Road, Carlingford Road, West Green, N.

July 25, 1884. Kern, J. J., "Fern Glen," Selhurst Park, South Norwood, S.E.

May 17, 1901. Kingsford, T. G., 1, Fortescue Villas, Stafford Road, Wallington, Surrey.

Nov. 20, 1903. Kirkaldy, G. W., F.E.S., Department of Agriculture and Forestry, Honolulu, Territory of Hawaii.

May 17, 1901. Kirkman, Hon. Thomas, M.L.C., F.R.M.S., Croftlands, Esperanza, Natal.

Date of Election.

Mar. 22, 1889.	Klein, S. T., F.R.A.S., F.L.S., F.R.M.S., "Hatherlow," Raglan Road, Reigate.
Feb. 20, 1903.	Klingler, E. W., 25, Jackson Road, Holloway, N.
Nov. 21, 1902.	Langton, W. H., 677, Holloway Road, N.
May 28, 1875.	Larkin, J., Delrow, Aldenham, near Watford.
Mar. 17, 1899.	Larmer, Edward, F.R.M.S., Springfield, Reigate.
Feb. 24, 1888.	Lathangue, R., 83, Cranwich Road, Stamford Hill, N.
June 17, 1904.	Lawrence, Frederick George, c/o Lionel Samson & Son. Cliff Street, Freemantle, West Australia.
June 17, 1904.	Laws, John, "The Hall" Nurseries, Watford.
Mar. 16, 1900.	Lawson, Peter, F.R.M.S., 11, The Broadway, Walham Green, S.W.
June 25, 1869.	Layton, C. E., 17, Cornwall Terrace, Regent's Park, N.W.
Oct. 21, 1904.	Lee, Major-Gen. Henry Herbert, "The Mount," Dinas Powis, near Cardiff.
Nov. 21, 1902.	Leonard, Edward, 12, Melbourne Road, Ilford.
Nov. 25, 1887.	Lewer, J. J., 20, Crossfield Road, Belsize Park, N.W.
April 27, 1866.	Lewis, R. T., F.R.M.S (*Hon. Reporter*), 41, The Park, Ealing, W.
June 26, 1868.	Lindley, W. H., jun., 29, Blittersdorffs Platz, Frankfort-on-Maine.
Nov. 18, 1898.	Liston, Montrose W., 63, Hillfield Road, West Hampstead, N.W.
Mar. 20, 1891.	Lloyd, H. W., 51, Camden Square, N.W.
Nov. 24, 1866.	Lovibond, J. W., F.R.M.S., Lake House, Salisbury.
May 21, 1897.	Mackenzie, James, 12, Cavendish Road, Brondesbury, N.W.
May 25, 1883.	Mainland, G. E., F.R.M.S., 14, The Norton, Tenby, South Wales.
June 20, 1902.	Margary, T. A. G., 9, Dafforne Road, Upper Tooting, S.W.

Date of Election.

June 17, 1898. Marks, Kaufmann J., F.R.M.S., 9, Randolph Gardens, N.W.

Feb. 15, 1895. Marshall, William John, F.R.M.S., 3, Ellingham Road, Shepherd's Bush, W.

Mar. 20, 1896. Martin, Herbert Sydney, F.R.M.S., 101, Algernon Road, Lewisham, S.E.

April 15, 1904. Martin, Victor Callingham, 34, Warwick Gardens, Kensington, W.

Nov. 18, 1898. Massee, G., F.L.S. (*Vice-President*), Royal Gardens, Kew.

April 26, 1867. Matthews, G. K., St. John's Lodge, Beckenham, Kent.

Jan. 15, 1892. Maw, W. H., F.R.M.S., F.R.A.S., 18, Addison Road, Kensington, W.

Feb. 15, 1895. Measures, John W., M.R.C.S., L.S.A., 5, Exe View Terrace, Exmouth.

May 19, 1893. Merlin, A. A. C. Eliot, F.R.M.S., British Consulate, Volo, Greece.

July 27, 1877. Michael, A. D., F.L.S., F.R.M.S. (*Vice-President*), 9, Cadogan Mansions, Sloane Square, Chelsea, S.W.

Mar. 20, 1896. Micklewood, G. R., 65, Oakfield Road, Stroud Green, N.

May 17, 1901. Miles, John P., 34, Tyrrell Road, East Dulwich, S.E.

June 16, 1899. Miller, Duncan S., 17, Kennington Terrace, S.E.

July 7, 1865. Millett, F. W., F.G.S., F.R.M.S., Eniscoe, Brixham, Devon.

Oct. 18, 1901. Moore, Harry, F.R.M.S., 12, Whiston Grove, Moorgate, Rotherham, Yorks.

July 26, 1878. Morland, Henry (*Hon. Treasurer*), Cranford, near Hounslow.

Jan. 15, 1897. Mottram, James, Bank Street, Norwich.

Jan. 16, 1891. Muiron, C., 2, Agamemnon Road, West Hampstead, N.W.

Mar. 24, 1876. Nelson, E. M., F.R.M.S., Beckington, Bath.

Mar. 20, 1903. Nelson, E. W., Christ's College, Cambridge.

May 16, 1902. Nevill, Rev. T. J., F.R.M.S., 2, Genoa Road, Anerley, S.E.

Date of Election.

April 19, 1895. Neville, James, 55, Gresham Road, Brixton, S.W.

Nov. 25, 1881. Nevins, R. T. G., Pembroke Lodge, Hildenborough, Tonbridge.

Jan. 26, 1872. Newton, E. T., F.R.S., F.G.S., Geological Museum, Jermyn Street, S.W.

June 17, 1904. Newton, Leonard Owen, 3, Peldon Avenue, Sheen Road, Richmond, S.W.

June 15, 1894. North, The Right Honble. Sir Ford, F.R.S., F.R.M.S. (*Vice-President*), 76, Queensborough Terrace, Bayswater, W.

Feb. 16, 1900. O'Donohoe, T. A., F.R.M.S., 115, Cardigan Road, Leeds.

Jan. 24, 1879. Offord, J. M., F.R.M.S., 62, Gordon Road, Ealing, W.

Dec. 22, 1876. Ogilvy, C. P., F.L.S., Sizewell House, Leiston, near Saxmundham, Suffolk.

Nov. 18, 1892. Orfeur, Frank, F.R.M.S., 91, Effra Road, Brixton, S.W.

Dec. 27, 1867. Oxley, Frederick, F.R.M.S., 1, Dock Street, E.

Dec. 18, 1903. Oxley, F. J., M.R.C.S., 1, Dock Street, E.

Feb. 19, 1904. Page, John William, 13, Crescent Road, Sidcup, Kent.

Mar. 20, 1896. Pantin, Henry, "Staplegrove," The Avenue, Beckenham.

Oct. 27, 1871. Parsons, F. A., 15, Osborne Road, Finsbury Park, N.

Dec. 19, 1902. Partridge, H. S., 38, Estcourt Road, Wandsworth Common, S.W.

July 23, 1886. Paul, R., Holmbush, Cyprus Road, Exmouth, Devon.

Jan. 18, 1901. Paulson, Robert, 10, Denholme Road, Maida Hill, W.

May 24, 1867. Pearson, John, 40, Maida Vale, W.

May 17, 1901. Pedley, George Aston, M.R.C.S., L.D.S., The Terrace, High Street, Tonbridge, Kent.

May 20, 1904. Perks, Frederick John, 48, Grove Park, Denmark Hill, S.W.

Date of Election.

Feb. 20, 1903.	Pilcher, C. F., 82, Portway, West Ham, Essex.
Nov. 15, 1895.	Pillischer, J., F.R.M.S., 88, New Bond Street, W.
Mar. 18, 1904.	Pinkerton, William, 19, Langley Road, Watford.
June 19, 1903.	Piovanelli, Sebastiano C. E., 28, Via Prenestina, Rome, Italy.
Nov. 19, 1897.	Pittock, George Mayris, M.B., F.R.M.S., 23, Cecil Square, Margate.
June 17, 1904.	Plaskitt, Frederic J. W., 27, Great Percy Street, W.C.
Jan. 15, 1904.	Pledge, John H., 115, Richmond Road, Dalston, N.E.
Nov. 23, 1883.	Plowman, T., Nystuen Lodge, Bycullah Park, Enfield.
Sept. 21, 1894.	Pollard, Jonathan, F.R.M.S., 10, Porteus Road, Paddington Green, W.
June 15, 1900.	Poole, Henry, 54, Hazelville Road, Upper Holloway, N.
May 18, 1900.	Poser, M., F.R.M.S., 29, Margaret Street, Regent Street, W.
June 21, 1895.	Poulter, Christopher S., Mount Lodge, Parkhurst Road, Bexley, Kent.
Mar. 21, 1890.	Pound, C. J., F.R.M.S., Bacteriological Institute, Brisbane, Queensland.
Feb. 17, 1899.	Powell, Arthur, 28, Stafford Terrace, Kensington, W.
May 17, 1901.	Powell, David, M.A., F.R.M.S., 17, Warwick Mansions, Cromwell Crescent, Earl's Court, S.W.
July 7, 1865.	Powell, Thomas H., F.R.M.S., 14, St. George's Avenue, Tufnell Park, N.
Feb. 16, 1894.	Praill, Edward, 3, Parkhill Road, Hampstead, N.W.
June 27, 1873.	Priest, B. W., Bank House, Reepham, Norfolk.
Feb. 25, 1881.	Probyn, Lieut.-Colonel Clifford, 55, Grosvenor Street, W.
May 16, 1890.	Pyman, F. H., "Mount Grove," 82, FitzJohn's Avenue, Hampstead, N.W.
Mar. 21, 1902.	Quilter, Horace J., Meadowside, New Road, Windsor.

Date of Election.

Feb. 21, 1902. Radcliffe, William, 43, Queen's Road, Brownswood Park, N.

Jan. 18, 1901. Radley, Percy E., F.R.M.S., 30, Foxgrove Road, Beckenham, Kent.

Nov. 17, 1893. Randell, George J., F.R.M.S., 14, Wavertree Road, Streatham Hill, S.W.

June 24, 1881. Ransom, F., "The Chilterns," Hitchin, Herts.

Mar. 20, 1896. Rheinberg, Julius, F.R.M.S., 16, Coolhurst Road, Crouch End, N.

Sept. 18, 1891. Richards, F. W., 252, St. James's Street, Montreal, Canada.

Jan. 18, 1901. Richardson, John, 14, Townshend Road, Richmond, Surrey.

June 21, 1901. Rickomartz, Edward Adonia, "Argosy," 62, South Croxted Road, West Dulwich, S.E.

Jan. 19, 1894. Roberts, Charles Philip, 31, St. Mary's Road, Canonbury, N.

Nov. 21, 1902. Roberts, Martin, M.I.C.E., F.C.S., Mabshill, Epsom.

June 21, 1901. Robertson, H. R., F.R.M.S., Upton Grange, Chester.

May 20, 1892. Robinson, J., 6, Hampstead Hill Mansions, Hampstead, N.W.

Nov. 16, 1900. Rogers, G. H. J., F.R.M.S., 55, King Street, Maidstone.

Mar. 20, 1903. Rolfe, R. A., "Woodville," Painswick Road, Cheltenham.

Jan. 25, 1884. Rosseter, T. B., F.R.M.S., East Kent Club, Canterbury.

Jan. 26, 1883. Rousselet, Charles F. (*Hon. Secretary for Foreign Correspondence*), Curator R.M.S., 2, Pembridge Crescent, Bayswater, W.

Dec. 15, 1899. Royle, A. E., 56, St. Kilda's Road, Lordship Road, Stoke Newington, N.

May 17, 1901. Rundle, E. H., Harewood Road, Calstock, Cornwall.

Mar. 21, 1902. Rushton, Charles H., 8, Billiter Square, E.C.

April 27, 1888. Russell, J., 16, Blacket Place, Newington, Edinburgh.

Oct. 27, 1865. Russell, James, 10, Shoreditch, E.

Date of Election.

Nov. 21, 1902. Sanderson, R. Z., 26, Beaconsfield Road, St. Margaret's, E. Twickenham, Middlesex.

Dec. 19, 1902. Sayers, H. M., Rusper Lodge, 11, Knollys Road, Streatham, S.W.

Jan. 16, 1890. Scherren, H., F.Z.S., 9, Cavendish Road, Harringay, N.

Feb. 18, 1898. Scott, David Bryce, Moncton, New Brunswick, Canada.

June 20, 1890. Scourfield, D. J., F.R.M.S., 63, Queen's Road, Leytonstone, E.

Mar. 22, 1889. Scriven, J. B., Brigade Surgeon, 95, Oxford Gardens, North Kensington, W.

May 20, 1898. Sears, Robert S. W., 1, Lisson Grove, N.W.

Feb. 15, 1901. Sexton, Louis E., L.D.S., 19, Portland Square, Plymouth.

May 26, 1876. Shepheard, Thomas, F.R.M.S., Kingsley, Bournemouth West.

June 19, 1896. Sidwell, Clarence J. H., F.R.M.S. (*Hon. Curator*), 46, Ashbourne Grove, Dulwich, S.E.

Nov. 23, 1877. Simpson, T., "Fernymere," Castlebar, Ealing, W.

Oct. 26, 1903. Skorikow, Alexander Stepanovic, Musée Zoologique de l'Académie Impériale des Sciences, St. Petersburg, Russia.

Dec. 28, 1866. Slade, J., F.G.S., 7, Chapel Road, Bexley Heath, Kent.

Oct. 23, 1868. Smart, William, 27, Aldgate, E.

May 25, 1866. Smith, Alpheus (*Hon. Librarian*), 14, Leigham Vale, Streatham, S.W.

Oct. 21, 1904. Smith, Arthur Edgar, 69, Wilberforce Road, Finsbury Park, N.

Mar. 25, 1870. Smith, F. L., 3, Grecian Cottages, Crown Hill, Norwood, S.E.

Mar. 17, 1899. Smith, Frank P. (*Hon. Editor*), 15, Cloudesley Place, Islington, N.

Nov. 19, 1897. Smith, Herbert Havet, "Levuka," Westcliff-on-Sea.

Nov. 18, 1898. Smith, Thomas J., c/o W. Watson & Sons, 313, High Holborn, W.C.

Jan. 17, 1902. Soames, Rev. H. A., M.A., F.L.S., The Hawthorns, Otford, Sevenoaks, Kent.

Date of Election.

Jan. 15, 1892. Soar, C. D., F.R.M.S., 37, Dryburgh Road, Putney, S.W.

May 17, 1901. Soutter, Andrew G., "Roseneath," 79, Bethune Road, Stamford Hill, N.

April 21, 1899. Spitta, Edmund J. (*President*), L.R.C.P., M.R.C.S., V.P.R.A.S., F.R.M.S., 41, Ventnor Villas, Hove, Brighton.

April 21, 1899. Spitta, Dr. Harold, Ivy House, South Side, Clapham Common, S.W.

Jan. 15, 1904. Sprague, T. B., LL.D., 29, Buckingham Terrace, Edinburgh.

Sept. 25, 1885. Spriggs, A. T., Bank of England, E.C.

Mar. 18, 1904. Staehler, Max, 29, Margaret Street, W.

Dec. 19, 1902. Stamp, W.B., Elmhurst, Streatham Common, S.W.

April 15, 1904. Stephens, Walter L., "Colomberie," West Bay, Bridport.

Nov. 17, 1899. Stevens, John, F.R.M.S., 50, St. David's Hill, Exeter

April 17, 1891. Stevens, Col. L., 239, Southwark Bridge Road, S.E.

Nov. 27, 1885. Stevenson, G. T., "Glencairn," Castelnau, Barnes, S.W.

June 22, 1877. Stewart, Charles, LL.D., F.R.S., F.L.S., F.R.M.S., etc., Royal College of Surgeons, Lincoln's Inn Fields, W.C.

June 18, 1897. Still, Arthur L., Addington, Croydon.

Nov. 16, 1894. Stokes, William B., 6, New Street, Bishopsgate, E.C.

Dec. 15, 1893. Sturt, Gerald, "Lismore," Cavendish Road, Weybridge.

Jan. 18, 1901. Sully, F. Harold, 18, Trebovir Road, Earl's Court, S.W.

Nov. 17, 1899. Summers, Edgar J. W., "Ingoldsby," Blakeney Road, Beckenham.

June 24, 1870. Swain, Ernest, Little Nalders, Chesham Bucks.

May 17, 1895. Swan, Michael Edward, 64, Dyne Road, Brondesbury, N.W.

Feb. 26, 1886. Swanson, A. J., 112, Cheapside, E.C.

Date of Election.

June 15, 1900. Swears, G. P., 23, Antrim Mansions, Haverstock Hill, N.W.

Dec. 17, 1875. Swift, M. J., "Trematon," Acton Lane, Harlesden, N.W.

April 17, 1891. Tabor, C. J., The White House, Knott's Green, Leyton, Essex.

July 27, 1877. Tanqueray, A. C., 16, Palace Street, Buckingham Gate, S.W.

Nov. 28, 1879. Tasker, J. G., 30, Junction Road, Upper Holloway, N.

Feb. 15, 1895. Tatham, John, M.A., M.D., Rathronan Lodge, The Avenue, Berrylands, Surbiton.

Oct. 16, 1896. Taverner, Henry, F.R.M.S., 319, Seven Sisters' Road, Finsbury Park, N.

Mar. 21, 1902. Taylor, F. B., The Bird's Nest, Lyndhurst, Hants.

Dec. 22, 1865. Terry, John, F.R.M.S., 8, Hopton Road, Coventry Park, Streatham, S.W.

Mar. 16, 1894. Teversham, Fred. W., 317, Wightman Road, Hornsey, N.

Feb. 18, 1898. Thelwell, F. W. Watts, "Tresillian," Harlyn Bay, near Padstow, Cornwall.

June 20, 1902. Thomas, R. H., Box 149, Salisbury, Rhodesia.

Feb. 17, 1893. Thorpe, V. Gunson, Staff Surgeon R.N., 34, Kensington Hall Gardens, West Kensington, W.

May 16, 1902. Tilling, George, F.R.M.S., "Grasmere," Rydal Road, Streatham, S.W.

Dec. 21, 1894. Traviss, Will. R., 44, Huddlestone Road, Willesden Green, N.W.

Nov. 21, 1902. Tryon, B. F. T., Down Hall, Epsom, Surrey.

May 15, 1903. Tupman, G. Lyon, Lt.-Col., F.R.M.S., College Road, Harrow.

June 17, 1892. Turner, C., "Glencoe," Agamemnon Road, West Hampstead, N.W.

June 21, 1901. Tyrrell, E. G. Harcourt, P.O. Box 135, Pietermaritzburg, Natal.

Mar. 16, 1900. Underhill, T. H., M.B., 51, Dulwich Road, Herne Hill, S.E.

Date of Election.

May 23, 1879. Vezey, J. J., F.R.M.S., 188, Lewisham High Road, Brockley, S.E.
May 16, 1902. Vicarey, William, 10, Northumberland Grove, Tottenham, N.

July 25, 1873. Walker, J. S., 6, Warwick Road, Upper Clapton, E.
Jan. 16, 1903. Walker, Wallace O., Belle Vue House, Carey Place, Watford, Herts.
May 22, 1868. Waller, J. G., F.S.A. (*Vice-President*), 75, Charlton Road, Blackheath, S.E.
Nov. 20, 1903. Waller, W. T., 15, Atney Road, Putney, S.W.
June 17, 1904. Ward, Montague Wesney, 4, Chepstow Mansions, Bayswater, W.
Oct. 19, 1900. Warne, Norman D., 8, Bedford Square, W.C.
June 17, 1904. Waterhouse, Alfred N. V., Inanda, Broad Lane, Hampton, Middlesex.
July 24, 1874. Webb, C. E., Wildwood Lodge, North End, Hampstead, N.W.
Oct. 19, 1900. Webb, G. H. D., 111, Clifton Hill, St. John's Wood, N.W.
Dec. 21, 1900. Webster, Rev. T., 13, Victoria Road, Exmouth, Devon.
June 16, 1899. Wedeles, James, F.R.M.S., 231, Flinders Lane, Melbourne, Australia.
May 24, 1867. Weeks, A. W. G., 36, Gunter Grove, West Brompton, S.W.
Feb. 15, 1901. Wesché, Walter, F.R.M.S., 139, Castellain Mansions, Maida Hill, W.
April 17, 1891. West, C., "Fernville," Fortis Green, N.
May 26, 1882. Western, G., F.R.M.S., "Lalbagh," Bushey Park Villas, Park Lane, Teddington.
Nov. 19, 1897. Weston, Digby St. Aubyn Percy, Lieut. R.N., H.M.S. *Albion*, China Station.
Feb. 25, 1876. Wheeler, George, 64, Canonbury Park South, N.
April 21, 1899. Wheler, Edward G., Claverdon Leys, Warwick.
May 17, 1901. Whiting, Oswald, 24, Lechmere Road, Willesden Green, N.W.
June 25, 1880. Wickes, W. D., F.L.S., F.R.M.S., 20, Warrior Square, Southend-on-Sea.

Date of Election.

May 17, 1901. Wilde, Leonard M., 39, Elm Grove, Cricklewood, N.W.

Mar. 25, 1881. Wildy, Arthur, Shord Hill, Kenley, Surrey.

Nov. 23, 1877. Williams, G. S., 20, Oxford Road, Kilburn, N.W.

April 17, 1903. Williams, H., Fulham Infirmary, St. Dunstan's Road, Hammersmith, W.

May 17, 1901. Winter, William F. G., "Greenways," Crane's Drive, Surbiton.

Dec. 20, 1895. Wood, Walter J., F.R.M.S., "Ernecroft," Abbey Road, Grimsby.

Nov. 16, 1894. Wooderson, Edwin, 15, Bernard Street, Russell Square, W.C.

Mar. 19, 1897. Woodley, Ernest, 84, Jerningham Road, New Cross, S.E.

April 15, 1904. Woolley, H. Leslie, Selwood, Beckenham.

Nov. 21, 1902. Worthington, Frank, 38, Westgate Road, Newcastle-on-Tyne.

Feb. 21, 1902. Wyatt, Edward, 27, Sudeley Street, Islington, N.

Jan. 18, 1901. Wykes, William, 7, Plaistow Park Road, Plaistow, Essex.

Nov. 23, 1888. Young, G. W., 82, Bridge Road West, Battersea.

June 22, 1883. Young, William Martin, 48, Sinclair Road, West Kensington, W.

Dec. 19, 1902. Zimmermann, Prof. C., F.R.M.S., St. Mary's College, Hales Place, Canterbury.

NOTICE.

Members are requested to give early information to the Treasurer of any change of residence, so as to prevent miscarriage of Journals and Circulars.

List of Exchanges and of Societies, etc., which Receive the Journal.

American Microscopical Society, c/o Prof. H. B. Ward, University of Nebraska, Lincoln, Nebraska, U.S.A.

"American Monthly Microscopical Journal," Washington, D.C., U.S.A.

Bausch & Lomb Optical Company, Publication Department, Rochester, N.Y., U.S.A.

Bergens Museums Bibliothek, Bergen, Norway.

Berlese, Prof. Antonio, R. Scuola di Agricoltura, Portici, Italy.

Birkbeck Literary and Scientific Institution, Bream's Buildings, Chancery Lane, W.C.

Birmingham Natural History and Philosophical Society, Norwich Union Chambers, Congreve Street, Birmingham.

"Botanical Gazette," University of Chicago Press, Chicago, Ill., U.S.A.

Botanical Society of Edinburgh (The Curator), The Botanic Gardens, Edinburgh.

Brighton and Sussex Natural History Society (The Librarian), Royal Pavilion, Brighton.

Bristol Naturalists' Society (The Librarian), Ashgrove House, 145, Whiteladies' Road, Redland, Bristol.

Canadian Institute, W. H. Vandersmitten, Esq., Secretary, 46, Richmond Street East, Toronto, Canada.

Concilium Bibliographicum, Zürich-Neumünster, Switzerland.

Croydon Natural History and Scientific Society (The Secretary), Public Hall, Croydon.

Dohrn, Dr. Anton, The Zoological Station, Naples.

"English Mechanic," Clement's House, Clement's Inn Passage, W.C.

Entomological Society, 11, Chandos Street, Cavendish Square, W.

Essex Field Club, Essex Museum of Natural History, Stratford, Essex.

Geologists' Association (The Librarian), University College, Gower Street, W.C.

Herts Natural History Society, c/o Daniel Hill, Esq., "Herga," Watford, Herts.

Historical and Scientific Society of Manitoba, Winnipeg, Canada.

Hull Scientific and Field Naturalists' Club, Royal Institution, Hull.

Illinois State Laboratory of Natural History (Library), Urbana, Ill., U.S.A.

Imperial Leopold-Caroline Academy, Halle-on-the-Saale, Germany.

"Knowledge," c/o F. Shillington Scales, Esq., "Jersey," St. Barnabas Road, Cambridge.

Leicester Literary and Philosophical Society (The Secretary), Corporation Museum, Leicester.

Linnean Society, Burlington House, Piccadilly, W.

Literary and Philosophical Society of Manchester (The Librarian), 36, George Street, Manchester.

Lloyd Library, Cincinnati, Ohio, U.S.A.

London Institution (The Librarian), Finsbury Circus, E.C.

Microscopical Society of Liverpool, Royal Institution, Colquitt Street, Liverpool.

Missouri Botanical Garden, St. Louis, Mo., U.S.A.

Natural History Society of Glasgow (The Librarian), 207, Bath Street, Glasgow.

Netherlands Zoological Society, Zoological Station, Helder, Holland.

New York Microscopical Society, c/o Rev. J. L. Zabuskie, Waverley Avenue, Flatbush, L.I., New York, U.S.A.

"Nuova Notarisia," c/o Prof. G. B. De Toni, Université Royale de Modena, Modena, Italy.

"Nyt Magazin for Naturaidenskaberne," c/o Prof. Dr. N. Wille, Botan. Garten, Christiania.

Oberhessische Gesellschaft für Natur- und Heilkunde, Giessen, Germany.

Patent Office Library, 25, Southampton Buildings, Chancery Lane, W.C.

Philadelphia Academy of Natural Sciences, Philadelphia, Pa., U.S.A.

Philippine Exposition Board, Calle General Solano 384, Manila, Philippine Islands.

R. Scuola Superiore di Agricoltura, Portici, Italy.

Royal Dublin Society, Leinster House, Dublin.

Royal Institute of Cornwall, Truro.

Royal Institution, 21, Albemarle Street, W.

Royal Medical and Chirurgical Society, 20, Hanover Square, W.

Royal Microscopical Society, 20, Hanover Square, W.

Royal Society, Burlington House, Piccadilly, W.

Royal Society of New South Wales, c/o Messrs. Trübner & Co., Paternoster House, Charing Cross Road, W.C.

Saunders, Sibert, Esq., The Bank, Whitstable, Kent.

Smithsonian Institution, Washington, D.C.

Société Belge de Microscopie, c/o Mons. A. Castaigne, 28, Rue de Berlaimont, Bruxelles.

Société Botanique Italienne, Florence, Italy.

Society of Arts, John Street, Adelphi, W.C.

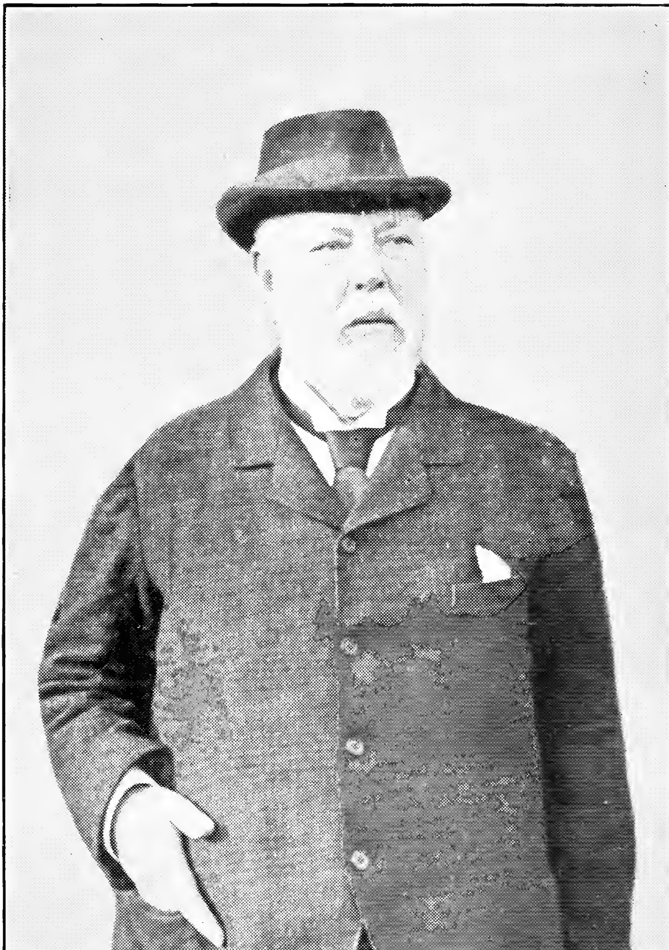
Tempère, Mons. J., Grèz-sur-Loinn, par Bourron, Seine et Marne.

Tyne Side Field Club and Natural History Society (The Librarian), Newcastle-on-Tyne.

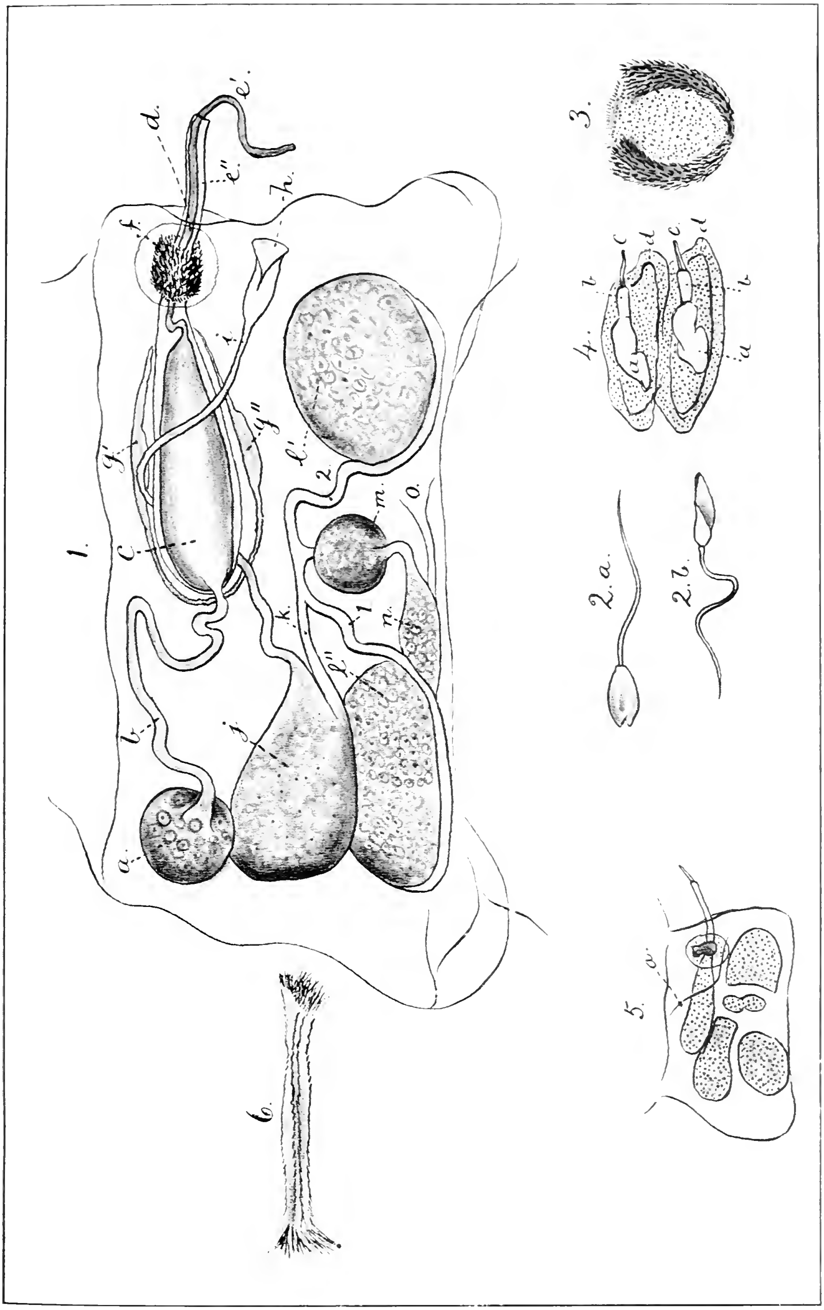
Wagner Free Institute, Montgomery Avenue and 17th Street, Philadelphia, U.S.A.

Zacharias, Dr. Otto, Biologische Station, Plön, Holstein, Germany.

Zoologish-botanische Gesellschaft in Wein, Wollzeile 12, Wien Austria.

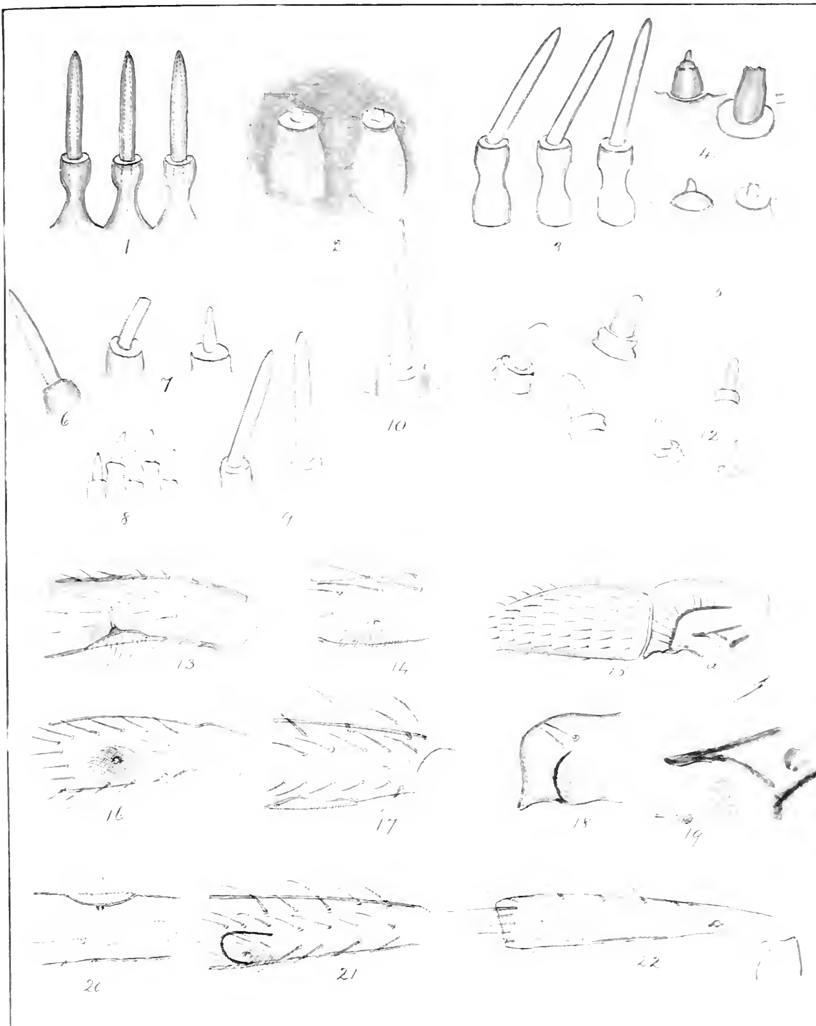


The Late EDWARD DADSWELL, Esq., F.R.M.S.



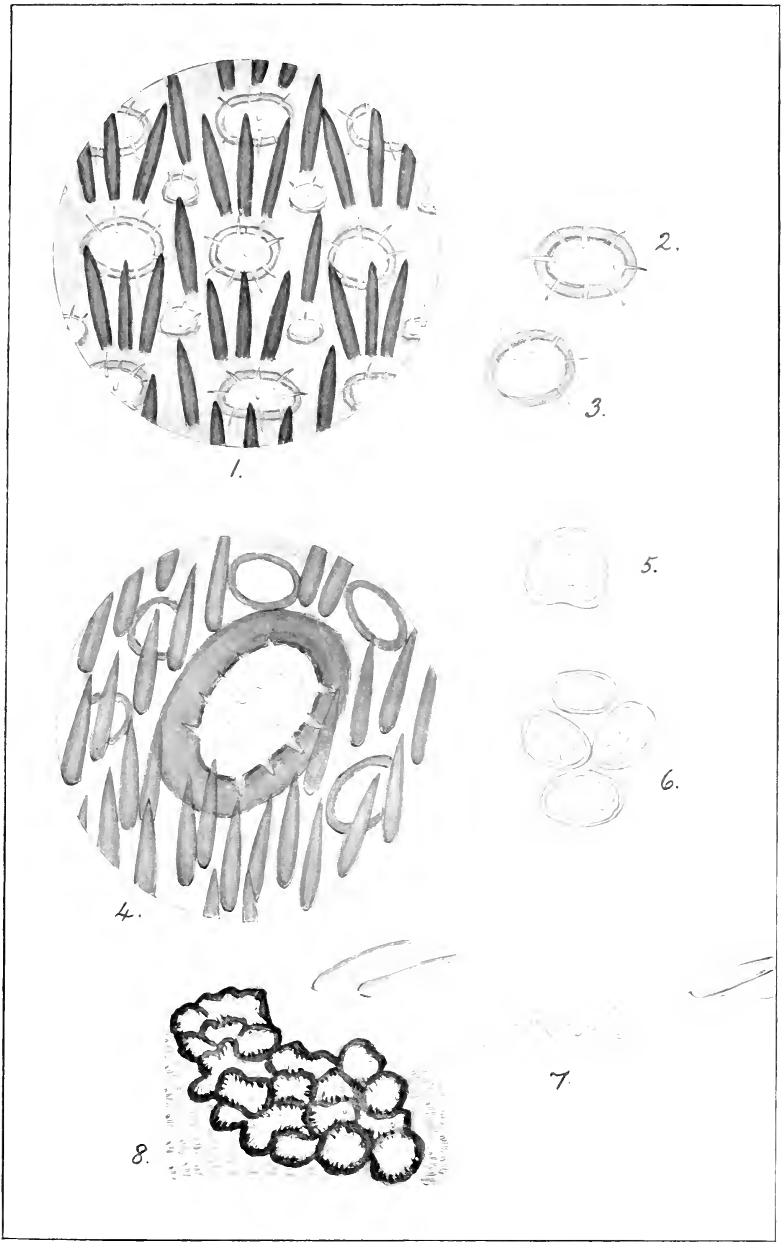
T. B. Rosseter, *del.*

Genital Organs of Taenia Sinuosa.



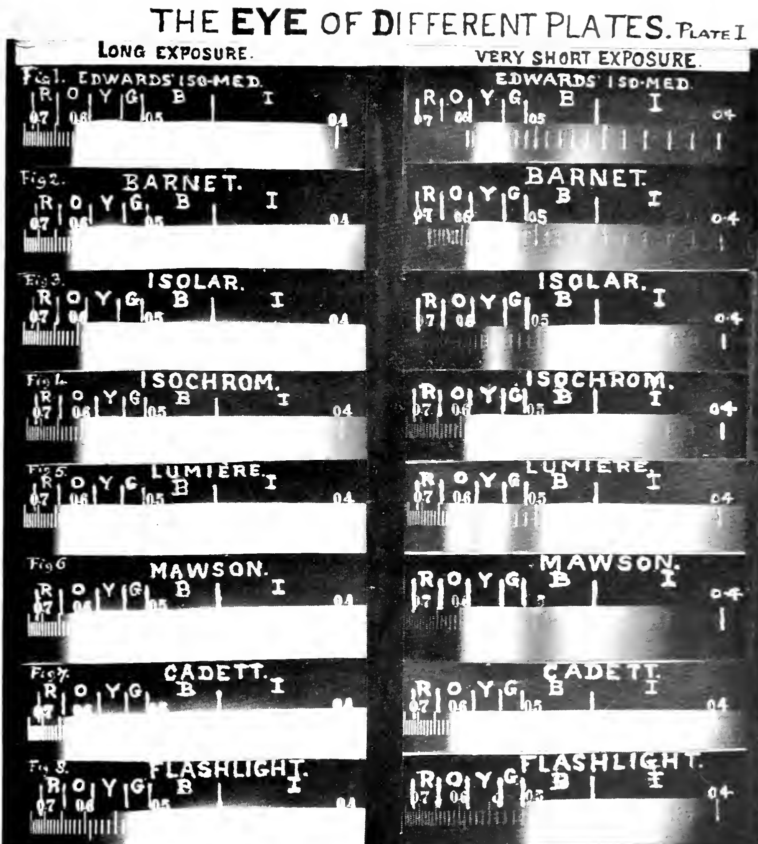
W. WESCHÉ. *del. ad nat.*

SENSE ORGANS OF INSECTS.



W. Wesché. *del. ad nat.*

Olfactory Organs of Diptera



The "Eye" of Various Plates.

FRESH-WATER BIOLOGICAL STATIONS.

By D. J. Scourfield, F.R.M.S.

(*Résumé of lecture delivered December 16th*, 1904.)

In dealing with the subject of Fresh-water Biological Stations, it will be useful, first of all, to glance rapidly at the progress made in fresh-water biology in recent years, paying special attention to the factors which have led to the movement in favour of the establishment of such stations.

The successful founding of the Naples and other marine stations in the 'seventies and early 'eighties, while actually retarding for a time the progress of fresh-water biological research, owing to the impetus given to marine investigations, no doubt suggested to many that the organisation of somewhat similar institutions for work on inland waters would necessarily yield excellent results. But this factor alone does not seem to have had much immediate effect, although it was to bear fruit later.

By the middle of the 'eighties, however, the general deepening of biological research was making it evident that, in spite of an almost overwhelming accumulation of morphological facts, obtained by a host of individual workers with the microscope and microtome, something more was wanted for the solution of most of the fundamental problems of biology—namely, the study of organisms as living creatures in their normal environment. But such a task, if it is to be undertaken in anything approaching a thoroughgoing manner, is quite beyond the power of any number of isolated workers, and so the idea of co-ordination of specialists in biological stations was forced to the front; and since the conditions of existence in fresh water are so much simpler and so much more under control than in the ocean, the movement in favour of fresh-water stations for this purpose gained in consequence.

In countries, too, situated far from the sea, the need was beginning to be felt about the same time for something similar to the marine stations, but near at hand. It was recognised that no biologist's education could be considered complete if he had not worked for a time in a biological station. As, however, the benefit derived therefrom was certainly not entirely due to the material used in his researches, but very largely to the training in methods and to the enthusiasm aroused by intercourse with other workers, there was no reason why fresh-water stations should not prove at least a partial substitute for the marine stations, to those who could not make it convenient to spend some time at one of the latter. The universities of the great inland states of the United States had this idea brought home to them in connection with the training of their numerous students, and it is in these States—Illinois, Indiana, Minnesota, Ohio, etc.—that the principal development of fresh-water biological stations has taken place. The ordinary investigations into the natural history of such inland countries also tended in the same direction, and, as a matter of fact, the earliest of the fresh-water biological stations—a little portable laboratory with accommodation for only two workers—was specially designed to facilitate the natural history survey of Bohemia.

As another factor of great importance, in connection with the increased amount of attention now being given to fresh-water biology and to the establishment of fresh-water biological stations, must certainly be reckoned the rise of limnology, or the study of lakes from every possible point of view. This we owe mainly to Prof. F. A. Forel, who has shown by his work on Lake Geneva what may be done for science by careful investigations of single bodies of fresh water. But if there is one result of limnological work which stands out clearer than another, it is certainly this—that the problems to be solved are found to be so complex, especially on the biological side, that mere random observations are of little use. Systematic work for a long time is absolutely necessary, and, of course, this can only be secured, as a rule, by the founding of stations specially equipped for the work.

The desire to improve fresh-water fisheries, which has been so strongly manifested on the Continent and in America, though not much in this country, has also in recent years produced some excellent results as far as fresh-water biology is concerned. Numerous attempts have been made to introduce scientific methods of increasing the yield of fresh-water fisheries, but in nearly all cases it has been found that more facts about the conditions of existence in the lakes, ponds, and streams in which the fishes live are required before a rational method of fish-culture can be devised. With this end in view several observation and experiment stations have been founded. The work done in these is essentially biological, although limited, as far as possible, to the particular problems connected with the rearing of marketable fishes. There are two such stations in Germany, one of which, the Müggelsee Station, is to be made into a "Reichsanstalt für das Fischereiwesen," at a cost of 150,000 marks, and with a grant from the State of 25,000 to 30,000 marks per annum.

The growing importance of the subject of a pure water supply for great towns can also be considered to have had some influence on the study of fresh-water biology in recent years, although it has only been in a comparatively few instances that adequate provision for biological work in this connection has been made. Nevertheless, the investigations already carried out, especially in the United States—*e.g.* by Whipple in the technical station of the Boston Waterworks—have been of a very instructive character, and have led to some important improvements in the methods of research. It is very probable that in the near future many other large waterworks will find it advantageous, if not absolutely necessary, to maintain laboratories for attacking the special biological problems with which they are from time to time confronted.

The last factor that need be referred to in relation to the progress of fresh-water biology and of the demand for fresh-water stations is the introduction of the quantitative method of investigating the plankton—*i.e.* the whole assemblage of minute organisms living permanently in the open waters of the sea and lakes. Prof. Hensen, of Kiel, first showed how, by means of a special net drawn vertically from a known depth at a definite speed, comparable samples of the plankton could be collected and treated statistically. Apstein, in 1891, applied the method to the study of lakes, and brought to light a whole series of new facts in connection with the fresh-water plankton organisms. Although his investigations were not made with the advantages afforded by a biological station, he fully acknowledged how much easier and how much more satisfactory it would be to do such work at a special station situated by the side of a lake. And it is, moreover, perfectly evident that to get full, regular, and continuous records it is practically indispensable that a number of biologists should work together at the same place—at a biological station, in fact, whatever it may be in name.

Turning now to the fresh-water biological stations actually in existence, we may refer first of all to those on the Continent, then to those in the United States, and lastly to our own little station in Norfolk.

As already stated, the first fresh-water biological station seems to have been the little portable laboratory started by Drs. Fritsch and Vávra in Bohemia in 1888. A good deal of work has been and is still being done by its aid, and there is no doubt of its usefulness in districts where it would be otherwise impossible to get accommodation for biological work on the spot. Bohemia also possesses a little permanent station, erected in 1892, on the Unterpočernitzer Teich, about three hours' journey from Prague.

The most important fresh-water station on the Continent is, however, that at Plön in Holstein, founded by Dr. Otto Zacharias, who is still in charge of the institution. It was opened in the early part of 1892, and has the additional distinction, therefore, of being the oldest of the permanent stations for fresh-water biological research. It is a purely scientific laboratory, not concerned specially with fishery or other economic problems, although naturally such questions are not excluded from its field of work. The district surrounding the station is an exceedingly good one from the point of view of the fresh-water biologist, for directly in front of the building the Grosser Plöner See stretches away to the south for nearly five miles, and there are numerous other lakes, ponds, and swampy hollows within a very short distance. A very large amount of work has been done at this station, as is evidenced by numerous papers in the *Forschungsberichte aus der biologischen Station zu Plön*, of which twelve volumes have now appeared. But, unfortunately, owing to want of the necessary funds, it has not been possible to carry out any of those more elaborate co-ordinated researches which it should be the ambition of every fresh-water biological station to undertake.

Germany possesses two more fresh-water biological stations in addition to that at Plön—namely, the Müggelsee Station, near Berlin, opened in 1893, and the Trachenberg Station in Silesia, opened in 1895. Both of these, however, are essentially fishery experiment stations, and the scope of their work is therefore somewhat limited. The former, as already stated, is to be much enlarged, and converted into a State institution for fishery matters.

It is impossible to refer in detail to the other Continental fresh-water stations, but it may be mentioned that such stations, usually of a very unpretentious nature, exist in many different countries. For example, in Denmark there is the little station on the Furesö, opened in 1900, which is connected with the university of Copenhagen, and where Dr. Wesenberg-Lund has carried out some most excellent investigations, as may be seen from his fine *Studier over de Danske Söers Plankton*, and other publications. In France there is a station at Besse in the Auvergne, in Sweden at Finspong, in Finland at Ewois, and in Russia at Bologoje, Nicolokoje, Glubokoje, and Saratow. Although there is no formal station in Switzerland, several of the laboratories connected with the universities and high schools, situated as they are in close proximity to the lakes, are really to be regarded as fresh-water biological stations.

In the United States a number of fresh-water stations were established, usually in connection with universities, from 1893 to 1899, and most of these are still in existence. One of the earliest, and at the present time probably the best known, is the Illinois Biological Station at Havana, on the Illinois River. It was started in 1894 by Prof. S. A. Forbes, and is peculiar in that it consists of a large floating laboratory, accompanied by a steam launch and other smaller boats. Some very valuable investigations have been carried out, and several important methods of work devised at this station, such as the employment of a pump for the collection and a centrifuge for the deposition of plankton material.

The Indiana Station was at first established on Turkey Lake in 1895, but was removed subsequently to Winona Lake. Prof. Eigenmann and his pupils have carried out some good work at this station, making a special feature of the study of the variation of aquatic organisms.

In Ohio there is a station at Sandusky on Lake Erie, which was founded by the late Prof. Kellicott in 1896, and is now under the charge of Prof. H. Osborn. The United States Fish Commission has also maintained a biological laboratory in the same state, at Put-in-Bay on Lake Erie, since 1898.

Yet another fresh-water station is the Montana Biological Station at Flathead Lake, founded in 1899 by Prof. M. J. Elrod.

In addition to these special stations, the Zoological Laboratory of the University of Wisconsin, under the care of Prof. Birge, must be classed as a fresh-water biological station for all practical purposes, both from its fortunate position on the shores of Lake Mendota, and from the valuable researches carried out there on the plankton of the lake.

Altogether there seems little doubt that the fresh-water biological station has a great future before it in the United States. At present, however, it seems to be looked upon in that country too much as a biological training college for its higher possibilities to be fully realised.

In England, proposals for the founding of a fresh-water biological station were made in 1895 and 1896, but nothing practical was done in the matter until 1902, when Mr. Eustace Gurney established the Sutton Broad Laboratory in Norfolk. This station was erected, and is still maintained, entirely at Mr. Gurney's expense. Although it is a private laboratory, the founder wishes to make it available to workers in any branch of fresh-water biology as far as the limited accommodation permits. When the existence of this well-equipped little station (which is under the direction of Mr. F. Balfour Browne, M.A.), is more widely known, it is to be hoped that it will afford many biologists an opportunity of carrying out special researches on the wonderfully varied, and in some respects unique, fauna and flora of one of the most interesting districts in the British Isles. The "Broads" of Norfolk are already famous in many ways, and deservedly so; they can now boast of the additional attraction, to the biologist at least, of the first British fresh-water biological station.

The work done at the Sutton Broad Laboratory has hitherto necessarily been largely of a preliminary character, and only two papers containing results of investigations * have so far been published; but several more, dealing with aquatic Coleoptera,

* "The Fresh- and Brackish-water Crustacea of East Norfolk," by R. Gurney; "A Bionomical Investigation of the Norfolk Broads," by F. B. Browne. Both published in the *Trans. Norfolk and Norwich Naturalists' Society*, vol. vii., part 5, 1904. A short illustrated account of the laboratory is also contained in the same publication.

Cladocera, Hydrachnida, and Rotifera, are in the printer's hands.

So far the Sutton Broad Laboratory is the only fresh-water station that has been established in this country, but it is only fair to call attention to the good work which has been carried out in Scotland since 1892 by the Lake Survey under Sir John Murray. Although concerned more particularly with the bathymetrical and physical features of the lakes, the biology has not been neglected, and it is not altogether improbable that the Survey may find it advisable at a future date to maintain a permanent station on one of the lakes more particularly for biological observations.

In conclusion, I would like to make a few remarks about the ideal fresh-water biological station of the future. It will be evident, from what has been said concerning the existing stations, that none of them, not even the largest and best endowed, are much more than experiments on a small scale, and that, with the exception of the Illinois Station perhaps, scarcely any attempt at co-ordinated research has been made, owing chiefly to lack of funds. But organised and continuous work of a staff of specialists for a considerable period of time ought to be a fundamental principle of an ideal station. If this were carried out properly, it would probably be found that, so far from following at a distance in the footsteps of the marine stations, as they have practically done up to the present, the fresh-water stations would take the lead in biological investigations in the future, because, owing to the simpler conditions of existence in fresh water, most of the fundamental problems could be attacked by them with more hope of success than by marine stations.

As I conceive it, therefore, the ideal fresh-water biological station of the future will be a somewhat elaborate institution, comparable to an astronomical and meteorological observatory, employing a permanent staff of at least four or five specialists and also providing accommodation for a number of temporary workers. Its functions will be (1) systematic and continuous observation of all the organisms in one or more pieces of water, and of the changes in their environment; (2) experimental work with selected species on various scales in artificial ponds and tanks; (3) special researches into the morphology, embryology, physiology, etc., of different species as suggested by the observations made under (1) and (2); and perhaps, (4), a certain amount of teaching work occasionally. The permanent staff would be responsible for and mainly concerned with the first of the foregoing functions, and also, of course, with the fourth if it were permitted; while the experimental and special research work might probably be largely undertaken by competent temporary workers.

With such an organisation I feel convinced that not only would our knowledge of fresh-water organisms become enormously extended in a few years, but good progress would be made with the elucidation of fundamental problems, as, for example, the laws of heredity and the causes of variation, the two most important questions before biologists—and the man in the street if he did but know it—at the present time.

The cost of such a station would, however, be considerable, and there seems but little hope of such an institution being established just yet. In the meantime, the existing stations are doing good work, and should be encouraged in every way, especially by being used more extensively by workers in different branches of fresh-water biology.

A DESCRIPTION OF THE ROUSSELET COMPRESSORIUM.

By Chas. F. Rousselet, F.R.M.S.

(*Read January 20th*, 1905.)

Some misconception seems to have arisen about the small compressorium which bears my name, and it will perhaps, therefore, be advantageous to here set forth its special features and advantages, more especially as no figure or description of it has hitherto appeared in the *Journal of the Quekett Club.*

The idea of this compressorium forced itself upon me about 1890, owing to the great difficulty and loss of time I experienced when examining small moving animals, such as Infusoria, Rotifera, etc., with high powers, under proper and critical illumination with modern condensers. The then existing compressors were not satisfactory, and failed to produce the desired result. My previously devised live-box,* though right in principle and efficient for objects not too small, did not allow of a sufficiently delicate and graduated movement and accurate control of the compression.

What I wanted was a small, handy compressorium which would satisfy the following conditions:

1. The securing with precision and holding of any small Rotifer or Infusorian between the glass tablet and cover-glass, without crushing or even hurting it.

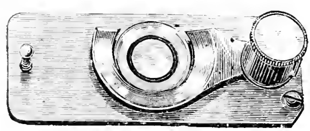
2. The possibility of examining the secured animal in any part of the field, wherever it may have been caught between the two glasses, with all powers, including water and oil immersion lenses.

3. The possibility of critically illuminating the animal from below with modern wide-angled condensers.

* For the special purpose of rendering it air-tight and preventing the evaporation of the water on the slide, this live-box can very well be modified and improved as suggested by Mr. Merlin (p. 169), and for the continuous observation of organisms which do not admit of compression, such as Monads and Bacteria, the live-box will probably answer better than the compressorium.

4. The possibility of adding a drop of water to the secured animal, or a drop of narcotising or fixing fluid, or other reagent when desired, without risk of losing the animal and without removing the compressor from under the microscope, or lifting the cover-glass.

All these points, which I consider most essential, are fully secured by this compressorium, and all those who have tried to follow and study a roving small animal with a high power will appreciate the facility and precision with which this can be done with the appliance here described. Some of the former compressors, which were otherwise good in design, failed in so far that they allowed the animals to wander under the brass ring and out of sight, or to a position near the edge of the drop of water where they could neither be reached with the high powers of the microscope, nor properly illuminated from below.



The accompanying figure shows the Rousselet compressorium and renders a detailed description almost unnecessary. I will, however, mention the dimensions of the parts and some essential points which should not be overlooked by the makers, but most carefully attended to in every detail in order to make the apparatus thoroughly efficient.

The length of the brass base-plate is $3\frac{1}{4}$ in., its width $1\frac{1}{4}$ in., its thickness $\frac{1}{16}$ in. The glass tablet, well polished and free from scratches, is $\frac{1}{16}$ in. thick and $\frac{1}{2}$ in. in diameter, and fixed almost flush with the underside of the slide, which is slightly countersunk on both sides; when fixed, the tablet stands a very little (equal to the thickness of a thin cover-glass) above the surface of the brass slide. It will be noticed also that the glass tablet's position is not in the centre of the slide, but a little above it.

The arm carrying the cover-glass must be a little stouter than the slide, say $\frac{3}{32}$ in., in order to secure sufficient rigidity; it forms a ring of $1\frac{1}{4}$ in. outer and $\frac{7}{8}$ in. inner diameter, about one-third of which is cut off on the upper side. The ring is bevelled from the outer to the inner edge.

The cover-glass, $1\frac{1}{8}$ in. to $1\frac{1}{4}$ in. in diameter and with a segment cut off, must be cemented firmly to the perfectly flat (not countersunk) under-surface of the ring with a very little goldsize. This is best applied to the brass ring and allowed to dry for half an hour, the cover being then put into proper position and very gently warmed, when it will adhere firmly on cooling and be ready for use. The cementing of the cover-glass is most important, in order to prevent the fluid from a water or oil immersion objective running between the brass ring and cover-glass, and ultimately finding its way to, and mixing with the water on the slide. In cementing, the cover-glass should be so arranged that the cut edge just reaches the upper edge of the glass tablet; this arrangement will allow a drop of water or reagent to be added with a fine pipette while the animals are under examination. The thickness of the cover-glass may be anything between 0·16 and 0·20 mm., but the thickness should always be known.

The arm moves parallel to the glass tablet, and is raised and lowered by a screw adjustment working against a spiral spring contained in the small brass drum. It is held in position by a spring catch, but can easily be turned aside. Although the arm is made to move parallel to the brass tablet, it should be to a very slight extent inclined forward, so that on being lowered the cover-glass first touches the distal part of the glass tablet, otherwise it will be found that very small creatures cannot always be firmly held. It is obvious also that if the cover-glass should first touch the lower or the near edge of the tablet, no amount of pressure by the screw will secure the animal; on the contrary, the other side of the cover will be raised. This condition of things, when it exists, can be remedied by fixing a strip of paper or thin glass to the under-surface of the ring at its distal part before cementing the cover-glass.

This compressorium was first shown by me at the meeting of the Royal Microscopical Society on April 19th, 1893, and was figured and described in the journal of that society for the same year (p. 386). I have had it in constant use ever since, and, so far, have not found occasion to modify it or to suggest any improvement.

There is only one desirable quality that it does not possess, and which cannot be given to it: it is not reversible. In actual practice, however, I find that by raising the cover slightly whilst under observation with a low power, the animal in swimming away soon turns round, when it is immediately again secured by a turn of the screw.

In 1900 Mr. G. H. J. Rogers introduced a modification of the above compressor, in which the cover-glass was held in position by two india-rubber bands instead of being cemented, claiming that it was thus easier to replace a broken cover-glass. I pointed out at the time that this very slight advantage was much more than counterbalanced by the introduction of two serious defects: in the first place, the cover-glass was no longer sufficiently firm and rigid for delicate manipulation; and secondly, the compressorium became quite unsuitable for use with water and oil immersion lenses, as these fluids could run under the brass ring and eventually mix with the water on the slide. The removal of a broken cemented cover is so readily effected by slightly heating it over a lamp, that no modification is required on that account—none at least that cancels two very essential qualities of my model.

In spite of these obvious defects, this modified compressor found entrance into several opticians' catalogues under the title, "Improved Rousselet Compressor," the india-rubber bands having meanwhile been replaced by two screws. These screws have introduced a fresh defect, because the arm has to be raised considerably before it can be turned aside. There is absolutely no reason why any one wanting such a compressor should not have it; but I think I must ask these opticians to be good enough to call their modified model by some other name, for I have always disapproved of it for the reasons stated above, and it is not my model and very much less an "improved" form of it.

THE PRESIDENT'S ADDRESS.

THE IMPROVEMENTS IN MODERN OBJECTIVES FOR THE MICROSCOPE POPULARLY EXPLAINED.

By E. J. Spitta, F.R.A.S., F.R.M.S., Etc.

(*Delivered February 17th*, 1905.)

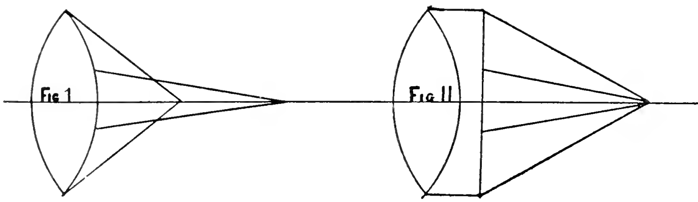
Plates 9 and 10.

Gentlemen,—

The introduction of the Jena glass has been of so much service to the computer of modern lenses, that the manufacture of the old type of achromatic objective may be said to have ceased to exist. At any rate, the improvement in definition and in colour correction in the new so-called semi-apochromatic objective is of so marked a character that I thought it might possibly interest the members of this Club if for a few moments I attempted to point out, in simple, untechnical language, in what way this new type of lens construction differs from the old achromatic on the one hand and the true apochromatic on the other. I have not the slightest intention of bringing before you an exhaustive treatise on lens construction, for that might not interest the majority of the members, even if I felt myself competent so to do—which I most certainly do not pretend for a moment. I wish merely, in a general way, to point out the leading lines upon which the modern computer has worked, and in what manner step by step he has so improved his computations as to furnish us with a type of lens which is such a decided advance upon anything hitherto constructed. I must confess that to put this in simple language and yet to handle the subject in a scientific manner has been a far more difficult task than I anticipated, and one, I think, to which I should have found myself unequal had it not been for the assistance of my friend Mr. Conrady, whose knowledge of these matters is, both practically and theoretically, so very extensive.

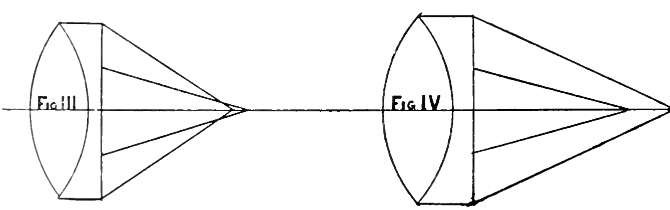
Before actually commencing my subject, I may perhaps be permitted to remind you of the interpretation and meaning of the following terms, in case some of you may not have them quite fresh in your minds.

SPHERICAL ABERRATION is a term which refers to a condition inherent in every uncorrected lens, by which is meant that the rays passing through its periphery, or outside portion, focus on the axis at a shorter distance than those passing through the more central portions of the lens, as shown in Fig. 1. If by suitable correction the rays are approximately brought to a



common focus on the axis, the lens is said to be spherically corrected, as in Fig. 2; but if they are not enough corrected, although the foci are brought nearer each other than obtains in the uncorrected lens (Fig. 3 for example), the condition is spoken of as under-correction. In Fig. 4 we find just the reverse. The whole correction is too much, because we see the outer ray is taking the position occupied by the central ray, and the central ray that formerly occupied by the outer. As the correction is here too great, we call this state of things over-correction.

ASTIGMATISM is a trouble which may occur in microscopical objectives, but is mostly found in photographic lenses for the



ordinary camera. As I dare say most of you are aware, the presence of this defect is indicated by the fact that it is impossible to simultaneously focus the two cross-bars of a simple +, placed so that one bar points towards the optical axis, at the edge of the field. When the radial line of the cross is sharp, the tangential one is fluffy; when the latter is sharp, the definition of the radial one ceases to be good. In microscopical objectives this defect is sometimes—though rarely, I admit—to be detected when using an Abbe test-plate (which consists of parallel lines drawn through a surface of finely deposited silver). At one focus all lines appear focussed, it is true, but only in concentric circles; whereas another plane of focus shows them sharply defined, but only in narrow bands radiating from the centre of the field as the spokes of a carriage wheel. It is not possible to focus both directions at one and the same time. Plates 9 and 10 are photomicrographs taken with a lens affected with this fault, and as it is rare I thought it worth while to show it to you.

COMA is a defect confined entirely to rays coming from points of the image lying outside the axis of the lens, and one not easy to explain for the simple reason that several who use the expression place upon it a meaning of their own. Although in

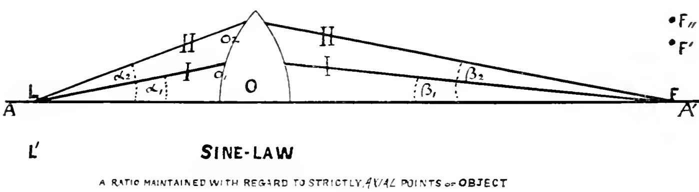


Fig. 5.

what follows I shall use the expression in a somewhat restricted sense, still, even then, the nature of the fault is such that it is not easy to explain in a few words. To make what follows more intelligible, I think it will be best to define it first, declaring it to be a peculiar defect due to the "non-fulfilment of the sine-law," because by so doing this will lead me at once to explain what this sine-law is, which will then enable me afterwards to show how its neglect causes *coma*.

In Fig. 5 the axis of the lens is shown at AA′, and L, a point of the object, is seen lying upon it. I is a ray proceeding from L to the lens O, meeting it at a point O_1, from which it passes to focus at F. Another ray following the course of II strikes the lens at O_2, focussing at the same point F. It is to be further understood, when in the future the zone O_1 is spoken of, it is not meant to include a piece of the lens from O to O_1, nor when talking of zone O_2, the portion included between O and O_2.

but simply to refer to an extremely narrow belt of glass; so that, to make my meaning clear, a lens should be considered as being made up of a very great number of zones—like, in fact, a lighthouse lens is made—only two of which for the present purpose are being considered. The angle that the ray I makes with the axis AA′ on the left hand of the diagram we call α_1, that on the right side being designated β_1; whilst the angles for ray II are called α_2 and β_2 respectively for each side. Now the sine-law is this: that the ratio the sine of the angle α_1 bears to the sine of the angle β_1 shall be the same as α_2 bears to β_2. If, then, these ratios be equally proportionate, we speak of the "sine-condition," or the "sine-law" as being fulfilled. I think it will make my meaning more clear if I resort to an illustration. Let us, for example, say we find the angle α_1 to measure 13° 54′, the sine of which we ascertain by the tables is ·240; whilst the sine of β_1, estimated at 6° 55′, we note as ·120. Here it is evident the ratio is as 2 to 1. Extending our examination to the angles α_2 and β_2, let us further suppose they are 22° 58′ and 11° 15′, the sines of which are respectively ·390 and ·195—just the same ratio as before, viz. as 2 is to 1. This is what is called a "fulfilment of the sine-law." I have already pointed out that coma is a defect confined to rays coming from points of the image lying outside the axis of the lens, but it remains for me now to further say that the beauty of the sine-law is this: that if the sine-condition is fulfilled with regard to the strictly axial points of the object, as I have previously explained it causes a distinct and good image of the portions of the object lying outside the optical axis, such as we might say lies at L_1. Let us proceed, then, to see what happens if this sine-relation be neglected, and how such non-fulfilment causes the defect (whatever it may be) we call coma. To begin with, I ought perhaps to state that the ratio between the sines, whatever it may be, is really the magnification of the object with the lens in question under the circumstances, so that this particular lens we have been dealing with would magnify the object twice. To be more accurate, I should say that the zone O_1—that narrow strip of the lens containing the ray I—magnifies twice, and that the zone O_2, containing ray II, does likewise. If, however, the sine-law be not observed by the computer of the lens, the effect is that these zones do *not* magnify the same, and hence that the rays coming from the outside points of the object will *not* focus on the same point; for ray I may come to a focus, say, at F_1, whilst ray II is at F_2.

In Fig. 6 A, the sine-law being supposed to have been fulfilled, it is quite evident that the two zones are yielding exactly the same magnification, for they are seen to be both focussing at the same point, F_1; whilst in the next illustration (Fig. 6 B), the

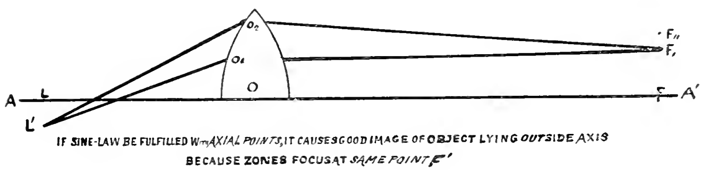


Fig. 6 A.

computer having neglected the sine-condition, the zones are shown coming to different foci—one at F_1 and the other at F_2. It is obvious how disastrous such a state of things would be for the definition; and if bad for two zones only, I leave you to imagine what it would be if all the zones of the object-glass were being considered. We should have a line extending from F_1 to F_2 instead of two points. But even yet I have not quite finished. This class of defect does not, I believe, ever occur quite alone; other evil genii associate themselves, rendering "confusion worse confounded," their evil influences making their presence apparent

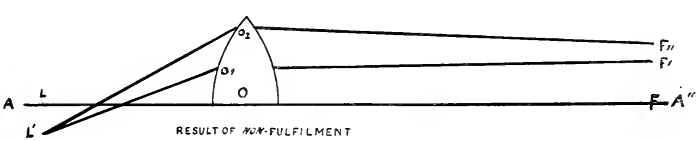


Fig. 6 B.

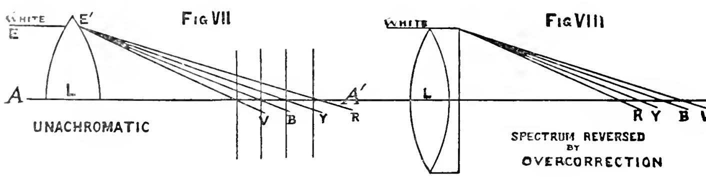
by causing the line, of which I have just been speaking, to be spread out more and more into something like a comet's tail.

Now, gentlemen, we have arrived at last at the end of the argument, for this comet-like smudge indicates what is called *coma*. I think from what I have said you will all understand how important a thing it is with objectives for the microscope that this law should always be faithfully carried out, and why the late Professor Abbe, who first called so much attention to it, laid so great a stress upon its observance.

Lastly, there is yet another defect to remind you of. It is one for which I claim your closest attention, for any little interest I can arouse in your minds in what follows is largely associated with what I have now to say, and so I wish you to grasp the situation in its entirety. I refer to the subject of—

Chromatic Aberration.—This—another name for the errors which occur in the performance of lenses due to the different paths pursued by light of differing wave-lengths—is a matter of the greatest interest.

Let us take first quite a simple lens, of short focus—such, indeed, as you meet with in an eye-piece. Let us presume it is mounted in a cell, so that we can attach it to the nose-piece of the microscope, and that a piece of finely ground glass is placed over

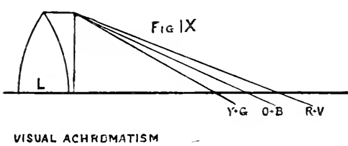


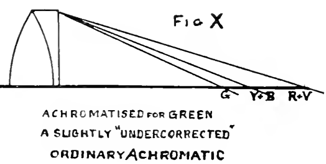
the eye-end of the drawtube, the ocular having been first removed. A well-defined object being focussed on this glass screen—using different apertures of the lens in succession, and employing monochromatic light first of one colour and then of another—discloses the fact that, owing to spherical under-correction, we only get reasonably sharp images with a small aperture of the lens, and generally owing to coma, only in or near the centre of the field. If, with a small opening, we now try other colours of the spectrum in succession, we find that an alteration of the focal adjustment is required for each colour; and also that the different coloured images, when in focus with a constant tube-length, differ in size, for the red really requires the longest focus and furnishes the smallest image, the violet having the shortest focus, whilst it yields the largest image; other colours in between. This is better understood by examining Fig. 7. L is the simple uncorrected lens; E is a beam of white light entering it; and E_1 the point where the lens, acting as a prism, breaks up the white light into its component colours. Red focusses on the axis AA′ at R, and violet at V, some of the other colours being omitted for clearness of diagrammatic representation. This is the performance of the simple uncorrected lens. A great improvement is at once effected by combining a convex crown lens with a concave flint; the four radii and the different dispersive properties of the two glasses enable the computer to,—

(1) Bring the central and marginal rays of one colour to focus at the same point—in other words, to cure spherical aberration for *one* colour, any wave-length that is chosen being spoken of as the "preferred colour";

(2) To correct coma for the same colour—in other words, to fulfil the demands of the sine-law for this preferred colour; and

(3) To cause the rays of other colours to concentrate very

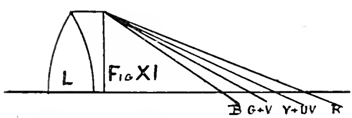




nearly upon the same point on the axis as those of the preferred colour.

The lens is now said to be achromatic in the ordinary sense of the word. If, however, the computer has over-corrected in the matter of colour, we shall have a state of things shown in Fig. 8, where red has become the shortest focus and violet the longest; so we call this total over-correction for chromatic aberration. If we examine Fig. 9 and those diagrams which immediately follow, we shall quickly notice that the focus of the preferred colour is always the shortest; so the spectrum may justly be said to be folded over at that point, for should the selected colour be yellow-green—which is, in fact, that usually taken for visual objectives—yellow-green will be seen to have the shortest focus; orange and blue are folded together, and further on red and violet. Achromatisation for green—what has been termed a slightly under-corrected ordinary achromatic—we see depicted in Fig. 10. Here the preferred colour has again the shortest focus, a blending of yellow and blue coming next, whilst red and violet are seen still farther on. A lens corrected for the blue ray—an ordinary photographic objective—is drawn in Fig. 11. Blue is seen to have the shortest focus, because it is the preferred colour; green and violet are joined up next; yellow and ultra-violet follow, whilst red, outstanding, has the longest focus of all.

We shall find that in the best work, by making the components very thin, or else by very carefully proportioning their relative thicknesses, the computer can also produce, at any rate very approximately, equality of focal length for the different colours, which, it should be borne in mind, also means that the differently coloured images will be of the same size. Such combinations, when seen at their best, are said to have all the serious aberrations corrected in their first approximations. Indeed, such a combination, well effected, is near enough perfection if the objective be of small size and of relatively long focus, say of not less than two inches; but directly the computer tries to make an



ACHROMATISED FOR BLUE

ORDINARY PHOTOGRAPHIC OBJECTIVE

objective of high power on these lines, where strongly curved lenses become necessary, a number of other imperfections soon become apparent, which rapidly place a limit on his powers. These secondary aberrations are as follows.

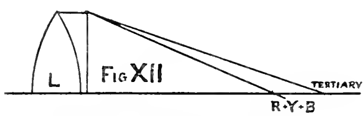
1. If we test an ordinary achromatic lens of considerable angular aperture, as previously detailed, with monochromatic light—the preferred colour selected being yellow-green for visual instruments, greenish-blue for photo-visual purposes, and blue-violet for purely photographic work—we find that, although we have cured the spherical aberration of the central and marginal rays, by making them come to the same focus, the rays from the intermediate zones of the lens do not do so, being generally found to be under-corrected. This defect is often called secondary spherical aberration, but, with the computer, spherical zones. It is the most formidable of all troubles with which the optician has to deal, even in the case of objectives of moderate power; and it has to be corrected by combinations of over- and

under-corrected elements acting in concert and in suitable sequence.

2. If we next substitute monochromatic light of wave-lengths different from that of the preferred colour, we shall find that for them spherical aberration is *not* corrected, even in the first approximation, the defect being generally that of under-correction for red and over-correction for blue. This kind of secondary aberration is, in microscopical objectives, next in importance to the last mentioned, and has been called by the late Professor Abbe "chromatic differences of spherical aberration," which he further pointed out could not be cured without the use of glass of different properties from that which was then in existence. The outcome of this remark was the starting of the Jena glass factory.

3. If we proceed to test for differences of focal adjustment with the different colours, we find that whilst light of nearly the same tint as the preferred colour shows no sensible difference of focus, light of considerably different colour does, and in a somewhat curious fashion:—If the lens be corrected for visual work. yellow-green, the preferred colour, will be found to have the shortest focus, as we have before explained; the other colours, focussing at greater distances, blending, and in curious pairs, bright red being united with blue, and, at a still greater distance, deep red with indigo or violet, as we see in Fig. 9. This has been called the secondary spectrum, and is the most serious defect in telescopic objectives, but ranks only as an indifferent third in the manufacture of the microscopical objective. The earlier types of achromats made with the old kinds of glass will be found great offenders with regard to the correction of these secondary aberrations. In these the spherical zones are often found to be reasonably well corrected for the preferred colour, but the chromatic differences of spherical aberration are generally so serious as to greatly reduce the usefulness of this type—at any rate for accurate work, and particularly where a large cone of light is employed or oblique pencils are used. It is needless to say that for high-class photomicrography these lenses are simply useless.

As we have already said, the introduction of the Jena glass has changed the position of all things optical, for now we find the computer can produce objectives which are spherically corrected for two colours instead of only one, whilst the other wave-lengths are almost perfectly corrected; so we find ourselves face to face with an objective free from the chromatic differences of spherical aberration of which I have just made mention. These new objectives, if well made, should show no defect except that of the pure secondary spectrum. They appear in the market under many names—the achromatic of Zeiss, known as their "Improved type," being the same as the semi-apochromatics of other makers. Sometimes we have entirely new names, such as the "Holoscopic" of Messrs. Watson & Sons, or the "Modern achromatic" of Messrs. Powell & Lealand and others. This new type is really a most excellent lens for all general purposes, but, of course, for photomicrography it requires the use of a suitable screen because of the secondary spectrum, and with diatoms the image shows colour. This secondary spectrum is entirely eliminated in the best type of apochromatic objective, which makes it rank as the highest achievement of modern



COLOR PART OF APOCHROMATIC SYSTEM

THREE COLORS UNITED

computation. I suppose this must be called the *magnum opus* of Professor Abbe: but, really, he was such a genius in so many different directions that I scarcely like to say that any one result of his fertile brain was the best thing he ever did. In the apochromatic, then—to repeat—besides the cure of spherical zones and chromatic differences of spherical aberration, the secondary spectrum is entirely eliminated, leaving only a very faint tertiary spectrum outstanding. The best types of these remarkable lenses show hardly a trace of colour under any conditions. I should further state that as three colours are united, instead of two as in the semi-apochromatic objective, photographs can be taken in light of any wave-length without alteration of focus or adjustment. If we glance at Fig. 12 the improvement is diagrammatically represented. I should like to make one more remark before quitting the subject of apochromatics—namely, that it should be borne in mind that, just as the indiscriminate use of the Jena glass does not of necessity render a lens worthy of the name of semi-apochromatic, so the use of fluorite (which I might add enters into the formation of the true apochromatic) does not constitute such objective a true apochromatic. Indeed, there are some sold under this name which do not equal a good semi-apochromatic.

As most of these objectives necessitate the use of a special form of ocular it may be well here to describe its function, for I find it is often misunderstood, especially as the use of compensating eye-pieces certainly improves the performance of the better class of semi-apochromatics almost to the same amount as it does with the true apochromatics.

To explain the use of these compensating eye-pieces, let us first try a high-power apochromatic with an ordinary Huygenian ocular, using white light with an object of strong contrast such as may be furnished by an Abbe test-plate. We find, perhaps to our surprise, excellent definition in the centre of the field, but an immense amount of primary colour (that is, yellow and blue) in the marginal parts of the field. No wonder, therefore, that even some experienced microscopists are led to think that the compensating ocular plays a very large part in the colour correction of this modern type of objective. But if, retaining the same ordinary ocular, we substitute monochromatic light of various colours in succession, we find, again perhaps to our astonishment, that without alteration of focus (or, at any rate, with but a very slight one in the case of the semi-apochromatic), any one colour gives extremely fine and sharp definition *all over the field of view*; but that the different coloured images are of different magnitude—red, for example, producing considerably lower magnification than blue or violet. This peculiarity is due to the thick unachromatic front lens found in all these modern constructions, which causes them to have a shorter equivalent focus for blue than for red rays as before explained. A compensating ocular, then, is merely one which has a corresponding chromatic difference of magnification *but in the opposite direction*, although of the same amount, so that the final magnification is the same for all colours. This chromatic difference of magnification is, then, the only aberration that the compensating eye-piece can or does correct: all the other corrections must be effected by the objective itself.

In conclusion, it may be of interest to tabulate the number of conditions which the objectives of various degrees of perfection fulfil, as this will show the difficulties the ambitious computer has to face.

A. An ordinary low-power achromatic must be corrected for,—

(1) Primary spherical aberration ;

(2) Elimination of coma ;

(3) Primary colour.

B. An ordinary high-power achromatic, in addition, must be approximately corrected for,—

(4) Secondary spherical aberration (spherical zones) for the preferred colour.

C. Semi-apochromatics, besides fulfilling the above four conditions in a highly perfect manner, must be made free from,—

(5) Primary spherical aberration for a second colour (and nearly for all colours) ; and

(6) Should be computed so as to give equal magnifications for all colours when used with compensating eyepieces : whilst

D. The full apochromatic must further show,—

(7) Freedom from the secondary spectrum.

One word more and my story is told. In carrying out these corrections it is essential to bear in mind that the aberrations should be corrected in the order given ; an objective must be free from the first three to be entitled to the description of an achromatic one, from the first five to become a semi-apochromatic, and from all seven to merit the true application of the term apochromatic.

ON THE COLLECTED PAPERS OF ABBE, AND MICROSCOPE THEORY IN GERMANY.

By Julius Rheinberg, F.R.M.S.

(*Read March 17th*, 1905.)

There has just appeared, from the pen of Prof. H. Ambronn, in the *Zeitschrift für Wissenschaftliche Mikroskopie* of January, a most excellent detailed review of the collected papers of the late Prof. Abbe, which were published last year.* From no one could we have a more trustworthy account of the salient features of Abbe's work on the microscope than from Dr. Ambronn, a professor of the University of Jena who stood in close connection with Prof. Abbe for a number of years; and feeling sure that so comprehensive a summary of his work would be received with interest by the members of our Club—which, we may remember with pride, has counted Prof. Abbe as one of its honorary members for over twenty-five years—I am bringing before you, with the kind permission of Dr. Ambronn and of the editor of the *Zeitschrift für Wissenschaftliche Mikroskopie*, a translation of this review.

You will, I think, find even an additional interest in it, because one can clearly discern that not only are the views of Abbe set forth, but also that the paper faithfully reflects the present German standpoint on many questions of practical and theoretical importance. Differences of language act as a natural barrier; work done in one country is often not followed as closely in another as would be the case if they had a common language; and so it happens that we not unfrequently find the trend of thought and reasoning in two countries differing materially with regard to certain problems. In microscopy it is a matter of common knowledge that in this country and on

* *Gesammelte Abhandlungen von Ernst Abbe.* Edited by Dr. S. Czapski. Published by Gustav Fischer, Jena, 1904.

the other side of the Channel different views are still held on various questions, and therefore, whether we endorse all the views expressed or not, all will agree that it is valuable to have a clear *résumé* of them before us. I think you will consider me justified in referring to this additional point of interest in the paper, although I am aware that no supplementary reason is needed to interest you in Dr. Ambronn's summary of the work of the man to whom, more than any one else, we owe the perfection of the modern microscope.

I would only add that, if the phraseology of the translation does not read quite so smoothly as it might, it is because I thought it better to keep as literally to the German as possible, rather than give a freer translation, in which the risk is always run of the meaning being altered a little, according to the ideas of the translator.

Translation of Prof. H. Ambronn's Review.

Amongst practical microscopists the many treatises of Abbe on the theory of the microscope are little known, although their contents form the best basis for a correct interpretation of microscopic observations. For this strange fact several reasons might be advanced: one of them certainly is that the individual papers were issued in different journals, some of which are not readily accessible to all. By the issue of the present collection, prepared by some of the members of the scientific staff of the Zeiss Optical Works, this cause has at any rate been eliminated, especially as the almost entire absence of purely mathematical deductions, and the clear, crisp form in which the chief results are expressed, will materially facilitate their comprehension by readers whose previous theoretical knowledge of the subject may be limited.

To be sure, Nägeli and Schwendener had pointed out the epoch-making work of Abbe, and subsequently Dippel did so at much greater length in his *Handbook on the Microscope*, and it was generally recognised that through Abbe's influence on the construction of the microscope a powerful change had been brought about. All the more, however, was one inclined to consider as really existent what was observed by means of the now so much improved microscope. That microscopic images of fine structures are in many cases only an indication, and not a perfectly correct representation of the objects, remained either unknown to most microscopists, or they looked upon such conclusions as deductions from a doubtful hypothesis, which might perhaps be of interest to physicists, but which could in nowise fetter the living advance of the flourishing biological sciences in the chains of an abstract doctrine (cp. p. 134). There were even microscopists of acknowledged repute who regarded the views of Abbe as totally beside the mark (cp. Paper XIV., "On the Limits of Geometrical Optics"). Why should one trouble one's self about such things? If we only had first-rate microscopes, what necessity to bother about the path of the rays, or about the influence of diffraction on the microscopic image? The reality of what was seen was believed in.

Many a controversy about fine structures, striae, etc., would not have taken place if the parties concerned had been conscious that they were after all only discussing what they had seen, and not that which was really present in the object itself: if they had been aware that no one is in a position to tell from an ever-so-sharp appearance of the image of *Pleurosigma angulatum*, for example, what is the real construction of the siliceous frustule.

Although within the limits of a review no space can be found to enter fully into the contents of the separate treatises, an attempt will be made to regard a little more in detail the more important theorems—those which have a decisive bearing on observations with the microscope.

A number of papers contain essentially only descriptions of new apparatus, together with the theoretical reasons which were the primary consideration in their construction: *e.g.* Treatise I., "On a Spectroscopic Apparatus for the Microscope"; IV., "On a New Illuminator"; V., "Description of the Apertometer"; IX., "On Stephenson's System of Homogeneous Immersion"; XIII., "Description of a New Stereoscopic Ocular."

With the exception of No. I., all the above-mentioned, however, stand in close connection with other treatises, which deal with problems of a more general character, particularly with the two most important ones: II., "On the Determination of the Light Intensity in Optical Instruments"; and III., "Contribution to the Theory of the Microscope and Microscopical Observation."

Of high interest also is Treatise IV., "The Optical Means of assisting Microscopy." It is a report on the scientific apparatus at the London International Exhibition of 1876. This report is apparently one of Abbe's least-known papers, and yet it contained a summary intelligible to every one of what had been achieved so far, and of future prospects regarding the perfecting of the microscope, the extending of the limits of its capability, and, above all, the new era in the manufacture of glass, in which we find predictions of the results arrived at to-day. The conditions for the production of apochromatic objectives, for the increase in resolving power by the employment of ultra-violet rays, are already here clearly expressed. The remarks on the dependence of the further perfecting of optical systems on the production of new sorts of glass were the spur to the erection of the Jena Glass Works.

It is scarcely possible to present the optical capabilities of the compound microscope more shortly or pregnantly than is done in a few pages (pp. 135–9) of this treatise. The study of this chapter can be most warmly recommended to every microscopist.

The investigations on the light intensity in optical instruments have perfectly cleared up this difficult subject. Although this has only to do with comparatively simple geometrical and physical matters, the greatest confusion obtained about it in more than one respect; so that Abbe could rightly say elsewhere (p. 69) that since the time of Brewster and Wollaston the theory of illuminating apparatus was the *partie honteuse* of microscopic doctrine till Nägeli and Schwendener first brought clear and sound conceptions about it. In various other places, too, he brings out how the classical exposition of the laws of illumination, which appeared already in the first edition (1865) of Nägeli and Schwendener's book on the microscope, formed the starting point of his investigations (cp. pp. 31, 102, 275).

Only by sharply distinguishing between the geometrical and physical conditions determining the light effect, as is evidenced by contrasting the amount of radiation and the intensity of the radiation—the radiating power—could the confusion be cleared away. The intensity of a source of light depends substantially on the radiating power of its surfaces and on its temperature; in all effects it acts as a whole. The amount of radiation arriving at a surface depends on the angle of aperture of the illuminating pencils, and the total intensity of illumination depends besides on the angle which the axes of the illuminating pencils make with the normals to the surface. The results of the further investigations dependent on these simple laws form the basis for the determination of the light intensity in all optical instruments; these include, amongst other things, the general theory of illuminating apparatus, the effect of the diaphragms, and the signification of the aperture images of pupils,* although the latter term is not yet used in this treatise.

In the closest connection with these theoretical investigations stands the construction of the illuminating apparatus which is named after Abbe, and which to-day is considered as an almost indispensable accessory to all good microscopes, although it was really only designed by its originator for the testing of objectives and for experiments on the effects of diffraction. Several practical microscopists first pointed out the utility of the apparatus for diverse requirements in microscopic observation.

The formerly very prevalent view that by means of special apparatus the light serving for illumination could to a certain extent be condensed—hence also the name condenser—is without justification, and Abbe expresses it curtly (p. 102) that no illuminating apparatus, however ingenious, can ever give a more intense illumination than the source of light itself; the effect of such apparatus is, in fact, the very reverse of that which their name implies—they do not bring about a condensation, but an attenuation, in consequence of the unavoidable reflections and refractions, which cause a loss of the available illuminating power.

A complicated illuminating apparatus can only offer advantages because by its means the light can be regulated much more simply and with greater certainty, and because it allows of much greater variation in the direction of the incidence of light than can be attained by illumination from a simple mirror. The light rays can be made to impinge on the object from all directions if, in place of issuing from a limited surface, such as the mirror, it can

* This has reference to the so-called "entrance and exit pupils," a conception introduced by Abbe for the images of the diaphragms limiting the aperture, which has come to be generally used in German works treating of optical instruments.—TRANSLATOR.

be arranged that they issue from a surface which subtends at the object a very large angle, because then all the surfaces of light, differently situated and of various sizes, which are necessary for successively illuminating the object in different ways, are available. So, if we have a lens-system, the aperture of which for the emergent rays is 180°, it is only necessary to provide a stop which will allow of pencils of any desired degree of incidence and any desired width to be used out of the whole hemisphere. It is this stopping apparatus, the so-called diaphragm carrier, which is the essential part of the illuminator, and its arrangement, together with its connection with the lens-system, is that which constitutes the novelty in Abbe's construction.

The most important treatises of the whole collection are undoubtedly the contributions to the theory of the microscope. Although in this paper reference is made almost exclusively to the microscope, the result has become of no less importance for all optical instruments which produce images of non-self-luminous objects. The immediate object of Abbe was to provide a sound theoretical basis for the construction of microscopes, which till then had been almost wholly based on a system of trials, in like manner as Fraunhofer had created a basis for the construction of telescopes. The difficulties were incomparably greater than in the case of the telescope, and practical experts on the microscope doubted altogether the possibility of creating such a theoretical basis. Thanks to the connection of Abbe with Carl Zeiss, who for a number of years placed the excellent assistance of his workshops at Abbe's disposal, the end strived for was, after much work, attained. In the course of these studies it was found, however, that it was necessary practically to give up the old theory of the microscope altogether, if it is possible to speak of the existence of the latter. In the first place, the then prevalent conceptions as to defects in the image-aberration were not applicable to lenses of so wide an angle of aperture as high-power microscope-objectives; and secondly, it was found out that the microscopic image was bound up with physical matters whose seat was in the object itself, and which hitherto had been neglected.

Whereas the extension of the theory so far as it concerned the aberrations of the lens-system was purely a matter of mathematics, which could be completely solved by application of the known laws of dioptrics, the theory of the formation of the microscope image had to be created quite afresh. The general results are stated by Abbe in the following paragraph :

"Not only is it possible to determine a limit of smallness at which a bar is opposed to observation of microscopic structures, but a general factor also comes into play which may not be left out of account in the scientific use of the microscope. for it has come to light that the hitherto unassailed basis for the interpretation of microscopic observations—viz. that a microscopic image free from defects represents in all cases the real composition of the object—is for a whole class of observations by no means properly founded."

It is not to be gainsaid that for decades after this result was published, in 1873, scarcely any notice was taken of it by physicists or by most microscopists, although, very soon after, special reference was made to it by Nägeli and Schwendener, and a little later on, Dippel expounded Abbe's theory very fully in his *Handbook on the Microscope,* along with important supplementary additions which he had obtained through correspondence with Abbe.

It is true that experience had taught that the size of the angle of aperture was of great importance in the performance of microscopes, and that a great increase of eye-piece magnification by no no means led to the recognition of fresh detail. But these facts could not be brought into accordance with the laws of geometrical optics, or at all events, they led to quite absurd conclusions. Only a short time previously, Listing had proposed to use a compound microscope in place of the ordinary eye-piece, in order to increase the magnification.* It was this very proposal which led Helmholtz to examine the question as to why it was that by this plan, which looked very promising from a purely dioptrical standpoint, no improvement could be attained. Helmholtz, in his investigations (which he carried out under a certain assumption, that in general does not hold good for the microscope), arrived at the result that the diffraction due to the aperture of the objective imposed a very definite limit. Helmholtz at that time did not

* This proposal was made again, in all earnestness, in the year 1891, by A. Lendl. That such a proposal could be published in the foremost German journal on microscopy is surely a sign of how little the knowledge of Abbe's papers had become known generally.

know of Abbe's investigations in the same direction and of their results, although they had been published for almost a year. Abbe had started his investigations on the correct assumptions by taking into account the actual conditions which prevail in the employment of the microscope, and drew his conclusions only for the formation of images of non-self-luminous objects.

Both investigators had so far arrived at the same result that they were able to express the limit of resolving power by the same formula. Abbe's theory at once gave the explanation of the dependence of the resolving power on the aperture. Every non-self-luminous object diffracts the light transmitted through it, or reflected from it, to a greater or less extent. It depends on the amount of light which is grasped by the objective whether any image of the object will be formed, and, provided this is the case, to what extent it will resemble the object. But as a measure of the resolving power we cannot take angular value, *i.e.* the angle of aperture, but the sine of half the angle of aperture, *i.e.* the value later called "Numerical Aperture" by Abbe. It must be noticed that the simple value of the sine is only for dry systems, and that with immersion systems the numerical aperture is arrived at by multiplying the sine by the refractive index of the immersion fluid.

The description of the trials carried out for the experimental confirmation of the theory is of the greatest interest.

Gratings scratched in glass, or in silver deposited on glass, and similar well-known structures, were the objects used for the experiments, which were no less than astounding in their results. Every microscopist should make himself conversant with these experiments, which can be made in the simplest manner, with practically any microscope, by the use of Abbe's diffraction apparatus. How little these experiments are known was shown on the occasion of their demonstration at the Naturalists' Congress at Halle, in 1891, where they created a sensation as something quite new, although they ought to have been the common property of the physical and biological sciences for almost two decades at that time.

Abbe summed up the result of these experiments as follows:

"That different structures always produce the same image as soon as the difference of their diffraction effects is removed, and like structures always give different images if the diffraction effect (so far as it can be taken up by the microscope) is made dissimilar by artificial means. This really means that images of structure brought about by this process of diffraction do not stand in constant relationship to the real structure of the object; rather should we say that they stand only in a constant relation to the diffraction phenomenon by the help of which the image is brought about."

It is not feasible in this review to go any further into the valuable contents of this treatise. It may, however, be pointed out that already here the sharp division between the effect of the objective acting as a simple magnifier, and of the ocular apparatus acting like a telescope, is emphasised (pp. 60 and 61); and likewise, the importance of the chromatic difference of the spherical aberration and the chromatic difference of magnification for the improvement of objectives are brought into prominence, so that the goal attained later on by apochromats and compensation oculars [p. 56 (*f*)] is already indicated. We further find the theorem given for the aplanatism of optical systems, which is then proved in detail in Treatise XI. The method of examining objectives by means of the test-plate, employing the so-called sensitive path of rays, is likewise reviewed somewhat exhaustively.

The controversial paper against R. Altmann, who attempted to demonstrate that Abbe's views were entirely fallacious, constitutes a further contribution to the theory of microscopical observation. Although Altmann's attacks were the result of misconceptions and altogether incorrect hypotheses, it must be acknowledged that he was one of the few microscopists who had occupied themselves with the Abbe theory. Abbe's reply was, in places, somewhat forcible; it, however, gives an abundance of information concerning the development of the theory of diffraction, and, besides this, the important supplement regarding the absorption image. For purposes of emphasising the perfectly general validity of his views as to the way in which images of non-self-luminous objects are brought about he writes (p. 290): "Even fence-posts will be imaged in accordance with the same laws of secondary delineation, no less than bacteria or the finest striae of diatoms."

The paper further contains a lucid description of the differences between Helmholtz's and Abbe's researches (pp. 290–93).

Unfortunately the promised second part, on the limits of geometrical optics, has not appeared, though it is to be hoped that parts of it in manuscript may be published later on.

Treatise X., "On New Methods for improving Spherical Correction, applied to the Construction of Wide-angled Object-glasses," has theoretical importance for the calculation of objectives. The nature of the chromatic difference of spherical aberration is here explained theoretically exactly; and, at the same time, the problem of the illumination of this defect is solved by an expedient which was of little importance to practical microscopy, certainly—*i.e.* by employing so-called fluid lenses. But it was by this experimentally shown that, by having a great number of media suitable for the production of lenses at one's disposal, substantial progress could be attained. Only several years later, owing to the introduction of numerous new kinds of glass, and of fluorite, could this result be put to practical use, as is set forth very thoroughly in Treatise XX., "On New Microscopes," and Treatise XXII., "On the Employment of Fluorite for Optical Purposes," which treat of the method of production of apochromats.

The introduction of homogeneous oil immersions, which Abbe computed at the suggestion of Stephenson, was an epoch of not less importance in the construction of objectives. A quarter of a century before, Amici had already used different oils as immersion fluids, but these could not be designated homogeneous immersion systems. The independence attained of the thickness of the cover-glass, apart from the other great advantages of such objectives, constituted a decided advance. Treatise IX. contains interesting information concerning the origin of these objectives, which have become so extremely important for all delicate work in histology and bacteriology.

Another series of treatises, which originally appeared in English only, are devoted to lively discussions, principally carried on in English journals of microscopy, concerning the questions of the measurement of aperture, the relation between aperture and magnification, the conditions for stereoscopic vision, all-round vision, illumination by wide-angled cones of light, and the definition of magnified images. In this category are included: Treatise XII., "Some Remarks on the Apertometer"; XV., "On the Conditions of Orthoscopic and

Pseudoscopic Effects in the Binocular Microscope"; XVI., "On the Estimation of Aperture in the Microscope"; XVII., "The Relation of Aperture and Power in the Microscope"; XVIII., "On the Mode of Vision with Objectives of Wide Aperture"; XIX., "Note on the Proper Definition of the Amplifying Power of a Lens or a Lens-system"; and XXI., "On the Effect of Illumination by means of Wide-angled Cones of Light."

Among English microscopists the knowledge of Abbe's works was more general than on the Continent; and although a certain number of discordant voices were raised, the principal theorems of the new theories were intelligently appreciated, particularly among amateur microscopists.

If we leave aside the ridiculous dispute over the aperture question, it must be gratefully acknowledged that Abbe's numerous enlightening statements in the *Journal of the Royal Microscopical Society* were occasioned precisely on account of these discussions in English microscopic literature. In this way the confusion concerning stereoscopic effect was solved, first by the construction of stereoscopic oculars (Treatise XIII.) and then by the lucid statement of the conditions which govern the origin of orthoscopic and pseudoscopic impressions.

The treatise on the measurement of the aperture contains more rigorous statements as to the sine-condition and explanations concerning the influence of aperture on the clearness of images and the imaging power of the microscope. We also find here important observations regarding the images of isolated corpuscles or flagellae, whose diameters are fractions of a wave-length of light. Referring to this, Abbe says (p. 362): "Such objects can be seen however small they may be. This is only a question of contrast in the light effect, of good definition of the objective, and of sensitiveness of the retina." And in a note he expressly points out, to avoid all possibility of misunderstanding, that neither Helmholtz nor he himself had at any time spoken of a limit of visibility, but always of the limit of "visible separation." It is well known how both these things have often been confused, even quite recently, since the apparatus constructed by Siedentopf and Zsigmondy, for the rendering visible of ultra-microscopic particles, made it possible, by appropriate use of dark ground illumination, to see particles the diameters of which were only a few millionths of a millimetre.

In the researches as to the relations between aperture and magnification, a great many important rules are given for the selection of apertures and magnifications. They are expressed concisely by the general rule, "Wide apertures for objectives of short focus; small and medium apertures for low- and medium-power objectives." "Empty" over-magnified images are of no use; the employment of wide apertures in the case of low magnifying powers is also to no purpose. Although such rules now, perhaps, appear to be a matter of course, many a proposal was made, especially in English journals, which, by means of tables on the rational adjustment of aperture to magnification, are relegated to their proper places. In this respect the closing sentence is especially characteristic (p. 434): "In my opinion, the question here treated has a certain general importance for microscopy. Of course, it does no harm if lens-systems of any type, and for particular requirements, are produced, and in this respect complete freedom must be allowed. On the other hand, as the microscope has an important mission as the auxiliary of scientific research, scientific microscopy is consequently fully justified in claiming that improvements in the instrument should be always directed primarily to making it as useful as possible for its chief purpose, and that we should not ride any hobbies as regards the optical construction of the microscope."

The treatise on illumination by wide-angled cones of light gives the explanation why the employment of these is serviceable for deeply stained preparations (R. Koch's method), whereas for uncoloured elements an obliteration of the whole image (*Gesamtbild*) is, in some cases, brought about. The coloured portions only act by absorption, and the diffraction spectra produced by these do not differ amongst themselves for different obliquities of illumination; whilst the uncoloured structures only operate through different refraction and different retardation of the light transmitted, and therefore produce unlike, separate images, the mixture of which by wide cones of illumination causes the aforesaid obliteration of the image as a whole.

The discussions as to the correct definition of magnification are from the standpoint that the usual explanation of the magnification of a lens, or a lens-system, is strange and irrational, in which Abbe is certainly quite right. Instead of linear magnification for a fixed distance, therefore, he proposed the introduction of the term "Magnification Power," which is measured by the reciprocal of the focal length.*

By this he wished to combat the idea, particularly prevalent among microscopists, that the efficiency of the microscope is dependent on the accommodation of the eye of the observer. On account of the somewhat abstract conception of the idea of *power* of magnification, this expression, which is without doubt much more correct, has been almost entirely ignored, and the tables of magnification in the catalogues of optical works still contain linear magnifications for vision at 250 mm., although experience shows that this sometimes gives rise to the most curious notions.

Of the rest of the first volume of the collection of treatises under consideration, we will only mention VII., "On Micrometric Measurement by Means of Optical Images," and VIII., "On the Counting of Blood Corpuscles." In the first, the importance of the telecentric ray-path, for making the measurements independent of the position of the focussing plane, is shown; and, in the second, Abbe, on the basis of the calculus of probabilities, discusses in a thorough manner the question of the trustworthiness of the countings by means of the so-called counting chambers, which are ruled in squares, and gives lucid instructions for the judging of probable faults not connected with the faults of the apparatus. The critical employment of these methods of counting, which have become so important for medical diagnosis, was essentially advanced by this.

By the references given in the above review, the epoch-marking importance for microscopic observation of Abbe's works will be patent to every reader. On that account it is hoped the unusual length of this review will be excused, as it seemed particularly desirable to give more than a cursory reference on the appearance of this collection.

There was also another reason in favour of a detailed review. Scientific microscopy is no longer, as was the case a few decades ago, merely the servant of the biological sciences; the researches of Abbe have given it a position of its own in the world of science. The extent to which this science is taught at universities is, however, pitifully small. Instruction in the use of the microscope,

* In ophthalmology a similar expression had been introduced at an earlier period for the power of spectacle lenses (Dioptric).

in which the classical experiments with the Abbe diffraction-plate, or the examination of the objective by means of the Abbe test-plate and of the apertometer, are demonstrated, is even nowadays of rare occurrence. And yet practical microscopy must take heed of these things in many cases, if it does not wish to expose itself to the just reproach of carelessness. The old dictum which N. Pringsheim appended to his dissertation in the year 1848—"*Microscopium observatorem non fallit*"—has still to-day only too many advocates, towards whom, of course, the indulgence accorded to acting in good faith can mostly be unhesitatingly extended. If the publication of Abbe's treatises on the theory of the microscope only in some measure produces a change, even on this score, one of the aims which prompted the publication of the collection will, at any rate, be fulfilled.

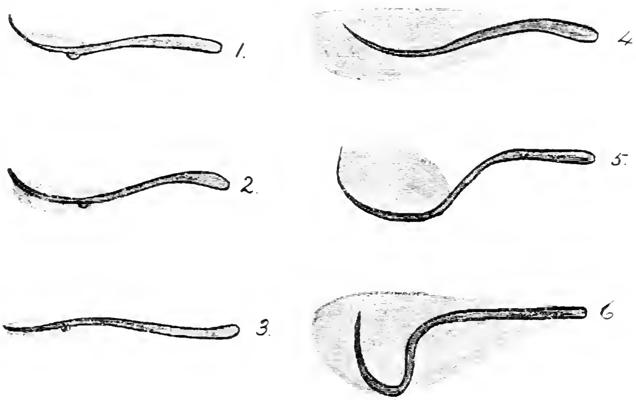
SUPPLEMENTARY NOTE ON THE FOOT OF THE HOUSE-FLY.

By A. A. C. Eliot Merlin, F.R.M.S.

(*Read November 18th*, 1904.)

With reference to my note on the foot of the house-fly, read January 15th, 1897 (see *Journal of the Quekett Microscopical Club*, Ser. II., Vol. VI., p. 348), I have now to announce a small further advance towards the elucidation of the ultimate structure of the tenent hairs.

The fuchsin-stained preparation referred to in my previous communication on the subject was especially made with the object of discovering, if possible, the orifice from which exudes the



viscous fluid which may be seen adhering to, and often entirely enveloping, the sickle filament; but no sign of any such opening or vent in the terminations of the hair was at the time detected with the optical means then employed—*i.e.* a good achromatic oil immersion $\frac{1}{12}$ in. by Powell, of N.A. 1·27. Quite recently, however, the identical preparation was again subjected to careful scrutiny under a very fine Zeiss apochromatic $\frac{1}{8}$ in., of N.A. 1·425, used with a 40 compensating ocular, thus giving a magnification of 3,200 diameters. The terminal filaments were perfectly, cleanly, and sharply pictured with this great power, and the existence of a knob or protuberance on the side of the sickle was clearly revealed.

The above six figures are diagrammatic representations of filaments, Nos. 1, 2, and 3 showing the excrescence which protrudes from the side of the sickle just mid-way between the point and the haft. When the hair is viewed in such a position as to exhibit the full curve of the sickle, as in Figs. 5 and 6, the boss cannot be made out, being then on the underside of the filament; it is only well seen when the hair is comparatively free from fluid, and is observed somewhat edgeways, as in the first three figures.

The lightly shaded portions of the diagrams represent the viscous fluid as seen adhering to the filaments depicted, and show how admirably they are adapted for the purpose they serve, the liquid being disposed, not in rounded globules, but in the form of a thin, flattened film held within or around the sickle, and frequently extending beyond it, especially on the fore part of the pad, where hairs with large films are commonly found, resembling Figs. 4 and 6.

The protuberance may simply mark the position of the opening through which the fluid exudes, our present optical means not being sufficient to allow one to speak with absolute certainty; but some filaments examined have given the impression of being in reality slightly cleft at this point, and possibly the opening may be thus capable of considerable expansion under pressure, otherwise the quantity of fluid required to make up a film would be supplied very slowly.

The surfaces of the films usually exhibit a roughened and wrinkled appearance, to represent which no attempt has been made in the annexed diagrams, which it is trusted may serve to illustrate the features referred to. Although drawn at the microscope with a power of 3,200 diameters, their actual scale is much greater, being roughly about × 5,000.

It appears to me that this observation is interesting, not only on account of the further light shed on the true structure of the object itself, but as proving what an increase in our knowledge of even common and comparatively coarse organisations may be confidently expected from each successive advance in the optical efficiency of our lenses; for here we have the case of a structural detail which, although especially searched for, eluded notice with an objective of N.A. 1·27, and yet immediately revealed itself and became quite noticeable with an optical combination of slightly superior resolving and defining power.

Since observing the protuberance on the filament with the apochromat, and being familiar with its exact position and appearance, I have experienced no difficulty whatever in demonstrating its presence with the older lens.

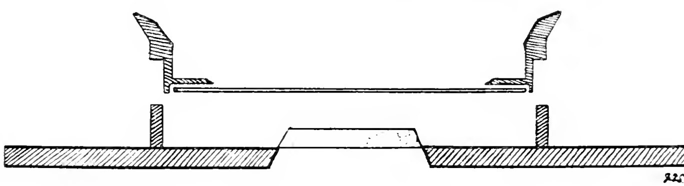
NOTE ON A MODIFICATION OF THE ROUSSELET LIVE-BOX.

By. A. A. C. Eliot Merlin, F.R.M.S.

(*Read November 18th*, 1904.)

I venture to draw attention to a slight modification in the construction of Mr. Rousselet's very admirable live-box that has been found useful for the continuous observation, under high powers. of living monad and bacterial forms.

As usually made, the appliance is perfectly adapted to the purpose for which it was designed—namely, the critical examination of animalcules in general; but when employed for studying the smaller kinds of monads and bacteria existing in infusions of



decaying matter, it is found in practice that the rapid evaporation of the water-film frequently cuts short the observation of some particularly interesting organism, which it would have been desirable to keep in view for a longer period.

In order to retard evaporation, the large cover-glass should be cemented to the carrier, instead of being held loosely in it by the screw arrangement, which is intended to facilitate the replacing of a fractured cover. The carrier can easily be constructed with a broad flange to facilitate this, and in the event of breakage, no practical microscopist would experience any difficulty in fixing another cover.

In addition to the cemented cover-glass, it is only necessary that the carrier should accurately fit into the box in such a manner that an elastic band may be placed round the rim of the whole, over the line of juncture, thus rendering the appliance practically air-tight.

I have had the live-box, thus modified, in use for a considerable period, have employed it in the critical examination of the smallest living forms under oil immersion objectives, and have found it possible to keep them under observation for several days; while with the live-box of the ordinary construction the water-film usually completely dries up within twenty-four hours.

With the Rousselet live-box an oil immersion objective may be employed without any fear of the oil mixing with the water in which the organisms exist; and, if necessary, the immersion objective may be changed, and the oil wiped from the cover, without seriously disturbing or injuring the living contents.

The large air-space within the contrivance is generally sufficient to keep the organisms active and healthy for some considerable time; but it is not suggested that the conditions are favourable for their development, or for the study of their life-histories; for such purposes the Dallinger Stage, and other descriptions of growing slides admitting plenty of fresh air, would, doubtless, be found preferable.

NOTE ON THE CUT SUCTORIAL TUBES OF THE DRONE-FLY'S PROBOSCIS AS A SUGGESTED TEST-OBJECT FOR MEDIUM POWERS.

By A. A. C. Eliot Merlin, F.R.M.S.

(*Read January 20th*, 1905.)

The expert has no difficulty in utilising a variety of objects, each one of which may serve as a test for objectives of suitable power. He judges by the quality of the resultant image taken as a whole, being thoroughly conversant with its appearance under lenses of the most perfect construction.

In this manner the well-known Blow-fly's proboscis has been used as an excellent and sensitive test for objectives ranging from an achromatic 2 in. of N.A. ·13 to the finest apochromatic $\frac{1}{6}$ in. of N.A. ·98. For the low-power lenses, the sharp definition of the structure of the cut suctorial tubes, and the general aspect of the entire proboscis, form the test; while the satisfactory rendering of the minute spinous hairs may, to trained eyes, sufficiently strain the defining qualities of the most powerful dry apochromats. But place this object in the hands of a tyro, who has only recently acquired a student's microscope and is desirous of satisfying himself that the $\frac{1}{4}$ in. or $\frac{1}{6}$ in. usually supplied with such small instruments is of fair quality, and no satisfactory result will be attained; for he will easily see the spines in question, but will be able to form no decided opinion as to whether the image afforded is really so good as it should be.

Even in the hands of a novice, however, the Blow-fly's proboscis may be taken as probably the simplest and most satisfactory test for objectives up to the 1 in. of N.A. ·3, as any low-power lens which will show the tubes and spines cleanly and crisply defined, without fog, and exhibiting strong contrast, when a very large solid illuminating cone is employed, must be sufficiently good for all practical purposes; but with medium-power lenses of N.A. ·6 to N.A. ·9, which should easily grasp all the structural features of this object, no one except a microscopist of considerable experience would be likely to form a reliable opinion.

Formerly, the Podura-scale was most generally and frequently used for testing the class of lenses referred to. The mode of employing it for this purpose was described by the late Richard Beck in a paper read before the London Microscopical Society on March 12th, 1862. This paper is accompanied by a beautiful plate illustrating the varying appearances of the markings. There can be no doubt that this object is a valuable and effective test for centring and colour correction, but, even apart from the fact that the right kind of Podura has apparently became extinct or excessively wary, and that consequently it is at present difficult to procure a good scale in optical contact with the cover-glass, as it should be to insure satisfactory results, here again considerable practical experience is required on the part of the manipulator.

It is suggested that in a balsam mount of the cut suctorial tubes of the common Drone-fly's proboscis, the structure of which is precisely similar to, although very much finer than, that of the Blow-fly, we possess a test which should enable even persons of small experience to form a trustworthy opinion regarding the quality of the ordinary cheap $\frac{1}{4}$ in. and $\frac{1}{6}$ in. objectives usually supplied with small histological microscopes. For test purposes, at least, a $\frac{3}{4}$ solid axial cone should be employed, and if with such illumination, and suitable tube length for cover correction, the "arches" and intervening fibres appear well separated and neatly, although probably somewhat faintly, defined, the lens may be safely considered a good one; for under the specified conditions a really poor objective would fail to show any distinct structure, and would break down utterly and unmistakably.

It has been found in practice that Powell's old achromatic $\frac{1}{4}$ in., of measured N.A. ·79 and working aperture ·6, with 12 eye-piece, will completely resolve the structure referred to, while the Zeiss apochromatic $\frac{1}{2}$ in., measured N.A. ·70, W.A. ·6, does so beautifully with 40 eye-piece. The Leitz semi-apochromatic $\frac{1}{4}$ in., $\frac{1}{6}$ in., and $\frac{1}{8}$ in. all show this delicate object clearly with very large illuminating cones, so that any cheap modern $\frac{1}{4}$ in. may be reasonably expected and required to do so.

NOTE ON EXPERIMENTAL PROOF THAT THE DOUBLING OF LINES IN THE ABBE EXPERIMENTS IS NOT DUE TO THE DIAPHRAGMS ABOVE THE OBJECTIVE.

By Julius Rheinberg, F.R.M.S.

(*Read March 17th*, 1905.)

The experiment which I have the honour to bring before your notice is intended to convince any one that the duplication of lines and other effects in the well-known experiments of Abbe, which are to be found in all text-books on the microscope, are due to the object itself, and not to the diaphragms placed in the back focal plane of the objective. The latter is a fallacy which is referred to and explained in Dippel's *Handbook on the Microscope* (Second Edition, 1882).* But in recent years the suggestion has again been brought forward that the diaphragms above the objective are the primary cause of the effect—a view which appears to be in a great measure based on the fact that in the

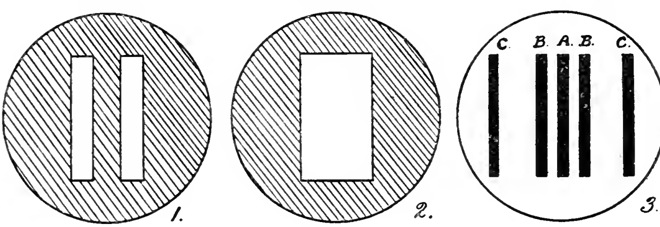


Fig. 1.

usual experiments on duplication of lines, stops are used, in which certain portions are blocked out, so that they have, in fact, two or three apertures [Fig. 1 (1)]. Diaphragms like these, it is supposed, would tend to cause a duplication of lines under any circumstances—which in some degree is perfectly true. My purpose, therefore, is to show you the same effect of the duplication of lines of a grating, using a diaphragm in the upper focal plane which has one single aperture only [Fig. 1 (2)]; and in order to demonstrate that the single aperture cannot produce the doubling in question (although I scarcely suppose this will be suggested by any one), we shall use the same aperture on the same grating, and produce the correct effect and the doubling alternately by merely shifting its position a trifle. The large and somewhat unfamiliar-looking instrument on which the effect is shown is the Abbe Demonstration Microscope, which is so

* Published at Brunswick by F. Vieweg & Sohn.

constructed that we can experiment with comparatively coarse objects, and in which the back focal plane of the objective is readily accessible. The object on the stage is a coarse grating of about 100 lines per inch, in which the width of the black lines and of the spaces are just equal. A grating in which the bars and spaces are equal happens, as we shall see, to be the best for our purpose. All you have to do is, whilst looking at the grating, to move the diaphragm in the back focal plane by about $\frac{1}{16}$ in. to the right and left alternately, and in the one position the lines of the grating will be seen correctly, in the other they will be seen doubled.

The explanation is this: The visible spectra which a grating with bars and spaces of equal width forms in the upper focal plane of the objective are spaced so that the distance between the central (or dioptric) beam and the first spectrum on either side is just half as great as between the first spectrum and the second visible spectrum [Fig. 1 (3)]. This curious arrangement follows

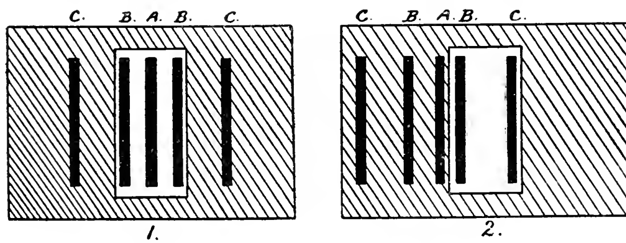


Fig. 2.

from the theory of diffraction applied to gratings, upon which I need not enter here, but only invite you to note that the spacing of the spectra is dependent upon the nature of the object, and has, of course, no connection whatever with the diaphragm in the back focal plane, the sole function of which, in this experiment, is to stop certain spectra from reaching the eye piece. What we do, therefore, is first to use the diaphragm so that it permits the central beam and the first spectrum on both sides to pass through [Fig. 2 (1)]. Under these conditions, the object is seen to have the correct number of lines.

Then we shift it to the second position, in which it will allow only the first and second visible spectrum to pass [Fig. 2 (2)]; and as the spectra are now twice as far apart as in the former case, the lines in the image are seen doubled, as explained in the descriptions of Abbe's experiments in the text-books.

I think it will be admitted that this conclusively shows that the effect is due to the object, and not to the diaphragm.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on October 21st, 1904, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., in the Chair, the minutes of the meeting held on June 17th were read and confirmed, and the additions to the Library and Cabinet announced.

Messrs. Arthur E. Smith, Walter B. Freeman, A. E. Conrady, F.R.A.S., F.R.M.S., Major-General H. H. Lee, and the Rev. S. Hebert were balloted for and duly elected members of the Club.

The Secretary said that it was his painful duty to announce the death of two old members of the Club who had passed away during the recess—viz. C. G. Dunning, who had died on September 29th, and Edward Dadswell, F.R.M.S., who died on October 6th.

On the motion of the President, a vote of sympathy with the relatives of the late members was unanimously passed.

Dr. Spitta then drew the attention of the members to a very fine exhibition which had been prepared for their benefit by Messrs. Watson & Sons. It comprised a large number of instruments of their latest design, and a fine collection of mounted specimens, principally marine objects, exhibited under the microscopes.

On the invitation of the President, Mr. J. Watson Baker, F.R.M.S., gave a brief description of the salient features of the exhibits.

The honorary editor, Mr. F. P. Smith, then delivered a lecture on "The Spiders of the *Erigone* Group." Mr. Smith commenced by briefly recapitulating the characteristic features of the family *Linyphiidae*, and then gave a somewhat more detailed account of a certain group of minute spiders comprising about thirty British species. A new genus, *Erigonidium*, was proposed for the species *E. graminicolum*, and new generic names were proposed for two other species—*Enidia* for *bituberculata*, and *Falconeria* for *cornuta*.

Mr. Smith's lecture, although it bristled with formidable names—for which he apologised, saying that all the nice easy names had been used up—was of a very entertaining nature, and at its close a hearty vote of thanks was accorded to him by acclamation.

At the meeting of the Club held on November 18th, 1904, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on October 21st were read and confirmed.

Messrs. E. A. Mignot, W. E. Harvey, F. R. Rowley, C. A. Birts, A. W. Cooper, J.P., H. Wallis Kew, R. J. L. Guppy, H. J. Gibbs, C. G. Kiddell, F. Winter, and W. D. Dade were balloted for and duly elected members of the Club.

The Hon. Secretary read a note by Mr. A. E. Merlin, F.R.M.S., on a "Modification of the Rousselet Live-Box," which had been found useful for the continuous observation under high powers of living monad and bacterial forms.

Mr. Merlin stated that he had used the live-box, thus modified, for a considerable time, that he had employed it in the critical examination of the smallest living forms under oil-immersion objectives, and that he had found it possible to keep them under observation for several days, while, with the ordinary form, the water film dries up in about twenty-four hours.

The Secretary then read a further communication from Mr. A. E. Merlin, F.R.M.S., "A Supplementary Note on the Foot of the House-Fly."

A hearty vote of thanks was accorded to Mr. Merlin for his two communications.

The President then invited Mr. A. E. Conrady, F.R.A.S., F.R.M.S., to give the Club a *résumé* of the paper which he had read before the Royal Microscopical Society on the previous Wednesday. No doubt many of the members were then present, but he felt sure that the paper, which was entitled "Theories of Microscopic Vision: a Vindication of the Abbe Theory," would be appreciated by those who were unable to attend the meeting of the R.M.S.

Mr. Conrady then gave a full précis of this important paper, illustrating his statements with diagrams on the blackboard.

A vote of thanks to Mr. Conrady for his kindness in giving the *résumé* of his paper was passed by acclamation.

At the meeting of the Club held on December 16th, 1904, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on November 18th were read and confirmed, and the donations to the Library and Cabinet announced.

Messrs. F. T. Barrett, George Patterson, S. F. McDonald, T. Garnett, M.A., and the Rev. S. Edge were balloted for and duly elected.

Mr. C. L. Curties, F.R.M.S., exhibited and described a new electric lamp arranged for use with the microscope. It consisted of a Nernst lamp mounted on a solid metal stand with three corked feet, having an upright with vertical sliding adjustment, and also an arrangement by which the lamp could be used at any desired angle. In the front of the lamp is a carrier for tinted or ground-glass screens, fitted to a removable arm. The lamp can be supplied for use with either 100- or 200-volt current.

Mr. Curties also showed and described a specimen of the new "Diagnostic" microscope.

The President said he was much struck with the firmness of the instrument. He had a considerable experience of portable microscopes, and this was always a weak point with them.

Mr. D. J. Scourfield, F.R.M.S., then gave a lecture on "Fresh-water Biological Stations," illustrated by lantern views of the exterior and interior of the principal fresh-water biological stations in Europe and America.

A hearty vote of thanks was accorded to Mr. Scourfield for his lecture.

At the meeting of the Club held on January 20th, 1905, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., in the Chair, the minutes of the meeting held on December 16th were read and confirmed, and the donations to the Library and Cabinet announced.

Messrs. J. Christie, J. P. Lord, J. Carrington, C. E. Burnell, W. H. D. Mence, W. S. Rogers, W. Milne, M. C. H. Pearson, and the Rev. F. C. Lees were balloted for and duly elected members of the Club.

The President, in announcing the death of Prof. Abbe, of

Jena, referred at some length to the distinguished services rendered by him to optical science, and especially to microscopy, culminating in the production of his apochromatic objective. An expression of the personal and scientific loss sustained was entered in the minutes, and it was resolved that a letter of sympathy should be sent by the Secretary to the late Professor's family.

The list of nominations by the Committee for Officers of the Club for the ensuing year was read by the Secretary.

Messrs. D. Bryce, J. M. Allen, J. T. Holder, E. Leonard, and W. Gardner were proposed for election as members of the Committee to fill four vacancies caused by the retirement of Messrs. Bryce, Hilton, Vezey, and Stokes.

Mr. Hicks was proposed and elected Auditor on behalf of the members.

Mr. C. F. Rousselet read a paper on "A Description of the Rousselet Compressorium," specimens of the instrument being exhibited.

A paper by Mr. Merlin "On the Cut Suctorial Tubes of the Drone-fly's Proboscis as a Suggested Test-object for Medium Powers" was read by the Secretary.

A discussion ensued as to the species of Drone-fly referred to, and the optical means employed in making the observation, in which Messrs. Wesché, Stokes, Conrady, Rheinberg, the Secretary and the President took part.

Votes of thanks were unanimously passed to the authors of the papers.

At the Annual Meeting held on February 17th, 1905, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on January 20th were read and confirmed.

Messrs. H. Brooks, R. W. Sindall, W. C. Mann, T. G. Taylor, C. A. Lambert, J. C. Webb, and J. Asals were balloted for and duly elected members of the Club.

The President having appointed Messrs. Downs and Dick as Scrutineers, the ballot for the election of Officers and Council for the ensuing year was taken.

The Secretary read the 39th Annual Report of the Club.

The Treasurer read his Statement of Account and Balance Sheet for 1904.

Mr. J. Neville moved that the Annual Report and Balance Sheet be received and adopted, and that they be printed and circulated in the usual way.

This was seconded by Mr. H. E. Freeman and unanimously carried.

A vote of thanks to the Auditors and Scrutineers was proposed by Rev. S. Edge, seconded by Mr. Fuller, and unanimously carried.

Mr. A. E. Conrady, F.R.A.S., F.R.M.S., then moved "that the best thanks of the Club be given to the Committee and Officers for their services during the past year."

This was seconded by Mr. F. H. Hicks, and likewise carried.

The Treasurer responded on behalf of the Officers, and took the opportunity of pointing out that as the future success of the Club depended largely upon the number of members, he hoped all would do what they could to increase the membership.

The result of the Ballot for Officers and Committee was declared to be as follows:—

For President	E. J. Spitta, L.R.C.P., M.R.C.S., F.R.A.S., F.R.M.S.
For Four Vice-Presidents.	J. G. Waller, F.S.A. A. D. Michael, F.L.S., F.R.M.S. The Rt. Hon. Sir Ford North, F.R.S. J. J. Vezey, F.R.M.S.
For Treasurer	H. Morland.
For Secretary	A. Earland.
For Foreign Secretary .	C. F. Rousselet, F.R.M.S.
For Reporter	R. T. Lewis, F.R.M.S.
For Librarian. . . .	Alpheus Smith.
For Curator	C. J. H. Sidwell, F.R.M.S.
For Editor	Frank P. Smith.
For Four Members of Committee.	J. M. Allen, F.R.M.S. J. T. Holder. D. Bryce. W. Gardner, F.R.M.S.

The Chair was then taken *pro. tem.* by Mr. A. D. Michael, F.L.S., and the President delivered his annual address on "The Improvements in Modern Objectives for the Microscope Popularly Explained," illustrated by means of the lantern.

A hearty vote of thanks was accorded to the President for his address.

OBITUARY NOTICE.

JEREMIAH SLADE, F.G.S.

Born July 19th, 1828; *died March 9th*, 1905.

By the death of the late Mr. Jeremiah Slade, F.G.S., who passed away March 9th, 1905, at the ripe age of seventy-six, of pneumonia, after only a few days' illness, the Club lost one of its oldest surviving members. Although not one of the original founders of the Club, Mr. Slade was elected as far back as December 28th, 1866, and appears to have immediately come into prominence, as he was elected to the Committee in 1867, serving for the usual period of three years. During this period he contributed a few papers dealing with the methods of preparation, and the structure of bone and shell, which will be found in the first volume of the Club's journal.

Mr. Slade had long ceased to take any active part in the conduct of the Club, but he retained his interest in its welfare, and his spare and active figure, giving little indication of his advanced age, was familiar at the meetings up to quite a short period before his death. He attended the special excursion to the Harrow district held in June 1904, and the writer noted that he bore the fatigue and entered into the enjoyment of the day's excursion as well as any of his juniors.

Outside the world of microscopy Mr. Slade was a familiar figure in several circles. Born in Clerkenwell, of a prosperous commercial family, he early in life developed a taste for natural history. Joining the Islington Literary and Scientific Society, he soon took an active part in the work of the "Philosophical Class," contributing lectures on many subjects, usually connected with his favourite pursuits of botany and geology. As an outcome of these meetings arose the Geologists' Association, which was founded in 1858, Mr. Slade and his friend Mr. G. Potter being associated with Mr. Wakefield in its inception. Mr. Slade also took an active interest in the Working Men's College, Great Ormonde Street, W.C., where he was a frequent lecturer, and he was one of the founders and the Hon. Secretary of the North London Naturalists' Club.

THIRTY-NINTH ANNUAL REPORT.

Your Committee is again in the position to report favourably upon the Club's progress during the past year, which has been even more prosperous than its predecessors.

During the twelve months ending December 31st, 1904, exactly fifty new members were elected. This compares very well with the thirty-three elected in the previous twelve months, and. with the exception of the year 1901, in which no less than fifty-five members joined, it represents the largest addition to the Club's strength for very many years. During the year twenty-two members were lost through resignation, and seven were removed for non-payment of subscriptions. Five members, nearly all of considerable seniority in the Club, died during the year—viz. E. Dadswell, M. F. Dunlop, C. G. Dunning, J. Spink, and H. Stocks. The loss of Mr. Dadswell, who had been a member since 1875, will be felt by a very wide circle of friends; and the deep interest which he had always evinced in the Club's welfare is marked by a legacy of £50, which he has bequeathed to the Club. An obituary notice of this gentleman and also of the late Mr. C. G. Dunning, who joined the Club so long ago as 1872 (but who, owing to absence from London, was seldom present at the meetings of late years), has already been published in the Club's Journal. The total number of members on the books of the Club on December 31st was 382, as compared with 379 in the previous year.

The attendance both on "gossip" nights and at the ordinary meetings has been extremely good throughout the year, and shows no tendency to fall off. Indeed, on several occasions the numbers present on "gossip" nights have been as large as is compatible with freedom of movement. The number and quality of the objects exhibited has also maintained its usual high standard; but the Committee note with regret that only a very small percentage of members record their observations in the shape of notes or papers, for the benefit of their fellow members.

The chief communications read at the meetings during the year are as follows:—

Jan. On a new Fresh-water Polyzoon from Rhodesia, *Lophodella thomasi* . Mr. Rousselet.

Feb.	President's Address, "On some Plant Diseases caused by Fungi" . .	Mr. Massee.
March	On a new method of constructing small Glass Tanks . . .	Mr. Kingsford.
,,	On the Phyllopods *Limnadia lenticularis* and *Limnetis brachyura* .	Dr. Vávra.
,,	On the Genital Organs of *Taenia sinuosa*	Mr. Rosseter.
April	On some new Sense-organs in Diptera	Mr. Wesché.
June	Two new British Water-Mites . .	Mr. Soar.
Oct.	The Spiders of the *Erigone* Group .	Mr. F. P. Smith.
Nov.	On a Modification of the "Rousselet" Live Box	Mr. Merlin.
,,	A Supplementary Note on the Foot of the House-Fly	,, ,,

In addidion to these papers, several very interesting lectures have been contributed during the year. In January Mr. J. T. Holder gave a Lantern Exhibition devoted to the Foraminifera, at which about thirty photographs were shown. In May an interesting lecture, "On the False Scorpions or Chelifers," also illustrated by means of the lantern, was given by Mr. H. Wallis Kew; and in the following month the President gave a lecture "On Screens for the Photomicrography of Stained Bacteria." An abstract of this lecture, which was illustrated by lantern demonstrations in which the President's son, Dr. Harold Spitta, and Mr. A. E. Conrady assisted, appeared in the Journal. At the meeting in November Mr. Conrady kindly gave a valuable *résumé* of his paper on "Theories of Microscopic Vision," previously read before the Royal Microscopical Society, and in December Mr. D. J. Scourfield gave a very interesting lecture on "Fresh-water Biological Stations," illustrated by lantern slides of many of the stations now in existence in Europe and America.

The Committee beg to thank the members who have communicated their investigations to the Club.

The following books, periodicals, and transactions have been added to the Library during the past year:—

British Desmidiaceae, Vol. 1. Ray Society.
Missouri Botanical Garden Report, 1904.
Smithsonian Report, 1903.
American Botanical Gazette.

Proceedings of Academy of Natural Science of Philadelphia.
Proceedings of the Royal Society.
Journal of the Royal Microscopical Society.
Quarterly Journal of Microscopical Science.
Annals and Magazine of Natural History.
Proceedings of the Geologists' Association.
Revue des Sciences Photographiques.

Eight volumes and pamphlets on *Plankton*, etc., from Dr. Wesenberg-Lund, and sundry other Proceedings and Transactions.

The publication of the new Catalogue of the works in the Library of the Club, which was announced in last year's report, has led to a considerable increase in the number of books borrowed by members. It would appear, however, that the sale of the Catalogue (which is published at 1*s*., and may be obtained of the Hon. Librarian) has not come up to expectations; and in view of the considerable outlay attendant on its publication, the Committee again desire to draw attention to the matter, in the hope that all members who have not already purchased a copy will do so, and thus show their appreciation of their Librarian's labours in compiling the Catalogue for their benefit.

The Journal has appeared with its usual regularity, and the Committee desire to place upon record their appreciation of the manner in which the Hon. Editor has succeeded in reducing the cost of production without lowering its previously high standard. This economy, the necessity for which was foreshadowed in last year's report, and which is unavoidable in view of the largely increased rental which the Club will in future have to pay, has been effected principally by the omission of reviews and by the cutting down of the reports of meetings. The interest felt in such reports is to a large extent of a temporary nature, and has more or less disappeared by the time the Journal is in print. Moreover, a very full report of the proceedings at each ordinary meeting of the Club is, by the courtesy of the editor of the *English Mechanic*, published in that paper on the fourth Friday of each month, the week after the meeting, so that country members and others who are unable to be present at the meeting can now keep themselves conversant with the Club's progress. A list of the members of the Club was printed in the November Journal, and will doubtless be appreciated.

The Hon. Curator reports a steadily increasing demand for slides from the Club's cabinets, about 2,250 slides having been issued during the year. The descriptive botanical series prepared by Mr. R. Paulson have been continuously on loan, and are highly appreciated. The total number of slides added to the Cabinet by donations during the year is 115. Fifty of these were presented by Miss Andrews (through Mr. J. M. Offord, F.R.M.S.) in memory of her late father, a very old member of the Club. Handsome donations were also received from Messrs. C. F. Rousselet, F.R.M.S., J. M. Offord, F.R.M.S., and H. Taverner, F.R.M.S., to whom, and to the other donors, the Committee desire to express their thanks. They also desire to express their thanks to Messrs. J. P. Miles and O. Whiting for valuable assistance rendered to the Hon. Curator in the distribution of slides.

Eight excursions were held during the year, which were attended in all by 105 members, being an average of thirteen to each excursion, the same as in 1903, when nine excursions were held. The visit to the Royal Botanical Gardens, as usual, commanded the largest attendance. The thanks of the Club are due to Lieut.-Colonel G. Lyon Tupman, F.R.M.S., at whose invitation and under whose guidance a very enjoyable excursion was held by a limited number of members on June 11th, 1904, in the Harrow district.

The Excursions Sub-Committee propose, if the matter receives due support, to hold a week-end excursion during the summer of 1905 to some centre farther from London than can be reached in the ordinary half-day trip. Members disposed to join the party should communicate with Mr. C. D. Soar, F.R.M.S., in order that the necessary arrangements may be made.

The year 1904 has been marked by an event of considerable importance to the Club—viz. the conclusion of a formal agreement between the Club and its landlords, the Council of the Royal Medical and Chirurgical Society. When the Club removed from University College to its present abode in January, 1890, no formal agreement was entered into, and so matters remained until the beginning of 1904, when it became necessary to secure further accommodation for the Club's collections and books. After prolonged negotiations this has been obtained, and the tenancy of the Club secured under agreement for a period of five years, which will expire in November 1909. This was effected only at a considerable increase in the Club's rent, which will in future be at the rate of £75 per annum instead of £54 12*s*., as hitherto. In their negotiations the Committee were obliged to take into account the general increase in rates throughout the West End of London; and having in view the splendid accommodation which the Club has so long enjoyed, through the consideration of their landlords, they do not doubt that their action will meet with the approval of all the members. The Committee desire to record their appreciation of the services of Mr. J. J. Vezey, F.R.M.S., by whom the negotiations were mainly conducted, and who thus adds very largely to the long list of services which he has rendered to the Club.

At the same time, the Committee think it their duty to point out that the increase in rent must be met in one of two ways—viz. either by curtailment of expenditure or by increased membership. The offices of the Club being entirely honorary, retrenchment can only be effected by economies in the Journal, and these have probably now been carried as far as possible without impairing its standard. The remedy, therefore, lies in an increased membership, and the Committee believe that this can be obtained if members will only take the trouble to bring the Club and its advantages more prominently before their microscopical acquaintances. At the present time the introduction of new members appears to be almost entirely due to the exertions of a quite limited number of gentlemen, as may be verified at any meeting when the list of members to be balloted for is read out.

The Balance Sheet shows that the Club's finances are in a sound condition. The item for rent and hire of bookcases shows a large increase on last year, due to the increase in the rental and to the fact that under the new agreement it has become payable in advance. As this was not hitherto the case, the Club is, for this year only, in the position of having paid five quarters' rent in the twelve months, and three of these on the new scale. In spite of this fact, the balance in hand is considerably increased, owing to the decreased expenditure on the Journal and other minor economies, and to the increase in the amount received from subscriptions.

In conclusion, the Committee desires to express its thanks to the officers for their individual and collective services, on which the Club so largely depends, and which have, as hitherto, been so ungrudgingly rendered.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1904.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance from 1903 ...	190	9	3	By Rent of Rooms and Bookcases ...	83	11	0
" Subscriptions received during 1904 ...	195	10	0	" Expenses of Journal ...	86	5	8
" Dividends, etc., on Investments ...	10	12	3	" Postage ...	8	4	0
" Sales of Journal ...	16	9	11	" Printing and Stationery ...	10	8	1
" Sales of Reprints ...	0	13	8	" Attendance ...	6	0	0
" Sales of Catalogues, etc. ...	5	17	8	" Petty Expenses ...	2	14	6
" Receipts for Advertisements ...	17	15	6	" Catalogues ...	16	18	6
				" Books ...	4	16	0
				" Balance in hand, £100 of which is at Deposit Account at Bank ...	218	10	3
	£437	8	3		£437	8	3

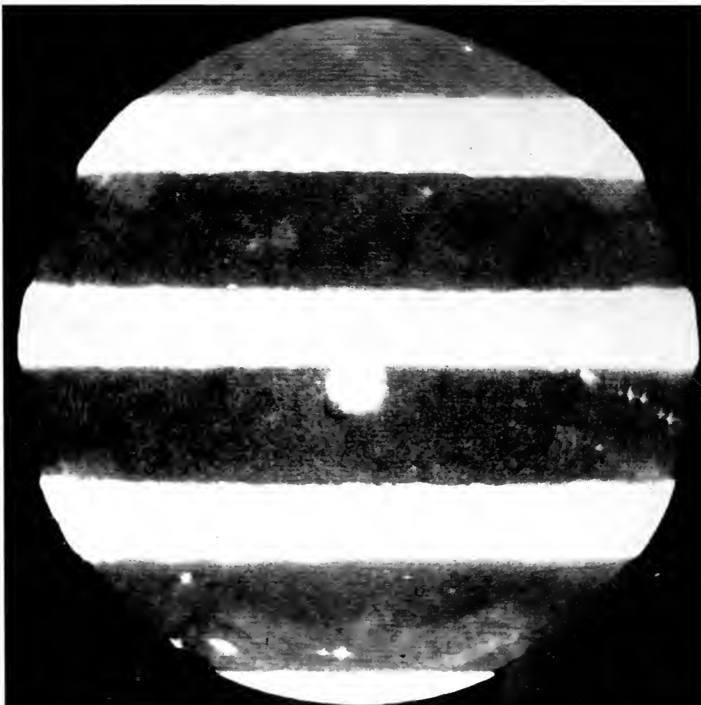
INVESTMENTS.

	£	s.	d.
$2\frac{1}{2}$ per cent. Consols ...	200	0	0
$2\frac{1}{2}$ per cent. Metropolitan Stock ...	49	5	2
$2\frac{1}{2}$ per cent. Annuities, 1905 ...	100	0	0
	£349	5	2

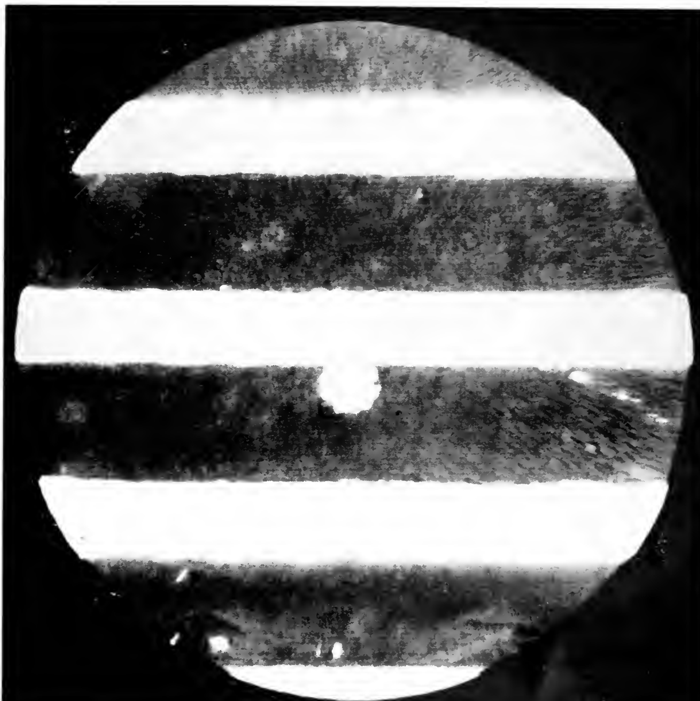
We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and have verified the Investments at the Bank of England, and find the same correct.

January 27th, 1905.

F. HUGHES }
F. H. HICKS } *Auditors.*



Abbe's Test-plate photographed with a 1/12th astigmatic objective (1st position.)



Abbe's Test-plate photographed with a 1/12th astigmatic objective (2nd position.)

THE FORAMINIFERA OF THE SHORE-SAND AT BOGNOR, SUSSEX.

By Arthur Earland.

(*Read May 19th*, 1905.)

Plates 11—14.

When staying at Bognor in October, 1895, I noticed that Foraminifera were abundant on the foreshore, and made a gathering at the western or Aldwick end of the town, beneath the old windmill, now removed, where the material was plentiful. No special examination of the material was, however, undertaken, as I was then busily engaged with other work. I formed the impression, moreover, based upon a cursory examination, that it was mainly a Milioline gathering and of no particular interest. In October, 1901, I was again at Bognor, and decided to collect material with the view of working out a complete list of the local species, little thinking what a heavy task I was undertaking. I found that, owing to some alteration in the local currents, there was practically no material obtainable on my former collecting-ground, or anywhere to the west of the town; but at Felpham, about a mile to the east, it was most abundant. In the course of two or three tides I gathered between twenty and thirty pounds of scrapings, which were packed off to London to be dried and cleaned. Having no microscope with me, I was unable to make any local examination of the material while fresh, and this is the more to be regretted as there are a few doubtful species, the true nature of which could have been settled without much doubt if living specimens had been procurable. It is to be hoped that some member of the Club, more fortunately situated than myself, or some local microscopist, will endeavour to clear up these doubtful points.

Upon my return to London I cleaned and floated the material, and my spare time ever since has been more or less occupied with its examination. I soon became aware of the fact that the list of species would prove a long one, and, indeed, it has kept constantly growing, nor do I imagine that the present list is absolutely exhaustive. Probably a local rhizopodist would be able to add many species to it by varying his methods of collecting and extending the area of research, as the whole of my material was obtained from about fifty yards of the foreshore between tide-marks.

The gathering is primarily a Milioline one. The genus *Miliolina* in various species occurs in an abundance quite out of proportion to other forms, and gives a characteristic porcellaneous appearance to the coarse material. The finer material is, however, very varied in the character of its contents, and is principally responsible for the very long list of species observed.

The total number of species identified, exclusive of a few doubtful forms, is 140, and is made up as follows:—

Miliolidae . .	28	Lagenidae . .	38
Astrorhizidae .	1	Globigerinidae .	3
Lituolidae . .	10	Rotalidae . .	28
Textularidae .	24	Nummulinidae .	8

Many of the species now recorded are of very rare occurrence in Great Britain, and, in addition, the list contains one new species, *Spiroplecta fusca*, and one new variety, *Massilina secans*, var. *tenuistriata*. There are also the following species, 15 in number, which, to the best of my knowledge, have not previously been recorded in Great Britain:—

Spiroloculina antillarum, d'Orbigny.
Sigmoilina costata, Schlumberger.
Massilina secans, d'Orbigny, var. *denticulata*, Costa.
Gaudryina subrotundata, Schwager.
Bolivina tortuosa, Brady.
,, *nobilis*, Hantken.
Lagena stelligera, Brady.
Nodosaria soluta, Reuss.
Cristellaria aculeata, d'Orbigny.
Polymorphina regina, Brady, Parker & Jones.
Uvigerina porrecta, Brady.
Discorbina vesicularis, Lamarck.
Anomalina grosserugosa, Gümbel.
Pulvinulina hauerii, d'Orbigny.
Rotalia calcar, d'Orbigny.

Both in the total number of species recorded, and in the number of rare and previously unrecorded species observed, Bognor will now take precedence over all other British collecting-grounds. For about forty years this position has been held by Dog's Bay, Connemara, whose shore-sands have been familiar to most microscopists. A list of the species observed at Dog's Bay, Connemara, containing 124 forms, was published in the *Irish Naturalist* (vol. ix., No. 3, March, 1900) by my friend Mr. Joseph Wright, F.G.S., of Belfast.

The question arises why Bognor should form such a rich collecting-ground. At Littlehampton, only a few miles to the east, Foraminifera are almost non-existent. In 1902 I endeavoured to make a gathering there, for comparison with the Bognor fauna, but was unable to find any trace of shore deposits, although I examined the coast-line for a distance of two miles in each direction.

The south-east coast is, speaking generally, a very poor collecting-ground for Foraminifera, although careful search will give some results in most localities. This is, doubtless, due to the scour of the Channel tides and the absence of suitable areas for the growth of the animals. The majority of the Foraminifera found in shore gatherings are dead shells which have gradually drifted with the currents and tides to the beach. Off Bognor there lies an extensive reef, known as the Barn Rocks, which are a noted fishing-ground, and which are doubtless covered with Algae, and form a suitable home for swarms of the lower animals. The bulk of the specimens have probably come from this source, but there are certain species abundant in the gathering which may have travelled still farther. Both *Miliolina fusca*, Brady, and *Trochammina inflata*, Montagu, are usually considered to be distinctively brackish-water organisms; but the mud-flats of Bosham and Chichester Harbours, nearly thirty miles away, are the nearest localities from which brackish-water organisms could have been derived, and as both those species are of a delicate and friable nature, one would hardly expect them to make such a journey undamaged. Moreover, I have noticed many specimens in which the sarcode was still visible, and this would seem to prove that some of the specimens, at any rate, are of local marine origin, and that we must no longer regard them as essentially brackish-water types. Perhaps some local microscopist may be able to decide this point of doubt.

As in nearly all the south-coast gatherings which I have had the opportunity of examining, there is a considerable number of fossil specimens observable. These are mostly derived from the Chalk, but there are others of Tertiary age, which have been washed out of the Eocene beds of Bracklesham and the Isle of Wight. No attempt was made to work out a complete list of the fossils, but I have notes of the occurrence of the following :—

Textularia globulosa, Ehr.
Bulimina affinis, d'Orb.
Lagena laevis, Mont.
,, *sulcata*, W. & J.
,, *hispida*, Rss.
,, *orbignyana*, Seg.
Nodosaria laevigata, d'Orb.
,, *raphanus*, Linné.
Frondicularia archiaciana, d'Orb.
Cristellaria acutauricularis, F. & M.
,, *recta*, d'Orb.
,, *cultrata*, Montft.
Sagrina nodosa, d'Orb.
Orbulina universa, d'Orb.
Globigerina cretacea, d'Orb.
Anomalina ammonoides, Rss.

FRUITS OF *CHARA*.

In conclusion, I must express my deep indebtedness to my friend Mr. Joseph Wright, F.G.S., of Belfast, the chief authority on our British Foraminifera, but for whose encouragement and assistance this paper would never have been completed. Mr. Wright not merely undertook the laborious task of verifying all my specimens, but also examined a large quantity of the material, thereby adding to the list many forms which I had overlooked.

The illustrations reproduced in Plates 11 and 12 are from drawings made by my friend Mr. Archibald J. French; those on Plate 13 and the figure of *Discorbina* in the text are from drawings by my cousin, Mr. J. A. Lovegrove; while the figures reproduced in Plate 14 are from photographs taken specially for this paper by our President, Dr. E. J. Spitta, F.R.A.S., who devoted much time and trouble to photographing my specimens, a task the difficulty of which can only be appreciated by those who have attempted it. I think the actual photographs will be especially valuable as showing the range of form exhibited by some of the species. To these three gentlemen I beg to tender my grateful thanks for their assistance.

Sub-kingdom—**PROTOZOA.**

Class—RHIZOPODA.

Order—FORAMINIFERA.

Family II.—MILIOLIDAE.

Sub-family 1—NUBECULARINAE.

Nubecularia, Defrance.

Nubecularia lucifuga, Defrance.

Nubecularia lucifuga, Defrance, 1825, *Dict. Sci. Nat.*, vol. 25, p. 120; *Atlas Zooph.*, pl. xliv., fig. 3.
,, ,, Brady, 1884, *Report "Challenger,"* p. 134, pl. i., figs. 9—16.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common, and in all the usual protean forms, both attached and free and labyrinthic. The specimens are well developed and quite typical, but do not, of course, attain a very large size compared with those obtained from warm seas. Minute specimens, exhibiting the regularly spiral arrangement of the early chambers, are of frequent occurrence in the fine floatings. (Plate 11, Figs. 1, 2, 3, and Plate 14, Fig. 2.)

The species has been previously recorded from the Cornish coast, 60 fathoms, and Mounts Bay, Cornwall (F. W. Millett); also from the Southport coast (Chaster), and Kilchattan Bay, Bute, 25 fathoms (Robertson). It does not appear to have been recorded from Ireland.

Sub-family 2—MILIOLININAE.

Biloculina, d'Orbigny.

Biloculina ringens, Lamarck, sp.

Miliolites ringens, Lamarck, 1804, *Ann. du Muséum*, vol. v., p. 351, No. 1; vol. ix., pl. xvii., fig. 1.
Biloculina ringens, Brady, 1884, *Report "Challenger,"* p. 142, pl. ii., figs. 7, 8.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare; two specimens only were found, and these are weak.

Spiroloculina, d'Orbigny.

Spiroloculina planulata, Lamarck, sp.

Miliolites planulata, Lamarck, 1805, *Ann. du Muséum*, vol. v., p. 352, No. 4.
,, ,, Lamarck, 1822, *Anim. s. Vert.*, vol. vii., p. 613, No. 4.
Spiroloculina planulata, Brady, 1884, *Report "Challenger,"* p. 148, pl. ix., fig. 11, a, b.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare. The specimens are weak.

Spiroloculina excavata, d'Orbigny.

Spiroloculina excavata, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 271, pl. xvi., figs. 19—21.
,, ,, Brady, 1884, *Report "Challenger,"* p. 151, pl. ix., figs. 5, 6.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Spiroloculina limbata, d'Orbigny.

Spiroloculina limbata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 299, No. 12.
,, ,, Brady, 1884, *Report "Challenger,"* p. 150, pl. ix., figs. 15—17.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Spiroloculina acutimargo, Brady.

Spiroloculina acutimargo, Brady, 1884, *Report "Challenger,"* p. 154, pl. x., figs. 12—15.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

One specimen only, found by Mr. J. Wright.

Previously recorded from the estuary of the Dee (Siddall), and from Southport, Lanc. (Chaster), rare. Also by Messrs. Balkwill & Wright, from Lambay, Irish Sea, 45 fathoms; specimens small and poor.

Spiroloculina antillarum, d'Orbigny.

Spiroloculina antillarum, d'Orbigny, 1839, *De la Sagra's Hist. Phisiq.*, etc., Cuba, " Foraminifères," p. 166, pl. ix., figs. 3, 4.
,, ,, Brady, 1884, *Report* "*Challenger*," p. 155, pl. x., fig. 21, a, b.

One specimen found ; weak, but identifiable.

Not previously recorded in Great Britain. The species is at home in the shallow water of warm seas.

Sigmoilina, Schlumberger.

Sigmoilina costata, Schlumberger.

Sigmoilina costata, Schlumberger, *c.* 1893, " Monographie des Miliolides de Golfe de Marseille," *Mem. Soc. Zool. France*, vol. vi., p. 69, pl. i., figs. 51, 52, and text fig 4.

Rare. This species has not been previously recorded in Great Britain, but Mr. Joseph Wright informs me that he has been acquainted with it for many years as a fossil in the estuarine clay of Magheramorne, near Belfast, and that he has recently found it in shore-sand from North Donegal, and also off Dublin ; very rare at both places.

Miliolina, Williamson.

Miliolina trigonula, Lamarck, sp.

Miliolites trigonula, Lamarck, 1804, *Ann. du Muséum*, vol. v., p. 351, No. 3.
,, ,, Lamarck, 1822, *Anim. s. Vert.*, vol. vii., p. 612, No. 3.
Miliolina trigonula, Brady, 1884, *Report* "*Challenger*," p. 164. pl. iii., figs. 14—16.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common.

Miliolina tricarinata, d'Orbigny, sp.

Triloculina tricarinata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 299, No. 7 ; *Modèle*, No. 94.
Miliolina tricarinata, Brady, 1884, *Report* "*Challenger*," p. 165, pl. iii., fig. 17, a, b.

Miliolina tricarinata, Brady, 1887, *Synopsis British Recent Foraminifera.*

Fairly common, but less frequent than the last species.

It occurs at many points round the coast of the British Isles, but is nowhere abundant, whereas *M. trigonula* frequently is.

Miliolina oblonga, Montagu, sp.

Vermiculum oblongum, Montagu, 1803, *Test. Brit.*, p. 522, pl. xiv., fig. 9.

Miliolina oblonga, Brady, 1884, *Report "Challenger,"* p. 160, pl. v., fig. 4, a, b.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Miliolina seminulum, Linné, sp.

Serpula seminulum, Linné, 1767, *Syst. Nat.*, 12th ed., p. 1264, No. 791.

" " Linné, 1788, 13th (Gmélin's) ed., p. 3739, No. 2.

Miliolina seminulum, Brady, 1884, *Report "Challenger,"* p. 157, pl. v., fig. 6, a, b, c.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very common, as it is in most localities round our coast. There is also a considerable range of form.

Miliolina venusta, Karrer, sp.

Quinqueloculina venusta, Karrer, 1868, *Sitzungsb. d. k. Ak. Wiss. Wien*, vol. lvii., p. 147, pl. ii., fig. 6.

Miliolina venusta, Brady, 1884, *Report "Challenger,"* p. 162, pl. v., figs. 5—7.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare. This is normally a deep-sea species, and is most at home at depths below 1,000 fathoms. Out of fourteen *Challenger* stations from which it is recorded, Brady notes that twelve were below 1,800 fathoms. It has, however, been previously recorded in this country from the estuary of the Dee (Siddall), and from the Southport shore (Chaster); also by Robertson from deep water in Loch Fyne.

Miliolina auberiana, d'Orbigny, sp.

Quinqueloculina auberiana, d'Orbigny, 1839, *De la Sagra's Hist. Phisiq.*, etc., Cuba, "Foraminifères," p. 193, pl. xii., figs. 1—3.

Miliolina auberiana, Brady, 1884, *Report "Challenger,"* p. 162, pl. v., figs. 8, 9.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common. This appears to be very local in its distribution, and there are few British records of its occurrence, but it is common at Puffin Island, Lanc. (Chaster).

Miliolina contorta, d'Orbigny, sp.

Quinqueloculina contorta, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 298, pl. xx., figs. 4—6.

Miliolina contorta, Halkyard, 1889, *Trans. Manchester Mic. Soc.*, p. 6, pl. i., fig. 4.

,, ,, Sidebottom, 1904, *Mem. Manchester Lit. and Phil. Soc.*, vol. xlviii., No. 5, p. 13, pl. iv., figs. 7—9.

This most variable species occurs very frequently, and at least four distinct types are noticeable. They are characterised by (1) smooth test, (2) rough and subarenaceous test, (3) peripheral edges rounded, (4) peripheral edges angular. Halkyard's specimens from Jersey were mostly referable to variety (2), and his figure represents variety (4). Sidebottom's figure has also angular edges, and it is stated that the surface of his specimens is rough. They were from Delos, in the Mediterranean.

Miliolina subrotunda, Montagu, sp.

Vermiculum subrotundum, Montagu, 1803, *Test. Brit.*, pt. 2, p. 521.

Miliolina subrotunda, Brady, 1884, *Report "Challenger,"* p. 168, pl. v., fig. 10.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Very common, and in a wide range of form.

Miliolina seminuda, Reuss, sp.

Quinqueloculina seminuda, Reuss, 1865, *Denkschr. K. Akad. Wiss. Wien*, xxv., p. 125, pl. i., fig. 11.

One specimen only, found by Mr. Wright.

The species is closely allied to *Miliolina subrotunda*, Montagu, from which it differs in having the peripheral edge striate. It has been recorded by Halkyard from Guernsey, Herm, and Jersey, and by Wright from Dog's Bay, etc. It occurs at many places round the Irish coast.

Miliolina circularis, Bornemann, sp.

Triloculina circularis, Bornemann, 1855, *Zeitschr. deutsch. geol. Ges.*, vii., p. 349, pl. xix., fig. 4.

Miliolina circularis, Brady, 1884, *Report "Challenger,"* p. 169, pl. iv., fig. 3, a, b, c, and pl. v., figs. 13, 14.

Abundant. The species is closely allied to *M. subrotunda*, Montagu, and is probably often confounded with it. In Brady's *Synopsis of the British Recent Foraminifera*, the two forms are apparently run together under the name *M. subrotunda*.

The species is very common all round our coast, and especially so at Dog's Bay, Connemara.

Miliolina ferussacii, d'Orbigny, sp.

Quinqueloculina ferussacii, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 301, No. 18; *Modèle*, No. 32.

Miliolina ferussacii, Brady, 1884, *Report "Challenger,"* p. 175, pl. cxiii., fig. 17, a, b.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Miliolina insignis, Brady.

Miliolina insignis, Brady, 1884, *Report "Challenger,"* p. 165, pl. iv., figs. 8—10.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

One specimen only found.

Previously recorded by Mr. J. Wright from the shore-sand of Dog's Bay, Connemara, and from Belfast Lough, 60 fathoms.

Miliolina bicornis, Walker & Jacob, sp.

Serpula bicornis, Walker & Jacob, 1798, *Adam's Essays*, Kanmacher's ed., p. 633, pl. xiv., fig. 2.

Miliolina bicornis, Brady, 1884, *Report "Challenger,"* p. 171, pl. vi., figs. 9, 11, 12.

Miliolina bicornis, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rather common. The specimens exhibit much variation in shape, arrangement of chambers, and strength of the costae.

Miliolina pulchella, d'Orbigny, sp.

Quinqueloculina pulchella, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 303, No. 42.

" ", Soldani, 1798, *Testac.*, vol. ii., p. 53, pl. xviii., fig. *f.*

Miliolina pulchella, Brady, 1884, *Report "Challenger*, p. 174, pl. vi., figs. 13, 14, and pl. iii., figs. 10—13.

" ", Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent. The specimens are somewhat small, and have their surfaces ornamented with smooth longitudinal ridges, without secondary striae.

The species is not uncommon round our coast in dredgings from depths below 30 fathoms, but it is of very rare occurrence in shore-sands.

Miliolina fusca, Brady.

Quinqueloculina fusca, Brady, 1870, *Ann. and Mag. Nat. Hist.*, ser. 4, vol. vi., p. 286, pl. xi., fig. 2.

Miliolina fusca, Brady, 1887, *Synopsis British Recent Foraminifera.*

Very common; the specimens are both triloculine and quinqueloculine. This species is usually regarded as one of the most typical of brackish-water Foraminifera, and its presence at Bognor in such numbers is one of the most noticeable features of the gathering. Further remarks on the subject will be found in the preface to this paper.

Massilina, Schlumberger.

Massilina secans, d'Orbigny, sp.

Quinqueloculina secans, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 303, No. 43; *Modèle*, No. 96.

Miliolina secans, Brady, 1884, *Report "Challenger,"* p. 167, pl. vi., figs. 1, 2.

" ", Brady, 1887, *Synopsis British Recent Foraminifera.*

Massilina secans, Schlumberger, 1893, *Mem. Soc. Zool. France*, vol. vi., p. 218, figs. 31—34, pl. iv., figs. 82, 83.

Most abundant, the shells forming a large proportion of the entire gathering. The species occurs in similar profusion in the Jersey shore-sands, and at Dog's Bay, Connemara.

As might be expected, there is a considerable range of form observable. Abnormal and monstrous specimens are of frequent occurrence, and do not call for any special notice; but two well-marked varieties have been observed which deserve to be recorded.

Massilina secans, var. **denticulata**, Costa, sp.

Quinqueloculina denticulata, Costa, 1856, *Atti. Accad. Pontaniana*, vii., fas. 2, p. 325, pl. xxv., fig. 6, a, b, c.

This is a handsome and well-marked variety, in which the periphery is extended into an elegantly denticulate keel. It occurs in the Mediterranean, though never in any abundance, and it has not hitherto been recorded in Great Britain. A single very fine and typical specimen was found at Bognor, and several small specimens were observed, which exhibited a tendency towards variation in this direction. (Plate 11, Fig. 4.)

Massilina secans, var. **tenuistriata**, var. nov.

In this variety the entire surface of the test is covered with fine longitudinal striae, which are roughly parallel with the periphery. The striae vary in coarseness in different specimens, being in some cases as well marked as in *Biloculina comata*, Brady, while in others they are so fine and close together as to be difficult of detection with less than a 1-in. objective. The variety must not be confused with Halkyard's var. *obliquistriata*,* in which the test has "oblique, somewhat curved grooves ploughed in the surface of the last segment."

Very rare compared with the type, but a considerable number of specimens have been observed. (Plate 11, Fig. 5.)

* *Sigmoilina secans*, d'Orbigny, var. *obliquistriata*, var. nov., Halkyard, 1889, *Trans. Manchester Mic. Soc.*, p. 61, pl. i., fig. 7. This variety was subsequently withdrawn by the author; see *Trans. Manchester Mic. Soc.*, 1891, p. 20.

Sub-family 4—PENEROPLIDINAE.

Cornuspira, Schultze.

Cornuspira involvens, Reuss.

Operculina involvens, Reuss, 1849, *Denkschr. d. K. Akad. Wiss. Wien*, vol. i., p. 370, pl. xlv., fig. 20.

Cornuspira involvens, Brady, 1884, *Report "Challenger,"* p. 200, pl. xi., figs. 1—3.

„ „ Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent, but all the specimens are small.

Cornuspira *? sp.*

Some doubt exists as to the nature of the organism figured in Pl. 13, Fig. 2, and it is desirable that an attempt should be made to observe living specimens, which should not be difficult to obtain, as they are of common occurrence. I had referred my specimens to *Cornuspira foliacea*, Philippi, to which the outspread test bears some resemblance. Mr. Joseph Wright, however, on examining them, informed me that he was well acquainted with the form, which he regarded as the tube of an Annelid, and he added that this opinion had been confirmed by the late Mr. H. B. Brady, to whom he had submitted specimens. Mr. Wright kindly supplied me with a British example of *C. foliacea*, Philippi, which certainly differs widely from the Bognor specimens, being very depressed and outspread.

I thereupon withdrew *C. foliacea* from my list; but having subsequently found the abnormal specimens figured in Pl. 13, Figs. 3, 4, which closely resemble examples of multiple plastogamy, such as is frequently observed in the Foraminifera, I have thought it advisable to draw attention to them in the hope that some local observer may settle the nature of the organism.

Family III.—ASTRORHIZIDAE.

Sub-family 4—RHABDAMMININAE.

Hyperammina, Brady.

Hyperammina vagans, Brady.

Hyperammina vagans, Brady, 1879, *Quart. Jour. Micr. Sci.*, xix., p. 33, pl. v. 3.

„ „ Brady, 1884, *Report "Challenger,"* p. 260, pl. xxiv., figs. 1—9.

Frequent. Previously recorded in Great Britain only from Oban (Norman).

All the specimens found are more or less fragmentary. This is doubtless due to the nature of the organism, which is normally adherent to other bodies, and perfect specimens will doubtless be forthcoming if looked for in suitable positions, such as among the Algae and Bryozoa thrown up on the beach.

Family IV.—LITUOLIDAE.

Sub-family 1—Lituolinae.

Haplophragmium, Reuss.

Haplophragmium canariense, d'Orbigny, sp.

Nonionina canariensis, d'Orbigny, 1839, *Foram. Canaries*, p. 128, pl. ii., figs. 33, 34.

Haplophragmium canariense, Brady, 1884, *Report "Challenger,"* p. 310, pl. xxxv., figs. 1—5.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common. The specimens are all very neatly built, and with a large proportion of reddish brown cement. They are all of the compressed variety.

Haplophragmium anceps, Brady.

Haplophragmium anceps, Brady, 1884, *Report "Challenger,"* p. 313, pl. xxxv., figs. 12—15.

,, ,, Chaster, 1892, *Report Southport Soc. Nat. Sci.*, p. 57, pl. i., fig. 2.

Very rare. The specimens are also very small.

Previously recorded in Great Britain only by Dr. Chaster (*op. cit.*), from Southport, where also it is very small and rare. It is normally a deep-water species, at home in depths of 1,500—2,000 fathoms.

Placopsilina, d'Orbigny.

Placopsilina cenomana, d'Orbigny.

Placopsilina cenomana, d'Orbigny, 1850, *Prodr. Paléont.*, vol. ii., p. 185, No. 758.

,, ,, Brady, 1884, *Report "Challenger,"* p. 315, pl. xxxvi., figs. 1—3.

Placopsilina cenomana, Brady, 1887, *Synopsis of British Recent Foraminifera.*

Rare.

Sub-family 2—TROCHAMMININAE.

Thurammina, Brady.

Thurammina papillata, Brady.

"Orbuline *Lituola*," Carpenter, 1875, *The Microscope*, 5th ed., p. 533, fig. 273, g, h.

Thurammina papillata, Brady, 1879, *Quart. Jour. Micr. Sci.*, vol. xix., N.S., p. 45, pl. v., figs. 4—8.

" " Brady, 1884, *Report "Challenger,"* p. 321, pl. xxxvi., figs. 7—18.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

The specimens figured in Plate 11, Figs. 6, 7, and Plate 14, Figs. 1, 3, give but a very faint idea of the protean forms assumed by the organism which is, with some hesitation on the part of Mr. J. Wright and myself, referred to this species. They are of fairly frequent occurrence in the shore-sand, and no two specimens are alike, some being comparatively smooth and more or less regular in shape, while others are of the roughest construction and more or less lobate in outline. The specimens are both free and attached, and the free-growing tests are usually of much neater and more regular construction than the attached specimens. In colour they are of a light grey, and composed of sand-grains and a grey cement. The size of the sand-grains is very variable, even in a single specimen, and frequently one or more sand-grains of relatively enormous size (one-sixth to one-fourth of the whole bulk of the test) are built into the test, from the surface of which they project, giving a very rough and unfinished appearance to the shell. The sand-grains are attached to a delicate chitinous membrane which lines the cavity, and which in detached specimens is observable as a transparent film enclosing the body cavity. The "irregularly disposed perforate papillae," which, according to Brady, are characteristic of the test, are well marked in some specimens; in others they are entirely absent.

Brady records a single specimen of *Thurammina papillata* from Loch Scavaig, West Scotland, 45—60 fathoms, but does not state whether it was of normal character. Mr. Wright has records from the south-west of Ireland, 38—110 fathoms, but he informs me that his specimens were as spherical as *Orbulina universa*, d'Orbigny.

Although the Bognor specimens are so different in appearance from Brady's figures and Mr. Wright's Irish specimens, they agree fairly well with Brady's description of the species, which is admittedly subject to great variation. It further appears that fossil specimens are of greater diversity than recent ones. Writing of Dr. Haeusler's Jurassic specimens, Brady states that "comparatively few show any signs of external symmetry."

Ammodiscus, Reuss.

Ammodiscus incertus, d'Orbigny, sp.

Operculina incerta, d'Orbigny, 1839, *De la Sagra's Hist. Phisiq.*, etc., Cuba, "Foraminifères," p. 49, pl. vi., figs. 16, 17.

Ammodiscus incertus, Brady, 1884, *Report "Challenger,"* p. 330, pl. xxxviii., figs. 1—3.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

One specimen only found.

Ammodiscus gordialis, Jones & Parker, sp.

Trochammina squamata gordialis, Jones & Parker, 1860, *Quart. Jour. Geol. Soc.*, vol. xvi., p. 304.

Ammodiscus gordialis, Brady, 1884, *Report "Challenger,"* p. 333, pl. xxxviii., figs. 7—9.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Trochammina, Parker & Jones.

Trochammina squamata, Jones & Parker.

Trochammina squamata, Jones & Parker, 1860, *Quart. Jour. Geol. Soc.*, vol. xvi., p. 304.

" " Brady, 1884, *Report "Challenger,"* p. 337, pl. xli., fig. 3.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Trochammina inflata, Montagu, sp.

Nautilus inflatus, Montagu, 1808, *Test. Brit. Suppl.*, p. 81, pl. xviii., fig. 3.
Trochammina inflata, Brady, 1884, *Report "Challenger,"* p. 338, pl. xli., fig. 4, a—c.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common. The specimens are very fine and strongly built, and much larger than those which I obtained at Hampton, near Whitstable, in Kent. Brady states that the species is rarely met with, except in brackish waters, but many of the specimens have every appearance of having lived in the neighbourhood where they were gathered, the sarcode being still visible in many broken shells.

Trochammina inflata, var. **macrescens,** Brady.

Trochammina inflata, var. *macrescens*, Brady, 1870, *Ann. and Mag. Nat. Hist.*, ser. 4, vol. vi., p. 290, pl. xi., fig. 5.

Rare. Brady regards this as merely a depauperated form of *T. inflata*, due to existence in brackish pools, where the proportion of mineral constituents is so small that the animal is unable to secrete a firm shell. The test thus becomes little more than a chitinous envelope, so thin that the inflated contour of the segments is lost when the specimens are taken out of fluid and dried.

It is difficult to understand how such a fragile shell can have been transported many miles, such as would be required to meet the conditions required in the above hypothesis, without being entirely destroyed.

Trochammina robertsoni, Brady.

Trochammina robertsoni, Brady, 1887, *Journ. R. Micr. Soc.*, pt. vi., p. 893.
,, ,, J. Wright, 1890—1, *Proc. R. Irish Acad.*, 3rd ser., vol. i., No. 4, p. 469, pl. xx., fig. 4, a, b.

One specimen only found by Mr. Wright.

Family V.—TEXTULARIDAE.

Sub-family 1—Textularinae.

Textularia, Defrance.

Textularia gramen, d'Orbigny.

Textularia gramen, d'Orbigny, 1846, *For. Foss. Vienne*, p. 248, pl. xv., figs. 4—6.
,, ,, Brady, 1884, *Report "Challenger,"* p. 365, pl. xliii., figs. 9, 10.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Spiroplecta, Ehrenberg.

Spiroplecta saggitula, Defrance, sp.

Textularia sagittula, Defrance, 1824, *Dict. Sci. Nat.*, vol. xxxii., p. 177; vol. liii., p. 344; *Atlas Conch.* pl. xiii., fig. 5.
,, ,, Brady, 1884, *Report "Challenger,"* p. 361, pl. xlii., figs. 17, 18.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*
Spiroplecta sagittula, Wright, 1902, *Irish Naturalist*, vol xi., p. 211, pl. iii., figs. a—e.

Rare.

Spiroplecta fusca, nov. sp.

Test sub-arenaceous, elongate, compressed, stoutly built; lateral edges slightly lobulate, sub-angular, being more or less rounded in the terminal segments; chambers somewhat inflated; colour, brown. The spiral commencement consists of from four to six segments, the biserial portion of from five to ten segments in each series. The contour of the shell varies considerably, some specimens being very elongate, while others are short and widen rapidly towards the distal end. Length, $\frac{1}{30}$ in.; breadth, $\frac{1}{60}$ in. (Plate 12, Figs. 1, 2, 3.)

The foregoing is the description of a foraminifer which is of fairly frequent occurrence in the gathering, and for which Mr. J. Wright has happily suggested the specific name of *fusca*, owing to its characteristic reddish brown colour. Mr. F. W. Millett, F.R.M.S., to whom specimens were submitted by Mr. Wright, regards them as hybrids between *Spiroplecta biformis*, Parker & Jones, and *Spiroplecta americana*, Ehrenberg.

Spiroplecta biformis, Parker & Jones, sp.

Textularia agglutinans, var. *biformis*, Parker & Jones, 1865, *Phil. Trans.*, vol. clv., p. 370, pl. xv., figs. 23, 24.

Spiroplecta biformis, Brady, 1884, *Report "Challenger,"* p. 376, pl. xlv., figs. 22, 23, a, b.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Two specimens only found.

Gaudryina, d'Orbigny.

Gaudryina subrotundata, Schwager.

Gaudryina subrotundata, Schwager, 1866, *Novara Exped. Geol.* (2), p. 198, pl. iv., fig. 9, a, b, c.

" " Brady, 1884, *Report "Challenger,"* p. 380, pl. xlvi., fig. 13, a, b, c.

Very rare. Not previously recorded in Great Britain.

Gaudryina filiformis, Berthelin.

Gaudryina filiformis. Berthelin, 1880, *Mem. Soc. Geol. France*, sér. 3, vol. i., No. 5, p. 25, pl. i., fig. 8.

" " Brady, 1884, *Report "Challenger,"* p. 380, pl. xlvi., fig. 12, a, b, c.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare. The species is not uncommon in Irish dredgings.

Verneuilina, d'Orbigny.

Verneuilina spinulosa, Reuss.

Verneuilina spinulosa, Reuss, 1849, *Denkschr. d. K. Ak. Wiss. Wien*, vol i., p. 374, pl. xlvii., fig. 12.

" " Brady, 1884, *Report "Challenger,"* p. 384, pl. xlvii., figs. 1—3.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

This species is included in the list with some hesitation, as only a single specimen was found, and this is very poor and small. It is one of the most typical and widely distributed of all species in tropical and sub-tropical shallow waters, and has also been recorded in Great Britain from Westport, Ireland (Brady), Dublin coast (Balkwill & Wright), and the estuary of the Dee (Siddall).

Verneuilina polystropha, Reuss, sp.

Bulimina polystropha, Reuss, 1845, *Verstein. Böhm. Kreid.*, pt. ii., p. 109, pl. xxiv., fig 53.

Verneuilina polystropha, Brady, 1884, *Report "Challenger,"* p. 386, pl. xlvii., figs. 15—17.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common. Both the short and broad and the long and slender varieties occur.

Clavulina, d'Orbigny.

Clavulina obscura, Chaster.

Verneuilina polystropha, Reuss, sp., *dimorphous* form, Wright, 1886, *Proc. Belfast Nat. Field Club* (1885—6), Appendix, p. 320, pl. xxvi., fig. 2.

Clavulina obscura, Chaster, 1892, *First Rep. Southport Soc. Nat. Sci.* (1890—1), p. 58, pl. i., fig. 4.

Very rare.

Bulimina, d'Orbigny.

Bulimina elegans, d'Orbigny.

Bulimina elegans, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 270, No. 10; *Modèle*, No. 9.

,, ,, Brady, 1884, *Report "Challenger,"* p. 398, pl. l., figs. 1—4.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Bulimina ovata, d'Orbigny.

Bulimina ovata, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 185, pl. xi., figs. 13, 14.

,, ,, Brady, 1884, *Report "Challenger,"* p. 400, pl. l., fig. 13.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Bulimina pupoides, d'Orbigny.

Bulimina pupoides, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 185, pl. xi., figs. 11, 12.

,, ,, Brady, 1884, *Report "Challenger,"* p. 400, pl. l., fig. 15, a, b.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Bulimina elongata, d'Orbigny.

Bulimina elongata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 269, No. 9.

,, ,, Brady, 1884, *Report "Challenger,"* p. 401, pl. li., figs. 1, 2.

Frequent. This form has been recently recorded in the *Irish Naturalist* for the first time in Great Britain by Mr. George Gough, F.G.S., from Larne Harbour. Mr. Wright informs me that he has met with it at a few other Irish stations.

Bulimina squamigera, d'Orbigny.

Bulimina squamigera, d'Orbigny, 1839, *Foram. Canaries*, p. 137, pl. i., figs. 22—24.

,, ,, Siddall, 1878, *Proc. Chester Soc. Nat. Sci.*, pt. ii., p. 49.

Rare. Previously recorded in Great Britain only by Siddall from the estuary of the Dee, but Mr. Wright has found it at a number of Irish stations.

Bulimina marginata, d'Orbigny.

Bulimina marginata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 269, No. 4, pl. xii., figs. 10—12.

,, ,, Brady, 1884, *Report "Challenger,"* p. 405, pl. li., figs. 3—5.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Bulimina aculeata, d'Orbigny.

Bulimina aculeata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 269, No. 7.

,, ,, Soldani, *Testaceographia*, vol. i., pt. 2, p. 118, pl. cxxvii., fig. I., pl. cxxx., fig. v.v.

Bulimina aculeata, Brady, 1884, *Report "Challenger,"* p. 406, pl. li., figs. 7—9.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare; the specimens are also very weak.

Bulimina elegantissima, d'Orbigny.

Bulimina elegantissima, d'Orbigny, 1839, *Foram. Amér. Mérid.*, p. 51, pl. vii., figs. 13, 14.
,, ,, Brady, 1884, *Report "Challenger,"* p. 402, pl. l., figs. 20—22.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Bolivina, d'Orbigny.

Bolivina punctata, d'Orbigny.

Bolivina punctata, d'Orbigny, 1839, *Foram. Amér. Mérid.*, p. 63, pl. viii., figs. 10—12.
,, ,, Brady, 1884, *Report "Challenger,"* p. 417, pl. lii., figs. 18, 19.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Bolivina laevigata, Williamson, sp.

Textularia variabilis, var. *laevigata*, Williamson, 1858, *Rec. For. Gt. Br.*, p. 77, pl. vi., fig. 168.
Bolivina textilarioides, Reuss, 1862, *Sitzungsb. d. k. Akad. Wiss. Wien*, vol. xlvi., p. 81, pl. x., fig. 1.
,, ,, Brady, 1884, *Report "Challenger,"* p. 419, pl. lii., fig. 23—25.
Bolivina laevigata, Brady, 1887, *Synopsis British Recent Foraminifera.*

One specimen only found.

Bolivina dilatata, Reuss.

Bolivina dilatata, Reuss, 1849, *Denkschr. d. k. Akad. Wiss. Wien*, vol. i., p. 381, pl. xlviii., fig. 15.
,, ,, Brady, 1884, *Report "Challenger,"* p. 418, pl. lii., figs. 20, 21.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Bolivina tortuosa, Brady.

Bolivina tortuosa, Brady, 1881, *Quart. Jour. Micr. Sci.*, xxi., p. 57.

" " Brady, 1884, *Report "Challenger,"* p. 420, pl. lii., figs. 31—34.

Rare. Not previously recorded in Great Britain. It is of fairly frequent occurrence in tropical and sub-tropical seas, ranging from shallow water down to 675 fathoms, the deepest record, which is in the *Challenger* dredging, Station 120, off Pernambuco. It does not appear to have been recorded anywhere north of the Cape Verde Islands.

Bolivina nobilis, Hantken.

Bolivina nobilis, Hantken, 1875 (1876), *A magy. Kir. földt. int. évkönyve*, iv., 56, pl. xv., fig. 4, and *Mitth. a. d. Jahrb. K. ungar. geol. Anstalt,* iv., 1875 (1881), 65, same plate and figure.

" " Brady, 1884, *Report "Challenger,"* p. 424, pl. liii., figs. 14, 15.

Very rare. Not previously recorded in Great Britain, but Mr. Wright informs me that he has found it at Rockport, Belfast Lough, Strangford Lough, and Carlingford, and that Mr. F. W. Millett has obtained specimens from Torbay, Devonshire.

Brady records it from the South Pacific only. Mr. Millett found it in the Malay Archipelago, and I have specimens from anchor mud, Mauritius.

Bolivina plicata, d'Orbigny.

Bolivina plicata, d'Orbigny, 1839, *Foram. Amér. Mérid.*, p. 62, pl. viii., figs. 4—7.

" " Brady, 1870, *Ann. and Mag. Nat. History,* ser. 4, vol. vi., p. 302, pl. xii., fig. 7.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Common.

Sub-family 3—Cassidulininae.

Cassidulina, d'Orbigny.

Cassidulina crassa, d'Orbigny.

Cassidulina crassa, d'Orbigny, 1839, *Foram. Amér. Mérid.*, p. 56, pl. vii., figs. 18—20.

Cassidulina crassa, Brady, 1884, *Report "Challenger,"* p. 429, pl. liv., figs. 4, 5.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

One specimen only found.

Family VII.—LAGENIDAE.

Sub-family 1—Lageninae.

Lagena, Walker & Boys.

Lagena globosa, Montagu, sp.

Vermiculum globosum, Montagu, 1803, *Test. Brit.*, p. 523.
Lagena globosa, Brady, 1884, *Report "Challenger,"* p. 452, pl. lvi., figs. 1—3.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Lagena laevis, Montagu, sp.

Vermiculum laeve, Montagu, 1803, *Test. Brit.*, p. 524.
Lagena laevis, Brady, 1884, *Report "Challenger,"* p. 455, pl. lvi., figs. 7—14, 30.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common.

Lagena laevis, var. **clavata**, d'Orbigny, sp.

Oolina clavata, d'Orbigny, 1846, *For. Foss. Vienne*, p. 24, pl. i., figs. 2, 3.
Lagena vulgaris, var. *clavata*, Williamson, 1858, *Rec. For. Gr. Br.*, p. 5, pl. i., fig. 6.
Lagena clavata, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common.

Lagena lineata, Williamson, sp.

Entosolenia globosa, var. *lineata*, Williamson, 1858, *Rec. For. Gr. Br.*, p. 9, pl. i., fig. 17.
Lagena lineata, Brady, 1884, *Report "Challenger,"* p. 461, pl. lvii., fig. 13.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Lagena hispida, Reuss.

Lagena hispida. Reuss, 1858, *Zeitschr. d. deutsch. geol. Gesell.*, vol. x., p. 434.

,, ,, Brady, 1884, *Report "Challenger,"* p. 459, pl. lvii., figs. 1—4, and pl. lix., figs. 2—5.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Lagena sulcata, Walker & Jacob, sp.

Serpula (Lagena) sulcata, Walker & Jacob, 1798, *Adam's Essays*, Kanmacher's ed., p. 634, pl. xiv., fig. 5.

Lagena sulcata. Brady, 1884, *Report "Challenger,"* p. 462, pl. lvii., figs. 23, 25, 26, 27. 33, 34, and pl. lviii., figs. 4, 5, 6, 17, 18.

,, ,, Brady, 1887. *Synopsis British Recent Foraminifera.*

Frequent. Nearly all the specimens belong to Williamson's var. *interrupta*, in which the costae are of unequal length and discontinuous on the surface of the test. The variety, however, is of such a trivial character that it does not seem to be worth a separate record. Nearly every specimen of *L. sulcata* from shallow water possesses these features in a more or less marked degree.

Lagena striata, d'Orbigny, sp.

Oolina striata. d'Orbigny, 1839, *Foram. Amér. Mérid.*. p. 21, pl. v., fig. 12.

Lagena striata, Brady, 1884, *Report "Challenger,"* p. 460. pl. lvii., figs. 22, 24, 28, 29, etc.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Lagena semistriata, Williamson.

Lagena striata. var. *semistriata*, Williamson, 1848, *Ann. Mag. Nat. Hist.*, ser. 2, vol. i., p. 14, pl. i., figs. 9, 10.

Lagena semistriata, Brady, 1884, *Report "Challenger."* p. 465, pl. lvii., figs. 14, 16, 17.

Lagena semistriata, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Lagena williamsoni, Alcock, sp.

Entosolenia williamsoni, Alcock, 1865, *Proc. Lit. and Phil. Soc. Manchester*, vol. iv., p. 195.

Lagena williamsoni, Balkwill & Wright, 1885, *Trans. R. Irish Acad.*, xxviii. (*Sci.*), p. 339, pl. xiv., figs. 6—8.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Common.

Lagena stelligera, Brady.

Lagena stelligera, Brady, 1881, *Quart. Jour. Micr. Sci.*, vol. xxi., N.S., p. 60.

,, ,, Brady, 1884, *Report "Challenger,"* p. 466, pl. lvii., figs. 35, 36.

A single long and narrow specimen found by myself. The radiating base is well defined. Not previously recorded in Great Britain.

This is a deep-water form. Brady records it from fourteen localities in the Atlantic, Pacific, and southern oceans, ranging down to 2,740 fathoms. Only three of the records are of less depth than 1,300 fathoms.

Lagena squamosa, Montagu, sp.

Vermiculum squamosum, Montagu, 1803, *Test. Brit.*, p. 526, pl. xiv., fig. 2.

Lagena squamosa, Brady, 1884, *Report "Challenger,"* p. 471, pl. lviii., figs. 28—31.

,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Lagena squamosa, var. **montagui**, Alcock, sp.

Entosolenia montagui, Alcock, 1865, *Proc. Lit. and Phil. Soc. Manchester*, vol. iv., No. 15.

Lagena squamosa, var. *montagui*, J. Wright, 1900, *Irish Naturalist*, vol. ix., No. 3, p. 54, pl. ii., fig. 2.

Very rare. This striking variety, although described by Alcock in 1865, was not figured, and appears to have been overlooked until Mr. J. Wright recognised and figured it in his paper on the Foraminifera of Dog's Bay, Connemara. Its appearance is very striking when compared with the type, the test being much larger and more globular, while the surface markings are smaller and sometimes very weakly marked. The shell is often more or less irregularly compressed. According to Mr. Wright, the variety is generally distributed round the Irish coast, though rare compared with the type. This probably agrees with its distribution elsewhere. I first observed the variety nearly twenty years ago in the shore-sands of St. Brélade's Bay and St. Clement's Bay, Jersey, where it occurs with some frequency, the type being very abundant.

Lagena reticulata, MacGillivray, sp.

Lagenula reticulata, MacGillivray, 1843, *Hist. test. anim. Aberdeen*, etc., p. 38.

Lagena reticulata, Reuss, 1862 (1863), *Sitz. k. Ak. Wiss. Wien*, xlvi. (1), p. 333, pl. v., figs. 67 and 68.

Frequent. Usually regarded as a variety intermediate between the last species and the next (*L. hexagona*, Will.).

Lagena hexagona, Williamson, sp.

Entosolenia squamosa, var. *hexagona*, Williamson, 1848, *Ann. Mag. Nat. Hist.*, ser. 2, vol. i., p. 20, pl. ii., fig. 23.

Lagena hexagona, Brady, 1884, *Report "Challenger,"* p. 472, pl. lviii., figs. 32, 33.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

One specimen only found.

Lagena marginata, Walker & Boys.

Serpula (Lagena) marginata, Walker & Boys, 1784, *Test. Min.*, p. 2, pl. i., fig. 7.

Lagena marginata, Brady, 1884, *Report "Challenger,"* p. 476, pl. lix., figs. 21—23.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Lagena lucida, Williamson, sp.

Entosolenia marginata, var. *lucida*, Williamson, 1858, *Rec. For. Gt. Br.*, p. 10, pl. i., figs. 22, 23.

Lagena oblonga (Seguenza), J. Wright, 1876—7, *Proc. Belfast F.C.* (Appx.), p. 104, pl. iv., fig. 9, a, b.

Lagena lucida, Brady, 1887, *Synopsis British Recent Foraminifera.*

Most abundant. Trigonal specimens, similar to that figured by Mr. Wright under the name of *L. oblonga* (Seguenza), also occur, as they do wherever the type is common, but as usual they are very rare.

Lagena quadrata, Williamson, sp.

Entosolenia marginata, var. *quadrata*, Williamson, 1858, *Rec. For. Gt. Br.*, p. 11, pl. i., figs. 27, 28.

Lagena quadrata, Brady, 1884, *Report "Challenger,"* p. 475. pl. lix., figs. 3 and 16.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

One long and slender specimen found by Mr. Wright.

Lagena quadricostulata, Reuss.

Lagena quadricostulata, Reuss, 1870, *Sitz. k. Ak. Wiss. Wien*, lxii. (1), p. 469; figured by Von Schlicht, "Foram. Septar. Pietzpuhl," 1870, pl. iv., figs. 25—30.

" " Brady, 1884, *Report "Challenger,"* p. 486, pl. lix., fig. 15.

Rare.

Lagena orbignyana, Seguenza, sp.

Fissurina orbignyana, Seguenza, 1862, *Foram. Monotal. Mess.*, p. 66, pl. ii., figs. 25, 26.

Lagena orbignyana, Brady, 1884, *Report "Challenger*, p. 484, pl. lix., figs. 1, 18, 24—26.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Sub-family 2—Nodosarinae.

Nodosaria, Lamarck.

Nodosaria laevigata, d'Orbigny.

Nodosaria (*Glandulina*) *laevigata*, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 252, No. 1, pl. x., figs. 1—3.

Nodosaria laevigata, Brady, 1884, *Report "Challenger,"* pp. 490, 493, pl. lxi., figs. 17—22 and 32.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Nodosaria soluta, Reuss, sp.

Dentalina soluta, Reuss, 1851, *Zeitschr. deutsch. geol. Ges.*, iii., p. 60, pl. iii., fig. 4.

Nodosaria soluta, Brady, 1884, *Report "Challenger,"* p. 503, pl. lxii., figs. 13—16.

Very rare. Not previously recorded in Great Britain.

Nodosaria communis, d'Orbigny.

Nodosaria (Dentalina) communis, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 254, No. 35.

Nodosaria communis, Brady, 1884, *Report "Challenger,"* p. 504, pl. lxii., figs. 19—22.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Nodosaria scalaris, Batsch, sp.

Nautilus (Orthoceras) scalaris, Batsch, 1791, *Conchyl. des Seesandes*, No. 4, pl. ii., fig. 4.

Nodosaria scalaris, Brady, 1884, *Report "Challenger,"* p. 510, pl. lxiii., figs. 28—31, and lxiv., figs. 16—19.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

One small and broken specimen was found.

Vaginulina, d'Orbigny.

Vaginulina legumen, Linné, sp.

Nautilus legumen, Linné, 1758, *Syst. Nat.*, 10th ed., p. 711, No. 248; 1767, *ibid.*, 12th ed., p. 1164, No. 288.

Vaginulina legumen, Brady, 1884, *Report "Challenger,"* p. 530, pl. lxvi., figs. 13—15.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

One large specimen was found by Mr. Wright.

Cristellaria, Lamarck, sp.

Cristellaria crepidula, Fichtel & Moll.

Nautilus crepidula, Fichtel & Moll, 1803, *Test. Micr.*, p. **107**, pl. xix., figs. g—i.

Cristellaria crepidula, Brady, 1884, *Report "Challenger,"* p. 542, pl. lxvii., figs. 17, 19, 20, and pl. lxviii., figs. 1, 2.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

One large broken specimen found.

Cristellaria gibba, d'Orbigny.

Cristellaria gibba, d'Orbigny, 1826, *Ann. Sci. Nat.*, vii., p. 292, No. 17.

" " Brady, 1884, *Report "Challenger,"* p. **546**, pl. lxix., figs. 8, 9.

Very rare. The specimens are very small.

Cristellaria aculeata, d'Orbigny.

Cristellaria aculeata, d'Orbigny, 1826, *Ann. Sci. Nat.*, vii., p. 292, No. 14.

" " Brady, 1884, *Report "Challenger,"* p. **555**, pl. lxxi., figs. 4, 5.

One small and immature specimen, found by Mr. Wright, and one much larger shell found by myself. The species has not been previously recorded in Great Britain.

Polymorphina, d'Orbigny.

Polymorphina lactea, Walker & Jacob, sp.

Serpula lactea, Walker & Jacob, 1798, *Adam's Essays*, Kanmacher's ed., p. 634, pl. xiv., fig. 4.

Polymorphina lactea, Brady, 1884, *Report "Challenger,"* p. 559, pl. lxxi., figs. 11—14, pl. lxxiii., fig. 14.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Polymorphina lactea, var. **oblonga**, Williamson.

Polymorphina lactea, var. *oblonga*, Williamson, 1858, *Rec. For. Gt. Br.*, p. 71, pl. vi., figs. 149, 149A.

One specimen only found.

Polymorphina lanceolata, Reuss.

Polymorphina lanceolata, Reuss, 1851, *Zeitschr. d. deutsch. geol. Gesell.*, vol. iii., p. 83, pl. vi., fig. 50.
" " Brady, 1884, *Report "Challenger,"* p. 564, pl. lxxii., figs. 5, 6.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Polymorphina compressa, d'Orbigny.

Polymorphina compressa, d'Orbigny, 1846, *For. Foss. Vienne.* p. 233, pl. xii., figs. 32—34.
" " Brady, 1884, *Report "Challenger,"* p. 565, pl. lxxii., figs. 9—11.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Polymorphina rotundata, Bornemann, sp.

Guttulina rotundata. Bornemann, 1855, *Zeitschr. d. deutsch. geol. Gesell.*, vol. vii., p. 346, pl. xviii., fig. 3.
Polymorphina rotundata, Brady, 1884, *Report "Challenger,"* p. 570, pl. lxxiii., figs. 5—8.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Polymorphina regina, Brady, Parker & Jones.

Polymorphina regina, Brady, Parker & Jones, 1870, *Trans. Linn. Soc.*, xxvii., p. 241, pl. xli., fig. 32, a, b.
" " Brady, 1884, *Report "Challenger,"* p. 571, pl. lxxiii., figs. 5—8.

A single specimen found.

Not previously recorded in Great Britain. Brady states that its distribution is confined to shallow water in the warm Pacific. It is common round the Australian coast-line.

Polymorphina concava, Williamson.

Polymorphina lactea, var. *concava*, Williamson, 1858, *Rec. For. Gt. Br.*, p. 72, pl. vi., figs. 151, 152.

Very rare.

Uvigerina, d'Orbigny.

Uvigerina canariensis, d'Orbigny.

Uvigerina canariensis, d'Orbigny, 1839, *Foram. Canaries*, p. 138, pl. i., figs. 25—27.
,, ,, Brady, 1884, *Report "Challenger,"* p. 573, pl. lxxiv., figs. 1—3.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent. Brady mentions the species as having been recorded from three British localities—viz. Holy Island (Brady), estuary of the Dee (Siddall), and South-west Ireland (J. Wright), at all which it is very rare. Since 1887 a fourth locality, Southport, has been recorded, a single specimen having been found there by Dr. Chaster.

Uvigerina asperula, Czjzek.

Uvigerina asperula, Czjzek, 1848, *Haidinger's Naturw. Abh.*, ii., p. 146, pl. xiii., figs. 14, 15.
,, ,, Brady, 1884, *Report "Challenger,"* p. 578, pl. lxxv., figs. 6—8.

A single very weak specimen found.

Uvigerina angulosa, Williamson.

Uvigerina angulosa, Williamson, 1858, *Rec. For. Gt. Br.*, p. 67, pl. v., fig. 140
,, ,, Brady, 1884, *Report "Challenger,"* p. 576, pl. lxxiv., figs. 15—18.

Very rare.

Uvigerina porrecta, Brady.

Uvigerina porrecta, Brady, 1879, *Q. Jour. Mic. Sci.*, xix., p. 60, pl. viii., figs. 15, 16.
,, ,, Brady, 1884, *Report "Challenger,"* p. 577, pl. lxxiv., figs. 21—23.

Very rare. The species has not been previously recorded in Great Britain. It is of frequent occurrence in tropical shallow waters.

Family VIII. GLOBIGERINIDAE.

Globigerina, d'Orbigny.

Globigerina bulloides, d'Orbigny.

Globigerina bulloides, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 277, No. 1; *Modèle*, No. 17 (young), No. 76.

Globigerina bulloides, Brady, 1884, *Report "Challenger,"* p. 593, pl. lxxvii. and pl. lxxix., figs. 3—7.
Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Sphaeroidina, d'Orbigny.

Sphaeroidina bulloides, d'Orbigny.

Sphaeroidina bulloides, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 267, No. 1; *Modèle*, No. 65.
" " Brady, 1884, *Report "Challenger,"* p. 620, pl. lxxxiv., figs. 1—7.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare. The specimens are poor, and are recorded with some hesitation. It is not uncommon off the south-west of Ireland in some of Mr. Wright's dredgings.

Pullenia, Parker & Jones.

Pullenia quinqueloba, Reuss.

Nonionina quinqueloba, Reuss, 1851, *Zeitschr. d. deutsch. geol. Gesell.*, vol. iii., p. 71, pl. v., fig. 31.
Pullenia quinqueloba, Brady, 1884, *Report "Challenger,"* p. 617, pl. lxxxiv., figs. 14, 15.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Family IX.—ROTALIDAE.

Sub-family 1—Spirillininae.

Spirillina, Ehrenberg.

Spirillina vivipara, Ehrenberg.

Spirillina vivipara, Ehrenberg, 1841, *Abhandl. k. Akad. Wiss. Berlin*, p. 442, pl. iii., fig. 41.
" " Brady, 1884, *Report "Challenger,"* p. 630, pl. lxxxv. figs. 1—5.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

A single specimen found.

Sub-family 2—ROTALINAE.

Patellina, Williamson.

Patellina corrugata, Williamson.

Patellina corrugata, Williamson, 1858, *Rec. For. Gt. Br.*, p. 46, pl. iii., figs. 86—89.
,, ,, Brady, 1884, *Report "Challenger,"* p. 634, pl. lxxxvi., figs. 1—7.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Discorbina, Parker & Jones.

Discorbina globularis, d'Orbigny, sp.

Rosalina globularis, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 271, No. 1, pl. xiii., figs. 1—4 ; *Modèle*, No. 69.
Discorbina globularis, Brady, 1884, *Report "Challenger,"* p. 643, pl. lxxxvi., figs. 8 and 13.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Discorbina obtusa, d'Orbigny, sp.

Rosalina obtusa, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 179, pl. xi., figs. 4—6.
Discorbina obtusa, Brady, 1884, *Report "Challenger,"* p. 644, pl. xci., fig. 9, a, b, c.

Common. The specimens are small. Plastogamic specimens are not uncommon. (Plate 12, Fig. 8, and Plate 14, Fig. 4.)

Mr. J. Wright informs me that this form is very common in many boulder clays.

Discorbina rosacea, d'Orbigny, sp.

Rotalina rosacea, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 273, No. 15 ; *Modèle*, No. 39.
Discorbina rosacea, Brady, 1884, *Report "Challenger,"* p. 644, pl. lxxxvii., figs. 1 and 4.
,, ,, Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Discorbina orbicularis, Terquem, sp.

Rosalina orbicularis, Terquem, 1876, *Anim. sur la plage de Dunkerque,* fasc. 2, p. 75, pl. ix., fig. 4.

Discorbina orbicularis, Brady, 1884, *Report "Challenger,"* p. 647, pl. lxxxviii., figs. 4—8.

„ „ Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Discorbina parisiensis, d'Orbigny, sp.

Rosalina parisiensis, d'Orbigny, 1826, *Ann. Sci. Nat.,* vol. vii., p. 271, No. 1; *Modèle,* No. 38.

Discorbina parisiensis, Brady, 1884, *Report "Challenger,"* p. 648, pl. xc., figs. 5, 6, 9—12.

„ „ Brady, 1887, *Synopsis British Recent Foraminifera.*

Very common. The specimens are small and somewhat variable, showing a great tendency to merge in the next species, *Discorbina wrightii,* Brady, from which it is not always easily distinguishable. I am of opinion that the two forms are very closely allied, if, indeed, they are not identical. (Plate 12, Figs. 4—7, and Plate 14, Fig. 5.)

A very noticeable feature in connection with the occurrence of these two forms at Bognor is the exceptionally large number of "twin" or *plastogamic** specimens which are to be found.

* *Plastogamy.*—Plastogamy is the term used to describe the more or less permanent union of two or more specimens of a foraminifer, and it appears to be due "to the conjugation of two or more individuals, whose nuclei are in a state of rest—*i.e.* not undergoing sub-division" (Chapman).

The Foraminifera in general are reproduced by a process of sub-division. The nucleus breaks up into a number of nucleoli. Each nucleolus takes to itself a portion of the parent's protoplasm, secretes a test or shell, and commences a separate existence, either within the parent shell or in its immediate vicinity. This method of reproduction by means of the sub-division of an active nucleus has been called "karyogamy." It is asexual, and, continued indefinitely, would no doubt end in the weakening and perhaps extinction of the stock.

Plastogamy, on the other hand, probably partakes more or less of the nature of a sexual conjugation, although there is at present no evidence in support of the sexual theory, and its object may be the rejuvenescence of a stock exhausted by long-continued karyogamy. It has been observed in many genera; I have myself notes of its occurrence in *Peneroplis, Textularia, Verneuilina, Bulimina, Lagena, Marginulina, Cristellaria, Patellina, Discorbina, Rotalia, Nonionina,* and *Polystomella.* It is, Probably not less than 10 per cent. of all the specimens show more or less evidence of this phenomenon.

From the large number of specimens observed at Bognor it is possible to add several observations to the foregoing description. I have noted:—

1. The two specimens are rarely identical in size, and sometimes the disparity is very noticeable.

2. The apertures do not necessarily coincide, and in a great number of instances the edges overlap, or the smaller specimen is set to one side of the vertical axis of the larger specimen.

3. Sometimes three, four, or more specimens are united in a more or less irregular manner (Plate 12, Fig. 7).

4. That in many instances the two specimens represent varying types, one being of the outspread *D. parisiensis*, while the other comes nearer to the more compact *D. wrightii.*

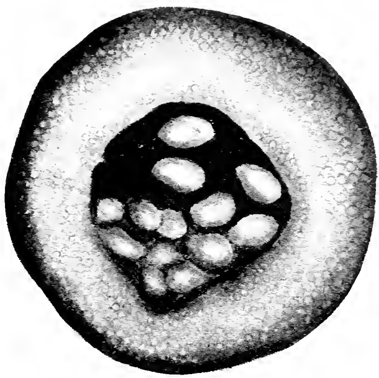
After the fusion of the protoplasm and the formation of the young brood within the cavities of the united parent shells, it appears that the shell substance by which the parents are united is again absorbed, and that separation of the parent shells ensues, the young tests escaping through the large opening produced by the absorption of the parent's base. Such separated specimens are of frequent occurrence, and one is represented in Plate 12, Fig. 5. It is noticeable that the whole of the internal septa have been absorbed, their position being marked only by septal lines on the inner wall of the test. The test thus resembles a hollow cone, the whole of the cavity being available for the growth of the young brood while they remain in the cavity. Probably the carbonate of lime thus obtained from the absorption of the septa and basal wall is utilised for the secretion of the monothalamous shells of the young brood. I have noted this complete absorption

however, of infrequent occurrence except in the genera *Textularia* (*T. folium*, P. & J.) and *Discorbina.*

Chapman, in his book *The Foraminifera* (Longmans, Green & Co., 1902, p. 31), quotes a description of the process of plastogamy as observed by Schaudinn in a species of *Discorbina.* "The flat or inferior faces of the tests are brought together with the apertures coinciding. The walls of the last-formed chambers are sometimes resorbed, and an enclosing shell made around the space between the tests. Then follows the breaking up of the nuclei and the formation of embryonic young, which speedily form their own investment to the extent of two or three chambers before breaking away from the enclosing shell."—Schaudinn, "Ueber Plastogamie bei Foram.," *Sitz. Gesellsch. naturforsch. Freunde*, 1895, No. 10.

of the septa in *Textularia* and *Verneuilina*, and I think it probably occurs in all cases of advanced plastogamy.

I was so fortunate as to find two specimens in which plastogamy had taken place, with subsequent separation of the parents, and in which the young shells still remained inside the cavity. One of these was unfortunately lost again, but I have the other, and the accompanying figure is reproduced from a careful



drawing made by my cousin, Mr. J. A. Lovegrove. It will be observed that the young specimens are monothalamous. They are extremely delicate and hyaline, and appear to be imbedded in sarcode.

Discorbina wrightii, Brady.

Discorbina wrightii, Brady, 1881, *Denkschr. d. k. Ak. Wiss. Wien*, vol. xliii., p. 104, pl. ii., fig. 6; *Ann. Mag. Nat. Hist.*, ser. 5, vol. viii., p. 413, pl. xxi., fig. 6.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Common, but probably less so than the last species.

Discorbina bertheloti, d'Orbigny, sp.

Rosalina bertheloti, d'Orbigny, 1839, *Foram. Canaries*, p. 135, pl. i., figs. 28—30.

Discorbina bertheloti, Brady, 1884, *Report "Challenger."* p. 650, pl. lxxxix., figs. 10—12.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Discorbina tuberculata, Balkwill & Wright.

Discorbina tuberculata, Balkwill & Wright, 1885, *Trans. R. Irish Acad.*, vol. xxviii. (*Science*), p. 350, pl. xiii., figs. 28—30.

A single weak specimen found by Mr. Wright.

Discorbina vesicularis, Lamarck, sp.

Discorbites vesicularis, Lamarck, 1804, *Ann. Mus.*, v., p. 183; and *f.* 7, pl. 62, viii., 1806.

Discorbina vesicularis, Brady, 1884, *Report "Challenger*," p. 651, pl. lxxxvii., fig. 2, a, b, c.

,, ,, Halkyard, 1889, "Recent Foraminifera of Jersey," *Trans. Manchester Mic. Soc.*, 1889, p. 15, pl. ii., fig. 8.

Frequent. Not previously recorded in Great Britain. The specimens are very small compared with those found in Australian shore-sands; but they are quite typical, and the asterigerine flaps are well developed. (Plate 12, Figs. 9 and 10, and Plate 14, Fig. 6.)

Halkyard's specimens from the shore-sand of St. Catherine's Bay, Jersey, must have been identical with the Bognor specimens, to judge by his figure. Mr. Wright informs me that he has met with the species in shore-sand from North Donegal (rare); also at Rockfort, Belfast Lough, between tides, where it was abundant. Mr. Millett has also found it on the south coast of England.

Discorbina turbo, d'Orbigny.

Rotalia (*Trochulina*) *turbo*, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 274, No. 29; *Modèle*, No. 73.

Discorbina turbo, Brady, 1884, *Report "Challenger*," p. 642, pl. lxxxvii., fig. 8, a, b, c.

Two specimens (one attached) were found, which are probably referable to this species, which does not appear to have been previously recorded in Great Britain. Mr. Wright, on examining them, wrote: "Your specimens, I think, come nearer to *turbo* than anything else. At the same time, it might be advisable to mark it with a query, as the specimens are not sufficiently typical to name with certainty."

Planorbulina, d'Orbigny.

Planorbulina mediterranensis, d'Orbigny.

Planorbulina mediterranensis, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 280, No. 2, pl. xiv., figs. 4—6; *Modèle*, No. 79.
" " Brady, 1884, *Report "Challenger,"* p. 656, pl. xcii., figs. 1—3.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare. The specimens are far from typical.

Truncatulina, d'Orbigny.

Truncatulina refulgens, Montfort, sp.

Cibicides refulgens, Montfort, 1808, *Conchyl. Systém.*, vol. i. p. 122, 31ᵉ genre.
Truncatulina refulgens, Brady, 1884, *Report "Challenger,"* p. 659, pl. xcii., figs. 7—9.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare. The specimens are small.

Truncatulina lobatula, Walker & Jacob, sp.

Nautilus lobatulus, Walker & Jacob, 1798, *Adam's Essays*, Kanmacher's ed., p. 642, pl. xiv., fig. 36.
Truncatulina lobatula, Brady, 1884, *Report "Challenger,"* p. 660, pl. xcii., fig. 10, pl. xciii., figs. 1, 4, 5.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare. Minute specimens are fairly common.

Truncatulina variabilis, d'Orbigny.

Truncatulina variabilis, d'Orbigny, 1826, *Ann. Sci. Nat.*, vii., p. 279, No. 8.
" " Brady, 1884, *Report "Challenger,"* p. 661, pl. xciii., figs. 6, 7.

Rare.

Truncatulina haidingerii, d'Orbigny, sp.

Rotalina haidingerii, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 154, pl. viii., figs. 7—9.

Truncatulina haidingerii, Brady, 1884, *Report "Challenger,"* p. 663, pl. xcv., fig. 7, a, b, c.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare.

Truncatulina ungeriana, d'Orbigny, sp.

Rotalina ungeriana, d'Orbigny, 1846, *Foram. Foss. Vienne*, p. 157, pl. viii., figs. 16—18.

Truncatulina ungeriana, Brady, 1884, *Report "Challenger,"* p. 664, pl. xciv., fig. 9, a, b, c, d.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Truncatulina reticulata, Czjzek, sp.

Rotalina reticulata, Czjzek, 1848, *Haidinger's Nat. Abh.*, ii., p. 145, pl. xiii., figs. 7—9.

Truncatulina reticulata, Brady, 1884, *Report "Challenger,"* p. 669, pl. xcvi., figs. 5—8.

" " Chaster, 1892, *First Report Southport Soc. Nat. Sci.*, p. 66, pl. i., fig. 16.

Very rare. Specimens poor and worn.

Previously recorded in Great Britain by Dr. Chaster, from Southport (Lancs.), shore-mud (one specimen only). Mr. J. Wright has a specimen dredged by his brother off Kinsale, which is quite typical, as also is Dr. Chaster's specimen.

Anomalina, d'Orbigny.

Anomalina grosserugosa, Gümbel, sp.

Truncatulina grosserugosa, Gümbel, 1868 (1870), *Abh. m.-ph. Cl. k. bayer. Ak. Wiss.*, x., p. 660, pl. ii., fig. 104, a, b.

Anomalina grosserugosa, Brady, 1884, *Report "Challenger,"* p. 673, pl. xciv., figs. 4, 5.

Rare. Not previously recorded in Great Britain. The specimens are very poor, and the species is now recorded with some hesitation.

Pulvinulina, Parker & Jones.

Pulvinulina concentrica, Parker & Jones.

Pulvinulina concentrica, Parker & Jones, 1865, *Phil. Trans.*, vol. clv., p. 393.

Pulvinulina concentrica, Brady, 1884, *Report "Challenger,"* p. 686, pl. cv., fig. 1, a, b, c.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare. The specimens are weak.

Pulvinulina auricula, Fichtel & Moll, sp.

Nautilus auricula, var. *a*, Fichtel & Moll, 1803, *Test. Micr.*, p. 108, pl. xx., figs. a, b, c.
" " var. *β*, id., *ibid.*, figs. d, e, f.
Pulvinulina auricula, Brady, 1884, *Report "Challenger,"* p. 688, pl. cvi., fig. 5, a, b, c.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare. The specimens are of the depressed form.

Pulvinulina hauerii, d'Orbigny, sp.

Rotalina hauerii, d'Orbigny, 1846, *Foram. Fossiles Vienne*, p. 151, pl. vii., figs. 22—24.
Pulvinulina hauerii, Brady, 1884, *Report "Challenger,"* p. 690, pl. cvi., figs. 6, 7.

Very rare. Not previously recorded in Great Britain.

Pulvinulina menardii, d'Orbigny, sp.

Rotalia menardii, d'Orbigny, 1826, *Ann. Sci. Nat.*, vol. vii., p. 273, No. 26; *Modèle*, No. 10.
Pulvinulina menardii, Brady, 1884, *Report "Challenger,"* p. 690, pl. ciii., figs. 1, 2.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare. Specimens very small.

Pulvinulina karsteni, Reuss, sp.

Rotalia karsteni, Reuss, 1855, *Zeitschr. d. deutsch. geol. Gesell.*, vol. vii., p. 273, pl. ix., fig. 6.
Pulvinulina karsteni, Brady, 1884, *Report "Challenger,"* p. 698, pl. cv., figs. 8, 9.
" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very rare. The specimens are very small.

Rotalia, Lamarck.

Rotalia beccarii, Linné, sp.

Nautilus beccarii, Linné, 1767, *Syst. Nat.*, 12th ed., p. 1162; 1788, *ibid.*, 13th (Gmélin's) ed., p. 3370, No. 4.

Rotalia beccarii, Brady, 1884, *Report "Challenger,"* p. 704, pl. cvii., figs. 2, 3.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Common. A smooth, thin-shelled variety also occurs, which appears to possess characters intermediate between *R. beccarii*, Linné, and *R. orbicularis*, d'Orbigny. The same form has been met with by Messrs. Balkwill & Wright in deep water off Dublin Harbour, and by Mr. F. W. Millett in shore-silt from Broad Sand, Torbay.

Rotalia calcar, d'Orbigny, sp.

Calcarina calcar, d'Orbigny, 1826, *Ann. Sci. Nat.*, vii., p. 276, No. 1; *Modèle*, No. 34.

Rotalia calcar, Brady, 1884, *Report "Challenger,"* p. 709, pl. cviii., figs. 3, 4.

Rare. Not previously recorded in Great Britain.

Sub-family 3—Tinoporinae.

Gypsina, Carter.

Gypsina inhaerens, Schultze, sp.

Acervulina inhaerens, Schultze, 1854, *Organ. der Polythal.*, p. 68, pl. vi., fig. 12.

Gypsina inhaerens, Brady, 1884, *Report "Challenger,"* p. 718, pl. cii., figs. 1—6.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Frequent.

Family X.—NUMMULINIDAE.

Sub-family 2—Polystomellinae.

Nonionina, d'Orbigny.

Nonionina depressula, Walker & Jacob, sp.

Nautilus depressulus, Walker & Jacob, 1798, *Adam's Essays*, Kanmacher's ed., p. 641, pl. xiv., fig. 33.

Nonionina depressula, Brady, 1884, *Report "Challenger,"* p. 725, pl. cix., figs. 6, 7.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very common.

Nonionina umbilicatula, Montagu, sp.

Nautilus umbilicatulus, Montagu, 1803, *Test. Brit.*, p. 191; *Suppl.*, p. 78, pl. xviii., fig. 1.

Nonionina umbilicatula, Brady, 1884, *Report "Challenger,"* p. 726, pl. cix., figs. 8, 9.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Nonionina asterizans, Fichtel & Moll, sp.

Nautilus asterizans, Fichtel & Moll, 1803, *Test. Micr.*, p. 37, pl. iii., figs. e—h.

Nonionina asterizans, Brady, 1884, *Report "Challenger,"* p. 728, pl. cix., figs. 1, 2.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very common. The specimens are weakly marked and not easily distinguishable from *N. depressula*, Walker & Jacob, but Mr. Wright agrees with me that they are correctly referred to this species. He states that the form is common in British gatherings and usually associated with *N. depressula*, Walker & Jacob. Brady, in his *Synopsis*, considers it doubtful whether the species should be retained in the British fauna, as all specimens which he had seen were minute and ambiguous. There seems to be no doubt that all the British records of this species refer to such weak forms as are found at Bognor.

Nonionina stelligera, d'Orbigny.

Nonionina stelligera, d'Orbigny, 1839, *Foram. Canaries*, p. 128, pl. iii., figs. 1, 2.

" " Brady, 1884, *Report "Challenger,"* p. 728, pl. cix., figs. 3—5.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Nonionina pauperata, Balkwill & Wright.

Nonionina pauperata, Balkwill & Wright, 1885, *Trans. R. Irish Acad.*, vol. xxviii. (*Science*), p. 353, pl. xiii., figs. 25, 26.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Rare.

Polystomella, Lamarck.

Polystomella crispa, Linné, sp.

Nautilus crispus, Linné, 1767, *Syst. Nat.*, 12th ed., p. 1162, 275.

" " Linné, 1788, *ibid.*, 13th (Gmélin's) ed., p. 3370, No. 3.

Polystomella crispa. Brady, 1884, *Report "Challenger,"* p. 736, pl. cx., figs. 6, 7.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very abundant and well-developed. Young specimens exhibit the peripheral armature of spines in a very marked degree, and the spines are frequently noticeable in shells of a considerable size.

Polystomella macella, Fichtel & Moll, sp.

Nautilus macellus, Fichtel & Moll, 1803, *Test. Micr.*, p. 66, var. *α*, pl. x., figs. e—g; var. *β*, pl. x., figs. h—k.

Polystomella macella. Brady, 1884, *Report "Challenger,"* p. 737, pl. cx., figs. 8—11.

Very common. Previously recorded in Great Britain only by Mr. J. Wright from the shore-sand of Dog's Bay, Connemara, and from off Rathlin Island; but he informs me that it is generally distributed around the Irish coast.

Polystomella striatopunctata, Fichtel & Moll, sp.

Nautilus striatopunctatus, Fichtel & Moll, 1803, *Test Micr.*, p. 61, pl. ix., fig. a—c.

Polystomella striatopunctata, Brady, 1884, *Report "Challenger,"* p. 733, pl. cix., figs. 22, 23.

" " Brady, 1887, *Synopsis British Recent Foraminifera.*

Very common.

Explanation of Plates 11—14.

Plate 11.

Fig. 1. *Nubecularia lucifuga*, Defrance. Upper surface of attached specimen.
,, 2. *Nubecularia lucifuga*, Defrance. Under surface of detached specimen, in which the chambers show a regularly spiral arrangement. The internal septa are visible through the shell substance.
,, 3. *Nubecularia lucifuga*, Defrance. Very young specimen, showing the unseptate spiral shell surrounding the primordial chamber.
,, 4. *Massilina secans*, d'Orbigny sp., var. *denticulata*, Costa.
,, 5. ,, ,, ,, ,, var. nov. *tenuistriata*.
,, 6. *Thurammina papillata*, Brady. Free specimen of irregular growth.
,, 7. *Thurammina papillata*, Brady. Underview of adherent specimen which has become detached, showing at *a* the delicate chitinous membrane (broken) which lines the test and forms a continuous wall between the sarcode body and the object to which the test is attached.

Plate 12.

Fig. 1. *Spiroplecta fusca*, sp. nov. Lateral view.
,, 2. ,, ,, ,, Peripheral view.
,, 3. ,, ,, ,, Oral view.
,, 4. *Discorbina parisiensis*, d'Orbigny, sp. Superior aspect.
,, 5. *Discorbina*. Inferior aspect of a specimen after plastogamic union. The greater part of the basal wall has been absorbed; the internal septa, which are indicated by the thick septal lines on the inner surface of the test, have also been absorbed.
,, 6. *Discorbina parisiensis*, d'Orbigny, sp. Inferior aspect.
,, 7. ,, ,, ,, ,, Plastogamic union of three specimens.
,, 8. *Discorbina obtusa*, d'Orbigny, sp. Superior aspect.
,, 9. *Discorbina vesicularis*, Lamarck, sp. Superior aspect.
,, 10. ,, ,, ,, ,, Inferior aspect.

Plate 13.

Fig. 1. *Cornuspira foliacea*, Philippi, sp. British specimen from Mr. Joseph Wright's collection. Dredged off South-west Ireland, 38—41 fathoms.

" 2. Specimen from Bognor shore-sand.

Figs. 3, 4. Specimens of the same from Bognor, showing the union (query, plastogamic) of several individuals.

Plate 14.

Note.—The figures on this plate are reproduced from photographs taken by Dr. E. J. Spitta, F.R.A.S., and are intended to give an idea of the general appearance of the species.

Fig. 1. *Thurammina papillata*, Brady, × 10 diam.

" 2. *Nubecularia lucifuga*, Defrance, × 15 diam.

" 3. *Thurammina papillata*, Brady, × 12 diam., showing the papillate processes.

" 4. *Discorbina obtusa*, d'Orbigny, × 24 diam. Plastogamic specimen in the centre.

" 5. *Discorbina parisiensis*, d'Orbigny, × 26 diam. The three specimens at the top show the basal view of specimens which have undergone plastogamic union and subsequent separation. The greater part of the base and the internal septa have been absorbed, so that the interior of the test is visible. The second and third rows contain specimens in plastogamic union. It will be seen that the specimens vary in size, and that their apertures rarely coincide.

" 6. *Discorbina vesicularis*, Lamarck, × 28 diam.

THE GENITALIA OF THE TSETSE FLY, *GLOSSINA PALPALIS.*

By W. Wesché, F.R.M.S.

(*Read June 15th*, 1905.)

Plate 15.

While carrying out some dissections of the mouth-parts of *Glossina palpalis* Des., the host of the germ of sleeping sickness, the genitalia attracted my attention owing to their large size and great complexity. I find that they homologise fairly well with those of *Scatophaga*, which I described in 1903 *; but the complexity of the central organ—the penis, adminiculum, or appendix interna—has necessitated the addition of fresh terminology to that used in the above-mentioned paper.

The males in Diptera may be divided into two classes: (1) those which have the segment containing the genitalia (the hypopygium) turned in under the abdomen; and (2) those in which this segment forms the end of the abdomen, the penis and appendages being sunk in a cavity, and the outer claspers or forcipes superiores quite evident at the extremity. These latter are of endless variety both in shape and size; they are very prominent in the families Tipulidae, Culicidae, Cordiluridae, and Anthomyidae, and I propose to classify these as "*hamate.*"

In the Muscidae, including the families Sarcophagidae and Tachinidae, the Syrphidae, as well as the smaller families of Conopidae, Pipunculidae, Lonchopteridae, and Phoridae, the hypopygium, armed as in the hamate families with the forcipes superiores on the ultimate segment, is turned in under the abdomen, hiding the claspers; this division I propose to call "*sub-hamate.*" In this must be included the Dolichopidae, or Fan-tailed Flies,

* *Journal of the Quekett Microscopical Club*, Series 2, Vol. 8, No. 52.

as, although the hooks are very palpable, yet the last segment is turned in under the abdomen.

Before describing the genitalia of *Glossina palpalis* I propose to formulate what I consider to be the typical armature.

On the ultimate segment of the abdomen, whether it be turned in or not, are paired hooks, the forcipes superiores, and between these hooks are paired hairy plates, the forcipes inferiores.

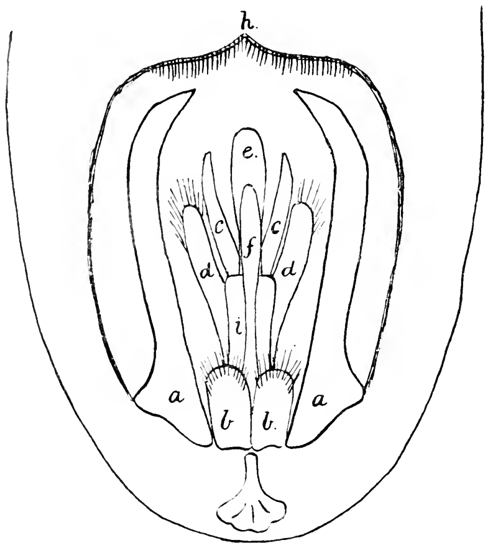


Diagram of the genitalia as usually found in Diptera.

a, forceps superior; *b*, ,, inferior; *c*, ,, interior; *d*, genital palpus; *e*, adminiculum; *f*, tittilator; *h*, laminae superiores; *i*, theaca, or sheath of penis.

On the edge of the abdomen, opposite to the forcipes superiores and bordering on the cavity containing the genitalia, are paired processes, often setose; these are the laminae superiores.

In the sub-hamate division, where the hypopygium is hinged on the penultimate segment of the abdomen, there is a chitinous arch or ring, which extends from the point where the laminae superiores are found, round the cavity of the genitalia, forming a fitting for the hypopygium—probably homologising with this part, as it seems a continuation of it.

Between the forcipes superiores and the laminae superiores is the penis, appendix interna, or adminiculum—a complex structure furnished with paired hooks, inner claspers, or forcipes interiores, paired palpi, genital palpi, and a single posterior hook known as the tittilator. In addition to these, an organ of spatulate form, the apodeme, is usually to be found situated below the whole of the parts.

The genitalia of *Glossina palpalis* are sub-hamate; the hypopygium is large and bulbous, and armed with two strong outer claspers (forcipes superiores) at its extremity (Plate 15, Figs. 2 and 5). The whole organ is hinged on to the penultimate segment of the abdomen, which has attached to it an arched plate (lamina superior), against which the hooks rest when the hypopygium is turned under. The forcipes inferiores are absent or rudimentary, represented by a membrane with two rows of hairs (Fig. 5).

Within the hypopygium is a second enclosing wall of chitin. When seen from above it has somewhat the shape of an arch, the ends being away from the forcipes superiores and joining on to a paired process connected with the adminiculum (Figs. 2 and 4). The sides of this wall have several thickenings or buttresses of chitin. At the top the sides rise, ending in a short, strong, bent rod which supports the curious structure, presently to be described, situated on the top of the adminiculum; this rod may homologise with the tittilator. The penis or adminiculum is an elaborate structure consisting of two rods, which fuse at their bases into a plate, which seems fitted for the attachment of muscles (Fig. 6). Between the fork of the rods is a curious club-shaped organ of small size (Figs. 3, 4, and 6). It is probably the atrophying remains of the central apodeme.

At the upper part of the adminiculum is a blunt, hook-shaped projection; over the whole organ is spread a membrane, which probably contains the spermatozoa in their passage through the organ; at the upper part this membrane has a number of chitinous plates and two hooks adhering to its surface. This structure is similar to that found on the genitalia of many insects. I give figures of that of *Apis melifica*, ♂, and that of *G. palpalis* for comparison, both drawn to the same scale (Figs. 10 and 11). Above the adminiculum are complicated pieces of mechanism, which on dissection are found to be paired processes; these are articulated on to the tops of the rods, which are rounded off for that purpose (Fig. 7). The diagram and drawing will better explain their shape than a lengthy description. I know of no similar structure in the Diptera, and I can only suggest that they may homologise with some of the plates found in *Blatta*, and thought to be of use in opening the genital pouch of the female cockroach.

Attached to the rods that form the penis are two chitinous plates, one to each rod, which appear connected with the enclosing wall of chitin (Fig. 4). This wall supports the forcipes interiores, which appear to have fused with the genital palpi and to have interchanged functions. On the hooks are some of the most remarkable hairs I have met with in insect anatomy. I have drawn a few of the extremities (Figs. 8 and 9). It can now be seen that, although these parts homologise with the genitalia of *Scatophaga lutaria*, there are striking differences.

(1) The penis is clearly a paired organ. (2) It does not spring from a sheath or from the same base as the appendages, but is continued downwards until it fuses into a disc, the whole working in the cavity formed by the surrounding walls. (3) Although it does not spring from the same base as the appendages, yet it is connected with it by two plates. (4) The chitinous wall probably homologises with the sheath of the penis. (5) The forcipes interiores and the palpi are fused together, and appear to have interchanged functions. (6) The process on the extremity of the adminiculum appears not to have been observed before in the Diptera.

With regard to the central apodeme, already referred to, I first observed this part in *Scatophaga stercoraria* L.; but I was not able to assign to it any definite function. If it is present in *S. lutaria* F., it is in a much altered form; but it is quite recognisable in *Norellia striolata* Mg., another species of the Cordiluridae. It is well marked, though relatively small in size in *Calliphora erythrocephala* Mg., but larger in *Lucilla cornicina* F. of the Muscidae. In the Lonchaeidae I have found it in *Palloptera ustulata* Fln. In *Nemopoda cylindrica* F., of the family Sepsidae, it is very long; it is of the same shape in an unidentified species of the same genus from Jersey, and it is also evident in *Diopsis apicalis* Dal., the curious fly, with eyes on long stalks, from Natal. In the Empidae it is marked in *Empis chioptera* Fln., *E. vitripennis* Mg., *Helara cilipes* Mg., and *H. matrona* Hal. In the Syrphidae it is present in *Syritta pipiens* Deg. In *Tipula oleracea* L. the ejaculatory apparatus is worked by a somewhat circular organ, to which are attached three levers for the attachment of muscles. In *Pachyrrhina maculosa* Mg. is a similar arrangement, but in place of the circular organ is a spatulate lever obviously homologous with those already enumerated. In a South Australian Asylid, at present unidentified, is the same apodeme, working at the base of a very short adminiculum, the ejaculatory apparatus being in the lower part of the organ. From this I conclude that the function of this lever, when present, is the same as in *T. oleracea.*

In *G. palpalis* there is a wide departure from the normal type. The base of the penis, having separated from its sheath and developing into a lever, has probably usurped the functions of the apodeme, which has become reduced to a mere rudiment. The size of the parts has but little bearing on the points likely to be raised by a discussion on these genitalia; but as no description can be considered complete without some reference to it, I may say that the double rods of the penis (Fig. 4) are $\frac{1}{17}$ of an inch or 1·494116 mm. long.

Explanation of Plate 15.

Fig. 1. Hypopygium seen from below.

,, 2. ,, removed from the abdomen, and showing the position of the adminiculum and appendages; the lettering as in the figure in the text.

,, 3. Rod situated in the bifurcation of the chitinous structure of the penis, and considered to be the rudiment of the central apodeme.

,, 4. Chitinous structure of the penis, showing the situation of the rod, and the two plates that connect with the surrounding structure. The upper plates (Fig. 7) are removed.

,, 5. End of the last segment, showing the forcipes superiores turned under and the rudiments of the forcipes inferiores.

,, 6. Chitinous structure of the penis, seen from the front, and showing the upper plates and central rod.

,, 7. Diagram of the upper plates, when dissected and flattened out.

,, 8. Extremities of hairs on the forcipes interiores.

,, 9. Forcipes interiores and genital palpus.

,, 10. Part of membrane of penis, near the upper part of the organ.

,, 11. Part of membrane on the genitalia of the male of *Apis melifica* L., drawn to the same scale as Fig. 10.

THE SPIDERS OF THE *WALCKENAËRIA* GROUP.

By Frank P. Smith.

(*Read October 20th*, 1905.)

The strict application of the international rules of nomenclature to the genera constituting the *Walckenaëria* Group has necessitated considerable alteration in the generally accepted arrangement of these small spiders. In the first place the spelling *Walckenaëria* will have to be adopted, this being the original one, in spite of the fact that Blackwall himself subsequently spells it *Walckenaera*. A generic name. once published, becomes public property. and its author has no more power or right to alter it than has any one else. *Viderius*, too, is the original spelling of the generic name usually given as *Wideria*. Simon, in *Histoire Naturelle des Araignées* (1864), spells this name both *Viderius* and *Widerius*, but the former, having priority in pagination, is selected as the correct spelling.

The following synonymic list includes all the species of the *Walckenaëria* Group which have occurred in the British Isles:—

Genus **Walckenaëria**, Bl., 1833.

1833. *Walckenaëria*, Bl., *Lond. Edin. Phil. Mag.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1864. *Neriene*, Bl., *Spid. G. B. I.* (*ad partem*).
1867. *Micryphantes*, Ohl., *Die Arach.* (*ad partem*).
1869. *Cornicularia*, Menge, *Preuss. Spin.*
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Cornicularia*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1883. *Lophomma*, " " " "
1884. *Cornicularia*, Sim., *Ar. de France.*
1886. *Trachynotus*, Dahl, *Monog. Erig.*
1886. *Lophomma*, " " " (*ad partem*).
1900. *Cornicularia*, Cambr., *List Br. Ir. Spid.*

The genus *Walckenaëria*, Bl. (1833), originally included three species—*W. acuminata*, Bl., *W. cristata*, Bl., and *W. cuspidata*, Bl. In 1837 *cristata* was withdrawn by Walckenaer (under the name *bicorne*, Wid.) and included in his genus *Argus*. In 1864 *acuminata* was withdrawn by Simon (under the name *camelinus*, Koch) and included in his genus *Arrecerus*. *W. cuspidata*, Bl., therefore, remains as the type. Thorell, in 1869, selected *acuminata*, Bl., as the type of *Walckenaëria*; but this he had no power to do, as the species had been already withdrawn by Simon under *Arrecerus* (1864). In 1869 Menge formulated the genus *Cornicularia* for a single species, which from his description and figure is obviously *unicornis*, Cambr., although by mistake he considered it to be *monoceros*, Wid. As long as *unicornis*, Cambr., and *cuspidata*, Bl., are held to be co-generic, *Cornicularia*, Menge, must sink as a synonym of *Walckenaëria*, Bl.

Type of *Walckenaëria*, Bl. = *W. cuspidata*, Bl.

Walckenaëria cuspidata, Bl., 1833.

1833. *Walckenaëria cuspidata*, Bl., *Lond. Edin. Phil. Mag.*
1864. *Walckenaera* ,, ,, *Spid. G. B. I.*
1872. *Neriene clara*, Cambr., *Trans. Linn. Soc.*
1879–81. *Walckenaera cuspidata*, Cambr., *Spid. Dorset.*
1879–81. *Neriene clara*, Cambr., *Spid. Dorset.*
1883. *Cornicularia cuspidata*, Bertkau, *Spin. Rheinp.*
1884. ,, ,, Sim., *Ar. de France.*
1886. *Trachynotus cuspidatus*, Dahl, *Monog. Erig.*
1900. *Cornicularia cuspidata*, Cambr., *List Br. Ir. Spid.*

Walckenaëria unicornis, Cambr., 1861.

1861. *Walckenaera unicornis*, Cambr., *Ann. Mag. Nat. Hist.*
1864. ,, ,, Bl., *Spid. G. B. I.*
1867. *Micryphantes stylifer*, Ohl., *Die Arach.*
1869. *Cornicularia monoceros*, Menge, *Preuss. Spin.*
1870–3. *Erigone unicornis*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera unicornis*, Cambr., *Spid. Dorset.*
1883. *Cornicularia unicornis*, Bertkau, *Spin. Rheinp.*
1884. ,, ,, Sim., *Ar. de France.*
1886. *Trachynotus* ,, Dahl, *Monog. Erig.*
1900. *Cornicularia* ,, Cambr., *List Br. Ir. Spid.*

Walckenaëria vigilax, (Bl.), 1853.

1853. *Neriene vigilax*, Bl., *Ann. Mag. Nat. Hist.*
1864. ,, ,, ,, *Spid. G. B. I.*
1879–81. *Neriene vigilax*, Cambr., *Spid. Dorset.*
1883. *Lophomma* ,, Bertkau, *Spin. Rheinp.*

1884. *Cornicularia vigilax*, Sim., *Ar. de France.*
1886. *Lophomma* ,, Dahl, *Monog. Erig.*
1900. *Cornicularia* ,, Cambr., *List Br. Ir. Spid.*

Walckenaëria lucida, (Cambr.), 1871.

1871. *Neriene lucida*, Cambr., *Trans. Linn. Soc.*
1879–81. *Neriene lucida*, Cambr., *Spid. Dorset.*
1900. *Cornicularia lucida*, Cambr., *List Br. Ir. Spid.*

Walckenaëria pavitans, (Cambr.), 1872.

1872. *Neriene pavitans*, Cambr., *Trans. Linn. Soc.*
1879–81. *Neriene pavitans*, Cambr., *Spid. Dorset.*
1900. *Cornicularia pavitans*, Cambr., *List Br. Ir. Spid.*

Walckenaëria pudens, (Cambr.), 1872.

1872. *Neriene pudens*, Cambr., *Trans. Linn. Soc.*
1879–81. *Neriene pudens*, Cambr., *Spid. Dorset.*
1900. *Cornicularia pudens*, Cambr., *List Br. Ir. Spid.*

Walckenaëria karpinskii, (Cambr.), 1873.

1873. *Erigone karpinskii*, Cambr., *Proc. Zool. Soc.*

Genus **Tigellinus**, Sim., 1884.

1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Phalops*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Diplocephalus*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1883. *Lophomma*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Tigellinus*, Sim., *Ar. de France.*
1900. ,, Cambr., *List. Br. Ir. Spid.*

Tigellinus furcillatus, (Menge), 1869.

1869. *Phalops furcillatus*, Menge, *Preuss. Spin.*
1879–81. *Walckenaera furcillata*, Cambr., *Spid. Dorset.*
1883. *Diplocephalus furcillatus*, Bertkau, *Spin. Rheinp.*
1884. *Tigellinus furcillatus*, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Tigellinus saxicolus, (Cambr.), 1861.

1861. *Walckenaera saxicola*, Cambr., *Ann. Mag. Nat. Hist.*
1864. ,, ,, Bl., *Spid. G. B. I.*

1870–3. *Erigone saxicola*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera saxicola*, Cambr., *Spid. Dorset.*
1883. *Lophomma saxicolum*, Bertkau, *Spin. Rheinp*
1884. *Tigellinus saxicolus*, Sim., *Ar. de France.*

Genus **Arrecerus**, Sim., 1864.

1834. *Theridium*, Wid., *Zool. Misc.* (*ad partem*).
1837. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Arrecerus*, Sim., *Hist. Nat. Araig.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Lophomma*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).
1884. *Prosopotheca*, Sim., *Ar. de France.*
1900. ,, Cambr., *List Br. Ir. Spid.*

The genus *Arrecerus* was formulated by Simon in 1864 for two species—*A. camelinus*, Koch (= *acuminatus*, Bl.). and *A. monoceros*, (Wid.). The former was removed by Menge in 1868 (under the name *cornutus*, Wid.) to his genus *Phalops*, leaving *monoceros*, (Wid.), as the type of *Arrecerus*. Simon, in 1894 (*Hist. Nat. Araig.*), selected *monoceros*, (Wid.), as the type of *Prosopotheca*, Sim., but this is impossible, since the species in question is the type of *Arrecerus*.

Type: *A. monoceros*, (Wid.).

Arrecerus monoceros, (Wid.), 1834.

1834. *Theridium monoceros*, Wid., *Zool. Misc.*
1837. *Argus monoceros*, Walck., *Ins. Apt.*
1861. *Erigone monoceros*, Westr., *Ar. Suec.*
1864. *Arrecerus monoceros*, Sim., *Hist. Nat. Araig.*
1864. *Walckenaera monoceros*, Bl., *Spid. G. B. I.*
1868. *Lophomma cristatum*, Menge, *Preuss. Spin.*
1870–3. *Erigone monoceros*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera monoceros*, Cambr., *Spid. Dorset.*
1884. *Prosopotheca monoceros*, Sim., *Ar. de France.*
1886. *Lophomma monoceros*, Dahl, *Monog. Erig.*
1900. *Prosopotheca monoceros*, Cambr., *List Br. Ir. Spid.*

Arrecerus atro-tibialis, (Cambr.), 1878.

1878. *Neriene atro-tibialis*, Cambr., *Ann. Mag. Nat. Hist.*
1879–81. *Walckenaera atro-tibialis*, Cambr., *Spid. Dorset.*
1900. *Prosopotheca atro-tibialis*, Cambr., *List Br. Ir. Spid.*

Arrecerus incisus, (Cambr.), 1870.

1870. *Neriene incisa*, Cambr., *Trans. Linn. Soc.*
1879–81. *Neriene incisa*, Cambr., *Spid. Dorset.*
1884. *Prosopotheca incisa*, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Genus **Evansia,** Cambr., 1900.

1900. *Evansia*, Cambr., *Proc. Dorset F. Club.*
Type: *E. merens*, Cambr.

Evansia merens, Cambr., 1900.

1900. *Evansia merens*, Cambr., *Proc. Dorset F. Club.*

Genus **Jacksonia** (new name to replace *Phalops*, preoccupied).

1833. *Walckenaëria*, Bl., *Lond. Edin. Phil. Mag.* (*ad partem*).
1836. *Micryphantes*, C. L. Koch, *Die Arach.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1864. *Arrecerus*, Sim., *Hist. Nat. Araig.* (*ad partem*).
1868. *Phalops*, Menge, *Preuss. Spin.* (*ad partem*).
1868. *Lophomma*, Menge, *Preuss. Spin.* (*ad partem*).
1868. *Tmeticus*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1884. *Walckenaera*, Sim., *Ar. de France.*
1886. *Phalops*, Dahl, *Monog. Erig.*
1886. *Trachynotus*, Dahl, *Monog. Erig.* (*ad partem*).
1900. *Walckenaera*, Cambr., *List Br. Ir. Spid.*

Of the three species included by Blackwall in *Walckenaëria* (1833), *cristata*, Bl., was removed to *Argus* (Walckenaer, 1837), and *acuminata*, Bl., to *Arrecerus* (Simon, 1864). In 1868 Menge removed *acuminata*, Bl. (under the name of *cornutum*, Wid.), to his genus *Phalops*, in which he also included *Erigone conica*, Westr., *Erigone gibbicollis*, Westr., and *Phalops furcillatus*, Menge. *E. conica*, Westr., is synonymous with *frontata*, Bl., which is the type of the genus *Savignia*, Bl. (1833). *E. gibbicollis*, Westr., is synonymous with *apicatus*, Bl., which is the type of the genus *Stylothorax*, Bertkau (1883). *P. furcillatus*, Menge, was removed by Simon to *Tigellinus* (1884). A single species, *cornutus*, Wid. (= *acuminata*, Bl.), therefore remains, and must of necessity be the type of *Phalops*. The name *Phalops* is, however, preoccupied, and I therefore propose the name *Jacksonia* to replace it.

Type: *J. acuminata*, (Bl.)

Jacksonia acuminata, (Bl.), 1833.

1833. *Walckenaëria acuminata*, Bl., *Lond. Edin. Phil. Mag.*
1834. *Theridium cornutum*, Wid., *Zool. Misc.*
1836. *Micryphantes camelinus*, C. L. Koch, *Die Arach.*
1837. *Argus cornutus*, Walck., *Ins. Apt.*
1861. *Erigone cornuta*, Westr., *Ar. Suec.*
1864. *Walckenaera acuminata*, Bl., *Spid. G. B. I.*
1864. *Arrecerus camelinus*, Sim., *Hist. Nat. Araig.*
1868. *Phalops cornutus*, Menge, *Preuss. Spin.*
1870–3. *Erigone acuminata*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera acuminata*, Cambr., *Spid. Dorset.*
1884. *Walckenaera acuminata*, Sim., *Ar. de France.*
1886. *Phalops acuminata*, Dahl, *Monog. Erig.*
1900. *Walckenaera acuminata*, Cambr., *List Br. Ir. Spid.*

Jacksonia capito, (Westr.), 1861.

1861. *Erigone capito*, Westr., *Ar. Suec.*
1870–3. „ „ Thor., *Rem. on Syn.*
1884. *Walckenaera capito*, Sim., *Ar. de France.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Jacksonia nodosa, (Cambr.), 1872.

1872. *Walckenaera nodosa*, Cambr., *Trans. Linn. Soc.*
1879–81. „ „ „ *Spid. Dorset.*
1879–81. „ *jucundissima*, Cambr., *Spid. Dorset.*
1884. „ *nodosa*, Sim., *Ar. de France.*
1884. „ *jucundissima*, Sim., *Ar. de France.*
1900. „ *nodosa*, Cambr., *List Br. Ir. Spid.*

Jacksonia obtusa, (Bl.), 1836.

1836. *Walckenaera obtusa*, Bl., *Lond. Edin. Phil. Mag.*
1864. „ „ „ *Spid. G. B. I.*
1879–81. „ „ Cambr., *Spid. Dorset.*
1884. „ „ Sim., *Ar. de France.*

1886. *Trachynotus obtusus*, Dahl, *Monog. Erig.*
1900. *Walckenaera obtusa*, Cambr., *List Br. Ir. Spid.*

Jacksonia nudipalpis, (Westr.), 1851.

1851. *Erigone nudipalpis*, Westr., *Goteb. Handl.*
1861. ,, ,, ,, *Ar. Suec.*
1868. *Tmeticus spinipalpis*, Menge, *Preuss. Spin.*
1870–3. *Erigone nudipalpis*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera nudipalpis*, Cambr., *Spid. Dorset.*
1884. ,, ,, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Genus **Viderius**, Sim., 1864.

1834. *Theridium*, Wid., *Zool. Misc.* (*ad partem*).
1836. *Micryphantes*, C. L. Koch, *Die Arach.* (*ad partem*).
1837. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Viderius*, Sim., *Hist. Nat. Araig.*
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1867. *Micryphantes*, Ohl., *Die Arach.* (*ad partem*).
1868. *Lophomma*, Menge, *Preuss. Spin.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Ithyomma*, Bertkau, *Spin. Rheinp.*
1884. *Wideria*, Sim., *Ar. de France.*
1886. *Lophomma*, Dahl, *Monog. Erig.* (*ad partem*).
1900. *Wideria*, Cambr., *List Br. Ir. Spid.*

Type: *V. anticus*, (Wid.).

Viderius anticus, (Wid.), 1834.

1834. *Theridium anticum*, Wid., *Zool. Misc.*
1836. *Micryphantes tibialis*, C. L. Koch. *Die Arach.*
1837. *Argus anticus*, Walck., *Ins. Apt.*
1841. *Walckenaera apicata*, Bl., *Trans. Linn. Soc.*
1847. *Argus apicatus*, Walck., *Ins. Apt.*
1861. *Erigone antica*, Westr., *Ar. Suec.*
1864. *Walckenaera antica*, Bl., *Spid. G. B. I.*
1864. *Viderius tibialis*, Sim., *Hist. Nat. Araig.*
1867. *Micryphantes tibialis*, Ohl., *Die Arach.*
1868. *Lophomma anticum*, Menge, *Preuss. Spin.*
1879–81. *Walckenaera antica*, Cambr., *Spid. Dorset.*
1883. *Ithyomma anticum*, Bertkau, *Spin. Rheinp.*

1884. *Wideria antica*, Sim., *Ar. de France.*
1886. *Lophomma anticum*, Dahl, *Monog. Erig.*
1900. *Wideria antica*, Cambr., *List Br. Ir. Spid.*

Viderius cucullatus, (C. L. Koch), 1836.

1836. *Micryphantes cucullatus*, C. L. Koch, *Die Arach.*
1837. *Argus cucullatus*, Walck., *Ins. Apt.*
1864. *Viderius cucullatus*, Sim., *Hist. Nat. Araig.*
1868. *Lophomma cucullatum*, Menge, *Preuss. Spin.*
1879–81. *Walckenaera cucullata*, Cambr., *Spid. Dorset.*
1883. *Ithyomma cucullatum*, Bertkau, *Spin. Rheinp.*
1884. *Wideria cucullata*, Sim., *Ar. de France.*
1886. *Lophomma cucullatum*, Dahl, *Monog. Erig.*
1895. *Wideria nequam*, Cambr., *Proc. Dorset F. Club.*
1900. „ *cucullata*, Cambr., *List. Br. Ir. Spid.*
1900. „ *nequam*, „ „ „ „

Viderius melanocephalus, (Cambr.), 1881.

1881. *Walckenaera melanocephala*, Cambr., *Spid. Dorset.*
1882. *Erigone glaphyra*, Sim., *Bull. Soc. Zool. Fr.*
1882. „ *decipiens*, Kulcz., *Opisy. now. Gatunk. Pajakow.*
1884. *Wideria melanocephala*, Sim., *Ar. de France.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Viderius nigriceps, (Cambr.), 1875.

1875. *Neriene nigriceps*, Cambr., *Ann. Mag. Nat. Hist.*
1879–81. „ „ „ *Spid. Dorset.*
1900. *Wideria* „ „ *List. Br. Ir. Spid.*

Viderius fugax, (Cambr.), 1870.

1870. *Neriene fugax*, Cambr., *Trans. Linn. Soc.*
1879–81. „ „ „ *Spid. Dorset.*
1884. *Wideria fugax*, Sim., *Ar. de France.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Viderius warburtonii, Cambr., 1902.

1902. *Wideria warburtonii*, Cambr., *Proc. Dorset F. Club.*

Viderius subitus, Cambr., 1902.

1902. *Wideria subita*, Camb., *Proc. Dorset F. Club.*

Viderius incertus, Cambr., 1902.

1902. *Wideria incerta*, Cambr., *Proc. Dorset F. Club.*

ANGLIA HANCOCKII, A SPIDER NEW TO SCIENCE.

By Frank P. Smith.

(Read October 20th, 1905.)

Plate 16.

Whilst examining a collection of spiders from Yarmouth, made in August, 1905, by Mr. R. Hancock, of Stechford, Birmingham, I met with a form which appears to me to be new to science, and I take this opportunity of describing and figuring its characteristics. I have great pleasure in naming it in honour of the discoverer.

In the matter of systematic position, it has affinities both with the Linyphiinae and the Erigoninae, but from the structure of the palpus and palpal organs I have no hesitation in placing it in the latter sub-family, of which it appears to be an early type. The presence or absence of a second tibial spine, although of much practical value in determining to which of these two sub-families a species belongs, is by no means infallible, the present species being a case in point, possessing as it does a second tibial spine upon two pairs of legs, but not upon the remainder. Several such species are known, the palpi being, as a rule, visibly erigonine. In fact, it is not at all improbable that several species having a second spine upon all of the tibiae will, eventually, be placed in the sub-family Erigoninae. In my list of British Spiders of the Erigone Group * this species should be inserted at the beginning, in front of *Oedothorax*.

Genus **Anglia**, n. g.

Cephalo-thorax oval, about one-third longer than wide, broad and bluffly rounded in front; cephalic portion very slightly constricted, somewhat convex above, but devoid of any eminence or post-ocular impressions.

Clypeus equal in height to central ocular area, slightly convex, sloping outwards.

* *Journal of the Quekett Microscopical Club*, Series 2, Vol. 9, No. 55.

Ocular area very small, compared with the width of the caput.

Eyes eight in number, arranged in two rows. Anterior row, viewed from in front, nearly straight, convexity directed downwards; eyes equidistant, separated by considerably less than the diameter of a central eye; centrals very slightly smaller than laterals. Posterior row, viewed from above, moderately curved, convexity directed backwards; eyes equidistant, separated by considerably more than the diameter of a central eye; centrals slightly smaller than laterals; between each central and the adjacent lateral is a curved bristle. Central ocular area slightly longer than broad, narrower in front than behind, but not greatly so. Lateral eyes in contact, equal in size, placed upon slight prominences.

Falces very large and divergent, more than twice the height of the clypeus; basal joint furnished on its outer surface with numerous granules, and also a very finely striate stridulating area; on its anterior face, near the middle and towards its inner side, is a very prominent denticule, provided with two strong bristles, one lateral and one terminal. Fang-groove very wide and deep; superior edge with four small teeth, the one farthest from the base of the fang being the largest, the rest about equal in size; inferior edge strongly chitinised and furnished with three large curved teeth and, at the base of the fang, a rounded chitinous projection. Fang highly developed.

Maxillae long, about three times the length of the labium, furnished with several conspicuous bristles, very broad at point of insertion of palpus, beyond that almost parallel, inclined somewhat towards each other in front of the labium; anterior extremity greatly produced externally and terminating in a sharp point bearing a long bristle.

Labium almost quadrate, its anterior edge bent outwards and bearing a row of hairs.

Sternum wider than long, terminating posteriorly between the hind-coxae, where it is truncated but not greatly inflected.

Palpus: trochanter with a rounded protuberance beneath; femur long, parallel, and much curved; patella long, its extremity produced below, forming a sharp, conical projection; tibia long, with a small apophysis; tarsus very small; palpal organs of very simple construction.

Legs: order of length, IV., II., I., III.; coxae normal, the hinder pair separated by less than the diameter of one of them; trochanters, normal; femora, especially I. and II., somewhat enlarged near the base, furnished beneath the extremity with two long conspicuous bristles in I., II., and III., and with one bristle only in IV.; patellae long, each with a small terminal spine; tibiae I. and II. with two very small spines, III. and IV. with one such spine, several sensory setae upon each tibia; metatarsi shorter than tibiae, but never less than three-fourths their length, furnished in I. and II. with a sensory setae about three-fourths from the base, but this is wanting in III. and IV.; tarsi more than half the length of the metatarsi, but in no case as much as two-thirds their length; tarsal claws three, superior ones large, the first denticulation large and at some distance from the extremity, the remaining denticulations rapidly diminishing towards the base of the claw; inferior claw with a very small denticule.

Abdomen oval, devoid of any scutum.

Spiracular organs and *spinners* normal.

Anglia hancockii, n. sp.

Length of male, 3·75 mm. Female unknown.

Cephalo-thorax smooth, minutely reticulated; cephalic portion blackish brown, with three longitudinal rows of short hairs, one in the centre and one behind each posterior lateral eye; thoracic portion orange, with a black spot at the central indentation, and suffused with black near its centre.

Falces pale brown, tinged with orange.

Maxillae dull orange, suffused at the margins with black, furnished with a few coarse hairs and bristles.

Labium brown.

Sternum orange, suffused with black towards its anterior edge; surface smooth, minutely reticulated and furnished with a few coarse hairs.

Palpus pale orange; trochanter with a rounded protuberance beneath, bearing a bristle; inner surface, where opposed to the stridulating area of the falx, somewhat roughened; femur long, parallel, considerably curved, with a few coarse hairs; patella long, more than half the length of the femur, furnished with coarse hairs, produced downwards at its extremity to form a sharp, conical projection; tibia slightly shorter than patella, somewhat enlarged towards its extremity, where it is furnished with numerous very long and conspicuous hairs, and, above, with a small black bifid apophysis, the two points of which are equal in size and curved somewhat downwards; tarsus very small, no wider than the extremity of the tibia, plentifully furnished with coarse hairs; external branch distinct; palpal organs simple, consisting chiefly of a bulb and a terminal pale grey point, surrounded by a transparent membrane.

Legs orange, furnished with coarse hairs.

Abdomen blackish above, with four impressed red spots forming a quadrilateral near the centre, steel-grey beneath with two dark impressed spots half-way between the laminal tracheae and the spinners. The whole surface of the abdomen is obscurely marked with pale reticulations and furnished with hairs.

Laminal-tracheal openings distinct, their edges somewhat chitinised and of a reddish tint.

Tube-tracheal opening very distinct, the ends of the transverse aperture being somewhat chitinised and of a reddish tint.

Spinners brown.

A single male of this species was taken by Mr. R. Hancock, of Stechford, Birmingham, at Yarmouth, in August, 1905.

Explanation of Plate 16.

Fig. 1. Maxillae, labium and sternum, × 30.
,, 2. Cephalo-thorax, viewed from above, × 30.
,, 3. Right palpus, viewed in profile, × 62.
,, 4. Cephalo-thorax, viewed in profile, × 30.
,, 5. Tibia of right palpus, viewed from above, × 62.
,, 6. Caput and falces, viewed from in front, × 30.

RECENT POPULAR WORKS ON MICROSCOPY.

NATURE THROUGH MICROSCOPE AND CAMERA. By Richard Kerr, F.G.S., F.R.A.S. $8\frac{1}{2} \times 5\frac{1}{2}$ in. 194 pages. Illustrated with 65 photo-micrographs by Arthur E. Smith. London, 1905. The Religious Tract Society. Price 6*s.* net.

Amongst the donations to the library is a copy of the above work, presented by Mr. Arthur E. Smith. It consists of a miscellaneous collection of photo-micrographs (not micro-photographs, as Professor G. Sims Woodhead, M.A., M.D., calls them, in his introduction), accompanied by brief, chatty descriptions of the objects portrayed and interesting details concerning them. With most of the information supplied the average working microscopist will no doubt be acquainted; but the book is hardly intended for a microscopist, its object being, apparently, to introduce to the general reader some of the wonders of the microscope, in the hope that he may be thereby inspired with a desire for a closer acquaintance with minute nature. When we consider, too, that the author endeavours to take a comprehensive glance at nature, and to express himself in less than thirty thousand words, it is not to be wondered at that the information on any one subject is somewhat scanty. The illustrations are, on the whole, very praiseworthy. Fig. 12, representing the radula of a whelk, is a most satisfactory production. In the case, however, of fig. 15, a section of an echinus spine, it is to be regretted that the photographer did not select a more striking form for representation. Diatoms are well represented by several very successful photographs. Vegetable sections occupy a number of plates, one of the most interesting being that of a clover stem with the parasitic dodder *in situ.* Insects and insect dissections occupy a prominent position. The leg of the honey-bee, shown in fig. 23, does not exhibit its fringe of hairs as well as might be desired; but any one who has endeavoured to photograph this object will be quite ready to make every allowance. Fig. 61 is a photograph of a wolf-spider, taken from a flattened preparation. The camera has done its work well, but so, alas! has the caustic alkali, and the final result consequently bears but little resemblance to the original object. Speaking of spiders, the author states that "a North American species, *Lycosa arenicola*, (Scudder), makes a structure resembling a huge bird's-nest." Probably "huge" has crept in by mistake; "tiny" would be nearer the truth. The use of the term "figure" in this work may possibly be somewhat misleading. There are no figures in the text, each of the sixty-five illustrations occupying a full-page plate. *Nature through Microscope and Camera* can be strongly recommended to any one in need of a gift-book for a youth, it being certainly a step in the direction of popularising the study of microscopy. F. P. S.

MICROSCOPES AND ACCESSORIES: HOW TO MAKE AND USE THEM. Edited by Paul N. Hasluck. $6\frac{3}{4} \times 4$ in. 160 pages. Illustrated with 140 diagrams in the text. London, 1905. Cassell & Company, Limited. Price 1*s.* net.

This valuable little book will be hailed with delight by every practical microscopist, containing, as it does, directions for the manufacture and use of everything from a slide to a compound microscope. It is a digest of a very large amount of information on microscopy culled from *Work*, of which journal Mr. P. N. Hasluck is the editor. The condensation and arrangement of this information has been carried out in a most praiseworthy manner, and the absence of technicalities will render the book intelligible to all. Every page bears the impress of practicability, and it is most pleasing to find that there is no tendency to perpetuate the whims of individual authors. I refer to such recommendations as the slicing up of bottles to make cells and the use of a razor in the cutting of echinus spine sections, both emanating from well-known writers. *Microscopes and Accessories* can be heartily recommended to any one who knows anything about the microscope, or who wishes to. F. P. S.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on March 17th, 1905, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on February 17th were read and confirmed.

Messrs. D. L. Chapman, F. Dean, W. Clemence, F. Smith, A. Goldsbrough, D. G. Paine, W. J. Phipps and A. Jaffe were balloted for and duly elected members of the Club.

Mr. Rheinberg read a description of an "Experimental Proof that the Doubling of Lines in the Abbe Experiments is not due to the Diaphragms above the Objective." The experiment was shown by means of an Abbe demonstration microscope, and further explained by blackboard illustrations.

Mr. Rheinberg also read a paper upon the published work of the late Professor Abbe, it being a translation of a detailed review by Professor H. Ambronn of *Gesammelte Abhandlungen von Ernst Abbe.* A hearty vote of thanks was accorded to Mr. Rheinberg for his communications.

The President announced the death of Mr. J. Slade, who had been a member of the Club since 1866, and in former years had served for a considerable time upon the Committee.

At the meeting of the Club held on May 19th, 1905, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on March 17th were read and confirmed.

Messrs. J. Chinn, F. H. Melhuish, J. Metcalf, jun., C. P. Harris, J. Kitchin and J. Reeve were balloted for and duly elected members of the Club.

Mr. Earland read a paper on "The Foraminifera of the Shore-sand at Bognor, Sussex," illustrated by numerous specimens under microscopes, and by drawings.

Mr. Wesché inquired whether it was a difficult matter to examine these interesting organisms in the living state.

Mr. Earland in reply stated that they could be found alive almost anywhere upon seaweed, and were easily kept in sea-water, where they would live for a considerable period.

The President, in conveying the thanks of the Club to Mr. Earland for his most valuable paper, expressed a wish that it might be the means of inducing some of the members to seriously study these organisms during their visits to the sea-side.

At the meeting of the Club held on June 16th, 1905, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on May 19th were read and confirmed.

Messrs. A. E. Littleboy, J. C. Myles, D. Davies, S. H. Allwood, W. C. Barton and W. N. Blair were balloted for and duly elected members of the Club.

Mr. W. Wesché, F.R.M.S., gave an abstract of his paper, "The Genitalia of the Tsetse Fly, *Glossina palpalis*," his remarks being illustrated by drawings and diagrams.

Mr. Wesché subsequently gave a popular lecture on Pond Life, illustrated by a series of lantern-slides designed to reproduce the effect of a dark ground illumination. They consisted of two large groups of various organisms, the individuals being subsequently projected on the screen separately and on a highly-magnified scale. Mr. Wesché disclaimed having anything fresh to say on the subject, especially before a gathering which included so many experts; but he hoped that his remarks would prove of interest to the novices who were present, and induce them to take up this fascinating study.

Mr. Julius Rheinberg, F.R.M.S., showed an experiment on the production of achromatic interference bands in a new manner, which formed the subject of a paper he had recently read at the Optical Convention. Certain experiments in connection with the theory of microscopic vision had led to the curious result in question, which amounted in effect to producing in the microscope, on the object stage of which a piece of celluloid or paper with a large perforation had been placed, the appearance as if a grating had been placed over it, the lines appearing perfectly sharp in black and white. It was well known that if a grating were placed on the stage of a microscope, and illuminated by a narrow beam of light, it would diffract the light, so that spectra would be seen above the objective when the eyepiece was removed; and one of Abbe's laws told us that at least two of these spectra must take part in the formation of the image, if that image was to show any detail, for if one spectrum only were allowed to pass the image would be a mere blur. The object of the present investigation had been to see whether, after blocking out all but one of these spectra which had been diffracted by the object, the other spectra could be replaced or imitated by producing precisely similar spectra in some other manner, and, if so, what would happen. In experimenting with this end in view, an Abbe demonstration microscope was used, in which the objective consisted of two parts—viz. a lens combination, which rendered all rays diverging from any point of the object parallel, and a further lens to bring these parallel rays to a focus. The two parts of the objective were separately mounted, so that any desired apparatus could be inserted between them. By means of a diaphragm just behind the first part of the objective, all the spectra arising from diffraction by the object were blocked out, except the central beam (zero spectrum), and the device ultimately hit upon for producing similar spectra to those blocked out was to pass the light from this central beam through two Thorp gratings of about 14,500 lines per inch. There were very peculiar properties connected with the passage of light through two gratings of similar pitch. When a parallel pencil of light impinged on the first grating, a pencil of violet rays would be diffracted at a certain angle, and when that pencil met the second grating of the same pitch, since a part of the light would be diffracted at precisely the same angle, it would issue parallel to the first pencil. A red ray would be diffracted by a greater amount; but since the angle of diffraction at the two gratings was equal, red rays would also issue parallel to the incident pencil; in fact, rays of all colours would issue parallel to one another, forming spectra just like those which occurred in the microscope between the two parts of the objective if a grating were placed on the object stage. This being so, the same visible effect should be produced if these two Thorp gratings were placed between the two parts of the objective as would be if the spectra from the grating on the stage had not been stopped-out, and, provided certain precautions were taken, it was found that this was the case.

The precautions consisted in stopping-out the central beam, after the light had passed both gratings, by means of a stop, allowing only one spectrum on each side to take part in the formation of the image. This was necessary in order to insure equality of optical path-length between the rays, which by their interference produced the image. At first it looked as though the law of Abbe previously mentioned had been circumvented; but a simple experiment showed that that was not so, for on revolving the grating on the object stage the grating structure seen in the microscope remained fixed in position. Indeed, it was found that, upon removing the object grating altogether, the grating structure seen through the microscope still remained. Clearly, therefore, the object grating had taken no part in the effect.

Whilst, therefore, so far as the theory of the microscopic image was concerned, nothing out of accordance with the known laws had resulted from this somewhat artificial attempt to circumvent one of them, it was seen that they led to the production of achromatic interference bands. Ordinarily, in interference experiments the bands or fringes were spaced according to their wave-lengths. A number of experimenters had tried to make the bands of different colours overlap or achromatise them.

The double-grating method was very simple, and apparently new. Mr. Rheinberg concluded by referring to the peculiarity that the result was independent of the distance between the two gratings, since this did not affect the black-and-white effect, although it afforded a convenient means of altering the pitch of the bands.

Votes of thanks were accorded to Messrs. Wesché and Rheinberg for their communications.

It was announced that the ordinary meetings were suspended until October 20th, the "gossip nights" being continued in the meantime.

OBITUARY NOTICE.

JOHN GREEN WALLER, F.S.A.

Elected a member of the Quekett Club, May 22nd, 1868; *served on the Committee,* 1873–75, 1881–90, 1892–94; *Vice-President,* 1876, 1898–1905; *President,* 1896–97.

By the death of Mr. Waller, who passed away at Blackheath on October 19th, at the ripe age of ninety-two, we lose one of our most versatile and popular members, whose many services are briefly summarised above. Ever one of the most regular attendants, his spare but active figure must have been familiar to all members, although probably very few of them knew that the white-haired old gentleman, who took so keen an interest in whatever was going on, had been born in the days of George the Third, and was already a promising young artist when the late Queen was crowned.

John Green Waller, who came of an East Anglian stock, was the son of a surgeon, and was born in 1813 in the old-world village of Hoxne, in Suffolk, where he spent his early years. Educated at a private boarding-school in Essex, the master of which was a man of superior attainments for those times, he there came in contact with a drawing-master, who appreciated and developed his artistic tendencies. From here he went to Sass's famous art school in Newman Street, where he was a fellow student of G. F. Watts and J. C. Horsley. Then, passing into the Royal Academy School, he won a "Frost" medal and a "life" studentship in 1836, and also a prize for a cartoon which is now preserved in Norwich Museum, the subject being taken from *Comus*. In 1851 he took a gold medal at the International Exhibition, but in the intervening years he had been drifting gradually into archaeology, for which he had a great taste, and in this field also he achieved a reputation, engraving a series of plates from English monumental brasses, and being elected an Honorary Fellow of the Society of Antiquaries. Combining his artistic training with his archaeological studies, he became well known as a designer of stained windows and monumental brasses, among his better known works being the Chaucer window in Westminster Abbey.

Mr. Waller's first introduction to microscopy was due to his sister, Mrs. E. Mayhew Edmonds, who survives him. She possessed a small instrument which attracted his attention, and he quickly became fascinated with the study. Joining the Club, he soon took a prominent part in the debates, besides contributing many papers dealing principally with the Sponges, a group in which he was particularly interested, and at which he continued to work up to the end.

FIG. 1.

FIG. 2.

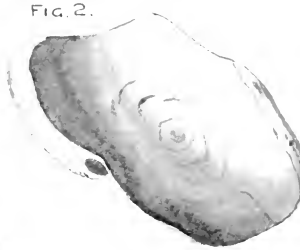


FIG. 3.

FIG. 4.

FIG. 5.

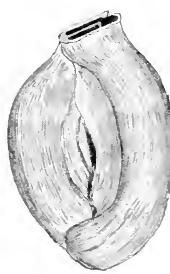


FIG. 6.

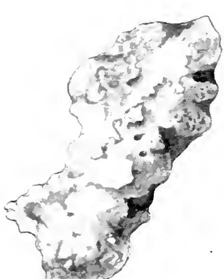


FIG. 7.

A. J. FRENCH, *del. ad nat.*

FORAMINIFERA FROM BOGNOR, SUSSEX.

FIG 1.

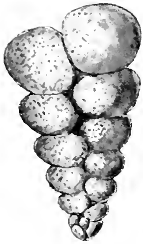


FIG. 2.

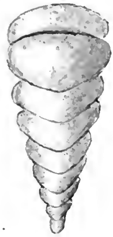


FIG. 3.

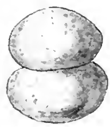


FIG. 4.

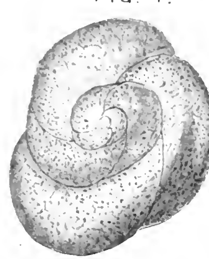


FIG. 5.

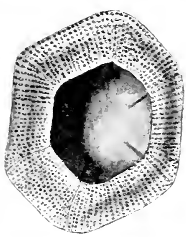


FIG. 6.

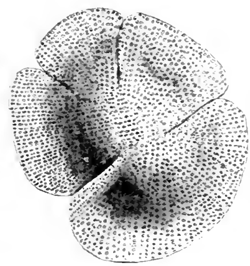


FIG. 7.

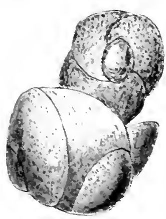


FIG. 8.

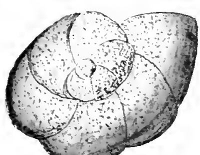


FIG. 9.

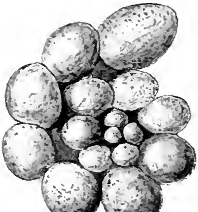
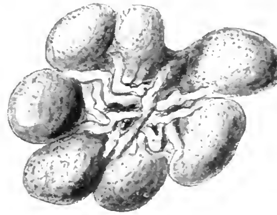


FIG 10.

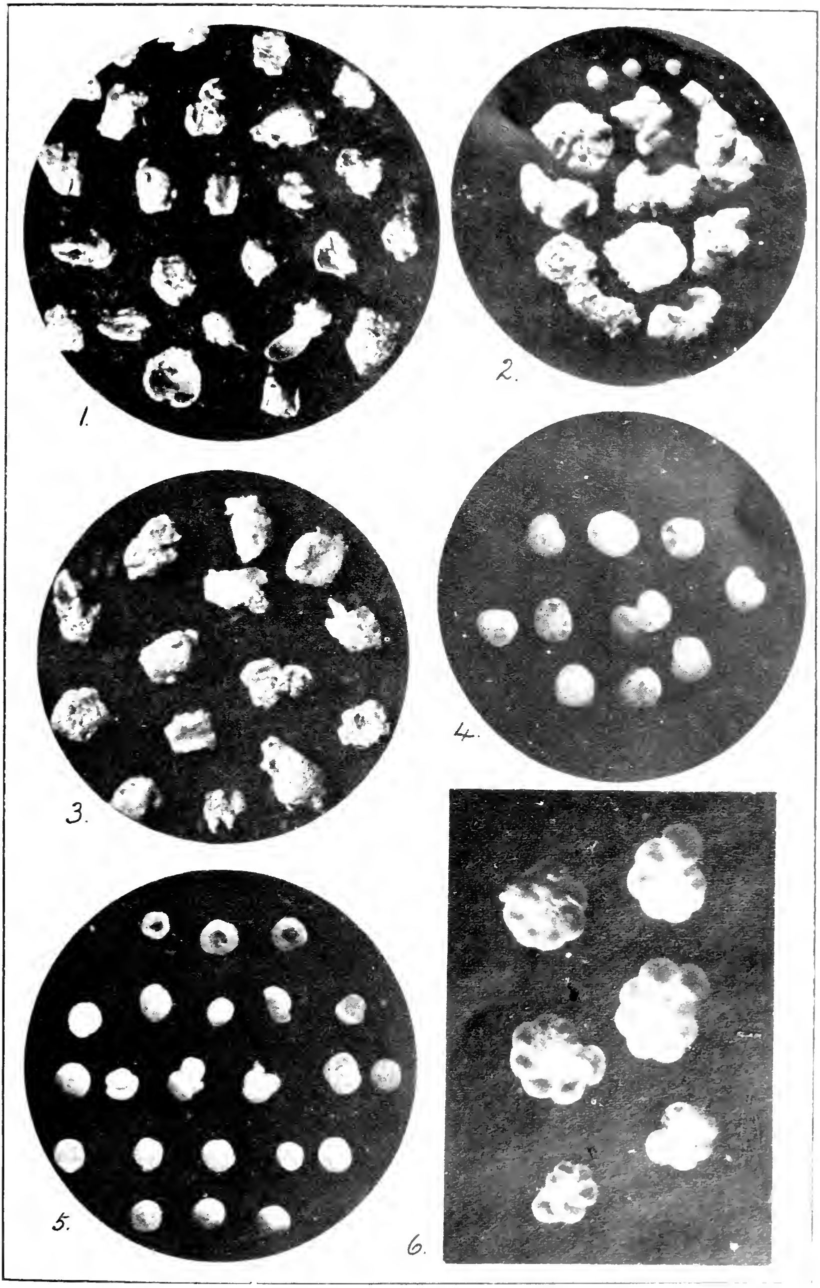


A. J. FRENCH, *del. ad nat.*

FORAMINIFERA FROM BOGNOR, SUSSEX.

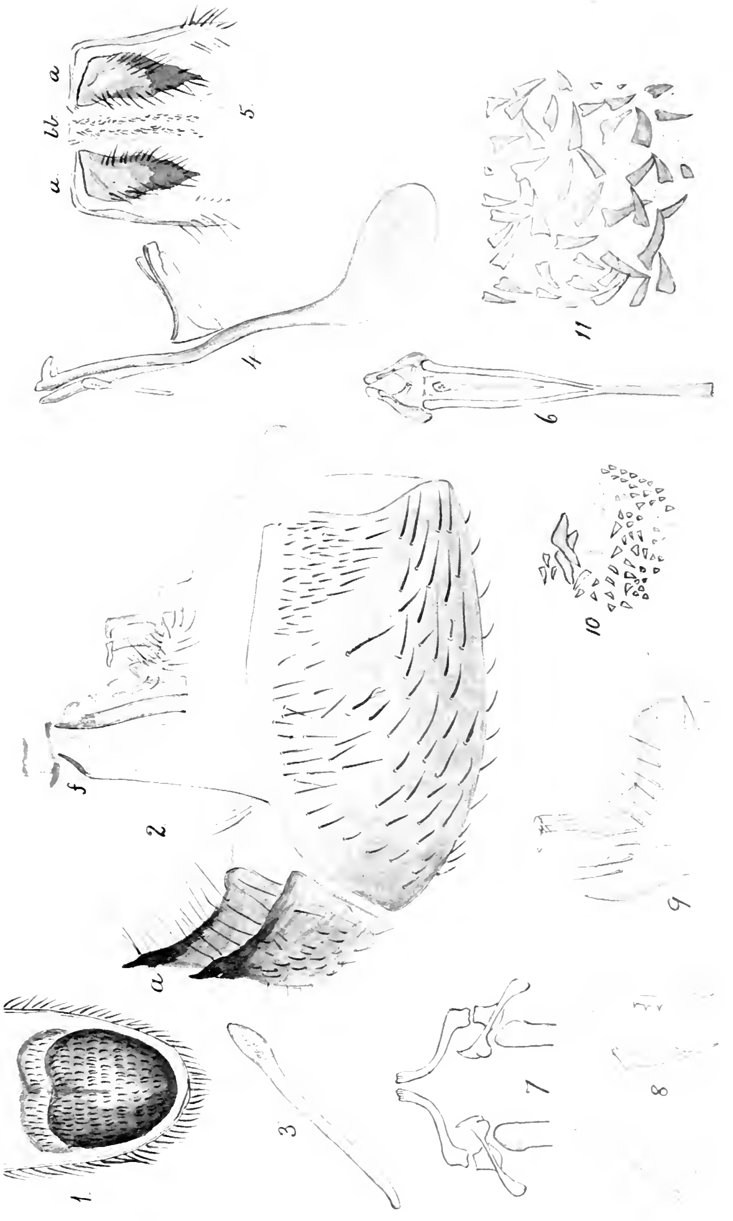
J. A. Lovegrove, *del. ad nat.*

Foraminifera—*Cornuspira.*



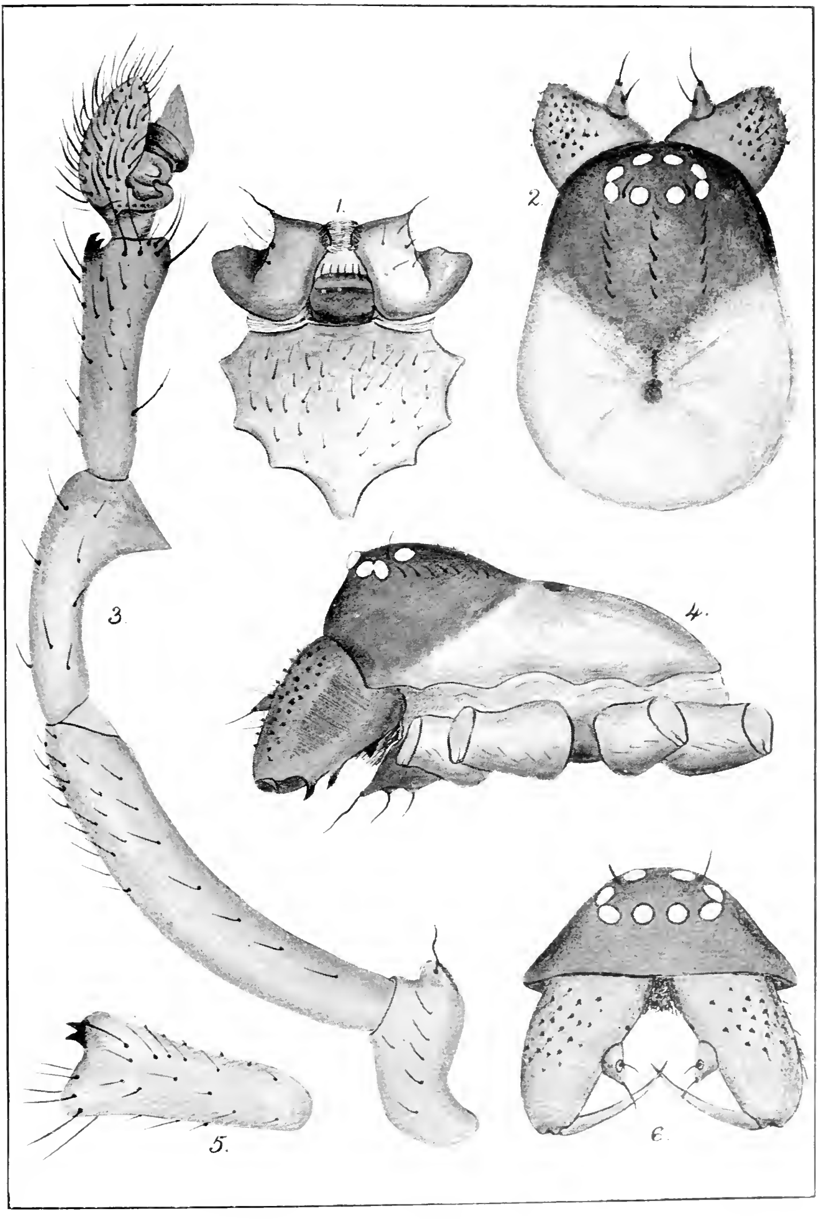
E. J. Spitta, *photo.*

Foraminifera from Bognor, Sussex.



W. WESCHÉ, *del. ad nat.*

GENITALIA OF *GLOSSINA PALPALIS*.



Frank P. Smith, *del. ad nat.*

Anglia hancocki, n. sp.

ON A NEW BDELLOID ROTIFER, *CALLIDINA VESICULARIS.*

By James Murray.

(*Read December* 15*th*, 1905.)

Plate 18.

In September, 1904, Mr. Bryce sent me some samples of moss, in order to show me *Callidina aculeata*, Milne, and *C. vorax*, Janson, two species with which I was not then acquainted. I was able to find examples of both of them. In the moss which contained *C. aculeata* I found also several specimens of a Bdelloid quite distinct from any species known to me. The animal was carefully studied, as far as the limited number of examples permitted. Mr. Bryce was immediately notified of the occurrence of the species in his moss, in the hope that he also would be able to study it. Unfortunately he was unable to find it, and up to the present has not detected a single example, nor have I, on further examination of the material, been any more fortunate.

We have therefore to depend solely on the observations made on the original three specimens.

As the species is a very well-marked one, easily distinguished from all other Bdelloids of which we have sufficient descriptions, and Mr. Bryce has not himself seen it, I venture to make a description of it.

Callidina vesicularis, n.sp.

Specific characters.—Large, hyaline; teeth, 6/5; vibratile tags, six pairs, very large, round or pyriform; first foot-joint with two blunt processes, spurs small, separated by wide interspace.

General description.—Length, 325μ. Diameter of trunk, 106μ; of corona, 86μ. Build somewhat like *C. quadricornifera*, Milne, to which the processes on the foot further suggest relationship, but head and foot relatively longer. It further differs conspicuously in the numerous teeth, a feature only found hitherto among the pellet-making and symbiotic species of *Callidina*. The vibratile tags differ from anything I have seen in Bdelloids. As a rule the tags are inconspicuous and difficult to see, so that, although I always look for them, I cannot claim to have observed them in all the species known to me. In all cases when they have been seen they are narrow, usually with straight parallel sides, but occasionally spindle-shaped. In this species they are conspicuous, and obtrude themselves on the attention without being specially looked for. They are nearly round, and look like little inflated bladders. The name is taken from this, the most striking character.

The corona is less in diameter than the broadest part of the trunk, and has large discs on which central papillae were seen, though no setae could be distinguished.

The discs are separated by a space about two-thirds of the diameter of one disc. The lateral folds of the upper lip are prominent, and stand some little distance apart.

The broad central portion of the trunk is longitudinally plicate, the folds few, broad, the dorsal faint, the lateral deep. The jaws bear six strong teeth on one side and five on the other, and many fine transverse striae. The voluminous stomach has very thick walls, which are filled with globules of moderate size and pale yellow colour. The foot is of four segments. The first bears a pair of processes, similar to those of *C. quadricornifera*, Milne. In that species the processes are usually acute, and directed backward. In this they are blunt and point forward.

The spurs are of moderate size, divergent, acuminate, obtuse, decurved, separated by an interspace greater than the length of the spur.

The toes were not clearly seen. They were rarely and only momentarily displayed. From the few glimpses I got I do not think they were symbiotic, but this is the one important point which was not satisfactorily made out. The jaws have not the broad border which I find in all the recognised symbiotic species.

The symbiotic foot, in which the toes are united to form a perforated disc, is unmistakable in those species where it reaches its fullest development, e.g. *C. russeola* and *C. scarlatina*; in some others it is rather obscure.

Recently I have been able to watch *C. scarlatina* hatch out from the egg. In the newly hatched young three toes could be traced. The two lobes of the disc of the adult are probably reminiscent of the two principal (ventral) toes. Zelinka himself figures *C. symbiotica* with two distinct toes, and I have often seen it with three, in this case also probably newly hatched.

Of the habits of this new species there is nothing important to tell. It creeps steadily and feeds sedately, like *C. quadricornifera*. Only one of the three examples found was ready to feed. From the others I was able to confirm the observations of the teeth, tags, spurs, and foot-bosses.

The yolk-mass had the usual eight nuclei; no egg or foetus was seen. The species is so well characterised that there is no other with which it need be minutely compared to prevent confusion. In the genus *Callidina* a higher tooth-formula than 3/3 is only found among the pellet-makers and the symbiotic species. *C. vesicularis* has no affinity with the former group, in which numerous teeth is the rule. From the known species of the symbiotic group it is distinguished by the processes on the foot and by the bladder-like vibratile tags.

It seems to me to have most affinity with *C. quadricornifera* and *C. habita*, but even from these it is widely separated by the characters of the teeth and the tags.

Habitat.—Among moss growing on a wall at Upper Sheringham, Norfolk, August, 1904 (D. Bryce).

Explanation of Plate 18.

Fig. 1. *Callidina vesicularis*, n.sp. Dorsal view of animal, feeding.
,, 2. The same, ventral, creeping.
,, 3. ,, ,, jaw with five teeth.
,, 4. ,, ,, lateral view of foot, to show processes.
,, 5. ,, ,, spurs.

ON SOME EXPERIMENTS RELATING TO THE COMPOUND EYES OF INSECTS.

By E. J. Spitta, F.R.M.S., F.R.A.S.

(*Read December 15th*, 1905.)

The compound eye of the insect appears outwardly to be an aggregation of six-sided facets, each of which represents the cornea of a simple eye called the "ommatidium." Each ommatidium produces an image of the object, so that the multitude of images is merely the effect of numerous ommatidia.

The subject, however, presents many difficulties, and is certainly very complicated. For the sake of brevity, and to make what follows more intelligible, it will be as well to commence by describing in a few words the structure of the human eye, as typical of the form which one finds in many animals. It is sufficient for the present purpose to say that this consists of a front portion, or limiting membrane, called the "cornea," behind which is a lens capable of alteration in form, so as to cause a change of focal length to suit the ever-varying distance of different objects, and finally, at the back of the eye, a screen upon which the image of the object is focussed, termed the "retina." The cornea may be said to possess no special refractive property—at any rate, none of importance in comparison with the function of the lens. This we are led to believe is true, because in cases of cataract—to cure which the diseased lens has to be removed—all patients require some sort of spectacles to enable them to see distinctly. In the human subject the screen or retina is a most highly complicated structure, and but little is definitely known of its various components revealed by the microscope. For our present purpose no detailed description is necessary of the different "layers," as they are called, but it will suffice merely to mention the two leading portions—the "cones" and "rods." The former are the flask-like bodies much in evidence, and the rods can be seen lying adjacent thereto. The point to bear in mind is that the rods and cones are separated from the cornea by the lens, the intervening spaces being filled by fluids of varying consistency, called the "humours." It has been said already that no explanation has been given as to the special use of the rods and cones, and consequently physiologists are driven to regard the retina, taken as a whole, as being a complicated membrane in communication with the brain for the reception or the perception of the image produced by the lens. We say "reception or perception," because it does not seem certain whether the retina perceives an image as such, and then communicates the fact to the brain, or whether it merely acts as a sensitive receptive screen upon which the image is cast, the real perception being due to the optic thalamus—the portion of the sensorium to which the nerve fibres from it are traceable. Fortunately for the present purpose, this difficult matter is of no consequence, for the decision is not at issue; but what I wish to impress upon the reader is, that the cones—whatever may be their function—have certainly nothing to do with the formation of the image, but only with its transmission.

We now pass on to the insect's eye in section. We note, first, that the retina is in direct contact with the cornea; secondly, that there is no lens proper, and we read that such is usually absent, and that when it is present it only consists of three or four hypodermis cells (Packman). I must here remark how curious it is that so many entomologists seem to mix up the cones of the retina with the true lenses, for they often call them the "crystalline lenses," ascribe to them quite a number of wonderful properties, and demonstrate how they assist in the formation of the image produced by the complete ommatidium. Yet in almost the same breath we are told that the insect's eye is divided into three well-marked varieties: the Eucone eye, that has a well-developed cone; the

Pseudocone eye, which has only a semi-fluid cone; and the Acone eye, that has none at all. From what has been said, it seems reasonable to assume that the retina of the insect lies in contact with its cornea, and that we have no right to assume that the cones have any different function from that which they possess in the human eye, although we admit that at present their immediate use is not positively known. The next question that forces itself upon the mind is this: If no lens is present, how are the images focussed upon the insect's retina? The generally accepted answer is, that the corneal facets are lenses; but if this be true, how can the images be focussed, seeing that the cornea is a rigid body, not capable of movement or of compression? The entomologist usually replies, that it is more than probable that the image is always blurred, and that the insect has no defined image save perhaps at one special distance, or of objects at what is termed "infinity." There is, however, another matter to which attention will be now directed, and to which a suitable reply seems impossible. If the corneal lenses be truly a reality, why do they not show signs of strain with polarised light, like any other lens would do if pressed as strongly by the cover-glass as the cornea has to be to get it sufficiently flat for the use of the microscopist? Any lens with such a pressure would show the most positive signs of "strain." Why do the facets present nothing of the kind? To the thoughtful mind it would seem difficult to believe in any theory which is threatened with such unanswerable questions.

Some four or more years ago I was searching for secondary markings in a diatom with well-marked cellular structure, and was surprised to see a little marking in the centre of each of the numerous small holes in the object. As these markings were so regularly visible in every hole, it was suspected that the effect must be due to some subjective influence. It was ultimately traced to the presence of a little piece of foreign matter in the cell containing green fluid, which was being employed as a monochromatic screen; for when such was removed, all trace of the multiple-image effect was removed also. The phenomenon was believed to be due to pin-hole effects. A friend, however, suggested that perhaps the multiple-image effect in the diatom might not have been due to the cause assigned, but may have arisen from some of the natural covering of the diatom not having been completely removed in the cleaning, and which, assuming a lenticular form, had produced the appearance in question. To solve this riddle I obtained some perforated zinc and photographed it. The operation was repeated several times, until the image of the perforations became so small as to almost require a lens to see them. This artificial cornea was placed on the stage of the microscope, and a little cross on a piece of glass placed beneath—in fact the same arrangement as that employed when the microscopist shows the multiple effect with the real cornea of the insect. There was at once revealed a little cross in each tiny hole of the photograph of the zinc, similar in fact to that seen in each facet of the insect's eye. There could be no doubt here that the phenomena were entirely due to pin-hole effects, and this led to the idea now suggested that it is possible that the multiple images produced by the insect's eye arises from precisely the same cause. As I have already said, these experiments were performed some years ago; hence a considerable time has elapsed for the consideration of the matter. But the longer I think upon it, the more the assumption seems worthy of acceptance; and it is in consequence of this that I have at last thought the moment ripe for bringing the matter before the Club, so as to have the benefit of the opinion of the members.

It would seem that if the facets of the cornea were considered as nothing but little holes—filled, it may be, with some non-refractive material—all the difficulties about the focussing arrangement are at once swept away; for it is well known that every image is to a more or less degree in focus with a pin-hole. This would seem to imply that a very perfectly defined image is afforded by the insect's compound eye, contrary to the generally expressed opinion. Then, again, the difficulty—hitherto unexplained—why the facets differ so much in size, even in the same specimen, seems possible of solution from the following circumstance. In using pin-holes to form images, it is well known that, although all objects are in focus, still to obtain the best possible results a certain relation must exist between the diameter of the hole, the distance of the screen, and perhaps the relative nearness of the object; and this relation should be strictly observed if the very finest definition be required. I suggest, then, that the reason for the variation of the diameters of the facets is to enable the insect to possess a differential selection of optical arrangements; so that if one set of holes did not furnish sharp results, one of the many movements of its body—intentional or otherwise—would facilitate the employment of a different group of holes, and the desired result would be brought about.

Again, if this pin-hole theory be accepted by the entomologist, it is needless to point out that the difficulty presented to the physicist—namely, the entire absence of all appearance of strain-effect in the cornea—disappears, for such would not be likely to appear if the little holes were filled with a non-refractive material. There is, however, one other point not yet touched upon. The facets certainly generally appear in the specimens of cornea as seen by the microscopist to possess a strongly-convex front. This is so; but in modern works upon the subject it is distinctly stated that in a great number of instances this is not really the case. It should also be borne in mind that the appearance may be merely a post-mortem effect. We have only to recollect the flattening which the specimen undergoes in order to make it lie beneath the cover-glass, to understand that this might be a contributory cause. Then it is only necessary to suppose the substance constituting the walls of the holes to be of a more contractile nature than the material which fills them, and the same effect would be produced.

Indeed, any of these causes—taken together or separately—might cause the convexity of the centre, and give rise to the lens-like front of which we have spoken. Then, again, the effect may be purely optical, for the appearance of the little holes in the artificial cornea strongly reminds one of that presented by the real facets, and there can be nothing like a round front in the photograph of the perforated zinc.

Although it does not bear directly on the multiple-image effect of the compound eye of the insect, still it might be taken in the light of something akin to an omission if no reference were made to Exner's experiment, as related by Carpenter. He produced a photograph of a window of his apartment through the eye of a Lampris, a result which attracted a good deal of attention at the time. The retina and pigment were removed, and the cornea and what remained of the eye were filled with glycerine and water of a refractive index of 1·346. It seems, however, to have escaped the attention of this illustrious observer, that by this process he practically converted that which remained of the eye into a lens with a refractive index of 1·346, which, of course, with the aid of the microscope, produced a photograph of the window of the apartment, just as my artificial cornea did when an auxiliary lens was used to take the place of the glycerine one. In fact it may be said that the photograph was obtained in spite of the cornea being present. In the last edition of Dr. Packman's book, although the name of Exner is frequently mentioned, no account of this experiment appears to be given. It would seem that such omission can only be by mutual consent.

ON *DREPANIDOTAENIA UNDULATA* (KRABBE).

By T. B. Rosseter, F.R.M.S.

(*Read January 19th*, 1906.)

Plate 19.

Taenia serpentiformis, noncollaris (Goeze, 1782).
Taenia undulata (Rudolphi, 1819).
Taenia undulata (*Taenia angulata*) (Duj., 1845).
Taenia undulata (*v.* Siebold, *Friss. Creplin. Kuchenmeister*, 1867).
Taenia undulata (Krabbe, 1869).
Taenia angulata = *undulata* (Professor J. Leidy, 1887).
Drepanidotaenia undulata (Rosseter, 1905).

This avian tapeworm has been taken by the above helminthologists at various times from the intestine of the following birds—rook, jay, fieldfare, blackbird, starling, redwing, and ring-ousel. My specimen was taken from *Turdus musicus.*

Following Raphael Blanchard (*Hist. Zoo. et Med. des Téniadés au genre Hymenolepis, Weinland*, pp. 68, 69), I have not placed *T. undulata* in the genus *Hymenolepis*, which genus, so far as it applies to avian tapeworms, I hope to consider in a future communication.

The following is Krabbe's description of this worm : "Longit., 280 mm.; latit., 4—5 mm.; uncinulorum, 46—64 mm. ; corona duplex, quorum anteriores longit. 0·073 mm., posteriores 0·063—0 092 mm., aperturae genitalium secundae ; longit. penis 0·21, latit. 0·016 mm.; hamuli embryonales, longit. 0·013—0·017 mm." (Krabbe's *Bidrag til Kundskab*, p. 83, no. 101, tab. 10, figs. 261—263).

Krabbe, in his *Bidrag til Kundskab* (p. 76, no. 90, tab. 9, figs. 238—240 ; p. 83, no. 101, tab. 10, figs. 261—263), rejects Dujardin's nomenclature of this tapeworm. The reason for his so doing is because Dujardin, in his *Histoire des Helminthes* (p. 565, no. 21, pl. 9, fig. *x*; p. 569, no. 26, pl. 9, fig. *h*), confounds *Taenia angulata* with *Taenia undulata* and *vice versâ*. This is demonstrable by the hooks, as the number, size, and characteristics of the hooks of Dujardin's *T. angulata* are coincident with those of Krabbe's *T. undulata*. If reference is made to Fig. 11, *a*, *b*, and Fig. 12, *a*, *b*, it will readily be seen that Fig. 11, *a*, Dujardin's *T. angulata*, and *b*, Krabbe's *T. undulata*, belong to one and the same species. Also that Fig. 12, *a*. Dujardin's *T. undulata*, and *b*, Krabbe's *T. angulata*, have the same application. Again, Dujardin says of his *T. angulata*, "Avec une trompe entourée de quarante crochets, long de 0·09—0·095 mm"; whilst Krabbe says of his *T. undulata*, "Uncinulorum, 46—64; corona duplex." Of his *T. undulata*, Fig. 12, *a*, Dujardin says, "Une trompe avec une couronne *simple* de dix à douze crochets, long de 0·02 mm., très courbés"; whilst Krabbe's description of *T. angulata*, Fig. 12, *b*, is, "Uncinulorum 10 (9—11); corona *simplex*, quorum longit. 0·020—0·025 mm." The *Taenia serpentulus* of Schrank, referred to by Dujardin and Krabbe, the latter thinking that Dujardin mistook *T. serpentulus* for *T. angulata*, cannot possibly in either case be the *T. serpentiformis* of Goeze (*T. undulata*, Krabbe), because the *T. serpentulus* referred to above has the corona "simplex"; whilst Goeze says of his *T. serpentiformis*, "Und baren oben ein *doppelter* hakenkranz" (Goeze, *Versuch einer Naturgeschichte*, etc., p. 392); and although he figures on tab. 31A, fig. 7, *b*, "der doppelte hakenkranz," unfortunately he does not give us one of the "haken" on the double rows of hooks of the rostellum, enlarged to enable us by this means to define his species as Krabbe's *T. undulata*. This, however, is explicable, as Rudolphi (*Ent.*, part i., p. 167, no. 88, and part ii., p. 528, no. 88) admits that to him the "hooks on the rostellum were only incidentally to be seen."

Professor Joseph Leidy, describing a tapeworm taken from *Turdus migratorius* sent to him by Dr. Warren, of West Chester, U.S.A., in *Journ. of Comp. Med. and Surg.*, vol. viii., January 1887, fell into the same error, no doubt misled by Dujardin's work, and also at that time being unacquainted with Krabbe's monograph. Leidy's own description shows that the tapeworm he had under observation was not as he diagnosed it, *T. angulata*, Rudolphi, but *T. undulata*, Rudolphi.

The hooks of my own specimens of *Drepanidotaenia undulata* correspond in detail with those of Krabbe's *T. undulata*.

As will be seen above, the description of the internal anatomy of this worm is very meagre, and under these circumstances I purpose to fill up the void by describing more fully the organs of generation.

The testes (Figs. 3 and 4, *d*), from thirty to forty in number, are situated dorsally in the posterior half of the proglottis. They are more numerous in the proximal and distal portion of the segment, but do not extend in either case beyond the lateral canals. In the medio-posterior line they are very sparse. Each testis sends off an efferent duct. These ducts coalesce until they are reduced to three, and these are again further reduced to a single duct, which becomes the vas-deferens, and, as such, enters what in other instances would be a vesicula seminalis, but which in this case is but an elongated cirrus-pouch. Consequently, there is no actual vesicula seminalis, but the spermatozoa are passed directly through the terminal duct to the cirrus within its pouch.

The male genital pore (Fig. 4, *a*) is situated in the proximal anterior third, on the dorso-lateral border of the segment, and is posterior to the female pore. The male genital pore in its early stage is but an insignificant aperture, and only when copulation is about to take place does it become protuberant, and then not to any great extent.

The cirrus (Fig. 4, *b*) is a long rod, and is capable, for copulatory purposes, of extending itself to a distance of 0·219 mm. beyond the male genital pore. The cirrus itself is smooth, but its cuticular sheath is spinous. This sheath is but a continuation of the vas-deferens, and in the act of copulation it enters the vagina together with the cirrus, and is apparently clasped by the vulva, for, on withdrawal, one frequently sees portions of the endothelid of the vagina drawn away by the act of retrocession of the spinous sheath, and there are times when the spinous sheath itself is torn away and left in the vagina, thus exposing the smooth cirrus.

The cirrus-pouch (Fig. 4, *b*) runs two-thirds of the whole length of the segment anteriorly, but posteriorly to the vaginal canal. The vas-deferens within the pouch is serpentine, and, emerging from it, forms a series of loops and gradually descends towards the dorso-median line of the segment, and then runs proximally. In its course the vasa-efferentia make a junction with it, and it thus receives the spermatozoa from the testes. These tortuous, looped semeniferous tubules, together with the serpentine vaginal canal, find their counterpart morphologically in the higher orders of nature—the vasa-deferentia of the insecta (*Nepa*) and the Mullerian duct of the salamander being cases in point.

The female genital pore (Fig. 5, *e*) is as insignificant exteriorly as that of the male. It is situated on the extreme anterior lateral-ventral corner of the segment, and is over-lapped and hidden from view by the posterior proximal border of the preceding segment, so much so that the cirrus, for the purpose of copulation, has to force its way through the angular terminal aperture of the preceding segment. It requires delicate manipulation with fine dissecting needles to lift up the posterior portion of the preceding segment in order to trace the pore and course of the vaginal canal. The female pore is a simple aperture in the tissue, devoid of papillae or protuberance. In stained sections the whole length of the vagina is seen to be composed of circular and longitudinal muscular fibres. As the vaginal canal (Fig. 5, *f*) recedes it becomes narrower, forms a series of loops, and then distends itself into a curved sac—the receptaculum seminalis, (Fig. 5, *g*)—whose distal end descends in the segment, and from which emerges the efferentia, or fructifying canal.

The efferential canal of the ovaries makes a junction with this canal, as also does the yelk and shell glands. The whole of these organs, with the exception of the shell-gland, lie in the central portion of the segment, ventrally, and are so crowded together and superimposed dorsally by the male organs that it is a difficult task to differentiate and study them *in situ*.

The paired ovaries (Fig. 5, *hh*) are composed of follicles whose efferent ducts fuse at the proximal end of each ovary and form the oviduct. The yelk-gland (Fig. 5, *j*) is dendritic, while the shell-gland (Fig. 5, *i*) is a long reniform gland which lies posterior to the other organs, and is the only one that can be clearly discriminated.

The uterus (Fig. 6) is composed of longitudinal pouches. These pouches occupy the whole of the ripe or uterine segment, and they are filled to repletion with oncospheres or six-hooked broods. Usually this hexacanth stage is a spherical object or an elongated homogeneous mass of impregnated protoplasm, waiting to find or be transferred to its specific *nurse*, so as to be transformed into a cystic scolex—cysticercoid.

In this instance there is a departure from the usual course of development, which is of itself interesting from an evolutionary standpoint. After passing through a series of successive stages in the uterus (and I have traced it through eight such stages of development), it finally evolves itself into a medusiform body or six-hooked brood (Fig. 9). These six hooks, placed at equal distances, support the velum from the interior of the invaginated gastrula cavity. This medusiform embryo is enveloped by two membranous coverings. The egg itself is semi-oval, its long axis being 0·058 and its vertical axis 0·05 mm. There is a clear space of 0·01 mm. between the outer covering and the inner membrane. The medusiform embryo is 0·034 mm. long, and its medio-vertical axis 0·024 mm. The embryonic hooks have a length of 0·017 mm.

I have in a previous communication expressed my conviction from my own observations that Professor Huxley's views in connection with the Cestoidae having possibly never advanced beyond a gastrula stage in their development were in the main correct, and this medusoid formation of the six-hooked brood strengthens that conviction, because the next succeeding stage in their development from the hexacanth stage is the cystic scolex, *Cysticercus*; and from this scolex is produced, in its final host, by strobilation, the mature tapeworm.

Explanation of Plate 19.

Figs. 1 and 2. Two different aspects of scolex, × 18.

Fig. 3. Young proglottis, showing early formation and position of testes in segment, × 18.

" 4. Male genital organs *in situ*, dorsal, × 18: *a*, male genital pore; *b*, cirrus-pouch and cirrus with serpentine vas-deferens enclosed; *c*, coiled and looped exterior vas-deferens; *d*, testes with vasa-efferentia.

" 5. Female genital organs *in situ*, ventral, × 18: *e*, female genital pore and vagina; *f*, vaginal canal; *g*, receptaculum seminalis; *hh*, distal and proximal ovaries; *i*, shell-gland; *j*, yelk-gland.

" 6. Uterine segment with mature egg, × 18.

" 7. Isolated testis with its vasa-efferentia, × 155.

" 8. Male and female genital pores, with cirrus exserted, × 155.

" 9. Medusiform embryo, or hexacanth stage, × 380.

" 10. Hooks from scolex (Figs. 1 and 2): *a*, primus; *b*, secundus, × 175.

" 11. *a*, Dujardin's *Taenia angulata*, × 200; *b*, Krabbe's *T. undulata*, × 261.

" 12. *a*, Dujardin's *T. undulata*, × 430; *b*, Krabbe's *T. angulata*, × 920.

ON A NEW TAPEWORM, *DREPANIDOTAENIA SAGITTA.*

By T. B. Rosseter, F.R.M.S.

(*Read January 19th*, 1906.)

Plate 20.

This worm was taken, amongst other helminths, from the intestine of a duck, *Anas boschas dom.*, during the month of January, 1905. It was a perfect worm, having a mean length of 178 mm., the mature proglottides having a breadth of 1·013 mm. and length 0·338 mm.

The scolex itself is pyriform, and perforated at its base with a circular orifice. This orifice is not a depression caused by the retraction of the rostellum inverting the cuticula of the base of the scolex, but is a naturally formed inverted cavity from whose sides spring the elastic muscles which elevate and retract the rostellum. When the rostellum emerges from the cavity it is a long, flexible-armed, attenuated organ, and, when fully exserted, has a length of 0·051 mm. The hooks with which it is armed are sickle-shaped, and are 0·010 mm. in length (Plate 20, Fig. 2). Their number was not ascertainable, as caducity of the same had set in; and there was, and is in my preserved specimen, only one hook left to enable me to determine the identity of the species.

At equal distances round the scolex are placed four oval suckers (Fig. 1), the distal end of each sucker standing out from the body of the scolex, so as to give it a barbed or arrow-headed appearance. The scolex is 0·135 mm. long, and its approximate diameter, including the suckers, is 0·203 mm. Strobilisation commences at about 0·321 mm. from the scolex.

The male genital pore is situated on the median lateral border of the proglottis (Fig. 3). The vesicula seminalis, with its attendant cirrus-pouch, curves strongly downwards, and then runs upwards to the dorso-anterior border of the segment, its serpentine vas-deferens ending in a moniliform spatulate testis.

The testis (Fig. 3, *d*) is 0·106 mm. long, and its diameter is

0·067 mm. Its distal end is concave, whilst its proximal end, or efferent duct, is drawn out to form the vas-deferens (Fig. 3, *c*), which is a short serpentiform duct. The vesicula seminalis (Fig. 3, *b*) is an elongated oval sac, 0·17 mm. long and 0·027 mm. in diameter. This includes the cirrus-sheath. The cirrus is a smooth rod 0·114 mm. long and 0·002 mm. in diameter. When exserted for the purpose of coition the cirrus-sheath is extruded with it from the male genital pore, and when so extruded a stricture occurs in the anterior portion of the hyaline sheath, which forms a hollow bulb.

Prostate glands are absent, or, if they exist, I have not been able to locate them by staining.

The female genital pore (Fig. 4, *e*) is situated behind the male, a distance of 0·034 mm. from the ventral lateral corner of the segment. It is a simple circular depression of the cuticle, and the vagina is a smooth muscular cavity. The vaginal canal (Fig. 4, *f*) runs obliquely upwards to the anterior border of the proglottis, when it curves distally and proximally, forming a ring, and, running distally, forms the receptaculum seminalis.

The receptaculum seminalis (Figs. 4 and 9) is an oval sac 0·085 mm. long, and with an approximate diameter through the median line of 0·034 mm. It is partially covered dorsally by the monotestis.

The ovaries (Fig. 4, *hh*) are paired organs. In the early stage of their development they are globular, but in the mature or secretive stage they develop into a series of lobular glands.

The yelk and shell glands (Fig. 4, *i*, *j*) are superimposed in the median posterior portion of the segment.

The uterus (Fig. 5) consists of a series of six or more globular pouches, clustered at intervals around the uterine canal in a staphylitic form. The uterine eggs (Figs. 7 and 8) are somewhat citron-shaped. They have a mean length of 0·044 mm., and a diameter of 0·034 mm. The shelly covering is, at either polar axis, elongated into what is apparently an air-chamber. Besides the outer covering or shell, the embryo is enclosed in a transparent structureless membrane. The proximal chamber, or pocket, yields by compression, and opens like a catch-spring; and by this means the contents of the ovum (viz. the six-hooked brood, or hexacanth stage) is emitted through the orifice (Figs. 7 and 8). These polar chambers or pockets are distinctly different from the papillae seen in the polar axes of the eggs of either *Hymenolepis murina* (Weinland) or those of *Trichocephalus dispar*. There is some affinity, however, with the latter, as the papillae of the former are the elongations of the embryonic membrane alone, and do not affect the shell. Neither is it comparable to the lid-like operculum of *Bothriocephalus latus*, but, as will be seen on reference to Figs. 7 and 8, it is a simple catch-spring arrangement of the shell.

In the determination of a new species of tapeworm, much depends on the character, number, length, and divisible length of the cephalic hooks—that is, if the creature is one of the armed species; but if unarmed, then the structural formation and anatomy, both external and internal, must be carefully studied and compared with other known species, so as to arrive at a definite conclusion. In the first case, although the hook must necessarily play an important part in arriving at a conclusion as to the species under consideration, still the case is at all times strengthened if proofs can be adduced of the dissimilarity in the anatomy of the species in question from any other known tapeworm. In this instance, as I have already mentioned, I have but one hook to guide me to defining the species; still, this hook, plus the number, is so dissimilar in divisibility of length and character from any other of the *Drepanidotaenia* (Railliet) as to give it a distinctive character.

Externally, the four oval suckers (Fig. 1) are so placed round the pyriform scolex as to give the head an arrow-like or sagittal appearance; that is to say, their proximal ends are attached to the base of the scolex, whilst their distal ends stand out prominently from the sides of the head. On the proximal lateral border the genital pores are not bossed, as one so often finds them in avian tapeworms, but are situated in depressions or cavities. These are all external characteristics. In its internal anatomy the spatuliform monotestis is somewhat remarkable, but otherwise there is little in the genitalia that calls for comment. The six-hooked brood, or hexacanth stage, however, cannot be so easily dismissed, as I know of no ovum—neither can I, on reference to the literature at my disposal, find one—with the catch-spring arrangement possessed by that of this species. This character, taken in conjunction with the hooks and the formation of the scolex with its suckers, strengthens the decision I have arrived at, and must be my apology for forming a new and distinct species for this avian tapeworm. I propose to name this species *Drepanidotaenia sagitta.*

Explanation of Plate 20.

Fig. 1. Scolex with suckers, × 70.
„ 2. Hook from rostellum, × 2,500.
„ 3. Male organs in segment, × 70.
„ 4. Female „ „ „ × 70.
„ 5. Uterine segment with staphylitic pouches, × 70.
„ 6. Segment filled with six-hooked brood, or hexacanth stage of development, × 70.
„ 7. Eggs from same, showing pockets and catch-spring arrangement of polar axis, × 350.
„ 8 and 9. Male and female genital pores with male organ protruded previous to copulation (diagrammatic).

[*a*, cirrus; *b*, vesicula seminalis; *c*, vas-deferens; *d*, spatulate monotestis: *e*, vagina; *f*, vaginal canal; *g*, receptaculum seminalis, with fructifying duct; *hh*, proximal and distal ovaries; *i*, *j*, shell and yelk glands.]

THE PRESIDENT'S ADDRESS.

THE RELATIVE MERITS OF THE LONG- AND SHORT-TUBE MICROSCOPES.

By E. J. Spitta, F.R.M.S., F.R.A.S.

(*Delivered February 16th,* 1906.)

Gentlemen,—

It was my intention at the last meeting, had there been time, to explain that I proposed this evening breaking through the conventional form of presidential address. It has been the custom for the President to choose a subject for this purpose, to enumerate the details connected therewith, and to dilate upon them in all their bearings. To-night, however, I propose to make this change: I shall say a few words upon the rival merits of the long- and short-tube form of microscope, but leave you to discuss the subject.

I think this is only in keeping with what you have heard me say before now, that I consider one of the real values of a society of this nature is to enlarge one's view upon any subject microscopical. You can easily understand that the philosopher in his study is apt to look out of his window and think the world uncommonly small—little, in fact, beyond that which is embraced in his narrow angle of view. If he comes to a society of this kind he will quickly find, with so many enthusiastic and able men present, that he is mistaken, and that his views have been too narrow; whereupon his mind becomes enlarged, the subject of his study is propagated and discussed, and science is thereby advanced.

The reason I have chosen the subject mentioned for my address to-night is because I think it is one of universal interest. I can assure you that the selection of something suitable is not easy; and here, again, I am bound to admit that I have left the customary paths, of which I hope you will approve when you hear my reasons for so doing. You all know that it has usually been the habit of the President to take for his subject the particular one with which he is most familiar; but I think you will agree with me that, as a general rule, doing this has made a rather dull evening for a great many of those present, simply from the fact that only a limited number can take a genuine interest in the special subject selected. I think special subjects require special lectures, and then those not interested in the particular line of research can silently steal out of the door—as I see them gracefully doing sometimes—and catch early trains home or seek more congenial environment.

It is not easy to ascertain who first designed the short-tube microscope, with its correspondingly corrected objectives, although I believe it was Oberhaeuser, in France. Personally, my first introduction was somewhere in the very early 'seventies; but, of course, on the Continent it was in existence long before this, and I have a copy of a picture of one made in 1857.

When first introduced into England, the short-tube stand and its objectives were not well received by the majority of microscopists. This arose from the fact that it was an unwritten law—like that of the Medes and Persians, which altereth not—that all, or very nearly all, the magnification of the object should be performed by the objective, and as little as possible by the ocular. Well can I recollect, several years ago, a learned man writing to me concerning the construction of a certain piece of experimental apparatus, to the effect that it was much the same as if you "used the eye-piece to contribute anything more than the smallest increment in the final magnification of the object with the microscope," and was consequently not of good design.

Every one in this room knows from experience, that if the tube of the microscope be shortened a sensible amount, the amplification is considerably reduced; hence it is equally obvious, that if the magnification has to be brought up again to what it was before the tube was shortened, a stronger ocular must be employed. To make this matter quite clear, I must point out that there are two tube-lengths in the microscope, whether of English or Continental length—the mechanical and the optical. The former is measured from the shoulder of the objective to the upper end of the draw-tube, where the eye-piece drops in, and is often called *the* tube-length. Its length is 250 mm. or 10 in. for the English type, and 160 or 170 mm. for the short or Continental design. The optical tube-length, however, is altogether different, and seldom heard of by the average worker.

To start from the commencement of the subject, you have all heard of the focal planes of an objective. It is to the upper focal plane of the microscopic objective that I want to call your attention for a moment. It would take too long to explain how its position is easily found experimentally; but for the sake of simplicity, and to make what follows more readily understood, I may mention that it usually lies near the front of the objective, either in front or behind the object-glass. In two apochromatic $\frac{1}{12}$-in. objectives actually measured, I found it was 22·7 mm. below the shoulder in one case, and 23·3 mm. in the other. This gives you a sufficiently accurate idea of its whereabouts, and will enable you to follow what I am going to say. If you were to place a piece of ground glass in this upper focal plane, you would find—perhaps to your astonishment—that the object was not magnified at all. Placed at 4 mm. it would be amplified twice, whilst at 12 and 18 mm. it would be magnified six and nine times respectively. You will see, then, that this distance away from the upper focal plane (whatever it may be), divided by the focus of the objective, gives you the magnification of the object. It is this distance that is called the "optical tube-length." It is permissible to define it as the distance at which the image is formed from the upper focal plane of the objective. Further, I might be allowed to state, whatever be the length selected—whether 160 or 180 mm.—the actual plane of focus is called the "image plane."

Years ago there was no fixed limit of length for the optical tube, one maker taking one length and another a different one. What was equally troublesome, there was no fixed distance at which the eye-piece should drop into the draw-tube, so that its lower focal plane should coincide with the image plane, just mentioned, of the objective. In consequence of this unsettled state, a trouble arose that an objective by one maker did not appear to magnify so much as, or perhaps it magnified more than, one of the same focus made by another firm. Obviously, if the eye-piece dropped in too far, it was like shortening the optical tube-length, because the image plane must be lowered by a change of focus so as to coincide with the lower focal plane of the ocular. I have already explained that shortening the optical tube-length means lessening the magnification, and hence the cause of the trouble. If the reverse—the eye-piece not dropping far enough—then it was the same as increasing the optical tube-length, for the image plane had to be raised in this instance to reach the lower focal plane of the ocular, which meant increasing the optical tube-length, and of course the magnification.

All these troubles were set right by the great ability of the late Professor Abbe. When he first took the subject in hand, everything was in a state of chaos and confusion; there was nothing definite. It was he who laid down the laws (at any rate, for his new apochromatic lenses) that the optical tube-length should be 20 mm. longer than the mechanical, whether English or Continental, and that the lower focal plane of every compensating eye-piece should be so computed as to lie 12 mm. below the mouth of the draw-tube. The direct outcome of this capital idea is that the compensating eye-pieces, when interchanged, do not require any change of focus save to a very limited amount, because the lower focal planes of each lie exactly the same distance down the draw-tube.

This slight digression leads me quite easily to the point. It is evident that at 180 mm. the magnification of the image produced by the 2-mm. is only 90, whilst at 270 mm. it is 135; hence it is obvious that the amplification of the short-tube objective requires more magnification by the eye-piece than one of a similar focus on the long tube—which is the same as saying that the ocular has more work to do on the short-tube system than on the long. This proves that the contention of the older microscopist was a valid one, and not a simple fancy, so far as it went; and I trust I have made the matter clear in its details.

Since the introduction of the Jena glass, however, opticians have been able to construct objectives which can stand eye-piecing in a way that the old school never dreamed of, even in their moments of wildest imagination; for you know as well as I do that a modern lens—a semi-apochromatic, I mean—that will not work successfully with an eye-piece that raises the final magnification of the object to a figure equal numerically to 1,000 times its numerical aperture, is not worth the box which contains it. This being true, which it undoubtedly is, the great objection is at once nullified, and the controversy is placed on a different footing.

As regards the relative diameter of the tubes in the two forms of make, the English type, being slightly larger, requires all the eye-pieces to be made in accordance. A gain in field in some instances results, but it is an open question whether this is of any real advantage. The modern objective, the high-power one especially, only gives sharp definition at one and the same time over the central and intermediate zones of the field of view, the outer one being always more or less fluffy; hence the question arises as to what real use is the enlargement of the field of view under such circumstances. There are microscopists I have met who have told me that they consider the modern objective is really no advance on the old—in fact, that it is retrograde—because of this limited diameter of true definition; and they point out that they possess old-fashioned ones of far more extensive diameter of field in what they call perfect focus. To such as these I must say that, according to existing knowledge, I believe no living computer can make an objective of high power which will give really perfect definition over the outer-lying portions of the field without a falling off in the central and intermediate zones. In fact, the whole thing is a compromise. If you have the best in the centre and intermediate, the outer zone must suffer; whereas if all three are to be in focus at the same moment, it is at the expense everywhere of the finest definition. Seeing that most microscopical objects only occupy the central and intermediate zones of the field of view, it is generally admitted to be better to make these zones furnish the finest possible definition, even though it be at the expense of the outer one, this being the reason why modern objectives show the falling off in the outermost parts of the field to which I have referred.

So much for the optical side of the question; now as to what may be termed the mechanical. There is no doubt that for the past several years the short-tube instrument has been steadily gaining favour, and that somewhat rapidly. If you take the trouble to investigate the matter, you will find that nearly every new stand or objective is of the Continental length, and hardly one of the English model. With respect to the student, the greater portability of the one over the other is a great inducement, and with those who have to take their instrument about with them, specially those going abroad, it is imperative, provided that the utility of the optical parts be not impaired thereby. With the biologist, and most certainly with the bacteriologist, the short tube is much preferred, because it permits the worker to sit at his bench and use his instrument upright—a necessity in some observations—which he cannot do with the long tube unless provided with an office stool, or some such elevated seat.

It has been said of my own profession that its members mostly prefer the English stand because it looks so much more important; but this is a libel, for I think the reason you see it so often in the consulting rooms of the older men is because it was bought years ago, when the shorter one was not in favour.

With the ordinary amateur, the form of stand which he uses does not seem so much to matter, because he can always incline it if found too high; but if he be one who is obliged to use his stand vertically because of the employment of fluid media on the stage, then he will, no doubt, prefer the Continental form.

As regards the use of the two stands in photo-micrography, another point comes to the front of which I have not yet spoken. Owing to the optical tube-length being so much shorter in the Continental instrument, the actual magnifying power of the objective is much less. Consequently, the ocular must be more powerful in the short than in the long tube to produce the same amplification with the same focus objective. Now, conversely, if it be desired to obtain the lowest magnification possible for the sake of the large-sized field afforded thereby, this can be more easily obtained with the Continental than with the English model. This is of importance: sometimes one may be just unable to get an object entirely in the field, even with the lowest ocular, when using the long tube; but by employing the short-tube objective of the same focus, the photographer may be enabled to obtain the desired effect—in other words, he can just get the entire object into the field of view, which he could not do before. There is, however, the opposite side of the question. Should he desire to obtain the fullest amount of magnification with the objective in use—just, perhaps, beyond that afforded by the greatest extension of the camera when using the short-tube objective and the highest ocular—he can always get one and a half times as much with the same camera extension and ocular by changing the objective for one of the same focus adapted for the long tube, if he has the longer stand available to put it on.

There is yet another item to mention which is in favour of the short tube. It is that the length of arm required to reach the coarse adjustment is so much less than in the long. Many photo-micrographers feel this advantage to be so great that they purposely use this stand on all possible occasions.

In conclusion, after some years of actual experience in this special line of work, as well as with the microscope for all other purposes, I think the ideal is to have a short-tube instrument in which provision is made for rapidly lengthening it into a long-tube one; then objectives of both Continental and English make can be used at pleasure.

A SIMPLE METHOD OF PRODUCING STEREO-PHOTO-MICROGRAPHS.

By W. P. Dollman (of Adelaide, South Australia).

(*Read before the Royal Microscopical Society February 21st, 1906.*)

Plate 21.

I will endeavour to put in as concise a form as possible the principal points in the production of the stereo-micrographs which will be shown this evening. I have taken a practical interest in stereoscopic photography since 1865, optical work having always an attraction for me. Some twelve or more months ago a friend called my attention to an article on stereo-photo-micrography (which I had perused at the time of its publication, but had since forgotten) in the *British Journal of Photography Almanac* for 1894, by the then editor, the late Mr. J. Traill Taylor, who therein explained several methods of producing stereograms of microscopic objects.

I adopted what I thought the simplest method—that of obscuring by a semicircular shield half of the objective in use. I have a cloth-lined brass tube with one end half-screened (blackened, of course), made to slip over the lens and to revolve smoothly on the mount. As the objectives vary in diameter, the tube was made to fit the widest one, and strips of cardboard were cut to make the tube fit the smaller ones. In the case of photo-objectives (I have used these from 2 to 6-in. focus), a semicircular shield of thin blackened brass can be dropped against the diaphragm between the combinations, and this is certainly the better place for the screen. I have used a 2-in. Dallmeyer portrait combination (which is specially good for this work), a $4\frac{1}{2}$-in. Unar, and a 6-in. Goerz. I use a f 5·6 diaphragm with the Dallmeyer, the same or f 8 with the Unar, and f 8 with the Goerz. Of course, for low magnifications of a rough object it is advisable to work with a low power (the $4\frac{1}{2}$-in. focus lens was used for most of the prints exhibited); but for larger objects a 6-in. lens would define better. The little Dallmeyer lens is a marvel for definition and flatness over the small field used. I have had extra tubes made for my microscope (a Van Heurck, by Watson), to take the place of the lower rack-work tube and the upper sliding tube, which carry the photo-lenses—the Dallmeyer at the bottom of the draw-tube, the Unar (for which I had a new mount made, so as to get it inside the tube) about $1\frac{1}{2}$ in. down the tube from the top, and the Goerz outside on the eye-piece end of the microscope. These adaptations enable the lenses to be carried at the suitable distances from the object on the stage, and allow sufficient rackwork for focussing. When the distance is too great (as it will be in low-power work) for the hand to reach the focussing pinion, I have to use a Hook's joint focussing-rod; but for the higher powers I have a long rod on the right side of the camera, with a pulley-wheel near the end, over which and the fine adjustment-screw head runs a cotton-thread loop, which I find quite effective for monocular work, even with a $\frac{1}{12}$-in. objective.

The camera I use is a whole-plate one with a long bellows, and, for long distance work, a telescopic attachment in front (made of rolled brown paper). The upright position of the plate in the camera is the more convenient for photographing opaque objects requiring to be lighted from the front and side, and, in this case, the objective should be divided horizontally. For transparent objects lighted centrally from the back the plate may be horizontal, and the lens divided vertically. I effect the reversal of the images on the plate, so that the prints will not require to be cut, and so simplify the mounting, by using a carrier in the dark slide (the whole-plate slide allows this to be done), in which the plate (5 by 4 in.) can be placed $2\frac{1}{4}$ in. out of centre, so as to receive the image from the right-hand or upper half of the lens on the left-hand or lower half of the plate. The opening in the carrier should be $7\frac{1}{2}$ by 4 in., a piece of glass $2\frac{1}{4}$ by 4 in. filling the otherwise unoccupied end. A screen of blackened card or thick paper with an aperture in the centre of $2\frac{1}{8}$ by 3 in. should be placed in the carrier, to protect one-half of the plate while the other is being exposed. After exposing one side of the plate the slide is taken into the dark room, and the plate moved to the other end of the carrier. Then the screen on the objective is moved half round, or, in the case of a lens in the draw-tube, the tube is given a semi-revolution without disturbing the focus, and the second exposure can be made. It is important to remember, when photographing opaque objects, that, to secure even illumination of the two halves, the illuminant must be on the same level as the centre of the objective. For the lighting of large transparent objects, when using the 4½ and 6-in. objectives, I have had a cell which carries a 4½, 6, or 8-in. focus uncorrected condenser fitted to the large aperture under the main stage of the microscope, and brought as near as possible to the object. For the smaller objects I use an achromatic condenser of 1·0 N.A. This can be altered in power by removing the top combination, or, if necessary, using only the lower of the three lenses. As illuminant I use acetylene (the finest light for all ordinary work) from a special burner I had made, limelight, and sometimes sunlight (parallel rays) through a heat-absorbing medium. On the platform carrying the apparatus I have marked a scale from 0 to 49 in., with the zero at the level of the microscopic stage. This, with the aid of tables for the various lenses used, enables me to work to definite magnitudes, and also to calculate approximately the focus of all objectives that can be used without an eye-piece.

I might remark in passing that low-power micro-objectives are almost invariably wrongly named, a nominal 3-in. being only 2·3 in., a so-called 2-in. only 1·5 in., and so on. I do not think I need say anything about exposure, as that depends upon the colour or brightness of the object, illumination, and magnification. I use ordinary developers, such as would be suitable for landscapes, using those which give hard results to accentuate feeble contrasts. Chromatic plates, with or without a yellow screen, are used, and a malachite-green light-filter when monochromatic light is desirable. A good deal of my apparatus is makeshift, but is effectual, and my optical outfit is of the best, both in low and high powers, condensers, etc. I might mention that (as the major conjucate focus is being used) all non-symmetrical photographic lenses, such as "Unars," "Stigmatics," and portrait combinations, should be reversed on the microscope (the front combination being presented to the plate) to enable them to perform to the best advantage.

Before concluding, I would like to draw attention to a curious (and to me interesting) optical defect noticeable in one of the prints. In a photograph of a slide of polyzoa (*Idmonea radians*) I noticed the distorted image of a small filament, which was on the underside of the cover-glass of the object and out of focus. It was noticed that on the right-hand half of the print this object took this shape (and on the left is curved in the opposite direction, thus). The true image should have been a straight, upright line. This distortion was due, no doubt, to the tendency of out-of-focus images to assume the form of the aperture through which the rays pass (in this case semicircular), thus bending the out-of-focus image of the straight line in opposite directions, when this image was formed by the opposite halves of a circular lens.

In this description I fear I have been rather diffuse, and have detailed much that is perhaps generally known; but I thought it expedient, owing to my inability to be present at the meeting when this paper will be read, to be a little particular.

Explanation of Plate 21.

Polyzoa—*Idmonea radians*, × 9.

A SIMPLE METHOD OF TAKING STEREO-PHOTO-MICROGRAPHS AND MOUNTING THE PRINTS WITHOUT CUTTING.

By H. Taverner, F.R.M.S.

(*Read April 20th*, 1906.)

Plates 22—24.

In November, 1903, I had the pleasure of exhibiting before the Royal Microscopical Society two photographs of the hairs on the leg of a water-mite, which I had taken through the right and left tubes of a binocular microscope, in order to demonstrate that the two images were not identical. I did not bring the matter forward as a new discovery, but simply because the object was particularly suited to demonstrate the fact, which I knew was disputed by some microscopists. The photographs in question were too small to be viewed stereoscopically, and I therefore exhibited, under a stereoscope at the same time, two prints of the same subject, taken by a different method, with a magnification of over 200 diameters, which proved that the two dissimilar images combined to form a stereoscopic picture. The method then adopted for the production of the photographs was to cover the front of the objective with a cap (Fig. 1, *a*), by means of which exactly one-half of the front of the lens was cut off. The rotation of this cap through 180° allowed separate pictures to be taken by the right and left halves of the lens.

I did not pursue the matter further at the time, but shortly before Christmas last I wanted a similar photograph for a friend, and it then occurred to me that the axial rays of light were detrimental to the formation of a stereoscopic image, and that if I could stop them out I should obtain better results stereoscopically than by my former method. I therefore tried the experiment of cutting out all the central rays of light by means of a stop placed behind the objective, having a circular aperture so situated that its inner edge was outside the optic axis of the lens (Fig. 1, *b*). The resulting photographs were a decided improvement on those obtained by my former method, and on showing these to Mr. Rheinberg he confirmed me in my intention of experimenting with stops of smaller aperture. I do not think I need say anything further on this point, except to mention that all the photographs on exhibition to night were taken with stops having circular apertures of $2\frac{1}{2}$ to 4 mm. in

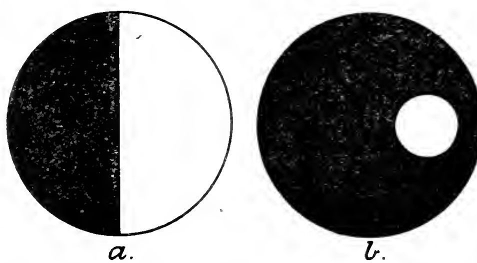


Fig. 1.

diameter, and with the inner edge of the aperture in no case more than 1 mm. from the optic axis of the lens. It will be found necessary to vary the size of the aperture in the stop according to the thickness of the object to be photographed and the objective in use; but the best results, without distortion or exaggerated stereoscopic relief, are to be obtained by the use of a stop having:—

1. The largest possible aperture that will give sufficiently sharp detail in the picture.

2. The inner edge of the aperture as near the optic axis of the lens as will give sufficient stereoscopic relief and, at the same time, the truest appreciation of the thickness of the object, or third dimension.

For convenience in working, Mr. Curteis has made for me a small piece of apparatus which screws into the nose-piece of the microscope, and is itself of the nature of a secondary nose-piece, to facilitate the changing of the stops. It is fitted with a swing-out arm, carrying a ring which holds the stops and which revolves through 180° exactly, thus changing the aperture in the stop from one side of the optic axis to the other, for the purpose of making the two exposures. Except for this revolution of the stop, the two photographs are taken without any alteration whatever in focus, illumination, position of object or apparatus, except, of course, the dry plate.

To obtain the two pictures on one plate in the correct position for printing and mounting without cutting, I use what is known as a repeating back. One picture is taken at a time, that on the left half of the plate with the aperture in the stop to the left of the optic axis, and that on the right half of the plate with the aperture in the stop on the right of the optic axis. The images are now on the negative in the correct positions for printing and mounting without any further trouble. This description is correct for the ½-in. objective and all lower powers, used with an eye-piece, but may possibly have to be reversed with higher powers.

In conclusion, I should like to add that particular care must be taken in fitting the nose-piece so as to ensure the true horizontal alignment of the apertures when the stop is revolved from one side of the optic axis to the other. If the apertures are not truly aligned, the finished prints will not superimpose properly, and will not be clear and sharp. I may, perhaps, also mention that my only trouble has arisen from a difficulty in obtaining equal illumination of both pictures with transparent objects by transmitted light; but as my photographs have been taken without an optical bench, this difficulty may not arise when one is used.

Explanations of Plates 22—24.

Plate 22.

Water-mite (*Ecpolus papilosa*, Soar), female, × 30. Collected and mounted by H. Taverner. Photographed with a $2\frac{1}{2}$-mm. stop. Beck's $1\frac{1}{2}$-in. objective and No. 1 eye-piece.

Plate 23.

Foraminifera (*Orbulina universa*), showing internal Globigerine structure, × 25. Mounted by Mr. A. Earland. Photographed with a $2\frac{1}{2}$-mm. stop. Beck's $1\frac{1}{2}$-in. objective and No. 1 eye-piece.

Plate 24.

Foraminifera. Various species from Timor Sea, 50 fathoms, × 25. Mounted by Mr. A. Earland. Photographed with a 4-mm. stop. Beck's $1\frac{1}{2}$-in. objective and No. 1 eye-piece.

THE SPIDERS OF THE *DIPLOCEPHALUS* GROUP.

By Frank P. Smith.

(*Read April 20th*, 1906.)

The *Diplocephalus* Group contains a vast number of minute spiders, including the smallest known species, and many of curious and grotesque form. A careful revision of the numerous genera constituting this group has resulted in considerable modification of the generally adopted nomenclature. I have made no alterations, however, without giving full details, and it will therefore be a comparatively simple matter, for those who care to take the trouble, to verify or question my conclusions from the data supplied.

The following synonymic list includes all the species of the *Diplocephalus* Group which have occurred in the British Isles :—

Genus **Lophomma**, Menge, 1868.

1847. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Neriene*, Bl., *Spid. G. B. I.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Lophomma*, Menge, *Preuss. Spin.* (*ad partem*).
1869. *Microneta*, ,, ,, ,,
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Tmeticus*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Lophomma*, Sim., *Ar. de France.*
1886. *Micrargus*, Dahl, *Monog. Erig.* (*ad partem*).
1894. *Lophomma*, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.*
1900. *Tapinocyba*, ,, ,, ,, (*ad partem*).

Type : *L. punctatum*, (Bl.).

Lophomma punctatum, (Bl.), 1841.

1841. *Walckenaera punctata*, Bl., *Trans. Linn. Soc.*
1847. *Argus trapezoïdes*, Walck., *Ins. Apt.*
1864. *Walckenaera punctata*, Bl., *Spid. G. B. I.*
1868. *Lophomma stictocephalum*, Menge, *Preuss. Spin.*
1869. *Microneta scrobiculata*, " "
1870–3. *Erigone punctata*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera punctata*, Cambr., *Spid. Dorset.*
1884. *Lophomma punctatum*, Sim., *Ar. de France.*
1894. " " Kulcz., *Ar. Hung.*
1900. " " Cambr., *List Br. Ir. Spid.*

Lophomma herbigradum, (Bl.), 1854.

1854. *Neriene herbigrada*, Bl., *Ann. Mag. N. H.*
1864. " " " *Spid. G. B. I.*
1870–3. *Erigone herbigrada*, Thor., *Rem. on Syn.*
1870–3. " *mordens*, " "
1879–81. *Neriene herbigrada*, Cambr., *Spid. Dorset.*
1881. " *exhilarans*, Cambr., *Ann. Mag. N. H.*
1883. *Tmeticus herbigradus*, Bertkau, *Spin. Rheinp.*
1884. *Lophomma herbigradum*, Sim., *Ar. de France.*
1886. *Micrargus herbigradus*, Dahl, *Monog. Erig.*
1894. *Lophomma herbigradum*, Kulcz., *Ar. Hung.*
1900. " " Cambr., *List Br. Ir. Spid.*

Lophomma laudatum, (Cambr.), 1881.

1881. *Walckenaera laudata*, Cambr., *Spid. Dorset.*
1884. *Lophomma laudatum*, Sim., *Ar. de France.*
1900. " " Cambr., *List Br. Ir. Spid.*

Lophomma curtipes, (Cambr.), 1875.

1875. *Erigone curtipes*, Cambr., *Proc. Berw. Nat. Hist. Club.*
1879–81. *Neriene curtipes*, Cambr., *Spid. Dorset.*
1900. *Lophomma* " " *List Br. Ir. Spid.*

Lophomma subaequalis, (Westr.), 1851.

1851. *Erigone subaequalis*, Westr., *Goteb. Handl.*
1861. " " " *Ar. Suec.*
1870–3. " " Thor., *Rem. on Syn.*
1871. *Walckenaera fortuita*, Cambr., *Trans. Linn. Soc.*

1879–81. *Walckenaera subaequalis*, Cambr., *Spid. Dorset.*
1900. *Tapinocyba* ,, Cambr., *List Br. Ir. Spid.*

Lophomma stativum, (Sim.). 1881.

1881. *Erigone stativum*, Sim., *Bull. Soc. Zool. Fr.*
1884. *Lophomma stativum*, Sim., *Ar. de France.*

Genus **Dicymbium**, Menge, 1868.

1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Neriene*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Dicymbium*, Menge, *Preuss. Spin.*
1870–3. *Erigone*, Thor., *Rem. on Syn.*
1879–81. *Neriene*, Cambr., *Spid. Dorset.*
1883. *Dicymbium*, Bertkau, *Spin. Rheinp.*
1884. ,, Sim., *Ar. de France.*
1886. ,, Dahl, *Monog. Erig.*
1894. ,, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type: *D. tibiale*, (Bl.).

Dicymbium nigrum, (Bl.), 1834.

1834. *Neriene nigra*, Bl., *Researches in Zool.*
1841. *Erigone serotina*, Koch, *Die Arach.*
1851. *Erigone scabristernis*, Westr., *Goteb. Handl.*
1861. ,, ,, ,, *Ar. Suec.*
1864. *Neriene nigra*, Bl., *Spid. G. B. I.*
1868. *Dicymbium gracilipes*, Menge, *Preuss. Spin.*
1870–3. *Erigone nigra*, Thor., *Rem. on Syn.*
1879–81. *Neriene nigra*, Cambr., *Spid. Dorset.*
1883. *Dicymbium nigrum*, Bertkau, *Spin. Rheinp.*
1884. ,, ,, Sim., *Ar. de France.*
1886. ,, ,, Dahl, *Monog. Erig.*
1886. ,, *scabristernis*, Dahl, *Monog. Erig.*
1894. ,, *nigrum*, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Dicymbium tibiale, (Bl.), 1836.

1836. *Neriene tibialis*, Bl., *Lond. Edin. Phil. Mag.*
1864. ,, ,, ,, *Spid. G. B. I.*

1868. *Dicymbium clavipes*, Menge, *Preuss. Spin.*
1879–81. *Neriene tibialis*, Cambr., *Spid. Dorset.*
1886. *Dicymbium tibiale*, Dahl, *Monog. Erig.*
1894. „ „ Kulcz., *Ar. Hung.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Genus **Tiso**, Sim., 1884.

1834. *Theridion*, Wid., *Zool. Misc.* (*ad partem*).
1840. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1841. *Erigone*, Koch, *Die Arach.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Neriene*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Tmeticus*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Tmeticus*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Tiso*, Sim., *Ar. de France.*
1886. *Microctenonyx*, Dahl, *Monog. Erig.* (*ad partem*).
1900. *Tiso*, Cambr., *List Br. Ir. Spid.*

Type: *T. morosus*, Sim.

Tiso vagans, (Bl.), 1834.

1834. *Neriene vagans*, Bl., *Researches in Zool.*
1834. *Theridion longipalpe*, Wid., *Zool. Misc.*
1840. *Argus longipalpis*, Walck., *Ins. Apt.*
1841. *Erigone longimana*, Koch, *Die Arach.*
1861. „ „ Westr., *Ar. Suec.*
1864. *Neriene vagans*, Bl., *Spid. G. B. I.*
1868. *Tmeticus hamipalpis*, Menge, *Preuss. Spin.*
1870–3. *Erigone longimana*, Thor., *Rem. on Syn.*
1879–81. *Neriene* „ Cambr., *Spid. Dorset.*
1883. *Tmeticus longimanus*, Bertkau, *Spin. Rheinp.*
1884. *Tiso vagans*, Sim., *Ar. de France.*
1886. *Microctenonyx longimana*, Dahl, *Monog. Erig.*
1900. *Tiso vagans*, Cambr., *List Br. Ir. Spid.*

Genus **Savignia**, Bl., 1833.

1833. *Savignia*, Bl., *Lond. Edin. Phil. Mag.*
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).

1869. *Phalops*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1884. *Prosoponcus*, Sim., *Ar. de France* (*ad partem*).
1886. *Walckenaera*, Dahl, *Monog. Erig.* (*ad partem*).
1900. *Savignia*, Cambr., *List Br. Ir. Spid.*

Type: *S. frontata*, Bl.

Savignia frontata, Bl., 1833.

1833. *Savignia frontata*, Bl., *Lond. Edin. Phil. Mag.*
1859. *Micryphantes conifer*, Grube, *Archiv. Nat. Liv.- Ehst.- and Kurlands.*
1864. *Walckenaera frontata*, Bl., *Spid. G. B. I.*
1869. *Phalops conicus*, Menge, *Preuss. Spin.*
1870–3. *Erigone frontata*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera frontata*, Cambr., *Spid. Dorset.*
1884. *Prosoponcus frontatus*, Sim., *Ar. de France.*
1886. *Walckenaera frontata*, Dahl, *Monog. Erig.*
1900. *Savignia frontata*, Cambr., *List Br. Ir. Spid.*

Genus **Monocephalus**, n.g.

1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1884. *Plaesiocraerus*, Sim., *Ar. de France* (*ad partem*).
1900. *Diplocephalus*, Cambr., *List Br. Ir. Spid.* (*ad partem*).
1900. *Tmeticus*, ,, ,, ,, ,,

Type: *M. fuscipes*, (Bl.).

The following are the most important characters separating this genus from the genus *Diplocephalus*. The clypeus in the male, from above to below, does not slope inwards. The tibia of the male palpus is produced, as in *Diplocephalus*, in the form of a large, broad apophysis, but differs in being obtusely, almost squarely, truncated at the extremity, and devoid of any curved projections. The form of the female epigynum is totally different from that of the typical *Diplocephalus*, being considerably more complex and devoid of a median fissure. *Diplocephalus* (*Plaesiocraerus*) *castaneipes*, Sim., 1884, a species which has not yet occurred in Britain, is referable to this genus.

Monocephalus fuscipes, (Bl.), 1836.

1836. *Walckenaera fuscipes*, Bl., *Lond. Edin. Phil. Mag.*
1864. „ „ „ *Spid. G. B. I.*
1879-81. „ „ Cambr., *Spid. Dorset.*
1884. *Plaesiocraerus fuscipes*, Sim., *Ar. de France.*
1894. *Tmeticus neglectus*, Cambr., *Ann. Scottish Nat. Hist.*
1900. *Diplocephalus fuscipes*, Cambr., *List Br. Ir. Spid.*
1900. *Tmeticus neglectus*, „ „ „

Genus **Diplocephalus**, Bertkau, 1883.

1833. *Walckenaëria*, Bl., *Lond. Edin. Phil. Mag.* (*ad partem*).
1834. *Theridion*, Wid., *Zool. Misc.* (*ad partem*).
1840. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1841. *Micryphantes*, C. L. Koch, *Die Arach.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Lophomma*, Menge, *Preuss. Spin.* (*ad partem*).
1868. *Lophocarenum*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Diplocephalus*, Bertkau, *Spin. Rheinp.* „
1883. *Lophocarenum*, „ „ „ „
1884. *Prosoponcus*, Sim., *Ar. de France* (*ad partem*).
1884. *Plaesiocraerus*, „ „ „ „
1886. *Walckenaera*, Dahl, *Monog. Erig.* „
1886. *Lophocarenum*, „ „ „ „
1886. *Moebelia*, „ „ „ „
1894. *Diplocephalus*, Kulcz., *Ar. Hung.*
1900. „ Cambr., *List Br. Ir. Spid.* (*ad partem*).
1901. *Erigonella*, Dahl, *Sitz-Bericht Gesell. Nat. Freunde* (*ad partem*).

Type: *D. foraminiferus*, (Cambr.), 1875.

Diplocephalus cristatus, (Bl.), 1833.

1833. *Walckenaëria cristata*, Bl., *Lond. Edin. Phil. Mag.*
1834. *Theridion bicorne*, Wid., *Zool. Misc.*
1840. *Argus bicornis*, Walck., *Ins. Apt.*
1841. *Micryphantes caespitum*, C. L. Koch, *Die Arach.*

1861. *Erigone bicornis*, Westr., *Ar. Suec.*
1864. *Walckenaera cristata*, Bl., *Spid. G. B. I.*
1868. *Lophomma bicorne*, Menge, *Preuss. Spin.*
1870–3. *Erigone cristata*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera cristata*, Cambr., *Spid. Dorset.*
1883. *Diplocephalus cristatus*, Bertkau, *Spin. Rheinp.*
1884. *Prosoponcus* ,, Sim., *Ar. de France.*
1886. *Walckenaera cristata*, Dahl, *Monog. Erig.*
1894. *Diplocephalus cristatus*, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Diplocephalus permixtus, (Cambr.), 1871.

1871. *Walckenaera permixta*, Cambr., *Trans. Linn. Soc.*
1879–81. ,, ,, ,, *Spid. Dorset.*
1884. *Plaesiocraerus permixtus*, Sim., *Ar. de France.*
1900. *Diplocephalus* ,, Cambr., *List Br. Ir. Spid.*

Diplocephalus spinosus, Hull, 1901.*

1901. *Diplocephalus spinosus*, Hull, *Naturalist.*

Diplocephalus latifrons, (Cambr.), 1863.

1863. *Walckenaera latifrons*, Cambr., *Zoologist.*
1867. *Micryphantes cucullatus*, Ohl., *Die Arach.*
1868. *Lophocarenum bihamatum*, Menge, *Preuss. Spin.*
1879–81. *Walckenaera latifrons*, Cambr., *Spid. Dorset.*
1884. *Plaesiocraerus* ,, Sim., *Ar. de France.*
1886. *Lophocarenum* ,, Dahl, *Monog. Erig.*
1894. *Diplocephalus* ,, Kulcz., *Ar. Hung.*
1900. ,, ,, Camb., *List Br. Ir. Spid.*
1900. ,, *alpinus*, Cambr., *List Br. Ir. Spid.*
1901. *Erigonella latifrons*, Dahl, *Sitz-Bericht Gesell. Nat. Freunde.*

Diplocephalus adjacens, Cambr., 1903.

1903. *Diplocephalus adjacens*, Cambr., *Proc. Dors. F. Club.*

* There is some doubt as to whether this spider ought to be regarded as specifically distinct, or merely as a variety of *D. permixtus*. (Cambr.). I hope to discuss this question, both with regard to the above species and to several other similar cases, in a future communication.

Diplocephalus jacksonii, Cambr., 1903.

1903. *Diplocephalus jacksonii*, Cambr., *Proc. Dors. F. Club.*

Diplocephalus picinus, (Bl.), 1841.

1841. *Walckenaera picina*, Bl., *Trans. Linn. Soc.*
1847. *Argus picinus*, Walck., *Ins. Apt.*
1864. *Walckenaera picina*, Bl., *Spid. G. B. I.*
1868. *Lophocarenum erythropum*, Menge, *Preuss. Spin.*
1879–81. *Walckenaera picina*, Cambr., *Spid. Dorset.*
1883. *Lophocarenum picinum*, Bertkau, *Spin. Rheinp.*, p. 232.
1883. *Lophomma* ,, ,, ,, ,, p. 269.
1884. *Plaesiocraerus picinus*, Sim., *Ar. de France.*
1886. *Moebelia picina*, Dahl, *Monog. Erig.*
1894. *Diplocephalus picinus*, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Genus **Entelecara,** Sim., 1884.

1834. *Theridion*, Wid., *Zool. Misc.* (*ad partem*).
1840. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophocarenum*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1883. *Microphantes*, ,, ,, ,, ,,
1884. *Entelecara*, Sim., *Ar. de France.*
1886. *Hypselomma*, Dahl, *Monog. Erig.*
1894. *Entelecara*, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type: *E. erythropus*, (Westr.).

In *Hist. Nat. Araig.*, 1894, Mons. Simon selects *E. acuminata*, (Wid.), as the type of this genus, apparently overlooking the fact that it is the type of *Hypselomma*, Dahl (1886). I here select *E. erythropus*, (Westr.), as the type.

Entelecara acuminata, (Wid.), 1834.

1834. *Theridion acuminatum*, Wid., *Zool. Misc.*
1840. *Argus acuminatus*, Walck., *Ins. Apt.*

1861. *Erigone acuminata*, Westr., *Ar. Suec.*
1863. *Walckenaera altifrons*, Cambr., *Zoologist.*
1870–3. *Erigone* „ Thor., *Rem. on Syn.*
1879–81. *Walckenaera altifrons*, Cambr., *Spid. Dorset.*
1883. *Lophocarenum* „ Bertkau, *Spin. Rheinp.*
1884. *Entelecara acuminata*, Sim., *Ar. de France.*
1886. *Hypselomma altifrons*, Dahl, *Monog. Erig.*
1894. *Entelecara acuminata*, Kulcz., *Ar. Hung.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Entelecara flavipes, (Bl.), 1834.

1834. *Walckenaera flavipes*, Bl., *Researches in Zool.*
1864. „ „ „ *Spid. G. B. I.*
1871. „ *implana*, Cambr., *Trans. Linn. Soc.*
1879–81. „ *flavipes*, „ *Spid. Dorset.*
1879–81. „ *implana*, „ „
1883. *Micryphantes flavipes*, Bertkau, *Spin. Rheinp.*
1884. *Entelecara* „ Sim., *Ar. de France.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Entelecara omissa, Cambr., 1902.

1902. *Entelecara omissa*, Cambr., *Proc. Dors. F. Club.*

Entelecara erythropus, (Westr.), 1851.

1851. *Erigone erythropa*, Westr., *Goteb. Handl.*
1861. „ „ „ *Ar. Suec.*
1862. *Walckenaera borealis*, Cambr., *Zoologist.*
1870–3. *Erigone erythropus*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera erythropa*, Cambr., *Spid. Dorset.*
1884. *Entelecara erythropus*, Sim., *Ar. de France.*
1894. „ „ Kulcz., *Ar. Hung.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Entelecara trifrons, (Cambr.), 1863.

1863. *Walckenaera trifrons*, Cambr., *Zoologist.*
1879–81. „ „ „ *Spid. Dorset.*
1884. *Entelecara* „ Sim., *Ar. de France.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Entelecara thorellii, (Westr.), 1861.

1838. *Micryphantes acuminatus*, Koch, *Die Arach.*
1861. *Erigone thorellii*, Westr., *Ar. Suec.*
1864. *Walckenaera fastigata*, Bl., *Spid. G. B. I.*
1870–3. *Erigone thorellii*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera thorellii*, Cambr., *Spid. Dorset.*
1883. *Lophocarenum* „ Bertkau, *Spin. Rheinp.*
1884. *Entelecara thorellii*, Sim., *Ar. de France.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Entelecara jacksonii, Cambr., 1902.

1902. *Entelecara jacksonii*, Cambr., *Proc. Dors. F. Club.*

Genus **Araeoncus,** Sim., 1884.

1847. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Lophocarenum*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophomma*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Araeoncus*, Sim., *Ar. de France.*
1886. *Walckenaera*, Dahl, *Monog. Erig.* (*ad partem*).
1894. *Diplocephalus*, Kulcz., *Ar. Hung.* (*ad partem*).
1900. *Araeoncus*, Cambr., *List Br. Ir. Spid.*

Type: *A. humilis*, (Bl.).

Araeoncus humilis, (Bl.), 1841.

1841. *Walckenaera humilis*, Bl., *Trans. Linn. Soc.*
1847. *Argus humilis*, Walck., *Ins. Apt.*
1864. *Walckenaera humilis*, Bl., *Spid. G. B. I.*
1868. *Lophocarenum globiceps*, Menge, *Preuss. Spin.*
1870–3. *Erigone humilis*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera humilis*, Cambr., *Spid. Dorset.*
1883. *Lophomma humile*, Bertkau, *Spin. Rheinp.*
1884. *Araeoncus humilis*, Sim., *Ar. de France.*
1886. *Walckenaera humilis*, Dahl, *Monog. Erig.*
1894. *Diplocephalus* „ Kulcz., *Ar. Hung.*
1900. *Araeoncus* „ Cambr., *List Br. Ir. Spid.*

Araeoncus crassiceps, (Westr.), 1861.

1861. *Erigone crassiceps*, Westr., *Ar. Suec.*
1863. *Walckenaera affinitata*, Cambr., *Zoologist.*
1870–3. *Erigone crassiceps*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera affinitata*, Cambr., *Spid. Dorset.*
1879–81. ,, *crassiceps*, ,, ,,
1884. *Araeoncus crassiceps*, Sim., *Ar. de France.*
1886. *Walckenaera* ,, Dahl, *Monog. Erig.*
1900. *Araeoncus* ,, Cambr., *List Br. Ir. Spid.*

Genus **Troxochrus**, Sim., 1884.

1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Lophocarenum*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophomma*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1883. *Lophocarenum*, ,, ,, ,,
1884. *Troxochrus*, Sim., *Ar. de France.*
1886. *Lophocarenum*, Dahl, *Monog. Erig.* (*ad partem*).
1894. *Troxochrus*, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.*
1900. *Diplocephalus*, ,, ,, ,, (*ad partem*).
1901. *Erigonella*, Dahl, *Sitz-Bericht Gesell. Nat. Freunde* (*ad partem*).

Type: *T. scabriculus*, (Westr.).

Troxochrus scabriculus, (Westr.), 1851.

1851. *Erigone scabricula*, Westr., *Goteb. Handl.*
1860. *Walckenaera aggeris*, Cambr., *Ann. Mag. N. H.*
1861. *Erigone scabricula*, Westr., *Ar. Suec.*
1864. *Walckenaera aggeris*, Bl., *Spid. G. B. I.*
1868. *Lophocarenum scabriculum*, Menge, *Preuss. Spin.*
1870–3. *Erigone scabricula*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera scabricula*, Cambr., *Spid. Dorset.*
1883. *Lophomma scabriculum*, Bertkau, *Spin. Rheinp.*
1884. *Troxochrus scabriculus*, Sim., *Ar. de France.*
1894. ,, ,, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Troxochrus cirrifrons, (Cambr.), 1871.*

1871. *Walckenaera cirrifrons*, Cambr., *Trans. Linn. Soc.*
1879–81. ,, ,, ,, *Spid. Dorset.*
1900. *Troxochrus* ,, ,, *List Br. Ir. Spid.*

Troxochrus ignobilis, (Cambr.), 1871.

1871. *Walckenaera ignobilis*, Cambr., *Trans. Linn. Soc.*
1879–81. ,, ,, ,, *Spid. Dorset.*
1884. *Troxochrus* ,, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Troxochrus hiemalis, (Bl.), 1841.

1841. *Walckenaera hiemalis*, Bl., *Trans. Linn. Soc.*
1861. *Erigone coriacea*, Westr., *Ar. Suec.*
1864. *Walckenaera hiemalis*, Bl., *Spid. G. B. I.*
1867. *Micryphantes capito*, Ohl., *Die Arach.*
1868. *Lophocarenum parvulum*, Menge, *Preuss. Spin.*
1870–3. *Erigone hiemalis*, Thor., *Rem. on Syn.*
1872. *Walckenaera similis*, Cambr., *Proc. Zool. Soc.*
1879–81. ,, *hiemalis* ,, *Spid. Dorset.*
1883. *Lophocarenum hiemale*, Bertkau, *Spin. Rheinp.*
1884. *Troxochrus hiemalis*, Sim., *Ar. de France.*
1886. *Lophocarenum hiemale*, Dahl, *Monog. Erig.*
1895. *Plaesiocraerus speciosus*, Cambr., *Proc. Dors. F. Club.*
1900. *Diplocephalus* ,, ,, *List Br. Ir. Spid.*
1900. *Troxochrus hiemalis*, ,, ,, ,,
1901. *Erigonella* ,, Dahl, *Sitz-Bericht Gesell. Nat. Freunde.*

Genus **Minyriolus,** Sim., 1884.

1834. *Theridion*, Wid., *Zool. Misc.* (*ad partem*).
1838. *Micryphantes*, C. L. Koch, *Die Arach.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1868. *Lophocarenum*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophocarenum*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Minyriolus*, Sim., *Ar. de France.*
1886. *Walckenaera*, Dahl, *Monog. Erig.* (*ad partem*).

* There seems to be some doubt as to the specific distinctness of this species. (See the footnote to *Diplocephalus spinosus*, Hull.)

1894. *Minyriolus*, Kulcz., *Ar. Hung.*
1900. „ Cambr., *List Br. Ir. Spid.*

Type : *M. pusillus*, (Wid.).

Minyriolus pusillus, (Wid.), 1834.

1834. *Theridion pusillum*, Wid., *Zool. Misc.*
1838. *Micryphantes ochropus*, C. L. Koch, *Die Arach.*
1861. *Erigone pusilla*, Westr., *Ar. Suec.*
1863. *Walckenaera minima*, Cambr., *Zoologist.*
1868. *Lophocarenum apiculatum*, Menge, *Preuss. Spin.*
1870–3. *Erigone pusilla*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera pusilla*, Cambr., *Spid. Dorset.*
1883. *Lophocarenum pusillum*, Bertkau, *Spin. Rheinp.*
1884. *Minyriolus pusillus*, Sim., *Ar. de France.*
1886. *Walckenaera pusilla*, Dahl, *Monog. Erig.*
1894. *Minyriolus pusillus*, Kulcz., *Ar. Hung.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Genus **Pocadicnemis**, Sim., 1884.

1847. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophocarenum*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Pocadicnemis*, Sim., *Ar. de France.*
1894. „ Kulcz., *Ar. Hung.*
1900. „ Cambr., *List Br. Ir. Spid.*

Type : *P. pumilus*, (Bl.).

Pocadicnemis pumilus, (Bl.), 1841.

1841. *Walckenaera pumila*, Bl., *Trans. Linn. Soc.*
1847. *Argus pumilus*, Walck., *Ins. Apt.*
1864. *Walckenaera pumila*, Bl., *Spid. G. B. I.*
1870–3. *Erigone* „ Thor., *Rem. on Syn.*
1879–81. *Walckenaera pumila*, Cambr., *Spid. Dorset.*
1883. *Lophocarenum pumilum*, Bertkau, *Spin. Rheinp.*
1884. *Pocadicnemis pumilus*, Sim., *Ar. de France.*
1894. „ „ Kulcz., *Ar. Hung.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Genus **Metapobactrus**, Sim., 1884.

1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophomma*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Metapobactrus*, Sim., *Ar. de France.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type: *M. falcifrons*, Sim.

Metapobactrus prominulus, (Cambr.), 1872.

1872. *Erigone prominula*, Cambr., *Proc. Zool. Soc.*
1879–81. *Walckenaera prominula*, Cambr., *Spid. Dorset.*
1883. *Lophomma prominulum*, Bertkau, *Spin. Rheinp.*
1884. *Metapobactrus prominulus*, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Genus **Tapinocyba**, Sim., 1884.

1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophocarenum*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Tapinocyba*, Sim., *Ar. de France.*
1884. *Plaesiocraerus*, Sim., *Ar. de France* (*ad partem*).
1886. *Dicyphus*, Dahl, *Monog. Erig.* (*ad partem*).
1886. *Microctenonyx*, Dahl, *Monog. Erig.* (*ad partem*).
1894. *Tapinocyba*, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.* (*ad partem*).
1900. *Diplocephalus*, ,, ,, ,, ,,

Type: *T. praecox*, (Cambr.).

Tapinocyba praecox, (Cambr.), 1873.

1873. *Walckenaera praecox*, Cambr., *Trans. Linn. Soc.*
1879–81. ,, ,, ,, *Spid. Dorset.*
1879–81. ,, *ingrata*, ,, ,,
1884. *Tapinocyba praecox*, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*
1900. ,, *ingrata*, ,, ,, ,,

Tapinocyba subitanea, (Cambr.), 1875.

1875. *Erigone subitanea*, Cambr., *Ann. Mag. N. H.*
1879–81. *Walckenaera subitanea*, Cambr., *Spid. Dorset.*
1884. *Tapinocyba subitanea*, Sim., *Ar. de France.*
1884. ,, *parisiensis*, ,, ,, ,,

1886. *Microctenonyx subitanea*, Dahl, *Monog. Erig.*
1900. *Tapinocyba* „ Cambr., *List Br. Ir. Spid.*

Tapinocyba mitis, (Cambr.), 1882.

1882. *Walckenaera mitis*, Cambr., *Ann. Mag. N. H.*
1900. *Tapinocyba* „ „ *List Br. Ir. Spid.*

Tapinocyba insecta, (L. Koch), 1869.

1869. *Erigone insecta*, L. Koch, *Zeits. Ferd.*
1884. *Plaesiocraerus insectus*, Sim., *Ar. de France.*
1894. *Tapinocyba insecta*, Kulcz., *Ar. Hung.*

Tapinocyba pallens, (Cambr.), 1872.

1872. *Erigone pallens*, Cambr., *Proc. Zool. Soc.*
1884. *Tapinocyba pallens*, Sim., *Ar. de France.*
1894. „ „ Kulcz., *Ar. Hung.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Tapinocyba beckii, (Cambr.), 1871.

1871. *Walckenaera beckii*, Cambr., *Trans. Linn. Soc.*
1879–81. „ „ „ *Spid. Dorset.*
1883. *Lophocarenum beckii*, Bertkau, *Spin. Rheinp.*
1884. *Plaesiocraerus* „ Sim., *Ar. de France.*
1886. *Dicyphus beckii*, Dahl, *Monog. Erig.*
1894. *Tapinocyba beckii*, Kulcz., *Ar. Hung.*
1900. *Diplocephalus beckii*, Cambr., *List Br. Ir. Spid.*

[**Tapinocyba**] **incurvata,** (Cambr.), 1873.*

1873. *Walckenaera incurvata*, Cambr., *Trans. Linn. Soc.*
1879–81. „ „ „ *Spid. Dorset.*
1900. *Tapinocyba* „ „ *List Br. Ir. Spid.*

Genus **Moebelia,** Dahl, 1886.

1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1870–3. „ Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).

* This species does not appear to be correctly placed in the genus *Tapinocyba*; but having had no opportunity of examining actual specimens, I am unable to give an opinion as to its true affinities.

1883. *Lophomma*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Styloctetor*, Sim., *Ar. de France* (*ad partem*).
1886. *Moebelia*, Dahl, *Monog. Erig.* (*ad partem*).
1894. ,, Kulcz., *Ar. Hung.*
1900. *Styloctetor*, Cambr., *List Br. Ir. Spid.* (*ad partem*).
Type: *M. penicillata*, (Westr.).

Moebelia penicillata, (Westr.), 1851.

1851. *Erigone penicillata*, Westr., *Goteb. Handl.*
1861. ,, ,, ,, *Ar. Suec.*
1862. *Neriene corticea*, Cambr., *Zoologist.*
1867. *Micryphantes cristatopalpis*, Ohl., *Die Arach.*
1870–3. *Erigone penicillata*, Thor., *Rem. on Syn.*
1879–81. *Neriene* ,, Cambr., *Spid. Dorset.*
1883. *Lophomma penicillatum*, Bertkau, *Spin. Rheinp.*
1884. *Styloctetor penicillata*, Sim., *Ar. de France.*
1886. *Moebelia* ,, Dahl, *Monog. Erig.*
1894. ,, ,, Kulcz., *Ar. Hung.*
1900. *Styloctetor* ,, Cambr., *List Br. Ir. Spid.*

Genus **Styloctetor**, Sim., 1884.

1884. *Styloctetor*, Sim., *Ar. de France* (*ad partem*).
Type: *S. broccha*, (L. Koch).

Being unable to discover that any definite indication of type has been made with regard to this genus, I here select *S. broccha*, (L. Koch), 1872.

Styloctetor uncinus, Cambr., 1905.

1905. *Styloctetor uncinus*, Cambr., *Proc. Dors. F Club.*

Styloctetor inuncans, Sim., 1884.

A spider from the county of Down, Ireland, was recorded by Dr. G. H. Carpenter as *Styloctetor broccha*, (L. Koch), in *Irish Naturalist* (1898). I feel pretty confident that this specimen is incorrectly identified. Dr. Carpenter states that the structural details of this species "agree closely with M. Simon's figures and descriptions of *S. broccha* (*Ar. de France*, tome v.)." This also seems doubtful; but even allowing it to be correct, there is a further doubt, and a very strong one, that the species described by M. Simon is not the true *S. broccha*, (L. Koch), *Zeits. Ferd.*, 1872.

Genus **Platyopis**, Menge, 1868.

1834. *Theridion*. Wid., *Zool. Misc.* (*ad partem*).
1868. *Platyopis*, Menge, *Preuss. Spin.*
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophomma*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Panamomops*, Sim., *Ar de France.*
1886. *Micrargus*, Dahl, *Monog. Erig* (*ad partem*).
1894. *Panamomops*, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type: *P. sulcifrons*, (Wid.).

I have had no opportunity of examining a specimen of *Platyopis sulcifrons*, (Wid.), but as M. Simon and Professor Kulczynski both regard it as being congeneric with *P. bicuspis*, (Cambr.), and *P. diceros*, (Cambr.), I am here adopting that arrangement. The name *Platyopis* is stated by M. Simon to be pre-occupied. After careful search, however, I have been unable to find that it had been employed previous to Menge's *Preuss. Spin.* (1868), and I therefore employ it in place of the generally accepted name *Panamomops*.

Platyopis diceros, (Cambr.), 1871.

1871. *Walckenaera diceros*, Cambr., *Trans. Linn. Soc.*
1879–81. ,, ,, ,, *Spid. Dorset.*
1883. *Lophomma* ,, Bertkau, *Spin. Rheinp.*
1884. *Panamomops* ,, Sim., *Ar. de France.*
1886. *Micrargus* ,, Dahl, *Monog. Erig.*
1894. *Panamomops* ,, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Platyopis bicuspis, (Cambr.), 1863.

1863. *Neriene bicuspis*, Cambr., *Zoologist.*
1879–81. *Neriene bicuspis*, Cambr., *Spid. Dorset.*
1884. *Panamomops* ,, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Genus **Caledonia**, Cambr., 1894.

1894. *Caledonia*, Cambr., *Ann. Scot. Nat. Hist.*
1900. ,, ,, *List Br. Ir. Spid.*

Type : *C. evansii*, Cambr.

Caledonia evansii, Cambr., 1894.

1894. *Caledonia evansii*, Cambr., *Ann. Scot. Nat. Hist.*
1900. ,, ,, ,, *List Br. Ir. Spid.*

Genus **Baryphyma**, Sim., 1884.

1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1879–81. ,, Cambr., *Spid. Dorset* (*ad partem*).
1884. *Baryphyma*, Sim., *Ar. de France.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type : *B. pratensis*, (Bl.).

Baryphyma pratensis, (Bl.), 1861.

1861. *Walckenaera pratensis*, Bl., *Ann. Mag. N. H.*
1864. ,, ,, ,, *Spid. G. B. I.*
1871. ,, *meadii*, Cambr., *Trans. Linn. Soc.*
1879–81. ,, *pratensis*, ,, *Spid. Dorset.*
1884. *Baryphyma schlickii*, Sim., *Ar. de France.*
1900. ,, *pratensis*, Cambr., *List Br. Ir. Spid.*

Genus **Peponocranium**, Sim., 1884.

1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1879–81. ,, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophocarenum*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Peponocranium*, Sim., *Ar. de France* (*ad partem*).
1886. ,, Dahl, *Monog. Erig.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type : *P. ludicrum*, (Cambr.).

Peponocranium ludicrum, (Cambr.), 1861.

1861. *Walckenaera ludicra*, Cambr., *Ann. Mag. N. H.*
1864. ,, ,, Bl., *Spid. G. B. I.*
1879–81. ,, ,, Cambr., *Spid. Dorset.*
1882. ,, *penultima*, Cambr., *Ann. Mag. N. H.*
1882. ,, *miser*, ,, ,, ,,
1882 ,, *orbiculata*, ,, ,, ,,
1883. *Lophocarenum orbiculatum*, Bertkau, *Spin. Rheinp.*

1884. *Peponocranium ludicrum*, Sim., *Ar. de France.*
1886. ,, *orbiculatum*, Dahl, *Monog. Erig.*
1900. ,, *ludicrum*, Cambr., *List Br. Ir. Spid.*

Genus **Thyreosthenius**, Sim., 1884.

1884. *Peponocranium*, Sim., *Ar. de France* (*ad partem*).
1884. *Thyreosthenius*, ,, ,,
1900. ,, Cambr., *List Br. Ir. Spid.*

Type: *T. biovatus*, (Cambr.).

Thyreosthenius biovatus, (Cambr.). 1875.

1875. *Erigone biovata*, Cambr., *Proc. Zool. Soc.*
1884. *Peponocranium biovatum*, Sim., *Ar. de France.*
1884. *Thyreosthenius biovatus*, ,, ,,
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Genus **Cnephalocotes**, Sim., 1884.

1869. *Microneta*, Menge, *Preuss. Spin.* (*ad partem*).
1884. *Cnephalocotes*, Sim., *Ar. de France* (*ad partem*).
1894. ,, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.* (*ad partem*).

Type: *C. elegans*, (Cambr.).

Simon, in 1884, included five species in this genus—*C. obscurus*, (Bl.), *C. elegans*, (Cambr.), *C. curtus*, (Sim.), *C. pusillus*, (Menge), and *C. crassirostris*, Sim. As far as I can discover, no one of these species was definitely cited as the type until 1894, when Simon selected *C. obscurus*, (Bl.). This, however, cannot be correct, as the species had been removed by Dahl, in 1886, to his genus *Eusticothrix*, of which genus it is, in fact, the type. I therefore here select *C. elegans*, (Cambr.), as the type of *Cnephalocotes.*

Cnephalocotes elegans, (Cambr.), 1872.

1872. *Erigone elegans*, Cambr., *Proc. Zool. Soc.*
1884. *Cnephalocotes elegans*, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Cnephalocotes laesus, (L. Koch), 1879.

1879. *Erigone laesa*, L. Koch, *Sv. Ak. Handl.*
1888. *Walckenaera interjecta*, Cambr., *Trans. Hertf. Nat. Hist. Soc.*
1894. *Cnephalocotes interjectus*, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Cnephalocotes curtus, (Sim.), 1882.

1882. *Erigone curtus*, Sim., *Bull. Soc. Zool. France.*
1884. *Cnephalocotes curtus*, Sim., *Ar. de France.*
1900. „ „ Cambr., *List Br. Ir. Spid.*

Cnephalocotes pusillus, Menge, 1869.*

1869. *Microneta pusilla*, Menge, *Preuss. Spin.*
1872. *Erigone sila*, Cambr., *Proc. Zool. Soc.*
1884. *Cnephalocotes pusillus*, Sim., *Ar. de France.*
1894. „ *silus*, Kulcz., *Ar. Hung.*
1900. „ *pusillus*, Cambr., *List Br. Ir. Spid.*

Cnephalocotes ambiguus, Cambr., 1905.

1905. *Cnephalocotes ambiguus*, Cambr., *Proc. Dors. F. Club.*

Genus **Eusticothrix**, Dahl, 1886.

1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophocarenum*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Cnephalocotes*, Sim., *Ar. de France* (*ad partem*).
1886. *Eusticothrix*, Dahl, *Monog. Erig.* (*ad partem*).
1894. *Nematogmus*, Kulcz., *Ar. Hung.* (*ad partem*).
1900. *Cnephalocotes*, Cambr., *List Br. Ir. Spid.* (*ad partem*).

Type: *E. obscurus*, (Bl.).

Eusticothrix, Dahl, originally included two species—*E. obscurus*, (Bl.), and *E. sanguinolentus*, (Walck.). The former must be the type species, as *E. sanguinolentus*, (Walck.), is the type of *Nematogmus*, Sim., 1884. Most modern authors have included *E. obscurus*, (Bl.), in the genus *Cnephalocotes*, whilst several have placed it with *N. sanguinolentus*, (Walck.), adopting the generic name *Nematogmus* and sinking *Eusticothrix* as a synonym. Although *E. obscurus* has affinities with both *Cnephalocotes* and *Nematogmus*, it possesses characteristics which, to my mind, justify its separation; and, this being so, *Eusticothrix* will, of course, be the correct title for the genus.

* Notwithstanding some slight discrepancies in the descriptions, I believe *Microneta pusilla*, Menge, and *Erigone sila*, Cambr., to be identical.

Eusticothrix obscurus, (Bl.), 1834.

1834. *Walckenaera obscura*, Bl., *Researches in Zool.*
1861. *Erigone impolita*, Westr., *Ar. Suec.*
1864. *Walckenaera obscura*, Bl., *Spid. G. B. I.*
1870–3. *Erigone* ,, Thor., *Rem. on Syn.*
1879–81. *Walckenaera obscura*, Cambr., *Spid. Dorset.*
1883. *Lophocarenum obscurum*, Bertkau, *Spin. Rheinp.*
1884. *Cnephalocotes obscurus*, Sim., *Ar. de France.*
1886. *Eusticothrix* ,, Dahl, *Monog. Erig.*
1894. *Nematogmus* ,, Kulcz., *Ar. Hung.*
1900. *Cnephalocotes* ,, Cambr., *List Br. Ir. Spid.*

Genus **Pelecopsis**, Sim., 1864.

1834. *Theridion*, Wid., *Zool. Misc.* (*ad partem*).
1847. *Argus*, Walck., *Ins. Apt.* (*ad partem*).
1864. *Pelecopsis*, Sim., *Hist. Nat. Araig.*
1868. *Lophocarenum*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophocarenum*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. ,, Sim., *Ar. de France* (*ad partem*).
1886. *Paractenonyx*, Dahl, *Monog. Erig.*
1894. *Brachycentrum*, Kulcz., *Ar. Hung.*
1900. *Lophocarenum*, Cambr., *List Br. Ir. Spid.*

Type: *P. elongatum*, (Wid.).

The genus *Pelecopsis* was formulated by Simon in 1864 for the reception of a single species, *P. inaequalis*, (Koch), 1841. This species is apparently identical with *T. elongatum*, (Wid.), 1834, a spider which has not occurred in Britain, but which appears to be congeneric with the three British species usually placed under the generic name *Lophocarenum*. This extensive group is greatly in need of revision, and will no doubt be subdivided at some future date. For the present, however, Simon's name *Pelecopsis*, having priority over Menge's *Lophocarenum*, seems to be the correct title for the genus. Dahl's *Brachycentrum* (1886) contained two species—*B. elongatum*, (Wid.), and *B. moebi*, Dahl. F. O. Pickard-Cambridge in 1903 selected *B. elongatum*, (Wid.), as the type of *Brachycentrum*; but this species, being the type of *Pelecopsis*, cannot serve. The type of *Brachycentrum*, therefore, is *B. moebi*, Dahl.

Pelecopsis mengei, (Sim.), 1884.

1884. *Lophocarenum mengei*, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Pelecopsis parallelus, (Wid.), 1834.

1834. *Theridion parallelum*, Wid., *Zool. Misc.*
1864. *Walckenaera parallela*, Bl., *Spid. G. B. I.*
1868. *Lophocarenum elongatum*, Menge, *Preuss. Spin.*
1870–3. *Erigone parallela*, Thor., *Rem. on Syn.*
1879–81. *Walckenaera parallela*, Cambr., *Spid. Dorset.*
1883. *Lophocarenum parallelum*, Bertkau, *Spin. Rheinp.*
1884. ,, ,, Sim., *Ar. de France.*
1886. *Paractenonyx parallelus*, Dahl, *Monog. Erig.*
1894. *Brachycentrum parallelum*, Kulcz., *Ar. Hung.*
1900. *Lophocarenum* ,, Cambr., *List Br. Ir. Spid.*

Pelecopsis nemoralis, (Bl.), 1841.

1841. *Walckenaera nemoralis*, Bl., *Trans. Linn. Soc.*
1847. *Argus nemoralis*, Walck., *Ins. Apt.*
1864. *Walckenaera nemoralis*, Bl., *Spid. G. B. I.*
1879–81. ,, ,, Cambr., *Spid. Dorset.*
1883. *Lophocarenum nemorale*, Bertkau, *Spin. Rheinp.*
1884. ,, ,, Sim., *Ar. de France.*
1894. *Brachycentrum* ,, Kulcz., *Ar. Hung.*
1900. *Lophocarenum* ,, Cambr., *List Br. Ir. Spid.*

Genus **Ceratinodes**, Banks, 1893.

1834. *Theridion*, Wid., *Zool. Misc.* (*ad partem*).
1845. *Micryphantes*, Koch, *Die Arach.* (*ad partem*).
1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Ceratina*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Ceratinella*, Bertkau, *Spin. Rheinp.*
1884. ,, Sim., *Ar. de France.*

1886. *Ceratina*, Dahl, *Monog. Erig.*
1893. *Ceratinodes*, Banks, *Journ. New York Ent. Soc.*
1894. *Ceratinella*, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type: *C. brevis*, (Wid.).

Emerton's action in *Trans. Conn. Acad.*, 1882, certainly ought not, in my opinion, to be regarded as the definite substitution of the name *Ceratinella* for *Ceratina*, Menge, pre-occupied, but as the formation of a new genus. This being so, *Ceratinodes*, proposed by Banks to replace *Ceratina*, is the correct generic name for the species usually referred to *Ceratinella*.

Ceratinodes brevis, (Wid.), 1834.

1834. *Theridion breve*, Wid., *Zool. Misc.*
1836. *Walckenaera depressa*, Bl., *Lond. Edin. Phil. Mag.*
1845. *Micryphantes phaeopus*, Koch, *Die Arach.*
1861. *Erigone* ,, Westr., *Ar. Suec.*
1864. *Walckenaera depressa*, Bl., *Spid. G. B. I.*
1868. *Ceratina brevis*, Menge, *Preuss. Spin.*
1870–3. *Erigone* ,, Thor., *Rem. on Syn.*
1879–81. *Walckenaera brevis*, Cambr., *Spid. Dorset.*
1883. *Ceratinella* ,, Bertkau, *Spin. Rheinp.*
1884. ,, ,, Sim., *Ar. de France.*
1886. *Ceratina* ,, Dahl, *Monog. Erig.*
1894. *Ceratinella* ,, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Ceratinodes scabrosa, (Cambr.), 1871.

1871. *Walckenaera scabrosa*, Cambr., *Trans. Linn. Soc.*
1879–81. ,, ,, ,, *Spid. Dorset.*
1894. *Ceratinella* ,, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Ceratinodes brevipes, (Westr.), 1851.

1851. *Erigone brevipes*, Westr., *Goteb. Handl.*
1861. ,, ,, ,, *Ar. Suec.*
1870–3. ,, ,, Thor., *Rem. on Syn.*

1879–81. *Walckenaera brevipes*, Cambr., *Spid. Dorset.*
1884. *Ceratinella* ,, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Genus **Maso**, Sim., 1884.

1861. *Erigone*, Westr., *Ar. Suec.* (*ad partem*).
1869. *Micronela*, Menge, *Preuss. Spin.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Micronela*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Maso*, Sim., *Ar. de France.*
1886. *Phylloeca*, Dahl, *Monog. Erig.* (*ad partem*).
1894. *Maso*, Kulcz., *Ar. Hung.*
1900. ,, Cambr., *List Br. Ir. Spid.*

Type: *M. gallica*, Sim., 1894.

Maso sundevallii, (Westr.), 1851.

1851. *Erigone sundevallii*, Westr., *Goteb. Handl.*
1861. ,, ,, ,, *Ar. Suec.*
1869. *Micronela* ,, Menge, *Preuss. Spin.*
1870–3. *Erigone* ,, Thor., *Rem. on Syn.*
1879–81. *Neriene* ,, Cambr., *Spid. Dorset.*
1883. *Micronela* ,, Bertkau, *Spin. Rheinp.*
1884. *Maso westringii*, Sim., *Ar. de France.*
1886. *Phylloeca sundevallii*, Dahl, *Monog. Erig.*
1894. *Maso* ,, Kulcz., *Ar. Hung.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*

Addenda et Corrigenda.

The following alterations and additions to the lists of spiders included in my papers in this Journal for 1904 and 1905, will bring the subject-matter up to date as far as British species are concerned.

Genus **Trichoncus**, Sim., 1884.

1864. *Walckenaera*, Bl., *Spid. G. B. I.* (*ad partem*).
1870–3. *Erigone*, Thor., *Rem. on Syn.* (*ad partem*).
1879–81. *Walckenaera*, Cambr., *Spid. Dorset* (*ad partem*).
1883. *Lophomma*, Bertkau, *Spin. Rheinp.* (*ad partem*).
1884. *Tigellinus*, Sim., *Ar. de France* (*ad partem*).

1894. *Trichoncus*, Kulcz., *Ar. Hung.*
1900. *Tigellinus*, Cambr., *List Br. Ir. Spid.* (*ad partem*).
1905. ,, F. P. Smith, *Journ. Quekett Club* (*ad partem*).

Type: *T. scrofa*, Sim., 1884.

Trichoncus saxicolus, (Cambr.), 1861.

1861. *Walckenaera saxicola*, Cambr., *Ann. Mag. N. H.*
1864. ,, ,, Bl., *Spid. G. B. I.*
1870–3. *Erigone* ,, Thor., *Rem. on Syn.*
1879–81. *Walckenaera saxicola*, Cambr., *Spid. Dorset.*
1883. *Lophomma saxicolum*, Bertkau, *Spin. Rheinp.*
1884. *Tigellinus saxicolus*, Sim., *Ar. de France.*
1894. *Trichoncus* ,, Kulcz., *Ar. Hung.*
1900. *Tigellinus* ,, Cambr., *List Br. Ir. Spid.*
1905. ,, ,, F. P. Smith, *Journ. Quekett Club.*

By the courtesy of Professor Kulczynski I have been able to examine a male palpus and a female of this species, which was previously unknown to me except by figures and descriptions. I have no hesitation whatever in removing it from the genus *Tigellinus*, with which it appears to have no affinity, and placing it in the genus *Trichoncus*. This alteration necessitates its removal from the *Walckenaëria* Group altogether, its proper position being at the end of the *Erigone* Group.

Genus **Tmeticus**, Menge, 1868.

1864. *Neriene*, Bl., *Spid. G. B. I.* (*ad partem*).
1868. *Tmeticus*, Menge, *Preuss. Spin.* (*ad partem*).
1879–81. *Neriene*, Cambr., *Spid. Dorset* (*ad partem*).
1884. *Tmeticus*, Sim., *Ar. de France* (*ad partem*).
1900. ,, Cambr., *List Br. Ir. Spid.* (*ad partem*).
1905. *Anglia*, F. P. Smith, *Journ. Quekett Club.*

Type: *T. affinis*, (Bl.).

Tmeticus affinis, (Bl.), 1855.

1855. *Neriene affinis*, Bl., *Spid. G. B. I.*
1868. *Tmeticus leptocaulis*, Menge, *Preuss. Spin.*
1879–81. *Neriene affinis*, Cambr., *Spid. Dorset.*
1884. *Tmeticus* ,, Sim., *Ar. de France.*
1900. ,, ,, Cambr., *List Br. Ir. Spid.*
1905. *Anglia hancockii*, F. P. Smith, *Journ. Quekett Club.*

I feel pretty confident that the spider described as *Anglia hancockii* is but a peculiarly coloured specimen of *Tmeticus affinis*, (Bl.). I still consider, however, that it has stronger affinities with the Erigoninae than with the Linyphiinae, and it certainly is not congeneric with the very motley assemblage of spiders usually included under the generic name *Tmeticus.*

Genus **Erigone.**

Erigone arctica, (White), 1852.

1852. *Micryphantes arcticus*, White, *Sutherland's Journal.*
1877. *Erigone arctica,* Cambr., *Ann. Mag. N. H.*

The var. *maritima* of this species was recorded from Dorset by Mr. Cambridge in *Proc. Dors. F. Club*, 1905.

Erigone longipalpis, (Sund.), 1830.

The spider described as *Erigone pascalis,* in Trans. Linn. Soc. 1873, is stated by Mr. Cambridge to be an immature form of *E. longipalpis*, Sund.

THE LITERATURE OF THE SUB-FAMILY ERIGONINAE.

By Frank P. Smith.

(*Read April 20th*, 1906.)

Recent research in connection with the Erigoninae having necessitated the exhaustive examination of a vast amount of literature, it has occurred to me that a list of the more important publications bearing upon the subject might be of service to my fellow workers.

The following list is far from being a complete bibliography of the subject. The number of works, both large and small, that were examined, could have been little short of a thousand; and although the compilation, from the *Zoological Record* and other sources of reference, of a complete list of those appearing to contain relevant information, would have been far simpler than the selection of only those which included descriptions of new species and genera or systematic modifications, I think that this restricted bibliography will be of more use to the average worker than had there been included several hundred papers dealing chiefly with local records. I do not mean in any way to underrate the importance of distributional papers, but think it advisable to keep them distinct from publications containing matter of a systematic nature.

I do not wish to put forward any claim for this list of literature as to completeness. Working, as I have been, entirely single-handed, it would be little short of miraculous if nothing had escaped my attention; but I trust that the omissions may, at any rate, be not very numerous, and that the list may form a pretty substantial nucleus for the worker who may wish to assist in puzzling out the extremely involved history of the Erigoninae.

The following abbreviations are employed :—

Ann. Mag. N. H. = *Annals and Magazine of Natural History.*
Proc. Dors. F. Club = *Proceedings of the Dorset Natural History and Antiquarian Field Club.*

Proc. Zool. Soc. = *Proceedings of the Zoological Society of London.*
Sv. Ak. Handl. = *Kongliga Svenska Vetenskaps-Akademiens Handlingar.*
Trans. Linn. Soc. = *Transactions of the Linnean Society.*

List of Publications.

1825–7. Savigny & Audouin, *Description de L'Egypt.*
1829–32. Sundevall, *Sv. Ak. Handl.*
1833. Blackwall, *London and Edinburgh Philosophical Magazine.*
1834. ,, *Researches in Zoology.*
1834. Wider, "Zool. Misc.," in *Senckenbergische Naturforschende Gesellschaft.*
1836. Blackwall, *London and Edinburgh Philosophical Magazine.*
1836. Koch, *Die Arachniden*, iii.
1837. ,, *Ubersicht des Arachnidensystems.*
1838. ,, *Die Arachniden*, iv.
1840.* Walckenaer, *Histoire Naturelle des Insectes-Aptères*, ii.
1841. Koch, *Die Arachniden*, viii.
1841. Blackwall, *Trans. Linn. Soc.*
1844. ,, *Ann. Mag. N. H.*
1847. Walckenaer, *Histoire Naturelle des Insectes-Aptères*, iv.
1850. Blackwall, *Ann. Mag. N. H.*
1851. Westring, *Göteborgs kungl. Vetenskaps-och Vitterhets-samhälles Handlingar.*
1853. Blackwall, *Ann. Mag. N. H.*
1854. ,, ,, ,,
1859. Grube, *Archiv. für die Naturkunde Liv.- Ehst.- und Kurlands.*
1860. Cambridge, *Ann. Mag. N. H.*
1861. Westring, "Araneae Suecicae," in *Göteborgs kungl. Vetenskaps-och Vitterhets-samhälles Handlingar.*
1861. Grube, *Bulletin de l'Academie de St. Petersburg.*
1861. Cambridge, *Ann. Mag. N. H.*
1861. Blackwall, ,, ,,
1863. Cambridge, *The Zoologist.*
1864. Blackwall, *Spiders of Great Britain and Ireland* (Ray Society).

* Notwithstanding the fact that the second volume of Walckenaer's *Histoire Naturelle des Insectes-Aptères* bears the date 1837, an examination of contemporary literature shows that it was in reality not published until 1840.

1864. Simon, *L'Histoire Naturelle des Araignées.*
1866–78. Menge, "Preussische Spinnen," in *Naturforschende Gesellschaft.*
1867. Ohlert, *Die Araneiden der Provinz Preussen.*
1869. L. Koch, *Zeitschrift des Ferdinandeums für Tirol und Vorarlberg.*
1869–70. Thorell, "On European Spiders," in *Nova Acta regiae Societatis Scientiarum Upsaliensis.*
1870. L. Koch, *Jahresbericht der Gelehrten Gesellschaft zu Krakau.*
1870–3. Thorell, *Remarks on Synonyms of European Spiders.*
1871. Cambridge, *Trans. Linn. Soc.*
1871. Thorell, *Ofversigt af kongl. Vetenskaps-Akademiens. Forhandlingar.*
1872. Cambridge, *Trans. Linn. Soc.*
1872. Thorell, *Ofversigt af kongl. Vetenskaps-Akademiens. Forhandlingar.*
1872. L. Koch, *Zeitschrift des Ferdinandeums für Tirol und Vorarlberg.*
1872. L. Koch, *Abhandlungen der Naturhistorischen Gesellschaft zu Nürnberg.*
1872. Simon, *Annales de la Société Entomologique de France.*
1872. Cambridge, *Proc. Zool. Soc.*
1873. ,, *Trans. Linn. Soc.*
1873. ,, *Proc. Zool. Soc.*
1874. Westring, *Göteborgs kungl. Vetenskaps-och Vitterhets-samhälles Handlingar.*
1874. Cambridge, *Proc. Zool. Soc.*
1875. Thorell, *Sv. Ak. Handl.*
1875. ,, *Tijdschriften voor Entomologie.*
1875. ,, *Horae Societatis Entomologicae Rossicae.*
1875. Fickert, *Zeitschrift für Entomologie des Vereins für schlesische Insektenkunde.*
1875. Cambridge, *Ann. Mag. N. H.*
1875. ,, *Proceedings of the Berwickshire Naturalists' Field Club.*
1875. Cambridge, *Proc. Zool. Soc.*
1877. Thorell, *Bulletin of the United States Geological Survey.*
1877. Cambridge, *Ann. Mag. N. H.*
1877. Lebert, *Die Spinnen der Schweiz.*
1878. Thorell, *American Naturalist.*

1878. Cambridge, *Ann. Mag. N. H.*
1879. L. Koch, *Sv. Ak. Handl.*
1879. Cambridge, *Ann. Mag. N. H.*
1879. Karsch, *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande, Westfalens, und des Reg.-Bezirks Osnabrück.*
1879–81. Cambridge, "The Spiders of Dorset," in *Proc. Dors. F. Club.*
1880. Simon, *Annales de la Société Entomologique de France.*
1880. Bertkau, *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande, Westfalens, und des Reg.-Bezirks Osnabrück.*
1881. L. Koch, *Abhandlungen der naturforschenden Gesellschaft zu Görlitz.*
1881. Simon, *Bulletin de la Société Zoologique de France.*
1882. Cambridge, *Ann. Mag. N. H.*
1882. Emerton, *Transactions of the Connecticut Academy of Arts and Sciences.*
1882. Simon, *Bulletin de la Société Zoologique de France.*
1882. L. Koch, *Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien.*
1882. Kulczynski, *Araneae in Montibus Tatricis Collectae.*
1883. Bertkau, "Beiträge zur Kenntniss der Spinnenfauna der Rheinprovinz," in *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande, Westfalens, und des Reg.-Bezirks Osnabrück.*
1884. Simon, *Les Arachnides de France.*
1884. ,, *Annales de la Société Entomologique de France.*
1884. ,, *Bulletin de la Société Zoologique de France.*
1884. Kulczynski, *Pamiętnik Akademii Umiejetnosci w Krakowie, wydzial matematyczno-przyrodniczy.*
1884. Cambridge, *Ann. Mag. N. H.*
1886. Dahl, "Monographie der Erigone-Arten," in *Schriften des naturwissenschaftlichen Vereins für Schleswig-Holstein.*
1886. Keyserling, *Die Spinnen Americas.*
1886. Koelbel, *Arachnida etc. of Jan Mayen.*
1886. Simon, *Actes de la Société Linnéenne de Bordeaux.*
1887. ,, *Mission to Cape Horn.*
1887. Kulczynski, *Rosprawy i Sprawozdania z posiedzeń wydzialu matematyczno-przyrodniczego Akademii Umiejętnósci.*

1888. Cambridge, *Transactions of the Hertfordshire Natural History Society.*
1888. Simon, *Annales de la Société Entomologique de France.*
1890. Marks, *Proceedings of the United States National Museum.*
1891. Fox, *Proceedings of the Entomological Society of Washington.*
1891. Urquhart, *Transactions of the New Zealand Institute.*
1891. Keyserling, *Die Spinnen Americas.*
1892. Banks, *Proceedings of the Academy of Natural Sciences of Philadelphia.*
1893. Banks, *Journal of the New York Entomological Society.*
1894. Simon, *Histoire Naturelle des Araignées.*
1894. Kulczynski, *Araneae Hungariae.*
1894. Thorell, *The Spiders of Burma.*
1894. F. Cambridge, *Ann. Mag. N. H.*
1894. ,, *Transactions of the Guernsey Society of Natural Science.*
1894. Cambridge, *Annals of Scottish Natural History.*
1894. Simon, *Anales del Museo Nacional de Buenos Aires.*
1894. Cambridge, "Araneae," in *Biol. Centr. Amer.*
1895. Kulczynski, *Természetrajzi Fuzetekkiadja a Magyar nemzet Múseum.*
1895. Cambridge, *Proc. Dors. F. Club.*
1895. Banks, *Journal of the New York Entomological Society.*
1896. ,, *Canadian Entomologist.*
1896. ,, *Transactions of the New York Entomological Society.*
1896. Becker, *Arachnides de Belgique.*
1897. Simon, *Proc. Zool. Soc.*
1897. Lenz, *Bibliographia Zoologica.*
1897. Banks, *Canadian Entomologist.*
1898. ,, *Proceedings of the California Academy of Sciences.*
1898. Carpenter, *Natural Science.*
1898. Sorensen, *Videnskabelige meddelelser fra den naturhistoriske Forening i Kjobenhavn.*
1898. Banks, *Canadian Entomologist.*
1898. Cambridge, *Journal of the Linnean Society.*
1898. Thorell, *Annali del Museo civico di Storia Naturale di Genova.*
1898. Kulczynski, *Fauna Aranearum Austriae inferioris.*
1899. ,, *Rosprawy i Sprawozdania z posiedzeń wydzialu matematyczno-przyrodniczego Akademii Umiejętności.*

1899. Banks, *Proceedings of the Entomological Society of Washington.*

1899. Banks, *Fur Seals.*

1899. Cambridge, *Proc. Dors. F. Club.*

1899. Boesenberg, *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande, Westfalens, und des Reg.-Bezirks Osnabrück.*

1900. Cambridge, *Proc. Dors. F. Club.*

1900. Simon, "Arachnida," in *Zool. Sandwich Isles.*

1900. Banks, *Proceedings of the Washington Academy of Sciences.*

1901. Strand, *Archiv for Mathematik og Naturvidenskab.*

1901-2. Boesenberg, *Bibliographia Zoologica.*

1901. Banks, *Proceedings of the Academy of Natural Sciences of Philadelphia.*

1901. Dahl, *Sitzungs-Berichte der Gesellschaft Naturforschender Freunde zu Berlin.*

1902. Kulczynski, *Bulletin international de l'Académie des Sciences de Cracovie.*

1902. Cambridge, *Proc. Dors. F. Club.*

1902. Strand, *Bergens Museum Aarbog.*

1902. Simon, *Ergebnisse der Hamburger Magalhaensischen Sammelreise.*

1903. Strand, *Bergens Museum Aarbog.*

1903. Cambridge, *Proc. Dors. F. Club.*

1904. Lessert, *Araignées du Basin du Léman.*

1904. F. P. Smith, *Journal of the Quekett Microscopical Club.*

1905. Strand, *Videnskabsselskalnt i Kristiana.*

1905. Jackson, *Transactions of the Natural History Society of Northumberland, etc.*

1905. Crosby, *Proceedings of the Academy of Natural Sciences of Philadelphia.*

1905. Cambridge, *Proc. Dors. F. Club.*

1905. Simon, *Bollettino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino.*

1905. Kulczynski, *Bulletin international de l'Académie des Sciences de Cracovie.*

1905. F. P. Smith, *Journal of the Quekett Microscopical Club.*

NOTE ON A NEW FINDER FOR THE MICROSCOPE.

By J. M. Coon.

(*Read before the Royal Microscopical Society, March 28th, 1906.*)

Being engaged on some research work necessitating frequent reference to microscopical slides, and also the indication of definite parts of these slides to correspondents, I found the usual methods for "finding" less convenient than desirable.

On any given microscope provided with a divided stage or Wright's Finder, it is easy to "find" objects on the slide by a simple method of registration; but calculations, or the construction of a new register, must be made for each microscope in use, as a slide registered on one cannot have parts found on another unless they are exactly alike in their calibration—a most unlikely occurrence, even with the same maker's instruments.

The Maltwood Finder will do this on a microscope with a mechanical stage, or Wright's Finder; but it is difficult on instruments with a sliding bar only, and much more so when the stage is only provided with spring clips. Further, each operation requires the changing of the slide for the finder and the finder for the slide, and twice focussing, occupying, to say the least, the expenditure of an unnecessary amount of time and effort.

The finder now described is extremely simple, can be used on any microscope, and will find on any stage, whether mechanical or provided with sliding bar or spring clips; and slides registered on one microscope can with equal readiness have parts found on any other instrument, and any number of parts can be found successively without the removal of the slide from the stage, or refocussing, which is of great moment when using immersion objectives or condensers. In fact, it is easier to find objects with it than by means of the mechanical stage, because the light and divisions are often inconveniently placed.

The actual design of this finder may vary, but it essentially consists of a means for attaching to the microscope a pointer with universal movement. That exhibited this evening has a plain clamp, with a milled-head screw for fastening it to the stage; and on the clamp is mounted a pointer-holder with horizontal

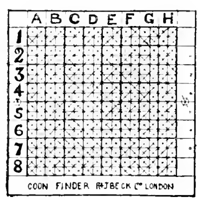


Fig. 1.

motion, a screw through which holds the pointer, having a vertical and sliding motion, and which also clamps the pointer when adjusted.

In conjunction with this finder a registering label is used. This may be ruled in many ways, but the author has found the method shown in Fig. 1 very suitable and simple. Vertical columns of squares are indicated by capital letters at top and horizontal lines numbered at the side. Each square is sub-divided into four smaller ones, indicated by small letters, *a*, *b*, *c*, *d*, each small square being divided by diagonal lines into four triangles. The side of each square measures 1·25 mm., and by the triangles it is easy to locate the position of the pointer to one-fifth of this—or, say, ·25 mm. or

$\frac{1}{100}$ in. As the field of the Zeiss 2-mm. N. A. 1·40 apochromatic objective is given as ·25 mm. in diameter, it is evident that the finder is available for use with high powers. The author finds no difficulty in using a Beck $\frac{1}{14}$th-in. Of course, care is needful, and the quiet of a laboratory most helpful. The slide has also two marks, one called the focussing mark, the other the registering mark.

To register a slide, the objective is focussed on the focussing mark, and the pointer adjusted to the registering mark. Both may be on the label, or, better still, the focussing mark may be placed on a vacant space on the cover-glass—in fact, this is necessary for use with high powers. The slide is then searched and parts registered by recording where the pointer indicates on the label, by entering the *capital letter* over the large square, the *number* opposite the horizontal square, the small square by its *small letter*, and the position of a triangle by a dot, thus ⩔. A complete record might be A, 1, *a*, ⩔, meaning that the point referred to is in the field when the pointer is under A, opposite 1, over small square *a*, and over the centre of the upper triangle.

To find an object, focus on the focussing mark, fix the pointer over the registering mark, move the slide until the pointer stands over that part of the label indicated by the register, when the object should be in the field of the objective.

The foregoing refers to microscopes with mechanical stages, or with a parallel sliding bar, the slide being kept in contact with the bar and a stop.

If the instrument has a plain stage with clips, the pointer has two points or other equivalent means of adjusting parallel to the ruling on the label; the right-hand point is set to the registering mark, and the left-hand point on a line continuing from it horizontally, the objective being focussed as before. The only necessary variation in its use is to remember to indicate with the right-hand point and keep the slide in such a position that the points are equidistant from any horizontal line on the label. The slide may move vertically or horizontally, but must be adjusted, finally, parallel to its first position, or the object will not be in the field.

NOTICES OF BOOKS, ETC.

A GLOSSARY OF BOTANIC TERMS. (Second edition.) By B. D. Jackson. $5 \times 7\frac{1}{2}$ in. xii + 371 pages. London, 1905. Messrs. Duckworth & Co. Price 7*s*. 6*d*. net.

No one engaged in botanical work, either elementary or advanced, can afford to deny this useful glossary a place amongst his works of reference. To scrutinise a volume of this description in the hope of catching the author in some error of commission or omission would be cavilling rather than reviewing, as absolute freedom from error must be the ideal rather than the expectation of every lexicographer. Taking the work as a whole, the definitions of the multitudinous terms included are concise and well selected, and the typographical setting is well calculated to facilitate speedy reference. It is somewhat of a pity that the terms additional to the first edition have been arranged as a supplement; but their incorporation alphabetically with the main portion of the work would have increased the price of the volume to an unjustifiable extent, and, after all, the primary glossary, irrespective of the supplement, will no doubt contain practically everything required by the average botanist. F. P. S.

THE BRITISH WOODLICE. By Wilfred Mark Webb, F.L.S., and Charles Sillem. $5\frac{1}{2} \times 8\frac{1}{2}$ in. x + 54 pages, with 25 plates and 59 figures in the text. London, 1906. Messrs. Duckworth & Co. Price 6*s*. net.

Messrs. Duckworth & Co. are to be complimented upon their promptness in negotiating with the Essex Field Club for placing this work upon the market. It was originally published serially in the *Essex Naturalist*, and the present issue in one volume will be found a great convenience to the busy student. Mr. Wilfred Mark Webb's name as the part author will be sufficient guarantee not only of the accuracy of the information contained, but of the clear and succinct impartation of this information. The plates, drawn from nature by Mr. Sillem and admirably engraved by Mr. Reader, are very commendable. Each plate consists of a considerably enlarged figure of a single species, the important structural distinctions (the flagellum and last peduncular joint of the antenna) being figured in the text.

Synonyms are given in all cases, and the distribution of the species, both in the British Isles and elsewhere, is carefully treated. There is, in addition, a most useful bibliography.

The study of the woodlice has been curiously neglected, and it is to be hoped that the publication of this admirable little volume may be the means of inducing students of natural science to devote more time to these interesting creatures. F. P. S.

HIGH-POWER MICROSCOPY. A paper by John W. Gordon, read before the Royal Institute of Great Britain, February 17th, 1905.

This short paper is very deserving of perusal by all interested in general microscopy, and is, happily, so far devoid of technicalities as to be intelligible to the average reader. The salient feature of the paper is the description of a method, which seems to be original, of producing an image of enormous amplification by an improved arrangement of the by-no-means-new expedient of substituting a compound microscope for the ordinary eye-piece. The innovation consists of placing, in the focal plane of the lower microscope, a disc of finely ground glass, the image formed upon it being further amplified by the upper combination. By this means the difficulty due to the relationship between the angle of the beam of light and the magnification, as expressed in the Lagrange-Helmholtz theory, is removed, the image upon the ground glass becoming, as it were, a definite object, free from all optical restrictions, and capable of being further enlarged by the superimposed microscope. It is obvious that the grain of the glass, being in the focus of the upper microscope, would be magnified to the same extent as the image, and would thus be a fatal objection to the method. The author has surmounted this difficulty by imparting to the screen an ingeniously devised erratic motion, which renders the grain invisible.

Exactly what good purpose is served by the forcing of enormous amplification is quite another matter, and one with which the author does not deal; and, in the face of the very considerable variance of opinion amongst the most advanced opticians on this point, it would be very unwise to regard the views of any one authority as *ex cathedra*. F. P. S.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on October 20th, 1905, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on June 16th were read and confirmed.

Mr. George G. Carter was balloted for and duly elected a member of the Club.

The Secretary announced the death of several members during the vacation, including one of the Club's Vice-Presidents, Mr. J. G. Waller, F.S.A., who had died a few days previously at the very advanced age of ninety-two. Mr. Waller became a member of the Club in May, 1868, and served as President for the years 1896—1897. He had contributed many papers to the Club's Journal, and was one of the most familiar figures at the Club, which he had attended regularly up to a few months ago. On the motion of the President, a vote of sympathy with the relatives of the deceased members was unanimously passed.

The President then said that he thought it would be to the Club's interest, and to the advantage of the members, if they could know in advance the subjects of the papers intended to be read at the meetings of the Club. Interest would be stimulated and debate made possible, if they could look up the subjects for themselves before listening to the papers. Notices of the meeting were, by the courtesy of the leading opticians, inserted in their windows a fortnight before the meeting, but these were of little use to country members. If the Secretary were only in the position to announce at each meeting the subject to be discussed at the ensuing meeting, it would be a great gain. He therefore appealed to the members to give earlier notice of their communications, and to set them a good example he would ask the Secretary to make an announcement on his behalf.

The Secretary then announced that at the meeting on Friday, November 17th, Dr. Spitta would read a paper on "Some

Experiments relating to the Compound Eyes of Insects." The paper, which would be illustrated by lantern slides prepared from the President's photographs, dealt with the familiar subject of the "Multiple Image," and would, he thought, prove highly interesting, inasmuch as Dr. Spitta's observations had led him to reject the accepted theory of the formation of the multiple image, and to attempt to substitute a new theory of his own to account for the phenomena observed.

Mr. James Burton then read a paper "On an Easy Method of Staining and Mounting Micro-Algae and Fungi," illustrated by a number of specimens displayed under microscopes. Mr. Burton said that in exhibiting micro-objects to friends who were not particularly well acquainted with natural history, it was always noticeable that they showed most interest in "common objects." A fly's foot or scales from a butterfly's wing drew more attention and gave more pleasure than rarer objects which were not understood. Among the objects suitable for popular exhibition, nothing could be more beautiful, when properly displayed, than the very common "moulds," which were universally familiar, and, indeed, only too often more familiar than welcome. But there was considerable difficulty in mounting them, or even in preparing them for exhibition as temporary mounts for transmitted light. This was due partly to the fact that the spores were very readily shed, and the whole plant disorganised, in the dry air of a room, and partly to the difficulty of getting water to effectually penetrate it. Some years ago a friend had sent him a bottle of fluid and some specimens of micro-algae preserved in dilute spirit, with the directions, "Wash out the spirit and mount in the fluid." The result was very satisfactory, staining and permanent preservation being effected at the same time, with only one medium. The method was found to answer equally well with fungi, the only difficulty lying in the preliminary process. The fluid consisted of glycerine, to which an alcoholic solution of Hoffman's blue was added in sufficient quantity to obtain the desired tint. It was essential that the blue should be of the best quality if permanent results were wanted. Methylen-blue could be used as a substitute, but the colour faded quickly. The method of mounting is as follows: A drop of alcohol of strength 80 per cent. to 90 per cent. is placed upon a glass slip. A small portion of the fungus is placed with as little disturbance as possible in the alcohol, which at once penetrates the fungus. The alcohol quickly evaporates, and another drop should now be placed on the object, which should be left to soak in it for about a quarter of an hour. Then a drop or two of more dilute spirit, say 25 per cent. strength is added. This will in its turn penetrate the specimen, and the slide should be left undisturbed for several hours, care being taken to ensure that the fluid does not evaporate altogether. By these processes the initial difficulty of the resistance to wetting is overcome, and at the same time the tissues are fixed and hardened. After some hours (or sooner if convenient) the spirit is washed out with distilled water. This can be done on the slide with a camel-hair brush, with which some of the superfluous spores can at the same time be removed. While the object is still wet, a drop of the coloured glycerine, diluted if the object was a delicate one, should be placed on the fungus and allowed to soak in thoroughly. It is a good plan at this stage to put the slip away in the cabinet for a time. Finally the specimen is arranged under the microscope, the diluted glycerine withdrawn with a brush, and a drop of glycerine in full strength substituted. The cover-glass is then placed in position and cemented down. Unless the object is thick, no cell is required. The algae could be treated in the same manner, but are much easier to deal with, as they do not require such delicate manipulation in the early stages.

The Hon. Secretary congratulated Mr. Burton on his interesting paper, and said that he could quite confirm Mr. Burton's remarks as to the fugitive nature of methylen-blue when used as a stain for fungi. He possessed some beautiful slides of fungi prepared with this medium by Mr. L. Still, a member of the Club, but unfortunately the colour was steadily fading, although they were kept in a light-proof cabinet. Overstaining of the specimens was to some extent a remedy for this tendency to fade.

Dr. Spitta confirmed the observation. He had had considerable experience of methylen-blue as a bacteriological stain, and had found it very fugitive.

A vote of thanks was accorded to Mr. Burton for his communication.

The Hon. Editor, Mr. F. P. Smith, then gave an *ex tempore* résumé of his further contributions towards the revision of the classification of the spiders of the sub-family *Erigoninae*, dealing with those species which he included in the *Walckenaëria* Group. Although this group was considerably the smallest, the amount of alteration in the generally accepted classification necessitated by the strict application of the international rules of nomenclature was greater than in any other group. Mr. Smith gave a brief outline of the characteristics of some of the more striking species in each of the genera concerned, but refrained from stating technical details, which would be published in the Club's Journal. He remarked that a work of revision of this kind necessitated a thorough overhauling of a vast amount of literature. A very large percentage of the papers examined contained no indication in their titles as to whether they included any reference to this particular sub-family, thus entailing a search through the whole of the works in question. After this preliminary selection a good deal of further labour was required to weed out the literature which contained no details of systematic importance. The residuum contained about 150 publications, a list of which it was proposed to publish in the Journal during 1906, for the benefit of those who might feel disposed to continue observations on the sub-family.

Mr. Smith then gave a description of a spider, *Anglia hancockii*, which he believed to be new to science. He stated that this was one of the largest-known species of the Erigoninae, and was a very early type, agreeing closely in its characters with the hypothetical ancestor of the group which he sketched in 1903. One of the remarkable characteristics of this species was to be found in the maxillae. These two plates, which are well developed in almost all spiders, and are really appendages of the first joint of the palpi, are usually more or less rounded externally at their extremities. In this species, however, they are produced into sharp angles, terminating in a long bristle. The falces were armed in front, each with a highly developed denticule or tooth, which was described in detail, and which resembled similar curious structures in other species of the group. Their functions were entirely unknown, but some of them were, no doubt, sense organs.

Mr. Smith's remarks were illustrated by means of sketches, and at their close a very cordial vote of thanks was accorded to him, after which the meeting adjourned.

At the meeting of the Club held on November 17th, 1905, the Right Hon. Sir Ford North, F.R.S., Vice-President, in the Chair, the minutes of the meeting held on October 20th were read and confirmed.

Messrs. Morris B. Evans, B. Karleese, C. H. Brown, J. U. Bremner, T. E. Bonser, A. M. Jones, H. F. Laughton, and the Rev. R. K. Levett were balloted for and duly elected members of the Club.

After the transaction of the usual business, Mr. H. Taverner, F.R.M.S., described a method of gauging the depths of cells sunk in glass slips, which was also applicable to other forms of cells. In mounting Hydrachnidae without pressure, he had always experienced difficulty in selecting a sunk cell sufficiently deep to hold the object without contact with the cover-glass, and yet sufficiently shallow to prevent the object from moving about. He had found the solution of the problem in a form of engineer's internal depth gauge, which was obtainable at any tool-shop. The slide of the gauge was engraved with a vernier, and the depth of a cell could be read in an instant within $\frac{1}{50}$th mm. The thickness of the object was previously ascertained, either by means of the fine adjustment of the microscope where the pitch of the screw was a known quantity, or by turning the object on its edge and comparing its thickness with an engraved scale dropped in the eye-piece.

The Hon. Secretary said that Mr. Taverner's remarks would prove of great service to many members. He had himself felt the want of such a simple device in mounting Foraminifera. Very often a cell which seemed amply deep at the time of mounting proved afterwards to be thinner than the object, and the gradual contraction of the cement drew the cover-glass down on the specimen, thus fracturing it. He had lost many good slides in this way.

The Secretary then said that he regretted to announce that their esteemed President, Dr. E. J. Spitta, was unable to be present, having contracted a severe chill. As they were aware, he had intended to read a paper on "Some Experiments relating to the Compound Eyes of Insects," to which they had all looked forward with great interest. Their Editor, Mr. Frank P. Smith, had very kindly come forward at a few hours' notice to fill the gap, and would give them an *ex tempore* lecture on "Spiders' Eyes." which would, he felt sure, deserve their closest attention.

After a brief introduction, Mr. Smith gave a general description, illustrated by drawings, of the eye of a spider, showing how, in its simple structure, it differed widely from the compound eyes of insects, but was strikingly analogous to the insect ocellus. He then went on to discuss at some length the division, by Mons. E. Simon, of spiders' eyes into two kinds—diurnal and nocturnal; and whilst agreeing with that eminent arachnologist that the differences between the more advanced examples of these two types were extremely distinct and of considerable scientific importance, he considered that the so-called nocturnal eyes were rather of the nature of atrophied organs, impaired by long disuse. The lecturer then went on to explain more fully the structure of eyes of both types. Whilst it was certain that an image of a very considerable degree of distinctness could be produced by an eye-lens of the diurnal type, he believed that the aborted and irregularly shaped "nocturnal" lenses were quite incapable of producing anything like a clear image, a belief which was supported by the fact that in many cases the retina seemed to have practically disappeared. Having treated on the structure of the eyes, Mr. Smith went on to explain the arrangement of these organs in the more important of the spider families, and to show how this arrangement and the habits of the spiders were, as a rule, visibly interdependent. In a few cases, however, curious exceptions had been discovered. A species of *Porrhomma*, for example, had long ago been found living in coal-pits, and as the eyes in this case were of quite a rudimentary type, it had been surmised, at the time of its discovery, that the underground darkness was the cause of this optical imperfection. Mr. Smith stated, however, that he had taken specimens of this very species amongst grass in several parts of Middlesex and Essex, and these individuals all exhibited eyes of the same rudimentary type as that of the pit spiders. He suggested that in the struggle for existence which must ensue between the vast numbers of spiders introduced into coal-pits with the horses' fodder, the species which was least dependent upon powers of vision would, in the end, survive at the expense of those forms which were more embarrassed by the absence of daylight. Many species of the families Linyphiidae and Theridiidae had, in the male, curious prominences, usually supposed to enlarge the spider's range of vision by elevating the eyes. The lecturer greatly doubted the accuracy of this, giving several reasons for his conclusions, amongst them being the fact that the elevations were in many cases quite independent of the eyes—in some instances even apparently interfering with their natural functions; and also that when the eyes *were* greatly elevated, they were often quite atrophied. The genus *Savignia*, for example, was formulated by Blackwall for a species which he believed to have only six eyes, quite overlooking an atrophied pair which were placed at the summit of the slender caput. The lecturer, who had illustrated his remarks by a number of clever sketches, concluded by alluding to the experiments which were necessary in order to test the powers of vision in spiders. Very little work had been done in this direction, and he ventured to recommend the subject to those members who required a new line of research.

Dr. Karop said that he must congratulate Mr. Smith upon his admirable lecture. While admitting the strong resemblance to eyes which many of these organs possessed, he preferred to maintain an open mind on the subject, and he had great doubt as to whether some of them, at any rate, were not organs endowed with senses beyond our knowledge, and not eyes at all in an optical sense. It had been proved long ago by Spallanzani, and the experiments had been verified since his time, that such a highly organised vertebrate as the common bat was not dependent on sight for its sense of direction. Bats which Spallanzani had deprived of sight were found to fly at full speed, and without hesitation, through apertures no larger than their own bodies; and when such a bat was released in a room crossed by a network of fine threads, the animal flew about without touching these threads. He then caught the bat and sealed its external ears with wax, and found, on again releasing it, that it could no longer find its way between the threads without striking them. This proved that the animal saw things not only by optical vision, but also by wave vibrations transmitted through the external ear; and if this were the case in a highly organised vertebrate, there surely could be no need to insist upon the possession of true optical vision in insects and spiders.

After considerable discussion, in which Messrs. Wesché, Earland and F. P. Smith took part, a very cordial vote of thanks was accorded to Mr. Smith for his lecture.

At the meeting of the Club held on December 15th, 1905, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., etc., President, in the Chair, the minutes of the meeting held on November 17th were read and confirmed.

Messrs. E. L. Gardner, A. J. Pullin, and T. Holgate were balloted for and duly elected members of the Club.

Mr. Bryce read a description, by Mr. James Murray, of a new Bdelloid rotifer (*Callidina vesicularis*), which had been discovered in moss gathered in August, 1904, from a wall at Upper Sheringham, Norfolk.

The Chair was then taken by Mr. J. J. Vezey, F.R.M.S., and the President read a paper entitled "Some Experiments relating to the Compound Eyes of Insects." In this paper, which is printed in full in the Journal, the author endeavoured to prove that the effects usually attributed to lenses in the insect's eye could be produced quite independently of the presence of such lenses.

Mr. Wesché remarked that, according to the usually accepted theory, a fly could see detail at 1 ft. distance equivalent to that which a man could make out at 50 ft., and to see the detail appreciated by a fly at $\frac{1}{10}$ in. a man would require the services of a high-power objective. He thought that the theory fell in with all the observed phenomena.

Mr. Lewis said that he objected to the use of the term "facet," which meant a *flat* surface. He had observed that in some small flies the number of lenses in the cornea were very few, and were widely separated—only a comparatively small number of the hexagons being supplied with lenses. But some other insects—*e.g.* dragon-flies—he thought had very many lenses; and suggested that very rapidly flying insects, and in particular those which prey upon smaller ones, often of equally rapid flight, must have very keen sight. He thought that when simple and compound eyes were both present, the simple eyes were mainly of use when the insect was crawling, and the compound eyes only while flying. As a parallel case, he would suggest that if we were travelling, say, in a train moving at ten miles per hour, we could see and recognise flowers on the banks, but at sixty miles an hour it would be quite impossible. He understood that the actual angle of human vision was about 15°, and thought that if it were possible to increase this angle to, say, 60°, we should be able to identify the flowers in the last-mentioned instance, because the passing of the image across the whole retina in, say, one-sixth of a second, would give the brain sufficient time to recognise the flowers on the bank.

Mr. Julius Rheinberg pointed out that in a number of pin-hole and diffractive experiments made with the microscope some time ago he had obtained practically similar results in the image plane, whether a lens or objective of low power or one of high power, or whether no lens at all, was used behind the pin-hole. This accorded with theory, and showed that the convexity of the lens played no special *rôle* under such circumstances. Assuming the usual theory as to the insect's eye, that what corresponded to the retina was at some little distance from the facets themselves, this would show that the shape or convexity of the facets did not matter much, and, in fact, tended to corroborate Dr. Spitta's remarks as to the facets acting rather in the manner of pin-holes than lenses. The usual theory, so far as he understood it, was that the function of each facet was to form on the spot of the retina apportioned to it the image of just the one small part of the object which was directed towards the axis of the facet, all the light from the other portions of the object being absorbed or cut off by the pigment surrounding the "pyramids," at whose lower end the surface corresponding to the retina was supposed to be. Helmholtz, in his *Physiological Optics*, had pointed out that even under these conditions the convexity of the facets would serve the useful purpose of better concentrating the light which falls axially on the facet, and in better helping to get rid of the light which falls on it from other directions. As the optical image of a point of light, whether formed by a lens or a pin-hole, was a little disc which could not be less than a certain size, the speaker had made a few rough calculations as to their size in the case of a fly's eye, of which he had a section, and found that a single disc would more than half cover, and in most cases completely cover, the spot on the retina apportioned to each facet, provided the fly saw with light of the same wave-length as we do. The calculation assumed that what corresponded to the retina was at the lower end of the pyramids, for if the surface on which the image was formed was just behind the cornea—*i.e.* practically in contact with the facets—no pin-hole images could be formed, and for that reason he did not quite understand that suggestion on the part of Dr. Spitta. With reference to Professor Exner's experiment, described in Carpenter, he thought the curious fact that the image of the R on the window was reversed, whilst the image of the church beyond was not, clearly pointed to a pin-hole effect in this photograph; and he drew attention to the analogy between this and the phenomenon recorded by Max Levy, of Philadelphia, in his diffraction experiments with the screens used in making half-tone negatives. Mr. Levy had found (see *Process Work*, January, 1896, pp. 2—4) that the image produced by the clear spaces of the cross-line screen of a T-shaped aperture was shown in correct position before the plane of best focus and reversed in position beyond this plane. It seemed quite conceivable that the effect in Exner's photograph might be due to a similar cause.

Dr. Karop said that he agreed in the main with Mr. Lewis. He did not think that the compound "eye" of insects was an eye in our sense of the term, but that it was a special organ, with a function of which we could at present form no idea.

Mr. Conrady, referring to the question of difficulty of focussing, said he would remind members that they were dealing with lenses of $\frac{1}{100}$ in. in focal length, and that in such cases an object 1 in. or more away would be practically at an infinite distance for such a lens. He thought there was evidence to show that some insects appreciated ultra-violet rays, just as certain insects were capable of responding to sound-waves of very much shorter length than could be appreciated by us.

Mr. Scourfield cited the Entomostraca, where one had cases of a very simple form of compound eye which appeared to have distinct lenses.

Mr. F. P. Smith raised a point of difficulty in the acceptance of the no-lens theory. The cornea of an insect eye—for example, *Dyticus*—when simply stripped from a recently killed specimen, exhibits the multiple-image phenomenon very beautifully. When, however, the specimen is treated with caustic alkali it gradually loses its power of producing the effect in question. The honeycomb framework is unaltered, and therefore it is only reasonable to suppose that a lens, or something akin to a lens, has been distorted or actually destroyed in each of the hexagonal apertures.

A hearty vote of thanks was accorded the President for his interesting communication.

Mr. Taverner exhibited a very fine series of water-mites (Hydrachnidae), mostly mounted in glycerine jelly.

At the meeting of the Club held on January 19th, 1906, Dr. E. J. Spitta, F.R.M.S., F.R.A.S., President, in the Chair, the minutes of the meeting held on December 15th, 1905, were read and confirmed.

Messrs. C. E. Heath, W. R. Clarke, B. Taplin, E. A. Robins, E. J. Duffield, C. W. Murray, P. E. Davies, J. Wilson, F. W. Hobbs, and the Rev. A. A. Dauncey were balloted for and duly elected members of the Club.

After the nomination of officers for election at the meeting to be held on February 16th, the Hon. Secretary announced that two papers of an extremely technical nature—"On *Drepanidotaenia undulata*" and "On a New Tapeworm, *Drepanidotaenia sagitta*"—had been communicated by Mr. T. B. Rosseter, F.R.M.S.

Mr. R. T. Lewis, F.R.M.S., then delivered a lecture on "The Senses of Insects," more particularly dealing with sight and hearing. As it was only possible for us to judge of these senses by comparison with our own capacities and experiences, it appeared necessary at the outset to have some idea as to how such sensations were conveyed to us, and if we could understand something as to this, we should be able more intelligently to recognise analogous structures in insects, and to reasonably infer that similar results might follow. The structure of the human eye and its functions as an optical instrument were too well known to need further description. We knew that a picture was formed by a lens, and that by the action of the light which produced this picture upon the retina sensations were conveyed to the brain by the optic nerve, and the phenomena of vision resulted. The microscope was competent to reveal the minute structure of the cornea, lens, and to some extent of the sensitive retina; but how the sensations excited by the action of the light were conveyed to and understood by the mind was beyond the power of the instrument to demonstrate, so that in endeavouring to understand a subject where demonstration of fact was impossible, we could only suggest some hypothesis or theory, and then see how far it was supported by observation. Of course, if these two were at variance, something must be wrong with one or the other; but the *fact*, whatever it might be, remained the same. The theory upon which he had been working was that of sympathetic ivrations, which certainly appeared capable of application to most of the phenomena of sound, heat, light, and electricity, and might reasonably be held also to apply to some of the obscure problems of psychology. The vibrations which we appreciate as sound, being from their comparative slowness easier to understand and to demonstrate than those of light, were taken by the lecturer as an illustration of the theory referred to. It was to be remembered that the pitch of a sound depended upon the length of the wave, and that its loudness increased with the height—*e.g.* the note middle C was the result of 256 double vibrations per second, and no matter how this number of vibrations was produced, whether by a siren, a tuning-fork, a string, by the tapping of a card upon the cogs of a revolving wheel, or by any other method, the note C would be heard. If a string tuned to give out this number of vibrations had a tuning-fork of the same pitch sounded near it, the string would at once respond, and, being set in vibration, would as a matter of course give out a similar sound. This was what was meant by sympathetic vibration. In accordance with this theory it was understood that the rods of Corti in the cochlea of the human ear were each responsive to their special sounds, and it was further assumed that the more delicate rods of the retina were similarly responsive to the more subtle vibrations of light, the vibrations so excited being conveyed by the auditory and optic nerves respectively to the sensorium, and there interpreted as sound and light. In the case of light it was shown that interpretation played a large part, and that many well-known illusions were neither optical nor ocular, but purely mental—the impression of increased diameter of the sun and moon when near the horizon, which was common to many people, being cited as a familiar instance. Illustrations were also given to show that the range of sound and of colour appreciable by the human ear and eye was limited; but there was every probability that there were vibrations beyond the compass of our physical capacity to appreciate, and it might fairly be assumed that it was quite possible that the more delicate organisation of insects would be capable of appreciating sounds which we could not hear, and of responding to fluoric rays which would affect no fibre of our retinal structure. In reference to human vision, it was suggested that the rods of the retina might be responsive to the vibrations of the primary colours, and that combinations would give rise to an appreciation of every tint in the spectrum—a natural three-colour process—the weakness or failure of any one set resulting in varieties of colour-blindness. Colour-blindness, the lecturer remarked, was almost always a congenital defect, only one case of its accidental acquirement having come to his knowledge—an instance communicated by Professor Tyndall. A sailor who occupied his spare time in wool-working was one evening engaged on a rose, and, endeavouring in the dusk to match the wools required, felt what he described "as if something had snapped in his head." He put aside his work for the night, but next day found that he was quite unable to recognise colour at all. Twelve years later, being experimented upon, he found that he could just perceive the colour sensation red when looking through a red screen at the intense light of the electric arc. After dealing briefly with pseudoscopic and stereoscopic vision, the lecturer said that binocularism was a very well-known optical effect; but the corresponding effect with sound-waves usually passed unnoticed unless under exceptional conditions. A very striking instance of this was given. At one of the Paris Exhibitions was an arrangement to illustrate "stereoscopic" hearing. A telephone transmitter was fitted on the right and on the left of the stage of the Opera House, and these transmitters communicated, each by a separate wire, with receivers at the Exhibition. On placing the receivers from the right and left of the stage to the right and left ears respectively, a most wonderful effect was obtained—quite a new sensation. The listener could locate the relative position of every instrument in the orchestra, and could easily follow the movements of the singers on the stage, etc. As the structure of the compound eyes of insects, and their probable function, was the subject of discussion at the previous meeting of the Club, it was not referred to at any length on this occasion, except to show that as insects lived in the same air and light as ourselves, similar—or at least analogous—structures in their organs might be looked for; hence we found the cornea, the lens, something corresponding to the iris, the retina, the optic nerve, and the sensory ganglia, all present, and numerous observations enabled us to be certain that many insects enjoyed keen powers of vision suited exactly to the conditions under which they lived. The auditory organs of insects undoubtedly existed, although, possessing a very great variety of structure, they were in many cases difficult to identify; but where observed, they appeared competent to receive and transmit vibrations of sound, and, just as many insects had multiple eyes, so some seemed to have multiple ears. The auditory organs of the Orthoptera (crickets, etc.) more nearly complied with the conditions we might expect to find in organs designed to receive such sounds as we ourselves could hear; but their position and number varied considerably in different families. In some there were two on each front leg, in others two only on the back; whilst the pygidium, which was regarded as a multiple auditory organ, was found in duplicate upon the tail. It was clear that in addition to the senses of hearing and sight, insects possessed those of taste, smell, and touch, and that some were endowed with that incomprehensible "sense of direction" which—though found in certain animals, and more especially in birds—seemed wholly absent in the human race. Several interesting instances in illustration of these facts were given from personal observation. The subject was further illustrated by a number of specimens under the microscope, and by a number of very fine drawings, mostly in colour—made by the lecturer with the aid of microscope and camera lucida—showing various types of insect eyes and auditory organs, and some obscure sense-organs found on the palpi of a mosquito (*Culex maculipennis*) and of several ticks. Before closing, the lecturer made an interesting statement regarding the figure in Carpenter reputed to be a reproduction of a photograph made through an insect's compound eye by Exner. He said that at the meeting of the Royal Microscopical Society on November 19th, 1890, Professor Bell exhibited a print of the original photograph by Exner, and, being interested in the matter, he (the lecturer) had made a rough copy in his notebook. This showed the letter R the *right way round*, and not reversed right and left as in Carpenter. A copy of his notebook drawing was now on the table before them.

A hearty vote of thanks was accorded to Mr. Lewis for his very interesting lecture.

At the meeting of the Club held on February 16th, 1906, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on January 19th were read and confirmed.

Messrs. S. C. Akehurst, A. S. Hoole, J. H. Lunn, C. H. Bestow, R. Inwards, F.R.M.S., H. Abson, and S. Glover were balloted for and duly elected members of the Club.

The 40th Annual Report was read by the Secretary.

The Statement of Accounts and audited Balance Sheet for the year 1905 was read by the Treasurer.

It was moved by Mr. Conrady, seconded by Mr. Caffyn, and unanimously carried: "That the Report and Balance Sheet be received and adopted, and that they be printed and circulated in the usual way."

The Scrutineers having handed in the result of the ballot, the following were declared to have been elected:—

For President	E. J. Spitta, L.R.C.P., M.R.C.S., F.R.A.S.
For Four Vice-Presidents.	A. D. Michael, F.L.S., F.R.M.S. The Rt. Hon. Sir Ford North, F.R.S. J. J. Vezey, F.R.M.S. G. C. Karop, M.R.C.S., F.R.M.S.
For Treasurer	H. Morland.
For Secretary	A. Earland.
For Assistant Secretary .	J. H. Pledge.
For Foreign Secretary .	C. F. Rousselet, F.R.M.S.
For Reporter	R. T. Lewis, F.R.M.S.
For Librarian	Alpheus Smith.
For Curator	C. J. Sidwell.
For Editor	Frank P. Smith.
For Four Members of Committee.	W. Wesché. E. Leonard. C. Turner. F. Hughes.

The President delivered his annual address, taking for his subject "The Relative Merits of the Long- and Short-Tube Microscopes."

Mr. Nevill said he thought it was impossible to get the same brilliancy of effect with the short as with the long tube, and that one got a better representation of the object with the long-tube form. Some time ago, wanting to obtain the greatest possible amount of magnification, he used an old-fashioned long-tube microscope, which was fitted with an erector, and thereby obtained the equivalent of a tube-length greater than any supplied by modern opticians. He was able to obtain a magnification of × 150, using only a two-thirds. He, of course, agreed that the short-tube form was best for bacteriological and similar work.

Mr. Conrady considered there was little to choose between the two forms, beyond the advantage mentioned by the President regarding the use of the short form in vertical observation. He recollected one advantage for the long tube claimed by Nelson, to the effect that an observer using a 10-in. tube and keeping both eyes open, as he should do, would be able to keep one eye at the microscope, and could watch an object on the stage with the other. The angle of the larger eye-piece of the long tube, having regard to increased amplification, would be about the same as with the short form. The practical diameter of the body tube depended on the corrections of the objective.

Mr. Rheinberg said the image obtained with the short tube was considerably sharper than with the long. All images might be considered as a mosaic of little discs, the size of the discs increasing with the magnification, and also with the tube-length, the smaller and sharper picture being composed of small discs, while with the 10-in. tube the picture was formed of larger discs. It was possible that it might sometimes be advisable to employ a large-disc image. The size of the little discs varies with the aperture of the objective—not the numerical aperture, but the effective back aperture—this being the reason why a 1-in. will give a much sharper image and will stand higher eye-pieceing than, say, an $\frac{1}{8}$-in. Therefore, discretion was advisable as to the tube-length to be employed. He agreed with the President that both forms had their advantages.

The meeting then concluded with the customary votes of thanks to the President, the Auditors and Scrutineers, and to the Committee and Officers for their much-appreciated services during the past year.

OBITUARY NOTICE.

JOHN JEWELL VEZEY, F.R.M.S.

Elected, May 23rd, 1879 *; on Committee,* 1887–91, *and* 1900–04 *; Treasurer,* 1892–99 *; Vice-President,* 1905–06.

Plate 25.

By the sudden and unexpected death of Mr. Vezey, which occurred on March 6th, the Club loses a member whose commanding personality and wide experience has for many years marked him out as one of its leaders. The record of his membership, printed above, speaks for itself, and is a matter of common knowledge to the members in general; but only those who have acted on Committee with him can really appreciate the value of his services to the Club, or the keen and critical interest which he took in its prosperity. Although an exceptionally busy man, and one who had many calls upon his leisure in connection with the affairs of numerous other societies, Mr. Vezey was always ready to place both time and his unrivalled business experience at the disposal of the Committee, and the loss of such a capable representative and adviser will be severely felt. Among the latest, and certainly not the least, of his services, may be mentioned his conduct of the recent negotiations with the Club's landlords, which resulted in the conclusion of an agreement satisfactory to both parties.

John Jewell Vezey was born November 25th, 1844, and was educated privately for commercial life. He was in business as a wharfinger in Mincing Lane for over forty years, and was a member of the London Chamber of Commerce. Apart from his business he was a man of wide attainments and of the most catholic interests. A mere list of the societies with which he was connected, in the majority of cases as an officer, would occupy considerable space. It may, however, be mentioned that he was elected F.R.M.S. in 1879, the same year in which he joined this Club, had served on the Council and as a Vice-President, and was the Treasurer of the Society at the time of his death.

Mr. Vezey's interests were not, however, confined to scientific or literary channels, for as a devoted Churchman he took an active interest in ecclesiastical affairs, was a member of the London and Rochester Diocesan Conferences, and has been a churchwarden of St. Dunstan's-in-the-East for the past eight years. He was also bound up with numerous philanthropic and charitable schemes, including the Miller Hospital and Royal Kent Dispensary, of which he was a governor. In short, his strong commonsense and keen business faculties won recognition wherever a versatile nature led him, and many widely separated circles will mourn the loss of a common friend and adviser.

A. E.

FORTIETH ANNUAL REPORT.

Your Committee is once more in the position to report favourably upon the substantial progress made by the Club during a year which completes the fortieth of its existence.

During the twelve months ending December 31st, 1905, forty-eight new members were elected. Although this is two less than the number elected in 1904, it is considerably above the average for the past ten years, which is only 37·6. During the year, twenty-three members were lost through resignation, and one was removed for non-payment of subscriptions. Nine have died, several of whom were very well known to all active members, and obituary notices of two of them—viz. Mr. J. G. Waller, an ex-President, and Mr. J. Slade—will be found in the Journal. The others are Dr. J. B. Scriven, Mr. N. D. Warne, Mr. A. W. Bird, Mr. W. M. Young, Mr. T. J. Barratt, Mr. J. H. Garnar, and Mr. C. Hoole. In common with the whole world of microscopists, the Club has also to deplore the death of the late Dr. E. Abbe, one of the oldest and most distinguished of its honorary members, who died on January 14th, 1905.

The wastage due to resignations, though no larger than usual, is a matter deserving the consideration of the Club, inasmuch as it neutralises to a very large extent the influx of new members. The bulk of the resignations come from members of quite recent election, and are no doubt largely due to a sense of strangeness in new surroundings. A new member frequently has no intimate acquaintances in the Club; he attends a few meetings after his election, wanders aimlessly about the room, feels a stranger and comes no more, resigning at the end of the first or second year.

If, on the other hand, he is so fortunate as to make acquaintances at the Club, he soon feels at home and continues a member. The new member should on first attending the Club make himself known to the Secretary, or to some other Officer, who will introduce him to other members, and otherwise endeavour to advise or assist him. The Committee desire to point out that the value of assistance in helping new members to settle down in their surroundings can hardly be overestimated.

The total number of members on the books of the Club on December 31st was 402, as compared with 382 in the previous year, and represents the highest figure which has been reached for very many years.

The attendance both on "gossip" nights and at the ordinary meetings has been extremely large, and continues to increase. The largest attendance during the year was on December 15th, when ninety-three members and twenty visitors were present; but the meeting on November 17th, with an attendance of eighty-three members and twenty-six visitors, makes a good second. The objects exhibited also show no falling off either in interest or number. The Secretary, however, continues to experience great difficulty in obtaining papers suitable for publication, and in default, it has on several occasions been necessary to fall back on lectures. These have been of an uniformly high standard of interest, and much appreciated by the audience; but unfortunately they do not contribute much material for use in the Journal. The lack of papers appears to be largely due to a reluctance to submit notes or short papers; but this is a mistake, inasmuch as a short paper may in itself be of the highest value, and even the briefest note may furnish more matter for discussion than a long paper. The maintenance of the Journal at the high standard which has been achieved in the past, and which has caused it to be sought in exchange by kindred societies in all parts of the world, can only be secured by a supply of new and interesting papers, and all members who are engaged in special research should assist, by the contribution of papers or notes on their methods.

The principal communications read at the meetings during the year were as follows:—

Jan.	A Description of the Rousselet Compressorium	Mr. Rousselet.
,,	On the Cut Suctorial Tubes of the Drone-fly's Proboscis as a Suggested Test-object . . .	Mr. Merlin.
Feb.	President's Address. The Improvements in Modern Objectives popularly explained	Dr. E. J. Spitta.
March	On the Collected Papers of Abbe, and Microscope Theory in Germany	Mr. Rheinberg.
May	The Foraminifera of the Shore-sand at Bognor	Mr. Earland.
June	The Genitalia of the Tsetse Fly, *Glossina palpalis*	Mr. Wesché.
Oct.	On an Easy Method of staining and mounting Micro Fungi and Algae	Mr. J. Burton.
,,	The Spiders of the *Walckenaëria* Group	Mr. F. P. Smith.
,,	*Anglia hancockii*, a New Spider .	Mr. F. P. Smith.
Dec.	On a New Bdelloid Rotifer, *Callidina vesicularis*	Mr. Jas. Murray.
,,	Some Experiments relating to the Compound Eyes of Insects . .	Dr. E. J. Spitta.

In addition, the following lectures were delivered:—

June	"Pond Life"	Mr. W. Wesché.
Nov.	"Spiders' Eyes"	Mr. F. P. Smith.

Mr. F. P. Smith's lecture on November 17th was given at a few hours' notice in order to fill the gap caused by the sudden indisposition of the President, who had been announced to read a paper on that date. The public spirit displayed in thus coming forward at such short notice was much appreciated by the large audience which had assembled.

The Committee desire to thank the lecturers and those gentlemen who have contributed their researches to the Club.

The Library has been much used by members during the year. During the recess the Hon. Librarian completed the removal and re-arrangement of the books in the new cases rented by the Club, and the increased space thus obtained has relieved the congestion which had for so long been a source of trouble. The cordial thanks of all the members are due to the Librarian for the manner in which this laborious work of removal was performed without interference with the issue of books.

The additions to the Library during the year are:—

Alder & Hancock's *British Tunicata*, Vol. 1. Ray Society.

West's *British Desmids*, Vol. 2. Ray Society.

Cash's *Fresh-Water Rhizopods*, Vol. 1. Ray Society.

Flatter's *Microscopical Research—Vegetable Histology.*

Connold's *British Vegetable Galls.*

Kerr & Smith's *Nature through the Microscope and Camera.*

Packard's *Text-Book of Entomology.*

Braithwaite's *British Moss-Flora.* Part 23 completing the work.

Smithsonian Report, 1904.

Missouri Botanic Garden, 1905.

American Botanical Gazette.

Proceedings of the Royal Society.

Journal of the Royal Microscopical Society.

Quarterly Journal of Microscopical Science.
Annals and Magazine of Natural History.
Transactions of the Botanical Society of Edinburgh.
Proceedings of the Geologists' Association.
Proceedings of the Academy of Natural Science of Philadelphia.
Sundry Transactions of other Societies, and Pamphlets.

Among the additions to the Library calling for special notice are :—

The final part of Dr. Braithwaite's *British Moss-Flora*, marking the conclusion of this monumental work, which must for a very long time remain the standard on its subject. Dr. Braithwaite, who is one of the Club's Trustees and was its President so far back as 1872—1873, had generously presented the whole of the previous parts as published, with special plates on India paper, and with the final number has presented his portrait, which will be bound up with the work. Every one will congratulate the distinguished author on the successful completion of his life-work.

Flatter's *Studies in Vegetable Histology* will be found very useful to those who may be engaged in the study of botanical structures. The Club is indebted to the Rt. Hon. Sir Ford North, F.R.S., for this useful work, which has been suitably bound at the expense of the donor.

Nature through Microscope and Camera was presented by another member, Mr. A. E. Smith, by whom the numerous photographs illustrating the work were taken. It has already proved to be a work in much demand.

Packard's *Text-Book of Entomology* was purchased by the Committee, and will prove a boon to those interested in Insect Anatomy, a subject which was previously very weakly represented in the Library.

The Journal has appeared as usual, and the cost of production has once more been kept down to the lowest limit compatible with efficiency. Should the membership continue to increase, it may shortly be possible to allow an increase of expenditure in this direction, and this would doubtless tend to increase the supply of papers, as it not infrequently happens that a valuable paper has to be declined owing to the excessive cost of the illustrations which would be required.

The Hon. Curator reports that the demand for slides from the Club's cabinets continues to increase, and that preparations of a definite educational interest are now in greater request than showy specimens. Over 2,500 slides have been borrowed during the year, and the number would have been still larger but for the fact that the limited accommodation at the Curator's disposal often renders it impossible to cope with the demands received during a meeting. The Curator trusts that those members whose applications for the loan of slides could not be immediately dealt with will appreciate this reason for the delay.

The Club's lantern, which had got into an unsatisfactory condition, has been overhauled and fitted with a new stand at the expense of the President, to whom the Committee desire to express their thanks for a gift which has added appreciably to the utility of the instrument.

During the year fifty-six slides have been added to the Cabinet by donation or purchase, and several sections of the Cabinet have been overhauled, preparations repaired, and where necessary remounted, and defective slides replaced when possible by new ones.

Nine excursions were held during the year, all of which were over old ground. The average attendance at each excursion was fourteen, and, as usual, the excursion to the Royal Botanic Gardens on April 8th was the most patronised, no less than thirty-four members being present. The Rye House excursion was abandoned, owing to the rain.

Besides the usual excursions, a special week-end trip was organised in July, in order to give an opportunity of collecting at a greater distance from town than is possible with a half-day excursion. The Tring district was chosen, and six members joined the party, which was in every way a success. The Excursions Sub-Committee hopes to be able to arrange others on similar lines during the present year.

The Balance Sheet bears witness to the sound financial condition of the Club, but otherwise does not call for much comment. The legacy of £50, bequeathed by the late Mr. Dadswell, has been received from his executors and invested in 2½ per cent. Metropolitan Stock. The sum of £96 10s. has been withdrawn from the balance at the bank, and £100 Metropolitan Water "B" Stock purchased. In spite of this the year closes with a balance in hand of £187 13s. 1d.

In conclusion, the Committee desires to express its thanks to all the Officers for the zealous manner in which they have rendered their services to the Club.

THE TREASURER IN ACCOUNT WITH THE QUEKETT MICROSCOPICAL CLUB

For the year ending December 31st, 1905.

DR.	£	s.	d.
To Balance from 1904	218	10	3
,, Subscriptions received during 1905 ...	200	10	0
,, Legacy, the late E. Dadswell, Esq. ...	50	0	0
,, Dividends, etc., on Investments ...	12	6	6
,, Sales of Journal	14	5	6
,, Sales of Reprints	0	4	3
,, Sales of Catalogues, etc.	3	0	3
,, Receipts for Advertisements	20	6	0
	£519	2	9

CR.	£	s.	d.
By Rent of Rooms and Bookcases ...	75	0	0
,, Expenses of Journal	72	13	11
,, Postage	7	14	2
,, Printing and Stationery	8	10	3
,, Attendant	6	0	0
,, Petty Expenses	5	4	0
,, Books and Slides	18	0	8
,, Purchase of £100 Metropolitan Water "B" Stock	96	10	0
,, Purchase of £50 14s. 10d.—$2\frac{1}{2}$ per cent. Metropolitan Consolidated Stock ...	41	16	8
,, Balance in hand	187	13	1
	£519	2	9

INVESTMENTS.

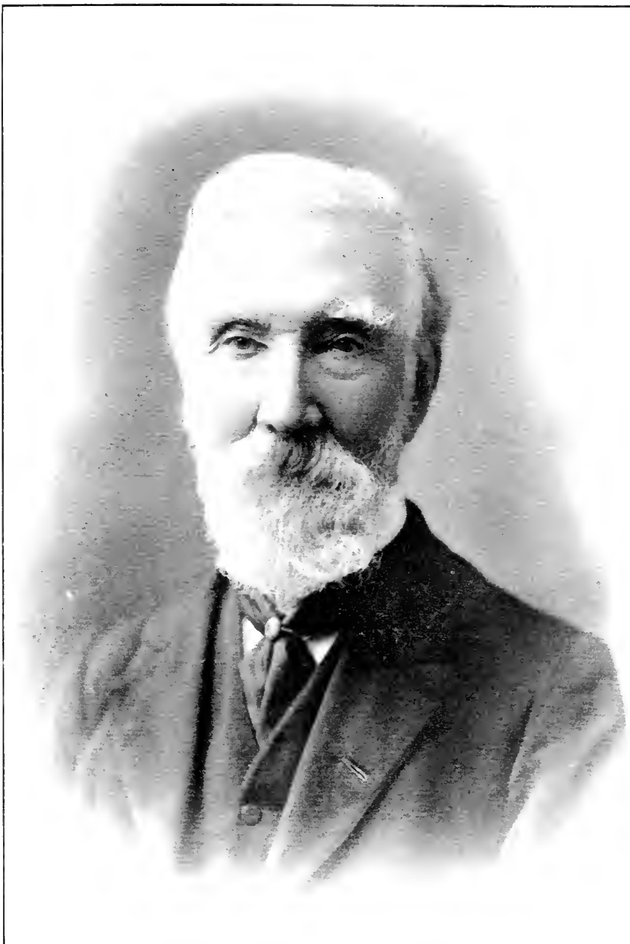
	£	s.	d.
$2\frac{1}{2}$ per cent. Consols	200	0	0
$2\frac{1}{2}$ per cent. Metropolitan Consolidated Stock	100	0	0
$2\frac{1}{2}$ per cent. Annuities, 1905	100	0	0
Metropolitan Water "B" Stock	100	0	0

We have examined the above Statement of Income and Expenditure and compared the same with the Vouchers in the possession of the Treasurer, and have verified the Investments at the Bank of England, and find the same correct.

FRED HUGHES
FREDERICK H. HICKS } *Auditors.*

February 2nd, 1906.

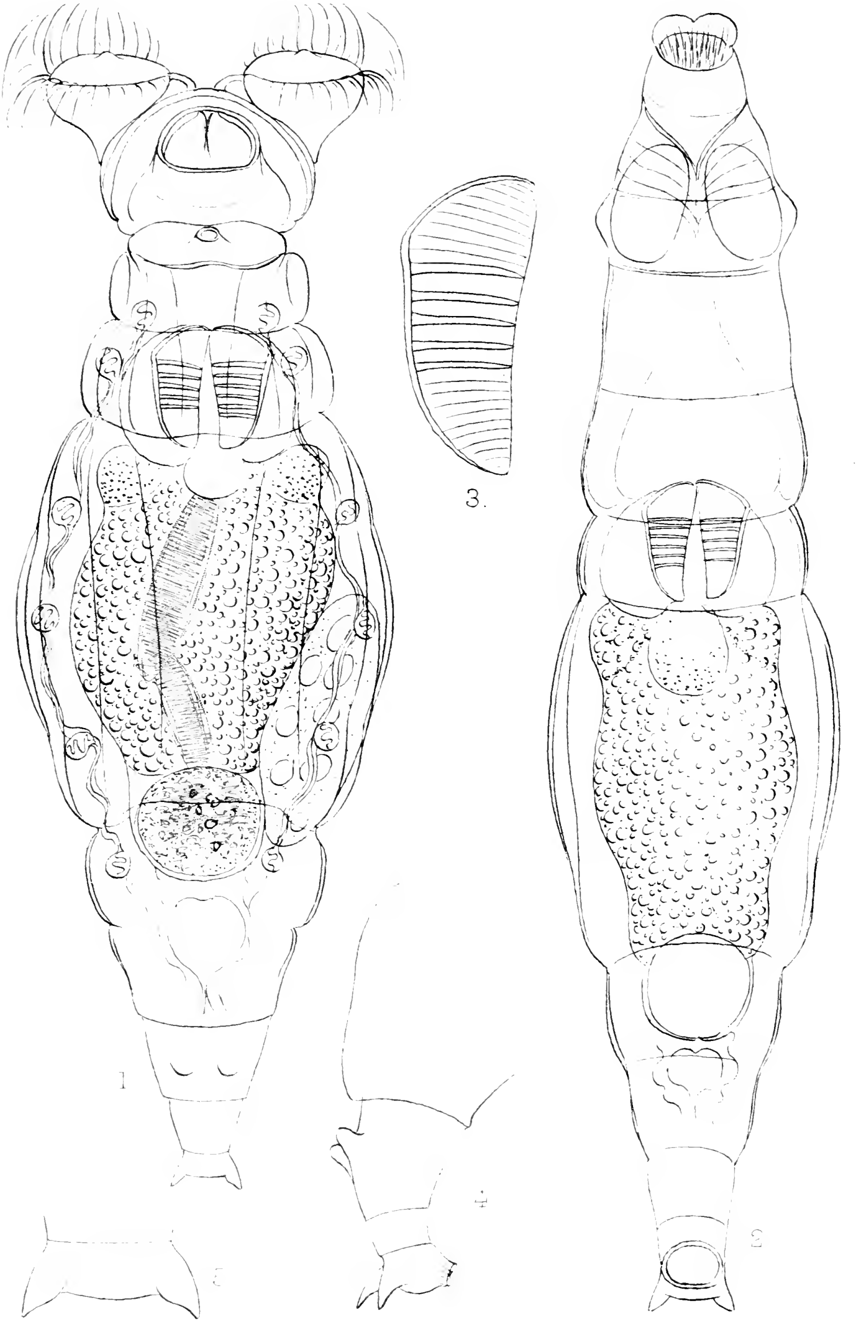
H. MORLAND, *Hon. Treasurer.*



THE LATE JOHN GREEN WALLER, F.S.A.

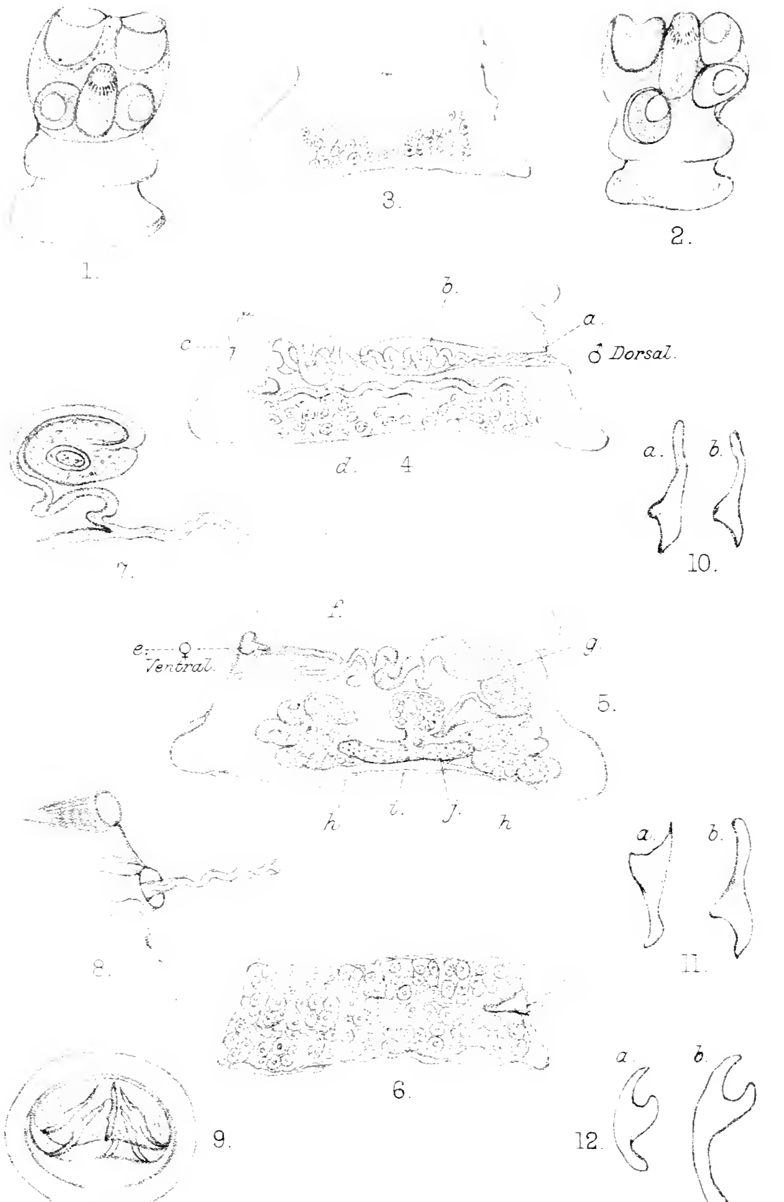
FROM A PHOTOGRAPH TAKEN IN HIS 62ND YEAR.

Correction.—In the Obituary Notice upon page 258 of the Journal, the late Mr. Waller was, by an oversight, described as having been born at Hoxne, Suffolk, the son of a surgeon resident there. William Green, M.R.C.S., the surgeon, of Hoxne, was the grandfather of our late President, who was born in the City of London, his parents being Susanna Green, the youngest daughter of the surgeon, and John Waller, of Harleston, Suffolk, an officer in the navy, who saw active service during the Napoleonic wars, and, subsequently retiring, became engaged in commerce.



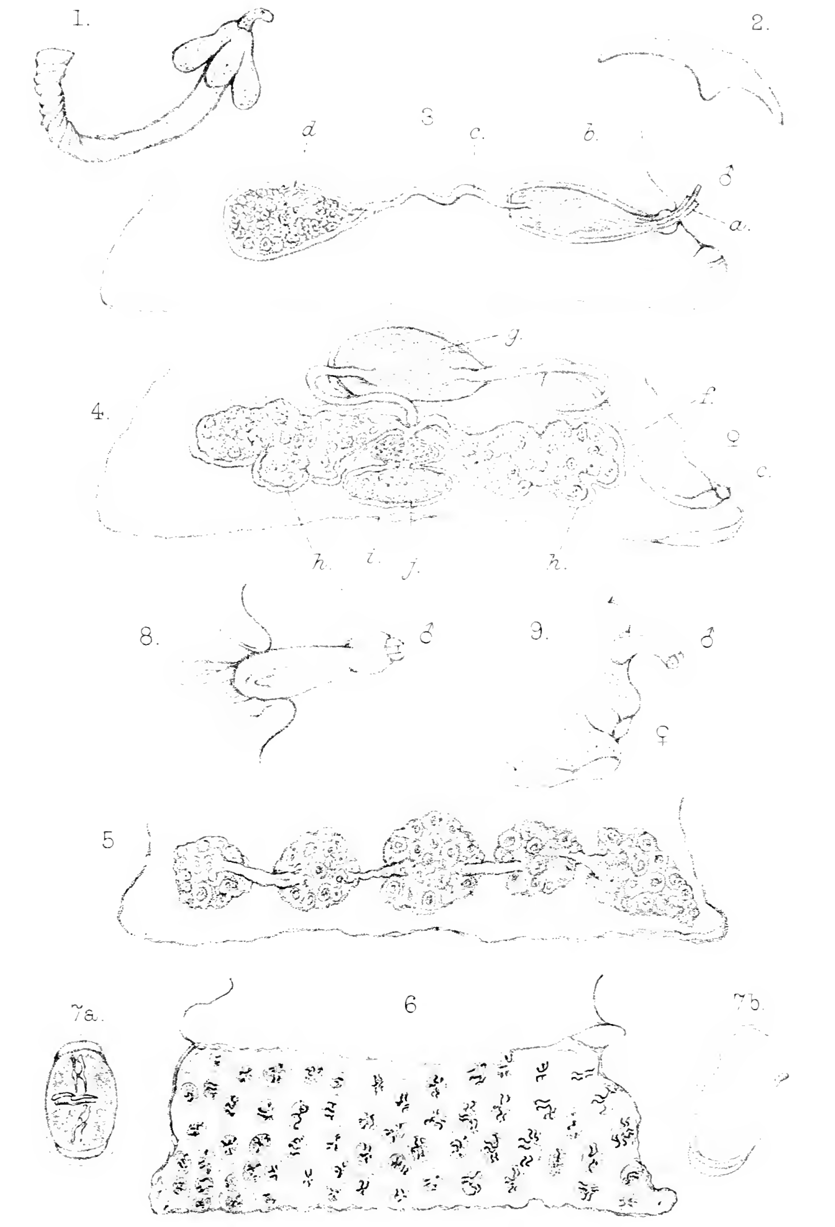
James Murray del. ad nat West, Newman lith

Callidina vesicularis n. sp.



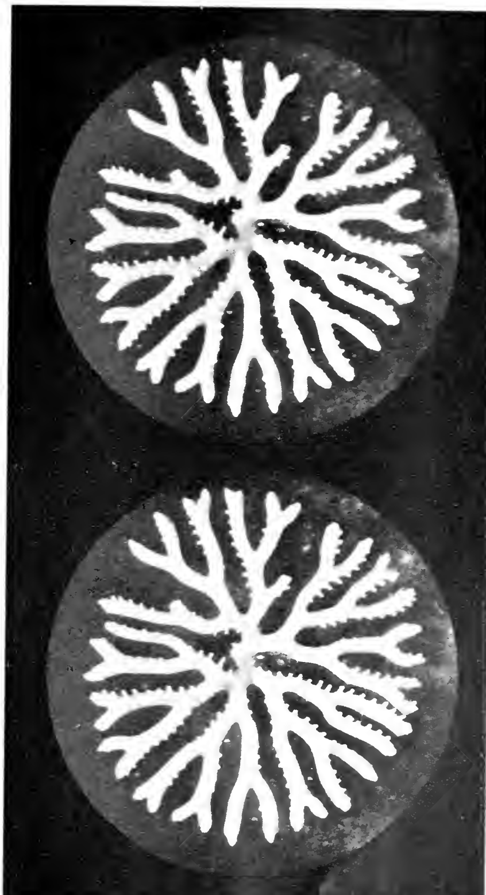
T.B. Rosseter del. ad nat. West, Newman lith.

Drepanidotaenia undulata.



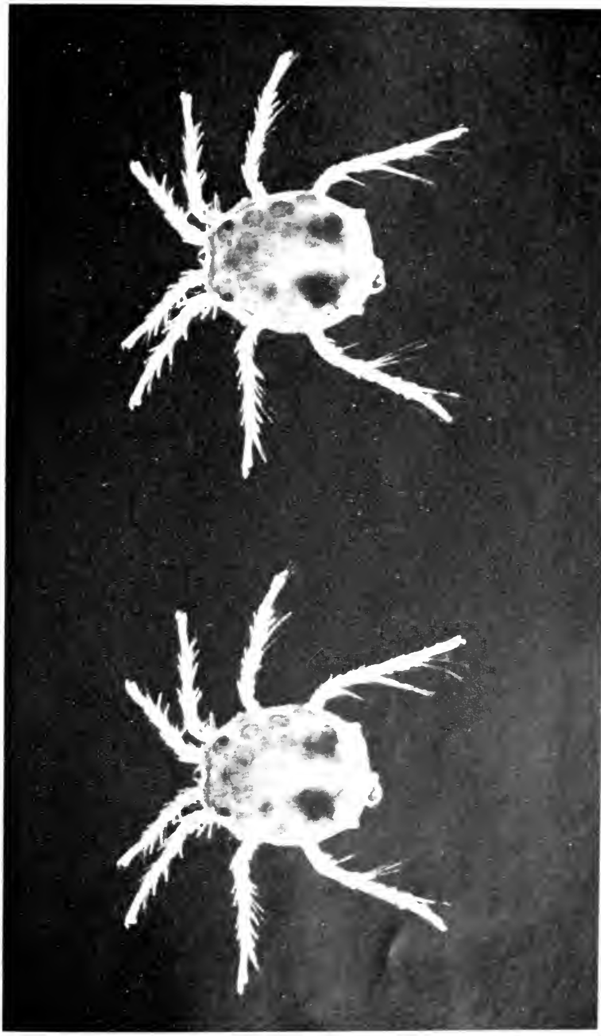
T.B. Rosseter del. ad nat. West, Newman lith.

Drepanidotaenia sagitta. *n. sp.*



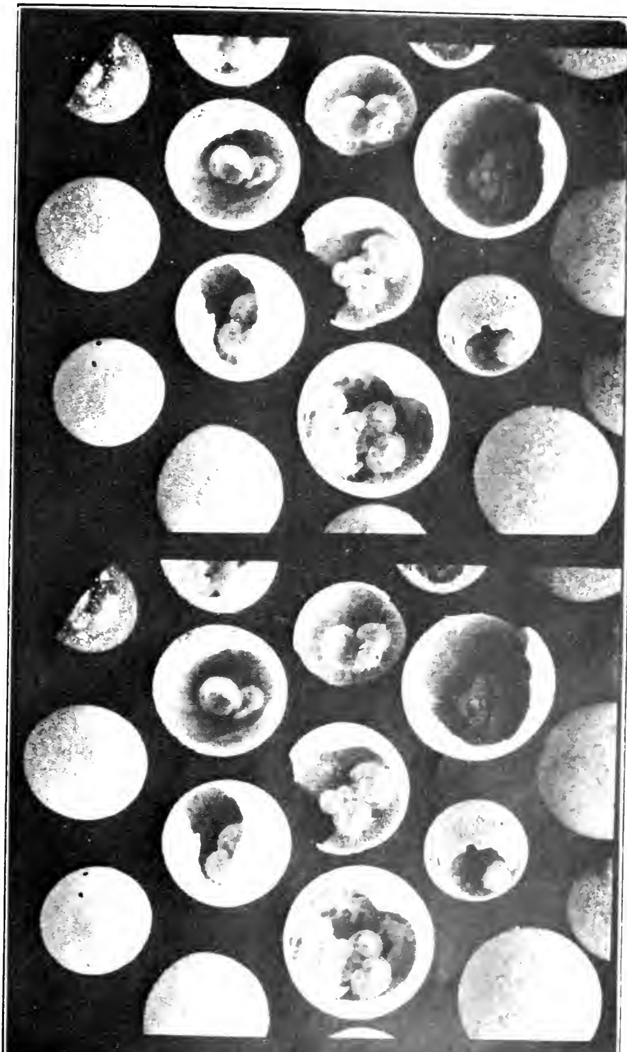
W. P. Dollman, *photo.*

Polyzoa (*Idmonea radians*).



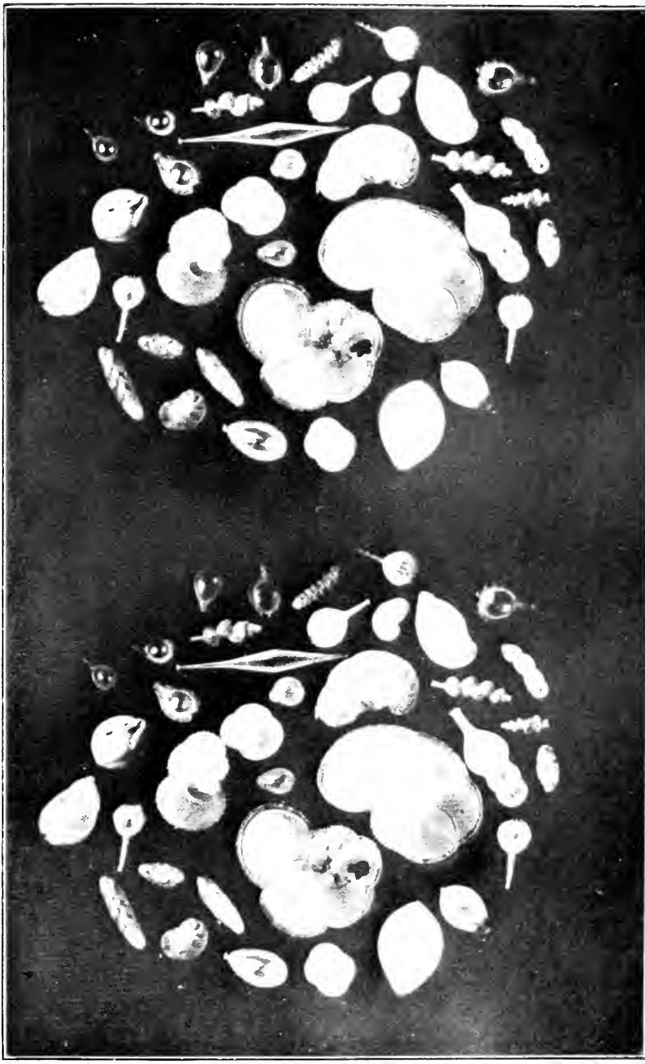
H. TAVERNER, *photo.*

WATER-MITE (*Ecpolus papillosa*, Soar).



H. Taverner, *photo*

Foraminifera (*Orbulina universa*).



H. Taverner, *photo.*

Foraminifera from Timor Sea.

The late John Jewell Vezey, Esq., F.R.M.S.

NOTES AND OBSERVATIONS ON THE LIFE-HISTORY OF FRESH-WATER MITES.

By C. D. Soar, F.R.M.S.

(*Read March 16th, 1906.*)

Plates 26—30.

It was nearly ten years ago that I first made a few remarks on the Hydrachnidae before this Club and mentioned some facts from my own observations on their early stages. Although some of my present remarks will be new, I shall recapitulate part of what I previously said, with this difference, that I am now able to illustrate the points which I wish to bring to your notice. There are at present more than sixty known genera of water-mites, and I do not think that in the case of more than about six of these have we any really definite information upon their early stages. Beyond the interest attached to the subject itself, I am also hoping to induce some of our members to note and report any little piece of evidence that may turn up during their own collecting expeditions, so as to help in adding links to the chain of the life-history of these interesting little creatures.

Some of the conclusions arrived at, and deductions drawn, may have to be modified as more facts become known. But when they are known I have no doubt but that we shall still find that a number of the habits of these little creatures are due to their environment, and the particular conditions under which they happen to be living at the time and place of capture.

The life-history of water-mites can be conveniently divided into four distinct stages—the egg, larva, nymph, and adult—and these we will take in their proper order.

As far as we know at present, all the Hydrachnids deposit eggs. None bring forth their young alive. But they do not all deposit their eggs in the same manner. Some fix them with a gelatinous film to some convenient object; some lay them inside the shells of fresh-water mussels; and others let them float freely in the water.

On the Quekett excursion to Tring last July our late member Mr. Bird dragged from a pond a large amount of *Anacharis alsinastrum*, which appeared to be covered with a mass of pink-coloured jelly. On further examination it was seen to be the ova of a water-mite. I took a quantity home with me, which hatched in a few days and produced larvae of a species of the genus *Eulais*—which one I should not like to say, as the genus contains a large number of species all very much alike in the larval stage. The

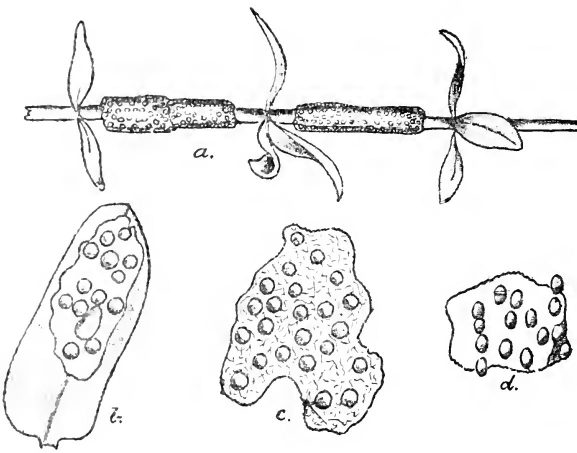


Fig. 1.

eggs in this case were deposited round the stem of the plant, between the leaves, as shown in Fig. 1, *a*, and when a section was cut through the stems it could be seen that the eggs were arranged two or three deep, in an almost colourless gelatinous film.

There is another common mite, *Limnesia histrionica*, which is also very fond of depositing its eggs on *Anacharis*; but its favourite position is on the under-side of the leaves (see Fig. 1, *b*). The *Arrhenuri* do not seem so particular, for although I have had water plants in the small glass tank in which I have kept females, they as often as not deposit their eggs on the sides of the glass vessel, Fig. 1, *c*, being an example of such a patch of eggs.

Fig. 1, *d*, is copied from Van Beneden to show how the eggs of *Atax ypsilophorus* are deposited on the branchiae of the fresh-water mussel. Mr. Williamson, of Edinburgh, has known species of the genus *Lebertia* to deposit eggs in the water, and says that they were pear-shaped, and in twos and threes, without the gelatinous envelope we find covering the eggs of other water-mites. It may be that some of the mites will only deposit eggs when the position is favourable for the parasitic stage. For instance, I kept a number of females of *Atax ypsilophorus* which were all filled with eggs for quite a long time in a small tank, but no eggs were deposited.

I have been able to watch the incubation period of several different species of water-mites. Take, for example, *Piona longipalpis*, Kren. This is one of the finest species of the genus, and allows observations to be taken very easily on account of its size. Plate 26, Fig. *a*, is a sprig of *Anacharis*. At Fig. *b* is shown how the eggs were placed on the upper-side of the leaf, always in a row, but not always of the same number. Fig. *c* is a side view showing the depth, and demonstrating how each egg is enveloped in a gelatinous film. The eggs seem to be laid separately, for the line of demarcation in the protective film is plainly seen for some considerable time after oviposition, this division gradually disappearing as the eggs develop. These eggs were deposited on April 28th, 1904. The drawing, Fig. *d*, was made on May 2nd, and after that every second day, until the living larvae escaped through the slits shown in Fig. *k*, which occurred on May 15th. It will be seen on reference to the Figs. *d*—*l* that the egg gradually grew during that time, and assumed the peculiar form of the larva. Fig. *m* is the dorsal surface of a larval form just hatched, and Fig. *n* is a larger drawing of the same, showing the ventral surface. All the larval forms have only six legs, and are, for the time being, free swimmers. They vary greatly in form—so much so that, in the extreme cases, *Atax*, *Neumania*, *Hygrobates*, *Limnesia*, *Hydrachna*, *Diplodontus*, and *Arrhenurus*, we can tell almost certainly to which genus any larval form belongs. But when it is a question as to the specific identity of the larva the case is very different—the differences between the species in the larval stage being so small. It is supposed that, as soon as the larva has escaped from the egg, its first duty is to look for a suitable host, in or upon which to locate itself for a long or short period, according to the nature of the particular mite; and as far as our observations have at present led us, this supposition is being extensively justified.

We will take the genus *Arrhenurus* first. There is a figure in the Journal of this Club, Series 2, Vol. 8, page 65, showing a small fish which I found with two parasites attached. There is also in the same volume, page 463, a note and some figures of an *Arrhenurus* larva which was found living in the stomach of a trout. But we are not sure if the mites were parasitic there, or if the fish had just devoured a quantity of water-weed with attached eggs just at the point of hatching out. It was certainly a place in which we did not expect to find the living larvae of water-mites. Krendowsky in 1879 gave a drawing of a dragon-fly with the wings covered with an *Arrhenurus* larva, which he says is *A. papillator*, Müll. Last year, while at the Sutton Broad Laboratory, the director, Mr. Browne, allowed me to examine all his specimens of dragon-flies. I found several with parasites, particularly such dragon-flies as *Agrion pulchellum* and *A. puella*. These were often covered all over the thorax with a small, blue-coloured larva, which proved to be one of the *Arrhenuri*, and I should think by the size and colour no other than *Arrhenurus globator*, Müll. Plate 26, *o*, shows *Agrion pulchellum*, Lind., with parasitic larvae on the under-side of the thorax, and at *p* is the abdominal portion of another dragon-fly, with the parasitic larvae on the posterior segments. Figs. *q* and *r* are drawings of one of the larvae detached. Lucas, in his monograph of British dragon-flies, mentions one, *Sympetrum meridionale*, as being nearly always attacked by a red acarus, so much so that its wings are tinted red by reason of the great numbers of these mites. Not being able to obtain one of these dragon-flies elsewhere, I went to the Natural History Museum, where Mr. Kirby kindly allowed me to examine his representatives of this particular species. I found several with parasites on the wings, and I have no doubt that they were the larvae of an *Arrhenurus*; but they were not in such great numbers as mentioned by Mr. Lucas. Possibly in the course of preservation a great many had fallen away.

The next genus which has furnished us with a little information as regards this interesting parasitic stage is the genus *Hydrachna*. This genus is a fairly large one. The various species seem to choose for their hosts members of the Coleoptera and Hemiptera, and the same species do not always confine their attentions to the same host, for I have found *Hydrachna globosa* parasitic upon several different insects. Plate 27, *a*, is *Ranatra linearis*, Linn., which I found in Epping Forest with a great many more lodgers than I have drawn; but I was able to keep this specimen alive long enough for some to break away. They proved to be *Hydrachna globosa*. At *b* is a figure of one of the parasites. Fig. *c* shows *Corixa geoffroyi*, another favourite host, and Fig. *e* shows the way in which the parasites were attached. Fig. *d* is another *Corixa*, whose specific name is unknown to me. It shows the larval form of a mite parasitic under the wing-cases. I found another specimen with three of these large red parasites in a similar position.

Plate 28, *a*, is *Notonecta glauca*, very commonly found with the legs covered with the red larval parasites, *b* showing the hind leg of one so infested. When these creatures leave the egg they have the appearance of the larva drawn in Fig. *c*. They attach themselves as soon as possible to their unfortunate hosts, and fix their mouth-organs firmly into the insect, growing as fast as the nourishment they get will allow. But they only grow in the soft-bodied part, the dorsal plate, the epimera, and the legs remaining the same size as at first (see Figs. *d* and *e*). In most cases, after a time, the legs fall away, being of no further use. Later on the nymph can be plainly seen inside the semi-transparent envelope (Fig. *f*), and in the spring the envelope breaks (Fig. *g*) and the mite escapes as a free swimmer with eight legs, and is known as the nymph. The case from which the mite has escaped remains attached to the insect, where, as far as we can judge, it had been attached for twelve months, from spring until spring comes round again. Fig. *h* is *Dytiscus marginalis*, showing a number of parasites on the ventral surface. This is not the only species of *Dytiscus* I have found with the *Hydrachna* larvae attached. They are also found on *D. dimidiatus*, *D. punctulatus*, and *D. circumcinctus*, and thanks to the kindness of Mr. Browne, of the Sutton Broad Laboratory, I was able to secure specimens showing the larval attachments. They hold on with great tenacity, and I have often held one of the larvae with the forceps and gently swung the beetle about without causing its separation. A writer the other day in one of the country papers was speaking of

Dytisci kept as pets, and said he had often scrubbed dirty ones, before introducing them into his aquarium, with a toothbrush, but it did not dislodge the little red parasites he found on the ventral surface. Sometimes one finds a *Dytiscus* crowded with parasites, but of different sizes. How is this to be accounted for? Are they attacked time after time as a fresh batch of larvae comes along, or do some secure more nourishment than others and thrive accordingly? Figs. *i* and *j* are *Nepa cinerea*, another favourite host for water-mites, drawn so as to show both surfaces, and giving some idea of the number of parasites this species often carries. It will be seen that the ventral surface is very badly attacked. Fig. *k* shows a mite dislodged. In this case the legs have not fallen away; perhaps the creature has never been in a favourable position to have them rubbed off. Water-mites parasitic on aquatic insects were known before Müller wrote his book in 1781, but they were then supposed to be the eggs of some water-mite, and not a parasitic stage of the larval form. Duges, I believe, in 1834, was the first to illustrate the larva of *Hydrachna globosa* in its parasitic form on *Nepa*, and its nymph and adult stages.

The next genus we will notice is *Hydryphantes*. Mr. Browne sent me last year a fly which had an orange-red parasite wedged between the thorax and abdomen (Plate 29, fig. *b*). I managed to get the greater part of the parasite away, and found it to be one of the *Hydryphantes*. I was now very curious to find out of what species was the fly, for I could not understand finding fresh-water mites parasitic on anything but an aquatic insect. Mr. Austin, of the Natural History Museum, kindly named it for me. He said it was *Caenia obscura*, Mg., of the family *Ephydridae*, and that it bred in the stems or leaves of water-plants. This was sufficient to account for the presence of a fresh-water mite on such a strange host. Our member Mr. Wesché kindly drew the fly for me (Plate 29, fig. *a*). There is another instance of *Hydryphantes* being parasitic, and that is on *Paludina contecta*, Carl Thon, 1899.

The genus *Atax* is one that has helped us very considerably with information as regards its parasitic life. The species *Atax ypsilophorus*, *A. bonzi*, and others, are always found parasitic in the fresh water mussel. The two species named I have never found free-swimming at any time of the year, although I have collected at places where I know there are plenty of mussels with the parasites inside. Of course, they must leave the mussel-shell at some time or another, or how is it that we find them more or less in all mussels? A number of writers have described the parasitic stage of *Atax*. Van Beneden in 1848 published a very fine paper, with figures showing the whole life-history of *Atax ypsilophorus*.

There is one species of *Atax* (*A. crassipes*) very common in some places, of which I have taken large numbers quite free-swimming. Plate 30, *d*, will give a good idea of the male. While on the Broads with Mr. Scourfield last August we one day rowed to Sutton Staithe, and as we were tying up the boat previous to landing we saw large quantities of fresh-water sponge (*Spongilla fluviatilis*) on the piles supporting the landing-stage. When we returned at night we took as much as we thought fit back with us to the laboratory for examination. Imagine our surprise when we found, on cutting sections through this sponge, that it contained large numbers of *Atax crassipes* in all stages. There were the egg, larva, nymph, and adult, and all in splendid condition. *Atax crassipes* is a very common mite on the Broads, but I was so pleased with this find that I was very impatient until I could get a sample of sponge from the East London Waterworks to see if that was affected in the same manner. But I am sorry to say I did not find any trace of *Atax crassipes* at all—or, in fact, of any other mite. It is only fair to say, however, that I did not succeed in finding any *Atax crassipes* free-swimming, so it is very likely that there are none at present in the reservoirs of the East London Waterworks.

Having completed their parasitic stage the larval mites become nymphs, with eight legs, so that they are practically the same in form as the adults, except in the genital area. We have no proof of their being parasitic in this stage, except those that we find living inside the shells of the fresh-water mussels, and these appear to be parasitic in all stages. How long the nymph stage lasts we are at present unable to say, but to all appearance the time in some cases, such as *Hydrachna*, is twelve months. As they gradually approach the completion of the nymph period of their existence the adult form is being formed inside in a similar manner as we observed the nymph being formed in the larval skin; but the actual change from nymph to adult is no doubt carried out in a different manner by different genera. I have had nymphs of the genus *Piona* which simply placed themselves in convenient positions, such as in the fork between the leaf and stem of *Anacharis* or other water-plants, and remained in a passive state for a day or two, then crawled out of the posterior end, leaving the old skin attached in the angle of the plant. Mr. Williamson, of Edinburgh, once sent me several specimens just at the right time for observing this process. Our member Mr. Taverner has also had the same experience; and as far as I have been able to judge from personal observation, this is the only time they change their skins. But all species do not act in this manner. I have observed several specimens myself, where the legs and all other appendages fall completely away, the mite being for the time a perfect egg-shaped creature; but so thin is

Fig. 2.

the envelope that one can easily see and almost identify the creature within. Fig. 2, representing a species of the genus *Eulais*, is a good example of this. Plate 29, *d*, *e*, and *f*, are figures of *Hydrachna globosa*, all drawn to the same scale, and are intended to show the approximate growth of a mite in three stages. Fig. *d* is the larva one day old, Fig. *e* is the nymph fully grown, and Fig. *f* is the full-grown adult. The legs are not drawn for want of space. Having thus demonstrated how little we really know at present, I will in conclusion express a hope that I may be able to supplement from time to time what I have here said as new material and facts become available in the life-cycles of these very beautiful and interesting little creatures.

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EXPLANATION OF PLATES 26—30.

Plate 26.

a. A sprig of *Anacharis*.

b. Eggs of *Piona longipalpis*, Kren., deposited on upper-side of leaf. April 28th, 1904.

c. Ditto, lateral view.

d. Two eggs selected for examination, May 2nd, 1904.

e to *l.* The same drawn every other day until May 15th, when they hatched out.

m. Dorsal view of larva just hatched.
n. Ventral view, somewhat larger.
o. *Agrion pulchellum*, Lind., showing parasites on under-side of thorax.
p. Another species of dragon-fly, showing parasites on posterior segments.
q. Dorsal surface of one of the larvae of *Arrhenurus globator*.
r. Ventral surface of ditto.

Plate 27.

a. *Ranatra linearis*, Linn., showing parasitic larvae of *Hydrachna globosa*.
b. One of the larvae detached, showing dorsal plate peculiar to all larvae of this genus.
c. *Corixa geoffroyi*.
d. Another *Corixa*. Specific name unknown, showing parasitic larvae under wing-case.
e. Leg of *Corixa geoffroyi*, showing parasites.

Plate 28.

a. *Notonecta glauca*.
b. Hind leg of same, showing parasites attached.
c. The parasitic larvae when first attached.
d. Ditto, showing growth of soft-skinned portion of body.
e. Ventral surface of same.
f. The same full-grown, showing traces of nymph inside.
g. The envelope as left on the host after the nymph has broken away.
h. *Dytiscus marginalis*, showing parasites on ventral surface and leg.
i. Dorsal surface of *Nepa cinerea*.
j. Ventral surface of ditto.
k. Larval parasite detached.

Plate 29.

a. *Caenia obscura*, Mg. This figure was drawn by W. Wesché.
b. Abdomen, showing position of parasitic larvae of *Hydryphantes*.
c. Figure of the larva.

d. Larvae of *Hydrachna globosa.*

e. Nymph of same.

f. Adult form. Legs not shown.

Plate 30.

a. *Spongilla fluviatilis.*

b. Larval form of *Atax crassipes.* Legs not drawn.

c. Nymph form of same. Legs not drawn.

d. Adult form of same, ♂.

ON STEREOSCOPIC EFFECT AND A SUGGESTED IMPROVEMENT IN BINOCULAR MICROSCOPES.

By Julius Rheinberg, F.R.M.S.

(*Read April 20th*, 1906.)

It may seem a commonplace to remark that the image plane of a microscope, or for the matter of that of any optical instrument, is only in perfectly true focus for one single plane of the object we may be looking at; and yet, on an adequate perception of that fact and what it entails depends the whole subject of stereoscopic vision with the microscope, and there are proofs in abundance, both in the literature of the past and present, that a want of proper appreciation of this simple matter has given rise to much confusion. The very term "stereoscopic vision"—and it is of course for this purpose that binocular microscopes are chiefly used—implies that we are dealing with objects of three dimensions. We desire to obtain a better sense of the form of such objects—to see them standing out in relief, just as we see objects with the naked eye. But if only one plane of the object can be in true focus at any time. it is evident that all the other planes must be more or less out of focus, and we must therefore see wherein these out-of-focus images differ before it is possible to discuss the subject of this paper.

Now if the object point is situated on a plane B, Fig. 1, a little further away than the plane A, which is in true focus at the view plane A^1, the rays reunite in a plane B^1 before reaching the plane A^1; if the object point lies a little nearer than the plane in true focus (as at C, Fig. 1), the rays reunite at C^1 after they have passed the view plane. In both cases, therefore, they are represented on the view plane itself by a disc, a so-called diffusion disc. If that disc be very small, the point of the object it represents is clearly seen: if it be larger, the image gets hazy and confused. Depth perception in an optical instrument depends upon the size of these discs. If they do not exceed a certain limit, conventionally fixed—of which more hereafter—the object is said to be in focus, although it is not in theoretically perfect focus. It will at once be seen that the size of the disc varies directly with the size of the free aperture of the lens, and that is the whole reason why stopping down a lens gives greater depth perception. This, then, is the first point which we note about the diffusion discs—one of common knowledge, universally recognised.

The next thing to note is not so generally recognised. Whilst in the case of the point, which is in true focus at the image plane, the rays which have traversed every part of the objective are united, this does not hold good in the case of the diffusion disc. The different parts of those discs are formed from light which has traversed the different parts of the objective. This may be seen from Fig. 1, the dark shaded part showing the course of the light passing through a certain part of the objective on the right-hand side. Looking at the view plane, it will be observed that the corresponding portion of the diffusion disc, which, coming from the nearer point, arrives there before coming to its true focus, is on the right hand of the centre of the disc; whilst from the further point—which has already passed its true focus when it arrives at the image plane—the shaded portion of the diffusion disc is on the left of the disc centre. When we want to name the position of any symmetrically shaped disc we naturally specify its central point, so we see that, if instead of utilising the whole objective we make use of a lateral part only, such as the shaded portion, the diffusion discs on the image plane get shifted towards the same side as the portion of the objective used when the object points which they represent are on a plane nearer to the one in true focus, and towards the opposite side when the object points are on a plane further away than the one in true focus. We further see that the amount of the shift depends on two things, viz:—

1. The distance between the centre of the objective and the centre of that part of it which may be in use.

2. The distance of the plane* on which the object point lies from the one in true focus.

And with regard to the latter it is well to note that, whereas the points on successive planes get shifted more and more the further they are from the one in true focus, all the points on any one plane get shifted by the same amount.

The next matter concerning the diffusion discs to which I

* All planes are regarded as at right angles to the optic axis of the objective.

desire to draw attention is that the general configuration of a section across any such disc is the same as that of the portion of the aperture of the objective utilised. Thus, if we use the whole objective the diffusion discs are circular; if we use half of the objective only the discs are half-moon shaped; if we placed a triangular stop over the objectives the diffusion discs would become triangular (see Figs. 2 and 3). The bearing of this on the subject of stereoscopic microscope images has, so far as I can find, hitherto altogether escaped attention. We shall see its importance a little later on.

We must now digress a little to recall some of the causes of our impressions of solidity and plasticity when we view objects with the naked eye, as this will afford some basis for comparison as regards similar effects in the microscope. Optical effects alone do not account for our impression of solid form, unconscious judgment and experience playing a *rôle* at least equally important. For our present purpose it will be convenient to distinguish between :—

1. Causes which operate even if only one eye is used.

2. Additional causes coming into play because of the use of both eyes.

To the former category belong in the first place :—

(1) Perspective effects due to the fact that the angle at which objects or areas of similar size subtend the eye alters with their position, so that differently sized pictures are formed on the retina. For our purpose it will be found necessary to sharply distinguish between three kinds of such perspective effects, viz. :—

(*a*) Those when any area is moved backwards or forwards —*i.e.* parallel to the direction of the optic axis of the eye. Let us call this "distance perspective."

(*b*) When an area is moved sideways—*i.e.* at right angles to the direction of the optic axis of the eye. Let us call this "position in field of view perspective."

(*c*) When an area is inclined or rotated with respect to the optic axis of the eye (or if the eye itself be rotated). Let us call this "inclination perspective."

(2) Comparison with other objects of known form and position, or comparison with similar objects in a different position.

(3) The accommodation of the eye—the unconscious degree of tension or relaxation of the muscles, which by flattening or

bulging the lens brings the object to a sharp focus on the retina, helps us to judge of the distance.

(4) Ocular parallax—*i.e.* the way in which, when we move the position of the eye, the images of the objects nearer or further away than the one we are regarding appear to shift their position in the same or in the opposite direction.

(5) The amount of haziness or clearness with which the objects are seen plays a certain *rôle*—*e.g.* objects a little distance away appear considerably further off to a short-sighted person when he removes his spectacles, because indistinctness of image is associated with the idea of distance.

(6) Colour effects, due to physiological as well as psychological causes—blue, for example, suggesting greater distance than red.

(7) Shadow effects—the position of the shadows enables judgment to be formed as to shape and position of the object.

The further causes of stereoscopic vision, when we use both eyes together, depend chiefly upon :—

(1) The mental blending of the dissimilar pictures formed on the retinae of the two eyes, because of the different position of the eyes.

(2) The degree of convergence of the eyes, unconsciously measured by the degree of tension on the muscles by which this convergence is effected.

Coming now to the microscope, we find that of the causes in the first category quite a number disappear. To begin with, the important aid furnished by "distance perspective" has to be dispensed with. In the microscope, areas of similar size at different distances yield pictures of similar size. This is easily susceptible of experiment. Take two millimetre scales on glass, place them on the object-stage on top of one another, so that the ruled surface is separated by the thickness of the glass (or, placing the upper scale face downwards, they can be separated by any convenient amount of cardboard or paper), and view them together in the microscope, using a 1-in. or 2-in. objective. When the lines on the upper scale are in sharp focus, the divisions on the lower scale will practically superpose and correspond in size.*

* To get sufficient penetrating power to see both scales at once it is advisable to use an iris diaphragm (Davis shutter) over the objective.

I have some photographs kindly taken for me by Mr. Taverner showing this.* This equality of magnification of different layers has been definitely stated as a fact by Abbe in his paper, "On the Mode of Vision with Objectives of Wide Aperture,"† but I have not come across any explanation. The full explanation of this curious matter is not altogether clear,‡ but one or two contributory causes are evident. The first one is that, although separate layers form images of different size at the respective planes at which they are in true focus, when we refer them to a common plane we are dealing with their projections on that plane; Fig. 4 illustrates this. AA, BB, CC have quite different magnifications at their own respective image planes; but in the plane A the axis of the diffusion discs of the points B and C practically coincide in position with A.

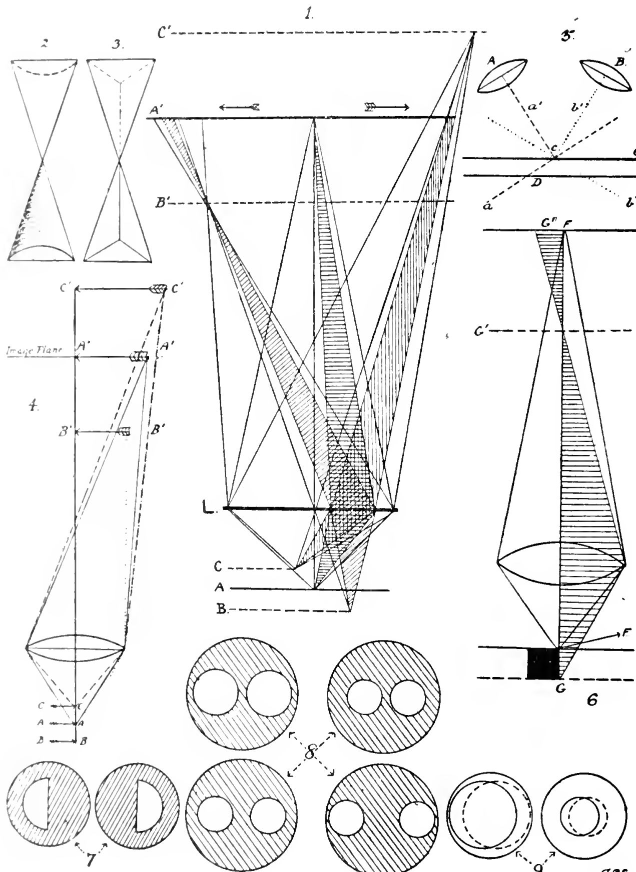
The other reason seems to be that the depth of the different layers which can be seen at one time is so small compared with the distance of the object from the objective that there is little scope for any appreciable perspective effect. It is as if we expected to notice any perceptible difference in size between the front and back of a little square with 1-in. sides held at a distance, say a yard, straight in front of the eye. To further complete the comparison, we may imagine the front to be seen sharply, but the back to be seen more hazily, so that its precise length could not be judged quite so clearly.

* Certain photographs, as yet unexplained, even show a tendency for the farther set of lines to be imaged slightly wider apart than the nearer set; in no case were the latter set the wider.

† *Journal Royal Microscopical Society*, 1884, pp. 20—26.

‡ Since this paper was read these statements require modification. Thanks to Mr. A. E. Conrady, who drew attention to the matter in the discussion following the paper, and likewise to Dr. A. Köhler, of Jena, to whom I am indebted for a long explanatory letter, it has been pointed out that the question was dealt with by Abbe in a paper in which one would scarcely seek for it. In an article, "Ueber mikrometrische Messung mittelst optischer Bilder" (vide *Abbe's Collected Works*, pp. 165—172), it is shown that the magnification of different layers of the object in a given plane of the eye-piece is dependent on and controlled by the position of the stops above the objective. It is not possible here to enter in any detail on this somewhat difficult subject. Suffice it to say that Abbe demonstrates that by having a stop in the upper focal plane of the objective, thereby producing what he has termed a "telecentric" passage of the light rays, the magnification of the various planes of the object can be practically equalised in the plane of the eye-piece diaphragm.

Altering the position in the field of view will likewise be found to make very little difference, so far as the layer in true focus is concerned, though it may under certain circumstances make rather more difference as regards out-of-focus layers.



Figs. 1—9.

However, the differences from this cause—as may easily be practically tried—are not sufficiently distinctive to aid us in the sense of perspective, so long as monocular vision is in question, and they will be more conveniently discussed when we deal with binocular vision.

On the other hand, difference of inclination, with respect to the optic axis of the instrument, makes a very appreciable difference in the perspective—a difference the more accentuated because, as we shall see a little further on, the apparent depth dimension of an object is exaggerated, as compared with the magnification of horizontal surfaces. This "perspective of inclination" would, in fact, seem to be the chief aid to our sense of solidity, when we get a number of objects of similar shapes in the field of view at the same time—as, for example, when we have a slide of Polycystina.

Comparison with objects of known form and position will, of course, aid us in vision with the microscope just as with the unaided eye; and though in general, owing to the restricted field of view, we may not have the known comparison objects at hand so frequently, yet the unconscious comparison with objects we are familiar with in ordinary vision will materially aid us in our conception of the form—in fact, may assist us to overcome any optical distortion which may be present.

Nos. 4 and 6 in our list of causes of impression of solidity have to be practically dispensed with. The pupil of the eye, when looking through a microscope, is placed near the position of the Ramsden circle of the microscope—the little bright ring of light, seen just above the eye-piece—and even with the lowest powers and low eye-pieces the size of this is considerably less than that of the pupil of the eye. Therefore there is little scope for lateral movements of the eye, and for any relative displacements of things seen, from this cause; although slight displacements may possibly occur owing to a *special* form of ocular parallax recently elucidated by Professor W. F. Barrett.* Different colours at different planes to help in the conception of solidity are rarely met with in the microscope in ordinary practice.

Shadow effects are mostly met with under such very different conditions to those in vogue in ordinary vision—because in general we either use transmitted light with the microscope, or throw the light on the objects from all sides as in dark ground illumination—that little reliable judgment can be formed from these under ordinary circumstances, although by using oblique illumination

* "On Entoptic Vision," *Scientific Proceedings Royal Dublin Society*, 1906, vol. xi., No. 8, p. 76.

in one azimuth (the relative pros and cons of which we need not stop here to consider) we frequently can gain some help in our estimation of the form, and the same assistance may be afforded by the use of suitable colour illumination.*

We have now to consider causes 3 and 5, both of which play an important *rôle* in vision with the microscope. Considering the latter first—viz. the way in which the relative clearness or haziness of different layers affect our estimation of their distance from one another—I am not sure that this has been recognised sufficiently; but the simple experiment of taking, say, a watch movement in which a number of thin wheels are visible one behind the other, and regarding this with a 1-in objective stopped down to various degrees by an iris diaphragm behind it, will quickly convince any one what a difference this makes. As soon as the stopping down of the objectives lessens the size of the diffusion discs of points in the out-of-focus layers, these seem to come appreciably closer to the one in true focus.

The accommodation of the eye is brought into play with the microscope just the same as in ordinary vision. This subject, together with the question of depth of focus of objectives, was exhaustively investigated by Abbe, and his results were given in a paper in the *Zeitschrift für Mikroskopie*,† which has been admirably summarised at some length in Carpenter's *Handbook*.‡ It will only be necessary here to touch upon some of the principal points.

It was shown that in vision with the microscope the whole penetrating power was due to depth of focus of the instrument, plus that due to the accommodating power of the eye. The focal depth of the objective depends upon the size of the diffusion discs which may be considered permissible; if the visual angle under which they are seen is about 3′ of an arc, the image is fairly distinct; if more than about 5′, the image becomes too indistinct. The size of these discs, as we have

* "On an Addition to the Methods of Microscopical Research by a New Way of Optically producing Colour-contrast between an Object and its Background, or between Definite Parts of the Object itself," J. Rheinberg, *Journal Royal Microscopical Society*, 1896, p. 384.

† "Beschreibung eines neuen stereoscopischen Oculars," *Zeitschrift für Mikroskopie*, pp. 216—225. Vide also *Journal Royal Microscopical Society*, 1881, pp. 687—689.

‡ pp. 83—90.

already seen in the beginning of this paper, vary directly with the size of the clear aperture; but Abbe showed that they also increased in size, as the square of the linear magnification. This is because the distance between the image planes, in which any points of the object which are in planes behind one another come to a true focus, is equal to the square of the distance the points would be apart in the image, supposing they lay in the same plane. For instance, suppose the object were a cube with 1-mm. sides, the linear magnification being 10. Then the horizontal sides would appear to be 10 mm., but the distance between the planes in which the top and bottom of the cube were in true focus would be 100 mm.* Suppose, then, we show both images in the plane in which the top is in focus, it is clear that the diffusion discs from the lower surface will have attained considerable dimensions.

By means of the accommodation of the eye we can, however, form sharp pictures on the retina of various planes, successively; and since the size of the diffusion disc varies according to the plane in which they are viewed, we can within certain limits focus our eyes—in other words, change the convexity of the eye-lens—to view that plane in which they are smallest. The extent of this accommodating power varies with the individual, and with his age; but to give some rough idea, it would enable a normal person to extend the depth perception of the object by about ·02 mm., if a wide-angled 1-in. objective were used with tube-length and ocular to give a magnification of 100 times. But since the solid image of the object increases in depth as the square of the linear magnification, so that the diffusion discs, when referred to any specified plane, vary in size at this same rate, if in the example just given the linear magnification were 1,000, the eye accommodation would only serve to penetrate ·0002 mm.; whilst

* This presumes the object to be in the air. If imbedded in a medium the distance would be 100 divided by the refractive index of the medium. It is perhaps desirable to here add a word of caution, that it must not be imagined that the exaggerated depth proportions of what we may term the "solid" optical image (usually referred to as the super-magnification or super-amplification of the depth dimension) are seen as such. It is not as if we were looking at an ordinary solid object of that shape with unaided vision. What we see, or think we see, depends entirely on the way the optical image affects our eye, and the means at our disposal for perception and judgment—the very matters we are at present considering.

had the magnification been 10 only, it would have served to penetrate 2 mm. It is seen, therefore, that whilst with very low powers the eye accommodation plays a very considerable part, as we go to higher powers its scope becomes more and more limited; and when we add the eye accommodation to the focal depth we get from the objective, so as to get the total penetrating power, the same thing holds good.

We can best form an idea of this by comparing the amount of penetration with the size of the field of view, and it is found that when we employ a moderate magnification, such as 100, the power to penetrate may amount to about $\frac{1}{100}$th of the diameter of the field of view; if the magnification is 1,000, we cannot penetrate to more than $\frac{1}{1000}$th of it.

Abbe also points out that the same causes which operate to seeming disadvantage in so greatly reducing the possibility of penetration when we increase the magnification have, however, a compensating advantage; for they serve to make the layers which *are* in focus stand out more distinctly from the others, so that, by adjusting for successive planes, we can accurately construe the form of the object, and form our ideas as to space relations with a like degree of certainty. This is an advantage which does not come into play with the unaided vision, but it is one almost wholly dependent upon the special judgment and experience of the observer.

If we confine ourselves strictly to those aids to the impression of solidity which are due either to optical effects or *unconscious* judgment, and sum up our results as we are now in a position to do, we may say that with the microscope, when one eye only is used, we are on the whole far more restricted than in monocular vision with the unaided eye. The perspective effects of distance and of position in the field of view are practically absent, and the image in the direction of the depth dimension is exaggerated. Our main guides would seem to be the comparison with the objects of known form, aided by the "inclination perspective"; also the amount of haziness or clearness with which the different parts or layers of the object are seen, which is assisted to a greater or less extent by eye accommodation.

We come now to the subject of stereoscopic effect in binocular vision; and the first thing to recognise is that everything which applies to our impression of space relations with one eye naturally applies with equal force when we use both. It would seem, indeed, that the mere fact of using both eyes serves to strengthen any impression of plasticity which may be formed when one eye only is used, even when the images are entirely similar. The experiment can be readily made with certain forms of binocular microscopes, or by using the Abbe binocular eye-piece under certain conditions. But far and away the most powerful aid to our perception of solidity in the binocular microscope is the mental blending of two dissimilar images, with its accompanying changes in the degree of convergence of the eyes, precisely the same as with the unaided eyes. It is, however, not enough that the images should be dissimilar. To yield the most correct result they ought to differ, as nearly as possible in the same way and degree, as do the images of objects on the retinae of the two eyes in ordinary vision; for if this is not the case we may have an impression of plasticity, it is true. but a false or distorted one. A very neat way of regarding the matter has been given by Czapski * in a paper on the Greenough binocular microscope. He says that Greenough formulated the desire that "the pictures presented to the two eyes, by the corresponding microscopes, must be in all respects similar to those which would be formed in the eyes of a dwarf, when regarding the object with unaided eyes—the dwarf being supposed to view the object at the very short distance commensurate to his own tiny size."

The question for consideration, therefore, is whether such a similarity of conditions is possible; if not, what nearest approach to it can be obtained. In regard to the two eye pictures in unaided vision, it is clear that difference of perspective plays the chief part; for we get a very considerable difference of "inclination perspective," for the reason that the optic axes of the two eyes are not parallel, but converge, when we regard near objects. Moreover, since we change the convergence to suit the distance of the point of the object we are looking at, the "inclination perspective" changes, and this doubtless assists in our conception of the form of the object, altogether apart from any judgment due to the differing degrees of tension on the muscles from the act of convergence itself. Further, a decided difference in the "position in field of view perspective" follows from the fact that the object looked at is either situated between

* *Zeitschrift für Wiss. Mikroskopie.* 1897, pp. 289—312.

the two eyes, so that it is regarded from entirely different directions, or, if not, because it lies much more sideways from one eye than the other.

As regards binocular microscopes, which we may divide into two classes—viz. those in which separate objectives are used, and those in which separate parts of a single objective are utilised—very different conditions prevail from those in unaided vision, although in the former kind a clever attempt has been made to realise the same conditions as nearly as can be done, the result of which is seen in the Greenough binocular microscope, made by Messrs. Zeiss.* In this instrument two separate objectives are mounted with their optic axes converging towards the centre of the object plane. Further, they are so mounted that the angle of convergence approximates to that of the angle of convergence of the eyes when regarding an object at 9 in. or 10 in. distant—viz. about 14°—and this, of course, necessitates a different separating distance between the two objectives, according to the power used. It is easy to follow that if a normal individual regards an object 10 in. away with eyes separated $2\frac{1}{2}$ in., then the objectives which focus an object only 1 in. away may not be separated more than $\frac{2\frac{1}{2}}{10} = \frac{1}{4}$ in.; and, in fact, the necessity for having the two objectives so very close together forms a restriction which prevents the principle being applied to the higher powers. But our present point is that here we have an instrument in which the object is imaged from two different station points, so arranged that the "perspective of inclination" and of "position in field of view" conforms to that in naked eye vision as nearly as can be obtained.

Where, however, the great difference comes in, is that:—

1. In both of the single images the effects due to the disproportionate magnification of the depth dimension are present, which, as we saw before, is inherent in the microscope.

2. Whilst in unaided vision we can direct both eyes to any point of an object, and see it with the same degree of clearness with both eyes, the two microscope lenses remain directed towards one point of the object only, all other points being imaged by them with a differing degree of distinctness.

* This would seem to be the only binocular microscope made upon this plan, although as long ago as 1677 Cherubin d'Orleans suggested and published a diagram of such a microscope in his book, *La Vision parfaite.*

The latter point may perhaps be better understood from a diagram. A and B (Fig. 5) are the two lenses, *a'* and *b'* their optic axes, *a* and *b* the planes of the object in true focus for each objective. If O be the plane of the object on the stage, then C will be the only point in true focus for both objectives. Any other points in this plane will be imaged as diffusion discs, and owing to the same causes which govern the disproportionate magnification in the direction of the depth dimension, the size of this diffusion disc will not be the same in both objectives, so that the point will be seen with greater clearness through the one objective than the other.

If we consider a plane slightly lower or higher than O, this difference becomes still more apparent. For here we have the point D in true focus for objective A, and represented by a large diffusion disc for objective B. We see, therefore, that in microscopes with two inclined objectives our two pictures have not only a different perspective, but the corresponding parts of the two eye pictures vary in distinctness. This fact, which becomes more prominent the higher the power, coupled with the small distance between the objectives permissible as we raise its power, sets the limit to the application of microscopes so constructed; but within the range in which they are made they yield excellent images, and it is noteworthy that the results of super-magnification in the direction of the depth dimension of different parts of the object are compensated to a material extent, because any distortions in the two images due to this cause are opposed to one another.

The plan for binocular microscopes upon which most work has been done, however, is that in which a single objective is used, the image yielded by one half being brought to one eye, that by the other half to the other eye. Since 1851, when the first practical form of such a microscope was devised by Professor J. L. Riddell, of New Orleans,* many have been the forms and devices of prisms over the objective by which this result has been obtained, the most convenient ones which are most generally used at present being the Wenham form of prism, which covers up the right half of the objective and directs the image towards the axis of the left eye-tube, and the Stephenson form, which is practically the same as Riddell's, in which two similar prisms

* See Carpenter's *Handbook*, p. 97.

cover up the right and left halves of the objective, and the images, after passing an erecting prism, are directed towards the right and left eye respectively. Now, strange to say, the undoubted efficacy of these arrangements depends upon causes which, as the literature of the subject shows, have been very imperfectly understood, and I believe are much misunderstood even to this day. It is generally assumed that the two halves of the objective act as two separate lenses, viewing the object from two different station points. This, however, is far from being the case. They could only do this if their optic axes were inclined towards each other, as in the Greenough microscope. But the single objective has only one optic axis, and all the parts of that objective combine to form an image projection, seen from that one direction. Put shortly, the "perspective of inclination" is the same for all parts of the objective. We will make the point clearer by an illustration.

Suppose a square in the plane of the object-stage to be the object viewed, and to be in sharp focus on the image plane when the whole objective is used. Then the image is also a square when half of the objective is used by itself, for all the rays proceeding from any part of the object are reunited in the same point of the image, whichever portion of the objective they have traversed. Next, suppose the square to lie in a plane above the one in true focus. Then, as we have seen in the earlier part of our paper, all points of the square are represented in the image plane by diffusion discs, and if we use the right half of the objective only we have all the right halves of the diffusion discs only. *All* the points are therefore shifted to the right, but the whole image still remains a square. And if the object square lies in a plane below the one in true focus the same holds good, excepting that, the rays reaching the image plane having passed their plane of true focus, the right halves of the diffusion discs have crossed over to the left, and the whole image is therefore bodily shifted to the left.

On this very simple property, that parts of an objective used by themselves bodily shift the image of any area lying in a plane at right angles to the optic axis of the whole lens, *without any change of actual shape*, depends the stereoscopic effect of the contrivances we are considering. If we may talk of the different parts of an objective as "looking at" an object, we might say that no separate part of an objective can "look" along any other direction than one parallel to the optic axis of the whole lens—a very different matter from "looking at" the object from the actual direction of the part of the objective utilised, in which case the object squares we were considering just now would be foreshortened, and assume different shapes according to the point from which they were regarded. Helmholtz appears to have recognised, almost half a century ago, the peculiar manner in which the different parts of an objective "look at" and "see" the object, for in his "Physiological Optics"* the action of Nachet's binocular microscope is explained as due to the causes stated, in a few crisp and short sentences. But no better proof can be given that his explanations were not understood till a much later date than that Naegeli and Schwendener, in their well-known work on the microscope, dismiss Helmholtz's remarks in a short footnote as being incorrect.†

The first to explain the whole matter at length was Abbe, who, in a series of papers in 1881 and 1882, notably in his paper "On the Mode of Vision with Objectives of Wide Aperture,"‡ clearly showed how the lateral shifting of the images of different planes of the object by different parts of the objective constitutes a particular form of parallactic displacements. Great controversies were going on in those days on the subject of "all-round" vision, wide-angled lenses being supposed to be able to look round a small object more than narrow-angled lenses; and Abbe's paper, by showing just exactly in what way the different parts of the objective do delineate the parts of an object, very materially elucidated this question. But as a perusal of Carpenter's *Handbook* shows, opinions on these matters continued to be very divided, even after the publication of Abbe's papers.

The following point, which I have not found mentioned anywhere, seems to be one worth noticing, because it is one giving results which might easily be wrongly interpreted. Imagine a small cube placed on the object-stage of the microscope, so that the optic axis of the objective passes through the

* *Handbuch der Physiologischen Optik*, 1867, p. 682.

† *The Microscope*, Naegeli & Schwendener. English translation, 2nd edition, 1892, p. 226. (The German edition of this work is, however, of an earlier date—viz. 1877.)

‡ *Journal Royal Microscopical Society*, 1884, pp. 20—26.

vertical side on the right hand (Fig. 6). We may suppose this side to be coloured red, and we will further suppose the top of the cube to be in true focus. Then it is evident that no light rays from the red side of the cube can reach the left half of the objective—all the light from the red side of the cube impinges on the right half of the objective only, and it would not be altogether out of place, therefore, in such a case to say that the right half of the objective "sees" what the left half does not "see." But how is the image formed in such a case? Clearly all points of the red side of the cube, except those in the surface plane F, which is supposed to be in true focus on the image plane I, are represented by semicircular diffusion discs, which increase in size as the distance increases from the plane F. The shaded part of Fig. 6 shows the course of the rays from a point G on the lowest plane of the cube; the diffusion disc G" lies on the left-hand side of F', the image of F. It will be evident that the diffusion discs from points intermediate between F and G will all overlap, and the resultant appearance in the image plane, therefore, is that of a broadened red patch, brightest at one edge and fading away towards the other.

Suppose next the cube to be slightly shifted towards one side. The same reasoning as before holds good, only the sector of the objective which "sees" the red side will either be less or greater than half the objective, and so the diffusion discs will be correspondingly greater or less. But as pointed out in the earlier part of this paper, the central point of a diffusion disc stands for the position of the disc as a whole, and the particular thing to which I wish to draw your attention is that here we have cases of lateral shifting of image points, notwithstanding the fact that the whole objective is given free play. In other words, when certain parts of an object block out the passage of the rays from other parts we are liable to get parallactic displacements, which, so far as the resultant image is concerned, simulate to a certain extent the appearance which would be presented if some isolated part of the objective were "looking at" the object, round the corner as it were. When we use the two halves of an objective separately, as in binocular microscopes, of course, the same thing holds good; and theoretically, at least, it is possible that certain points of an object represented in the one picture are not represented at all in the other.

Once having grasped the great feature that parallactic displacements in the image of successive layers of the object are the chief means by which stereoscopic effect is produced when the ordinary form of binocular microscope is used, some interesting deductions follow. It is, in the first place, clear that we can only get good results if these displacements tend to change the image pictures in the same way as the image pictures of an object change when viewed from the different station points of right and left eye respectively. Now if we take two objects, matches, for example, and hold them behind one another, looking at them with right and left eye alternately, if we consider the position of the nearer match in relation to the one further away it appears shifted further to the left when viewed with the right eye, or more to the right when viewed with the left eye. If, however, we consider the position of the further match in relation to that of the nearer one, the right eye sees it shifted toward the right, the left eye towards the left. But we have seen from our diagram (Fig. 1) that any portion of the right half of the microscope objective just shifts the images the other way —viz. the image of the nearer planes to the right, and those further away to the left. It is for this reason that in instruments like the Wenham binocular the pencils of rays from the two halves of the objectives are made to cross over so that the left-eye picture is formed by the right side of the objective, and *vice versâ*.* If, however, erecting eye-pieces or an erecting prism is used, as in the case of the Stephenson binoculars, then, since these already change all the pencils or rays from the right to the left and *vice versâ*, the necessity for making the rays cross over no longer exists, and the image from the right half of the objective is brought to the right eye, that from the left half to the left eye.

The recognition that parallactic displacements in the correct direction are *the* primary and essential factors for getting truthful stereoscopic effect when one objective has to supply

* Mention should here be made of a fact which I am indebted to Mr. Conrad Beck for pointing out, since this paper was read—viz. that the prism in Wenham binoculars is usually worked to such an angle that the object seen exactly in the centre of the field with the right eye, is not exactly in the centre of the field seen by the left eye. This naturally has a bearing on the stereoscopic effect, the general result, however, appearing to be that due to a displacement of the whole images bodily.

both eye pictures, and that the question as to the right or left half of the objective being used to produce the picture for either eye is but a secondary matter dependent on this, led Abbe to invent his binocular eye-piece, or "stereoscopic ocular," as it is usually called. With this all the effects obtainable with other forms of binocular microscopes can be produced, and it lends itself to further effects besides. Abbe argued that, so long as we can obtain the necessary and correct parallactic displacements, it does not matter how or where they are produced. Since the Ramsden circle (or exit pupil) above the eye-piece of the microscope is an image of the objective aperture, and forms a common section of the light pencils emanating from *all* points of the objective, cutting off a section of the pencils there amounts to the same thing as cutting them off just above the objective. So he arranges that two identical images are formed in the two eye-pieces by allowing the *whole* of the light to pass a partially reflecting surface in the microscope tube, and then the two inner halves of the Ramsden circles are blocked out by adjustable eye-caps, having a semicircular aperture as shown in Fig. 7.* The resulting images show precisely the same differences as if the separate halves of the objective had been used. If, now, the eye-caps are rotated so as to block out the outer halves of the Ramsden circles, and only allow the light from the inner halves to reach the eye, the contrary effect is produced. The objects appear turned inside out—they are seen "pseudoscopically" instead of "orthoscopically," to use the recognised nomenclature. We may, if we wish, remove the eye-caps altogether. Nearly all the stereoscopic effect, except that which we obtain from either picture viewed monocularly, then vanishes nearly—but not quite, because, as already mentioned, the mere fact of using both eyes together appears to strengthen any impression of plasticity. From the foregoing it will be seen that no better evidence of the true cause of stereoscopic effect when a single objective is used could be adduced than the mere fact and

* In the interests of those who may contemplate the acquisition of this piece of apparatus, it seems worth while to controvert the assertion, erroneously repeated in the last edition of Carpenter's *Handbook*, that the reflected image is an imperfect one. As made at present the right and left eye images are to all intents and purposes optically identical.

demonstration of the diversified action of the Abbe binocular eye-piece.*

We now come to some considerations which I believe to be new, and which lead to the suggested improvement in binoculars, which I desire to bring before you. But first I should like to mention that it is really Mr. H. Taverner with whom the methods in question have originated. Mr. Taverner a few months ago showed me some exceedingly fine examples of stereo-photo-micrographs, which he had taken by means of special stops placed behind the objective, inquiring whether I could explain the effects. On thinking the matter over, I discovered the causes at once, and saw that the same methods might be applied to the binocular microscope. This led me to a study of the literature of the subject of stereoscopic vision with binocular microscopes, and there I found my reasoning amply confirmed, although the following further deductions do not seem to have yet been drawn.

If parallactic displacements of out-of-true-focus layers of the object constitute the mechanism by which stereoscopic effect is produced, this in itself furnishes the necessary proof that the whole image, barring the one plane in true focus, consists of diffusion discs. The size and shape of these diffusion discs is therefore an important matter. We saw in the first part of this paper that the size of the diffusion disc varies directly as the size of the portion of the objective used; further, we saw that the shape it assumes is the same as that of the portion of the objective utilised. It is evident, therefore, that to have pictures of maximum clearness it is desirable to have these discs as small as the circumstances permit, and also that they should be circular in shape. At present in binocular microscopes no regard is paid to either of these matters; the size of the diffusion discs is not adapted according to the depth of the object to be viewed, and the image is formed of overlapping discs semicircular in shape. An unsymmetrical shape like this results in the image of the

* For the first moment it may appear puzzling that the outer halves of the Ramsden circles must be used for correct stereoscopic effect, and the inner halves for the inverted effect, since this means that the nearer planes of the object are shifted to the right on the retina of the right eye, and the planes further away to the left. To understand this it is necessary to remember that when we see an object moving from left to right, its image is moving on the retina from right to left.

same object being less distinct in certain directions than in others, or varying in distinctness according to the position in which it happens to lie in the field.

How it has come about that these matters have been overlooked is simple enough. As regards microscope images, attention has been chiefly concentrated—and justly so—on the perfection of the image of the object layer in true and perfect focus in the view plane, and for this particular plane other conditions prevail. It is the one layer which is free from parallactic displacement, no matter which part of the objective may be used. It is also the layer for which the laws framed from the study of the diffraction of light apply more particularly. And one of these laws is that the "diffraction discs," of which the image in this plane is composed, vary *inversely* in size with the aperture of the objective (or of the part of the objective) utilised. Smaller discs mean greater resolving power so long as the image magnification remains unaltered; therefore, for this one plane, the larger the aperture of the objective employed, the better the images, and the largest aperture available in binoculars is the half-objective. An instructive experiment consists in viewing a Grayson band plate with a binocular microscope. The effect of the semicircular shape of the half-objective may then be shown by rotating the plate. When the rulings lie in the direction of the straight edge of the half objective, a band with only about half the number of lines per inch is resolved as when they lie in the direction at right angles to this.

Although within certain limits the same principles hold good with respect to slightly out-of-focus layers,* the general feature remains that diametrically opposite conditions apply, as regards diminishing the size of the discs, when the layer of the object is in true focus and when it is not. The one necessitates the employment of parts of the objective aperture as large as possible; the other requires them to be as small as possible.

To which are we to give more weight, bearing in mind that the essence of stereoscopic effect lies in viewing a great number of planes simultaneously? Should we adapt our instrument for the single plane in true focus, or for all those others seen at the

* The question of diffractive effects in planes out of focus is an intricate one, and it would go beyond the scope of this paper to enter into a discussion on this subject.

same time? I think you will find it rational—the more so as, even in the single plane, we cannot secure equally good resolution in all directions—that we should extend a good deal of consideration to all those other layers; and the best rule to be followed—one which I believe Mr. Taverner, from his experiments in stereoscopic photo-micrography, has also arrived at—is: Use circular stops (as in Fig. 8), having them just small enough to secure a moderately fair image of the deepest layers which it is required to see simultaneously with the others. In other words, get the necessary depth of focus, but no more; for in securing more, the perfection of the image in other parts is being decreased. Similar objects being exhibited under binocular microscopes in which this rule has been followed, and under others in which the two halves of the objective are left as usual, the improved effect in the former is perceptible at a glance.

The application of circular stops permits of another advantage of a quite different description, in the cases where it is permissible to use them smaller in size than the semi-aperture of the objective. We are enabled to a certain extent to correct the inherent defect of super-magnification, in the direction of the depth dimension, to which reference has been somewhat frequently made in this paper; for, reverting to our experiment with the matches and unaided vision, we shall find that the further the one match is held away from the other, the greater is the difference of the apparent shift in position of either match when viewed with left and right eyes alternately. In other words, a plane appears further away the greater its parallactic displacement. We have seen that, using any two parts of an objective separately, parallactic displacements of any object layer varies directly as the distance between the centres of the parts used. In binoculars as used at present that distance is always just equal to half the diameter of the objective*; but when we use small stops, there is nothing to prevent us increasing or diminishing the distance, as Fig. 8 shows, and in this way

* There is one exception to this, inasmuch as Abbe pointed out that his form of binocular gives good stereoscopic effect when, instead of both Ramsden circles being half covered up, one of them is left uncovered. In the latter case the difference between the centres of the openings corresponds to a quarter of the diameter of the objective, and the parallactic displacements are only half as great.

introducing a certain amount of compensation for any distorted depth dimensional effects.

With regard to the best place to have the stops, there are various possible places. They are, 1, immediately in front of the objective; 2, between the lens and the Wenham or Riddell prism; or 3, above the eye-pieces in the plane of the Ramsden circle. Theoretically the last-named is the best place, and, experimenting with the Abbe stereoscopic eye-piece, I have obtained good results with the stops in this position; but owing to the minute size of the Ramsden circle, and the consequent extra difficulty of adjustments, that position cannot be recommended for other forms of binoculars. Immediately in front of the lens is a very convenient spot, but from certain experiments made does not appear to act quite so well as when the stops are behind the lens, and I have obtained the best results by having them immediately below the prism. I suggest that opticians will find it the most convenient plan to provide a sliding carrier, allowing the stops to come as near to the undersurface of the Wenham or Riddell prism as practicable.

Mr. Taverner has pointed out to me a concomitant advantage of a practical nature, which follows if binoculars are provided with the stop-carrier in the position named. At present most binoculars are provided with a fixed stop just below the prism, the diameter of which is too small to allow the full aperture of low-power objectives with large back lenses—*i.e.* of comparatively large N.A.—to be utilised. This is an inconvenience, particularly when, as is frequently desirable, the binocular is used as a monocular instrument. The purpose of the fixed stop seems to be partly to cut off light reflections, but chiefly, probably, because it would be found that penetrating power would not be great enough if it were larger. If a stop-carrier as suggested is employed there is no need for the fixed stop, and the instrument may be used as a monocular, utilising the full N.A. of any objective, such as a $\frac{1}{2}$-in. apochromatic.

It is a well-known practical fact that stereoscopic binoculars only act well with low and medium powers, and that they fail with high powers—at all events, comparatively speaking. It has been found by Stephenson and Abbe that the best stereoscopic results are obtained by the use of a stop with two circular apertures in the condenser, so that two separate cones of light impinge on the object, and form the image that is brought to the right and left eye respectively. Why stereoscopic effect fails with high-power binoculars is a subject of some complexity, and, indeed, does not appear to have been thoroughly investigated as yet. We know that it is influenced by the fact that we cannot fill our objectives with light in the way we are able to do with lower powers; also, that the small depth of the object it is possible to view at any one time limits its scope. The chief reasons, however, I believe, will be found to be in,—

1. Exaggerated parallactic displacements as we proceed to higher power. They follow from the same causes as those which produce the increasing super-magnification of the depth dimension.

2. The peculiar way in which the influence of diffraction makes itself felt when we are dealing with separated portions of objectives of large N.A., and have to consider out-of-focus images obtained from comparatively narrow cones of light. But further inquiry is necessary before it is possible to adequately enter into these matters.

Before concluding this paper, just a few words on the subject of stereoscopic photo-micrography. As already mentioned, Mr. Taverner's experimental results in this branch of microscopic work led to the present inquiry and adaptation of the method to binoculars. The conditions in the main are similar, but we have the following points of difference :—

1. The penetrating power in the case of photography depends *wholly* on the size and configuration of the diffusion discs, as the eye accommodation is absent. The improvement arising from substitution of circular stops for the semicircular half-objective aperture is even, therefore, slightly more marked.

2. Since we are able to use the parts of the objective wanted for the right and left eye pictures successively, instead of simultaneously, we have greater scope for adjusting the parallactic displacements, so as to obtain the correct impression of the perspective. We may, for example, use overlapping portions of an objective, as in Fig. 9. In the latter the amount of parallax (represented by the distance between the centres of the circular stops) is decreased, and yet good resolving power of the plane in true focus need not be sacrificed, as the size of the opening can be left sufficiently large to yield good resolution of the object.

It is interesting also to note that in stereoscopic photo-micrographs we are able to correct for perspective distortion subsequently in several ways :—

1. We may use weaker or stronger lenses in the stereoscope.

2. We may increase or decrease the distance between the same stereoscope lenses. In the former case we are looking through them nearer the margins of the lenses, which has the effect of flattening the picture.

3. We may decrease or increase the distance between the two pictures, the former flattening, the latter deepening the picture.*

Photographs of the minute spherical foraminiferal shells *Orbulina* have been taken by Mr. Taverner under all sorts of varying conditions—*i.e.* with the stops above or below the objective, variously placed. In the correct photographs the shells are seen nearly truly spherical ; in others they appear to be ovals of considerable depth. The same photographs, however, change in appearance as the distance between them is altered in the stereoscope, or as the distance separating the stereoscope lenses is changed, as indicated above.†

In conclusion, I must express my best thanks to Mr. Charles Baker and to Messrs. Carl Zeiss for their kindness in lending apparatus, and to Mr. Taverner for the experimental photographs taken to illustrate the various points.

* See paper on "Stereoscopic Distortion," by Lyndon Bolton, F.R.A.S., in the *Photographic Journal*, vol. xliii., No. 4, April 1903.

† One of Mr. Taverner's photographs of *Orbulina*, and several other stereoscopic photos, are reproduced on Plates 22, 23, and 24 of the last number of this Journal.

MENDELISM AND MICROSCOPY.

By D. J. Scourfield, F.R.M.S.

(*Read May 18th, 1906.*)

In spite of the very considerable amount of discussion that has taken place in certain sections of the biological world during the last six years on the subject of Mendelism, it can hardly be assumed that even the general outlines of this new branch of scientific knowledge and work are as yet very widely known. It is proposed, therefore, in the present paper, to devote in the first instance some attention to an elucidation of Mendelism—to consider, in fact, some details about Mendel himself, about what he did and how he explained his results—and to follow up the extensions in fact and theory which the subject has undergone in recent years. When this has been done it will be possible to go on to a consideration of the relations existing between Mendelism and various phases of microscopical investigation.

Mendelism is, of course, only a convenient term for the doctrine embodied in what is now known as Mendel's Law of Heredity. There is no need for me to say anything to arouse interest in the subject of heredity, for it is recognised by all as being of the utmost importance. Until quite recently an enormous number of facts accumulated in connection with this matter have been unclassified and apparently unclassifiable. Now, at last, we seem to have a clue to a certain number, at any rate, of these disconnected and supposed contradictory facts, and that clue is Mendel's law.

But some of you are no doubt asking, "Who was Mendel, and how did he come to formulate a law of heredity?"

So far as Gregor Mendel himself is concerned the facts are briefly as follows. He was a native of Austrian Silesia, being born at Heinzendorf, near Odrau, as long ago as 1822. In 1843 he entered the Augustine monastery at Brünn; but it was not until about 1854, after having studied natural science for a few years at Vienna, that he commenced the systematic experiments on the hybridisation of various plants, more especially peas, which led him to the enunciation of the law now associated with his name. For more than ten years he quietly pursued the somewhat monotonous work of tending and recording the results from many thousands of plants raised in the garden attached to the monastery, and in 1865 his now famous paper, "Versuche über Pflanzenhybriden" ("Experiments on Plant Hybrids"), was read before and published in the *Transactions of the Brünn Natural History Society*. In 1869 he published in the same Transactions a small paper on Hawkweed hybrids, but this did not tend to the further elucidation of the subject. About this time Mendel became Abbot of Brünn, and apparently found but little leisure to continue his experiments—at least, he did not publish anything further on the subject. He died in 1884. His work on plant hybrids did not attract any particular attention amongst his contemporaries, and was soon completely forgotten, only being brought to light again by the remarkable simultaneous and independent researches of three Continental botanists, De Vries, Correns, and Tschermak, in 1900.

We will now consider a little more closely what Mendel did. His efforts were directed essentially to the discovery of the number of forms which hybrids between different races of plants could assume, and the numerical relation existing between those forms. It is important to note that Mendel used the word "hybrid" for a cross between two races, even if only separated by a single character, as well as for a cross between two species. The word will also be used in this extended sense in this paper. The method by which Mendel endeavoured to get his results was to follow up the development of the hybrids in their progeny, and he saw quite plainly that three important conditions would have to be complied with in order to get clear answers to his problems. These were (1) the employment of suitable objects for experiment; (2) the keeping of separate records of the results obtained by planting every individual seed produced during several generations; and (3) the fixing of the attention upon certain selected characters to the exclusion of all other considerations.

As regards the first point Mendel laid it down as evidently necessary that plants suitable for such an investigation as he proposed must possess constant differentiating characters; that the hybrids from such plants must, during the flowering period, be protected, either naturally, or at least by easy artificial means, from extraneous pollen; and further, that the hybrids must not show any serious diminution in fertility. All these desirable qualities he found, after some preliminary investigations, to be offered by varieties of the garden pea, *Pisum sativum*, and it was with these that most of Mendel's work was done. The carrying out of the second condition mentioned—namely, the recording of the results obtained from every separate seed for several generations—involved, of course, an enormous amount of labour; but it proved to be a step of the greatest value, and was abundantly justified by the result, for it enabled Mendel to get, from the progeny, an insight into the constitution of the germ-plasm of the parents in a way which had never been done before. Even more important, perhaps, was the third condition, for the limitation of the observations to a few well-marked characters not only brought the task within something approaching manageable proportions, but it constituted a method of analysis which marked a new era in the experimental study of heredity, and it led Mendel directly to the formulation of the very definite law which now bears his name.

Confining our attention for the present to Mendel's experiments with peas, we may note that he selected for observation seven contrasted pairs of characters, namely,—

1. Form of the ripe seeds, whether round or wrinkled;
2. Colour of the cotyledons, whether yellow or green;
3. Colour of the seed-coat, whether grey or white;
4. Form of the ripe pod, whether inflated or constricted;
5. Colour of the unripe pod, whether green or yellow;
6. Position of the flowers, whether axial or terminal;
7. Length of the stem, whether long (6—7 ft.) or short ($\frac{3}{4}$—$1\frac{1}{2}$ ft.).

Plants belonging to varieties possessing one of the characters of one or more of the above pairs were united by cross-fertilisation with plants exhibiting the other character, and reciprocal crosses were made in all cases—*e.g.* the stigmas of "round pea" flowers would be dusted with pollen from "wrinkled pea" flowers, and *vice versâ*.

In every case Mendel found that in the hybrids produced from these first artificial crosses, one character of each pair appeared to the total exclusion of the other, and this was true whichever way the cross was made. The character thus entirely overpowering the other he called the "dominant" character. In the list given above it is the first-named of each pair which is the dominant character—thus, round are dominant over wrinkled peas, yellow over green, and so on. To the characters which failed to appear in the hybrids, Mendel applied the term "recessive," because he wished to suggest that, as he clearly showed to be the case, the characters thus described (or rather, the factors in the germ-cells representing them) were not actually annihilated, or even altered, but that they simply failed to manifest themselves in the presence of the dominant characters.

Mendel next planted the seeds from the first crosses and allowed the plants so raised to be self-fertilised. He then found that the recessive characters reappeared without any alteration, and in a proportion very closely approximating to one-fourth of the whole. Thus, out of every four plants belonging to the second generation, three on the average exhibited the dominant character and one the recessive character of the particular pair united in the original cross from which they were descended. As examples of the actual numbers obtained, the following will suffice: 5,474 round and 1,850 wrinkled seeds; 6,022 with yellow, and 2,001 with green cotyledons; 882 inflated and 299 constricted pods. The net result of all seven pairs of characters gave a proportion of 2·98 to 1.

Proceeding in accordance with his proposed plan of work, Mendel again planted his new crop of peas, and, after the self-fertilisation of the plants, obtained a third generation,* which showed that the dominant forms of the previous generation, although apparently all alike, had really been of two types. One of these, comprising on the average one-third of the total dominants, proved to consist of pure dominants—*i.e.* no recessives were produced; the other type, comprising the remaining two-thirds, consisted of hybrids producing progeny in the proportion of three dominants to one recessive in the same way as the original hybrids. The recessives of the second generation proved to be pure, for they produced no dominants in the third generation. This kind of work was carried on for as many as six

* For the sake of brevity, the different generations are now usually referred to as F_1, F_2, F_3, and so on, meaning the first, second, third, etc., filial generation from the parental generation which is indicated by the letter P.

generations in regard to two of the pairs of characters, for five generations for two other pairs, and for four generations for the remaining three pairs. Hybrids, whether of the first or any subsequent generation, always gave rise to three kinds of progeny in approximately definite proportions—namely, one pure dominant, two hybrids (looking like pure dominants), and one pure recessive.

Put into the form of a diagram, the foregoing results appear quite simple, though none the less remarkable:—

D × R	... Parents (dominant and recessive).
D(R)	... Hybrids (all dominant in appearance, but all containing the recessive character).
D D(R) D(R) R	... Progeny resulting from the self-fertilisation of the hybrids—namely, three dominants to each recessive. Two of the apparent dominants, however, as shown in the next generation, contain the recessive character, and are therefore hybrids like their parents. The other dominant, and likewise the recessive, are pure, and remain constant indefinitely.
D D D(R) D(R) R D D(R) D(R) R R	

Going a step further, Mendel next showed that even when two or more pairs of characters are associated in the same cross, the above rules hold good for each pair considered independently of the others. Thus, if one of the parent plants possesses all dominant characters (the dominance being previously ascertained by testing each pair of characters separately), then the hybrids produced will entirely resemble that parent, and not the other. If, on the other hand, the parent plants each possess a number of dominant and recessive characters, then the hybrids will not resemble either parent exactly, but will be of an intermediate nature, owing to their exhibiting all the dominant characters of both parents, but none of the recessive characters. In the next and later generations, obtained as before by self-fertilisation of the plants, the number of forms produced becomes somewhat complicated, but can be calculated exactly by combining the formula 1 : 2 : 1 (or, for outward form only, 3 : 1) as many times as there are pairs of characters involved.

For example, "round yellow" peas were crossed with "wrinkled green" peas, and the result in the second generation was as follows: 315 round yellow, 101 wrinkled yellow, 108 round green, and 32 wrinkled green, or approximately in the ratio of 9 RY + 3 WY + 3 RG + 1 WG, which ratio is evidently due to a combination of 3 R + 1 W and 3 Y + 1 G. The number of different types actually present was, however, not four, but nine, for it was found by the evidence of subsequent generations that, on the average, out of every 9 RY there were—

4 containing W and G in addition to R and Y
2 ,, W only ,, ,, ,,
2 ,, G ,, ,, ,, ,,
1 ,, R and Y only—*i.e.* pure in both characters;

out of every 3 WY there were—

2 containing G in addition to WY
1 ,, WY only—*i.e.* pure in both characters;

out of every 3 RG there were—

2 containing W in addition to RG
1 ,, RG only—*i.e.* pure in both characters;

while every WG was found to be pure.

The above combinations and their ratios could be predicted from the formula (1 R + 2 RW + 1 W) × (1 Y + 2 YG + 1 G).

It is of the greatest importance to notice that of the four classes mentioned above as having different outward characteristics, two represent combinations of characters not present in the original parents—namely, "wrinkled yellow" and "round green"; and as it has also been shown that in each of these classes there was a definite proportion of pure forms, the result is that, even in the second generation, Mendel obtained two new races which were constant without any further selection.

When three pairs of characters were united in one cross the result was also found to agree with what might have been predicted from a combination of the ratio 3 : 1 for each pair. In this case eight classes differing in outward appearance were obtained, and approximately in the ratio of 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1. Mendel did not undertake the herculean task that would be involved in carefully following up the development of hybrids combining in themselves more than three pairs of characters, but, in the course of his experiments, he did actually meet with the

128 possible constant combinations of the seven pairs of characters with which he had started.

The explanation which Mendel gave of the foregoing phenomena was exceedingly simple, but nevertheless most ingenious. Taking into consideration the everyday experience that in order to maintain a constant race it is necessary that individuals having similar characteristics should be mated together, he concluded that the constant forms which he obtained from hybrids must have been due to the mating of germ-cells containing similar factors and no others. He assumed, therefore, that in the formation of the germ-cells of hybrids, whether male or female, the factors determining the different characters are segregated in such a way that half the germ-cells contain only the factor for one of each pair of characters, and the other half only the factor for the other character—and this is Mendel's law. It has also been called the Law of "Gametic Purity," a term which emphasises the idea of the complete separation in the germ-cells, or gametes, of the contrasted characters combined in the formation of a hybrid.

Mendel himself saw that if his assumption were correct it ought to be possible to predict what would be the result of crosses made in various ways. For example, if a hybrid, instead of being self-fertilised, were fertilised by one of the recessive parental forms, then the progeny should no longer be produced in the ratio of three dominants to one recessive, but in the ratio of 1 : 1—*i.e.* both characters in equal numbers. He showed by experiment that this was actually the case.

In order to get a general idea of the possibility of making predictions by the help of Mendel's law, it is useful to set out in detail the possible combinations which can take place with one or more pairs of characters. Let us consider a cross between round and wrinkled peas. The resulting hybrid plants contain the factors for both characters, being, of course, the result of an association of the two; but, according to Mendel's law, when their germ-cells are formed, the factors for the two characters are separated again from one another, so that there are as many pollen grains with one factor as there are with the other factor, and similarly with regard to the ovules. There are evidently only four possible combinations in such a case—namely, ♂ R with ♀ R and with ♀ W, and ♂ W with ♀ R and with ♀ W, where

R and W stand for the factors determining round and wrinkled peas respectively.* Owing to the number of germ-cells containing each factor being equal, it also follows that each ♀ R and each ♀ W will have an equal chance, other things being equal, of being fertilised by either ♂ R *or* ♂ W, and consequently there will be on the average equal numbers of the four possible combinations. This may be put in simple form as follows:—

♂ R with ♀ R	= 1 RR (*i.e.* pure round)	} = 3 dominant.	
♂ R „ ♀ W	= 2 RW („ hybrid „)		
♂ W „ ♀ R			
♂ W „ ♀ W	= 1 WW („ pure wrinkled)	= 1 recessive.	

In the case previously supposed, when the hybrids are fertilised by recessives, the combination could of course only be,—

♂ W with ♀ R = 1 RW (*i.e.* hybrid round) = 1 dominant ;
♂ W „ ♀ W = 1 WW („ pure wrinkled) = 1 recessive.

Exactly the same method may be employed for two or more pairs of characters, but necessarily the statement of the combinations will be more complex. It must suffice to merely indicate here the possible combinations when two pairs of characters are joined in the hybrids. Taking R and W to represent the round and wrinkled shapes, and Y and G to represent the yellow and green colours of peas, the germ-cells produced will, according to Mendel's law, be of four kinds, neither more nor less—namely, RY, RG, WY, WG; and as pollen grains of each kind have on the average an equal chance of mating with ovules of each kind, the following sixteen matings are possible and in equal numbers:—

♂ RY with ♀ RY	♂ WY with ♀ RY
♂ RY „ ♀ RG	♂ WY „ ♀ RG
♂ RY „ ♀ WY	♂ WY „ ♀ WY
♂ RY „ ♀ WG	♂ WY „ ♀ WG
♂ RG „ ♀ RY	♂ WG „ ♀ RY
♂ RG „ ♀ RG	♂ WG „ ♀ RG
♂ RG „ ♀ WY	♂ WG „ ♀ WY
♂ RG „ ♀ WG	♂ WG „ ♀ WG

* If the ♂ and ♀ gametes bear similar factors the union is now usually described as being homozygous; if dissimilar, as heterozygous.

If the results from the above matings are tabulated it will be found that nine distinct combinations are produced, and when the effect of the dominance of R over W and Y over G is allowed for, the outcome is found to be 9 RY + 3 RG + 3 WY + 1 WG, a result already shown to be confirmed by experiment. The effect of back crossing with a recessive in both characters will obviously be exactly the same as shown by the fourth of the above sets of combinations—*i.e.* there will be equal numbers of RY, RG, WY, and WG. Mendel carried out this experiment among others, and found that he did get, as anticipated, approximately equal numbers of each of the four types.

In addition to his experiments with peas, Mendel also worked with beans, hawkweeds, and other plants. In the case of the beans he found that all the characters selected for observation, with the exception of colour, obeyed the same law as had been found to hold good for peas, and to explain the peculiarities in the inheritance of colour, he made the valuable suggestion that possibly two or more pairs of characters were involved in producing the naked-eye effect. This idea is most likely correct, and it has been found to be certainly true in other cases. The hawkweeds, on the other hand, did not seem to lend support to the law of gametic purity, but rather pointed to the existence of more complicated laws of inheritance. The experiments, however, were on a small scale and very difficult to carry out, and the results therefore not very convincing.

Some thirty-five years after the above results were obtained, it happened that a few botanists—*e.g.* De Vries, Correns, Tschermak, Spillman, and others—were independently carrying out somewhat similar experiments to those of Mendel, and getting practically identical results. The rediscovery of his paper in 1900, therefore, at once brought the subject into prominence, and thereby gave a great impetus to experimental work on heredity in general. Since that year there has been a very large amount of work done on the lines laid down by Mendel, and not only have his own experiments been repeated and verified, but the law he formulated has been found to apply to numerous characters other than those he dealt with, and to animals as well as plants.

On the botanical side may be mentioned such researches as those of De Vries, on maize and many garden plants; Correns, on stocks and maize; Tschermak, on stocks and beans; Bateson and Saunders, on peas, stocks, and other plants; Spillman, on wheat; Biffen, on wheat and barley; Hurst, on orchids, peas, etc. Experimental breeding of animals on Mendelian lines has been carried out by Cuénot, on mice; Bateson and Punnett, on poultry; Castle and Allen, on guinea-pigs, mice, and rabbits; Darbishire, on mice; Hurst, on poultry and rabbits.

All these workers and many others have obtained results for *certain* characters which are obviously in accordance with Mendel's law. Many beautiful examples of Mendelian inheritance in its most typical form—*i.e.* accompanied by the phenomenon of dominance—have been brought to light; *e.g.* in maize, where seeds in the ratio of three dominant to one recessive may be obtained for two pairs of characters on the same cob.* But even when dominance does not occur, and the hybrids, by the interaction of the characters of each pair upon one another, possess a special appearance of their own, it has been shown that the inheritance of the characters often strictly conforms to Mendel's law. In such cases the 1 : 2 : 1 ratio is, of course, at once apparent in the progeny of the hybrids—*e.g.* "Giant Lavender" among Chinese primroses, "Blue Andalusians" among fowls, etc. Further, it has been found that characters of the most subtle kind, such as power of resisting disease, little peculiarities of habit, etc., may be transmitted in accordance with the same law, and it now appears reasonable to believe that characters of every conceivable kind *may* come under its sway, presuming that the characters are based upon differences in the germ-plasm, and not merely produced by the action of the environment upon the individual.

But more significant than the demonstration of the wide range of characters obviously obeying Mendel's law have been the extensions of the application of that law in explaining certain apparently anomalous results. One of the most important developments in this direction is due to Cuénot.

In experimenting with mice, he, and others also, had been puzzled by the unforeseen appearance of entirely new characters, superimposed, so to speak, on a purely Mendelian inheritance of certain other characters. For instance, hybrids between pure races of grey and albino mice, although producing progeny in the

* Examples of maize-cobs showing the Mendelian ratios, grown by Mr. R. H. Lock at the Royal Botanic Gardens, Peradeniya, Ceylon, are exhibited in the Natural History Museum, South Kensington.

proportion of three coloured to one albino, might sometimes give rise to pure black mice. It was difficult to see how this could come about, but there was some slight reason for thinking that the black must have been derived in some way from the albino and not from the grey mice. Starting from this point of view, Cuénot imagined that there were two distinct pairs of characters concerned—namely, a pair for the particular colours involved, whether grey or black, and a pair representing, on the one hand, something which allowed the colour, whatever it might be, to show itself, and, on the other, something which prevented the colour appearing, thus producing albinos. The germ-plasm, in fact, was considered not as being represented by the obvious G (grey) and A (albino), as everybody had previously thought, but as requiring for its proper expression the following formula :—

Dominant characters.	*Recessive characters.*
C (colour-promoting factor).	A (colour-repressing factor).
G (grey).	B (black).

It may be thought at first sight that this is merely an example of Mendel's own conception of two or more pairs of characters being associated in the production of an apparently single pair. But really it is quite different, because, not only is the existence of one of the pairs a pure assumption, but, in order that the two pairs of characters may give the result desired, it is necessary to further assume that the characters of one pair have an influence over those of the other pair—in the case above-mentioned either promoting or preventing their appearance. This idea of characters belonging to different pairs influencing one another, while the members of each pair are being segregated and inherited strictly according to Mendel's law, is one of exceptional importance, and, judging by recent investigations, seems destined to come more and more into prominence in questions of heredity. It can only be added here that, by the help of the above formula (amplified so as to include the colour yellow), Cuénot was able to explain in simple Mendelian fashion the apparently contradictory results already obtained, and even to forecast the outcome of new kinds of matings never previously undertaken. He also found that the inheritance of the coat-pattern of mice could be explained satisfactorily by the same method. Other workers—notably Hurst, with rabbits—have obtained results of exactly the same kind, and explicable in the same way.

By a slight extension of Cuénot's hypothesis—namely, by conceiving of the "pairs" of characters as consisting in some cases of the presence of a character as opposed to its absence—it has been found possible to explain some extremely peculiar results which seemed at first to be quite outside the pale of Mendel's law in its original form. Thus the remarkable phenomena of the production of the "walnut" (Malay) comb in fowls, by the mating of individuals possessing "pea" and "rose" combs, and the subsequent production by the "walnut" forms not only of "walnut," "rose," and "pea," but also of "single" combs, have been brought into line with ordinary Mendelian inheritance by such a "presence and absence" theory. Briefly the idea is as follows. The "pea" and "rose" factors are probably distinct mutations of, or additions to, the factor for "single" comb, and belong to different pairs of characters or allelomorphs, as they are now often called. They can, therefore, exist side by side in the same germ-cell. Their co-existence, however, produces a new type of comb ("walnut"), a type which could not be predicted simply from our knowledge of "pea" and "rose." When the germ-cells of the "walnuts" are formed, in addition to all of them containing "single," half the number will contain the factor for "pea" and half the number the "rose" factor. Owing to the fact, however, that "pea" and "rose" *can* occur together, they *will* so occur on the average just as often as "pea" occurs by itself and "rose" by itself. But for every case where "pea" and "rose" occur together, there must be a case where there is neither "pea" nor "rose," and therefore "single" is exposed to view. Equal numbers of the four kinds of germ-cell—"single," "pea," "rose," and "pea + rose" (= "walnut")—will, therefore, be produced, and from these the results obtained by experiment can be explained. It is worthy of remark that here also the influence of characters belonging to distinct allelomorphic pairs upon one another, while present in the same individual, is necessarily involved in the above explanation of the "walnut" comb, and in a much more pronounced form than merely promoting or repressing the appearance of one of the pairs.

Another conception that has been added to Mendel's original idea is that of "compound allelomorphs." A certain amount of evidence seemed at one time to show that two or more pairs of characters might under some conditions become so linked together as to be inherited as a single pair, although separating again under other conditions. It is, however, not quite certain at present whether this assumption is really needed, for it has been found possible to explain some at least of the cases—*e.g.* the combs of fowls—in a more direct manner, as indicated above. There seems nothing unreasonable in supposing that several pairs of characters may at one time act as a single pair, and then, under other circumstances, break up again. Many cases of what seem to be linked characters—the so-called correlated characters, in fact—are known, although these appear never to break up into independently heritable units. Until, however, it is shown to be absolutely necessary, it will probably be better not to assume the existence of compound allelomorphs or hereditary radicals, as they might be called.

Having now completed the survey of Mendel's experiments and some of the more recent developments on the same lines, we can pass on to a consideration of the relation of Mendelism to microscopical work. There are, indeed, many points of contact between the two, but I think they may all be grouped under three main headings. Firstly, there is the very evident connection between Mendelism and cytological investigation, especially that branch which deals with the germ-cells; then there is the relation which arises from the fact that many naked-eye characters are founded upon microscopical elements; and, lastly, there is the possibility of using microscopic organisms for experimental work in the same way as Mendel used his peas, beans, etc. It will be convenient to take these three points of view in the order mentioned.

With regard to the first it is at once apparent that the position of affairs in 1900, when Mendel's paper was rediscovered, was very different to what it was in 1865, when the paper was published. An enormous advance had been made in the interval in the knowledge of the microscopical structure of plants and animals, especially in connection with cell-structure and cell-division. One of the earliest questions that arose, therefore, after the rediscovery of the paper, was, how does this new doctrine fit in with what is now known about the maturation, fertilisation, and division of the germ-cells?

It would be out of place here to enter upon even a brief account of the long series of researches by which it was demonstrated that the actual material bearers of the hereditary tendencies were the minute, highly stainable bodies existing within each cell-nucleus, and known as the chromosomes. The elaborate mechanism which comes into play in the process of cell-division (mitosis), by means of which the two daughter-nuclei are furnished with exactly half of *each* chromosome of the mother-nucleus, points at once to the extreme importance of these bodies; and the fact that, however diverse the male and female germ-cells of any species may be in other respects, they are, with very few exceptions, exactly similar in respect to their chromosomes, seems to make it sufficiently clear that the latter are the all-essential constituents of the cells, and therefore the bearers of the hereditary factors.* The answer to the above question consequently turns upon the correspondence or otherwise of the behaviour of the chromosomes with the Mendelian conception of segregation.

Owing largely, I think, to the Weismannian view, which prevailed in 1900, that the chromosomes were practically of equal value—*i.e.* that each one in a particular germ-cell possessed the potentiality of building up a complete organism agreeing in all essential particulars with the type of the species to which it belonged—there seemed to be some difficulty at first in making such a correlation. But in the last few years a number of facts have come to light which seem clearly to show that the different chromosomes in a cell are not all essentially alike—only two, in fact, being equivalent to one another in each body-cell. Coupled with other recent observations on the continuity of the individual chromosomes, etc., this view has rendered it possible to fit in the idea of gametic purity with cytological processes in a very feasible, if not absolutely convincing, way. The principal conceptions about the chromosomes which are necessary to connect them with Mendel's law are as follows:—

1. *The continuity of the individual chromosomes.*—The proof of this is not absolute, and perhaps never will be, owing to the fact that except for a short time before and after cell-division the chromosomes are unrecognisable as definite structures, being, as

* There are still some investigators who do not consider this question closed, but most authorities regard the arguments in favour of the chromosomes, and these alone, as overwhelming.

far as appearances go, merged into the general structure of the nucleus. There is good indirect evidence, however, that they nevertheless do retain their identity, for, apart from the fact that their number remains constant, if differences in size, shape, stainability, etc., occur, as they sometimes do, these peculiarities are most faithfully carried on from cell-division to cell-division. It is scarcely possible to imagine how this could be unless each chromosome maintained its individuality.

2. *The existence of the chromosomes in pairs, one of each pair being derived from one parent and the other from the other parent.*—The evidence for this depends upon the facts that when chromosomes of different size, etc., exist, they occur in pairs in each body-cell, that in the formation of the germ-cells only one of each sort is allotted to each gamete, and that when fertilisation takes place there is a pairing of the chromosomes with similar peculiarities.

3. *The qualitative difference between the chromosomes contained in each germ-cell.*—The differences in size, etc., already mentioned as occurring in some cases between the chromosomes, lend support to this; but until it is found possible to actually take out some of the chromosomes from a fertilised ovum and watch the results, it will not be possible to get incontrovertible proof of the idea. Boveri has carried out some ingenious experiments, however, which distinctly point to the necessity for the presence of at least one complete set of chromosomes—*i.e.* a set such as occurs in each germ-cell, equal to half the number in the body-cells—to ensure normal development. By the double fertilisation of sea-urchins' eggs he obtained three sets of chromosomes and two division-spindles in one cell, which necessarily led to an abnormal partition of the chromosomes in the daughter-nuclei. Following the development of these eggs he found that it was of an abnormal character. Altogether the conclusion seems justified that for the production of a normal individual a definite group of chromosomes is necessary, and that exactly this group exists in each germ-cell and twice over in each other cell.

4. *The separation of the pairs of chromosomes in the maturation divisions so that each germ-cell contains one of each pair.*—In spite of the most conflicting opinions as to the details of the process, and of considerable variations in the process itself, there now seem to be good grounds for believing that the final result of the

maturation divisions and concomitant phenomena is to give to each germ-cell one chromosome of each pair normally present in the body-cells. In outline the process, or rather one type of the process, is as follows. The cells destined to produce the germ-cells contain, like all the other cells of the body, the number of chromosomes, 4, 8, 12, 16, 24, 32, or whatever it may be, normal to the species. Immediately preceding the first of the two cell-divisions directly leading to the production of ripe germ-cells, known as the maturation divisions, the chromosomes are found to be split longitudinally. Now follows a kind of conjugation of the chromosomes belonging to each pair, so that bodies consisting of four closely approximated elements, and known as "tetrads," are seen in the place of double the number of original chromosomes. Each tetrad, therefore, pretty certainly contains two elements derived from the male and two from the female parent. In the cell-division which now takes place the tetrads are divided into two "dyads," one being allotted to each daughter-nucleus. Another cell-division follows quickly, and each of the two constituents of each dyad is moved into a separate nucleus. Four distinct germ-cells have thus been formed from every original mother-cell,* and the chromosomes have been treated in such a way that half the germ-cells contain chromosomes derived from one parent and half of them chromosomes from the other parent. As there is no reason for thinking that all the chromosomes from each parent are systematically passed on together into the germ-cells—all the evidence, in fact, being against this idea—it is reasonable to suppose that it is a matter of chance whether any particular germ-cell contains all or none or any intermediate proportion of the chromosomes of any one parent.

It will be apparent from the foregoing remarks that, if the very moderate assumption be made that the factors determining any pair of contrasted characters, such as the round and wrinkled shape of peas, etc., are situated in corresponding chromosomes in the germ-cells of the two parents, then the phenomena of hybridisation as worked out by Mendel can be easily translated into terms of cytological processes. So far so good. But there remains this difficulty, that the number of chromosomes charac-

* The only difference in the formation of the male and female gametes is that in the former all four daughter-cells become functional, while in the latter only one of the four becomes an ovum.

teristic of each species is comparatively small, so that instances are already known in which the characters which "Mendelise" are more numerous than the chromosomes. How can cases like these be brought into line with the facts of maturation and fertilisation? At present there is no definite answer to this question, but the most obvious suggestion is the one made by De Vries and elaborated by Lotsy, that during the conjugation of the chromosomes an interchange of equivalent constituents of each chromosome may take place. Such a process would, of course, have the same effect as increasing the number of chromosomes, and would therefore give ample scope to the play of Mendelian inheritance amongst the myriad characters composing the complex bodies of the higher organisms. Much more work is wanted, however, to put this and even some of the previously mentioned ideas about chromosomes on a satisfactory basis, and there are consequently openings here for any number of expert microscopists to add to our knowledge of a very important subject.

Coming to the next point of contact between Mendelism and microscopy—namely, the underlying microscopical basis for many naked-eye characters—we may usefully take as our first example the shape of peas. It will be remembered that in Mendel's experiments the round and wrinkled forms were shown to be distinct unit characters which did not influence one another in any way, except that when they were associated together in a hybrid the wrinkled character remained latent. In every generation pure forms of both types came out in definite proportions from the hybrids, and even after association for six generations the two characters came out just as sharply defined as at first. Apparently Mendel had no particular difficulty in distinguishing round from wrinkled peas, and in the vast majority of cases there is no difficulty; but it does sometimes happen that a number of seeds, especially in certain varieties, are troublesome to assign definitely to one category rather than the other. Some criticisms of Mendel's law have, in fact, been based upon this supposed impossibility of placing a certain small proportion of a crop of peas into their proper places. In 1903, however, it was shown by Gregory that round and wrinkled peas are characterised by quite distinct types of starch grains. In the former the starch occurs in ovoid grains with an entire margin, and having frequently a longitudinal internal fissure, in the line of the long axis, which, however, does not extend to the margin. Wrinkled peas, on the other hand, contain starch in grains of a more circular type, with four, five, or more notches on the edge, which represent the points where internal radiating fissures reach the margin. These grains may eventually break up along the lines of the fissures, and the starch is then seen in the form of minute segments of circles. The "roundness" and "wrinkledness" of peas is, therefore, really the outward expression (more or less imperfect, owing to various external causes) of a more fundamental difference connected with the condition of the starch; and the category to which any particular pea belongs can always be settled by an examination of the starch grains it contains. Hybrids between round and wrinkled races are found to exhibit, as their shape would indicate, only starch grains of the pure round type. Strangely enough, until the recent experiments undertaken to test Mendel's results led to an investigation of the matter, none of the specialists on starches seemed to have had any notion that pea-starch might be of two such radically distinct types. It is another illustration of the remarkable way in which new facts, about what are supposed to be hackneyed subjects, are brought to light by means of new working hypotheses, whether right or wrong. There is probably still a great deal to be learnt about the relation of starch grains to the external character of seeds of all kinds, and their systematic investigation from this point of view would be a task well worth taking up.

Another example of the connection between microscopic and macroscopic characters, from the standpoint of Mendel's law, is to be found in the pollen of certain plants, although in this case the naked-eye characters do not depend directly upon the minute structures referred to. In one of the varieties of sweet peas (*Lathyrus*), known as "Emily Henderson," pollen grains of two different forms are found—namely, round with two pores, and long with three pores. There is no visible difference in the plants bearing these, both producing white flowers; but when they are crossed they always give rise to plants with coloured, mostly purple, flowers. The two kinds of pollen grains, therefore, evidently indicate strains of plants of an unsuspected complexity in their differences. It may be added also that the long pollen behaves as a dominant to the round pollen.

Again, the colours of plants and animals very commonly depend upon microscopic structures, these being sometimes simple and sometimes compound. A very good case in point is to be found in the colours of stocks (*Matthiola*), which have been studied by Miss Saunders. In the course of her experiments four main types of coloration were observed—white, cream, red and purple* (uniformly coloured), and red and purple (with cream eye). These naked-eye characters were found to be produced as follows: the whites had colourless cell-sap and colourless corpuscles or plastids in the cells; the creams had colourless cell-sap and coloured (yellow) plastids; the uniformly coloured reds and purples had coloured cell-sap and colourless plastids; and, lastly, the reds and purples with cream eye had coloured cell-sap and coloured plastids. The experiments started with crosses between whites and creams, and the hybrids produced were all uniformly coloured purples, showing (1) that the coloured were recessive to the colourless plastids, a fact in itself sufficiently remarkable, as it has the appearance of a negative dominating over a positive character; and (2) that a coloured cell-sap was produced—*i.e.* an altogether new character appeared. The explanation of the latter phenomenon does not concern us in this connection †; but it must be observed that the production of the coloured cell-sap was not dependent in this instance merely upon the meeting of the coloured and uncoloured plastids, for they both occurred associated with either colourless or coloured cell-sap. The next generation gave rise not only to whites, creams, and uniformly coloured reds and purples, but also to the fourth type already mentioned—*i.e.* to reds and purples with cream eye, which were due to the reappearance of the recessive yellow plastids in association with coloured cell-sap.

There are undoubtedly many similar cases to the one just quoted, in which the naked-eye appearances are due to more or less complex associations of microscopic colour factors. One such occurs to me among the Entomostraca. When in Scotland a few years ago, making observations on this group of animals in connection with the Lake Survey, I found in Loch Tarff, near Fort Augustus, specimens of *Diaptomus laticeps*, Sars, which, to the

* The purple colour is due to an independent factor superimposed on the red.

† For the latest views on this and similar results, see Report III. to the Evolution Committee of the Royal Society, 1906.

naked eye, appeared to be wholly black, with the exception of the anterior half of the cephalothorax, which was white. Under the microscope the black coloration was seen to be produced by two factors—namely, a beautiful blue and a dark brown—the former being diffused in certain of the tissues, and the latter accumulated in little corpuscles or oil-globules. When preserved in formalin the animals lost their black appearance, and became vividly blue—a colour which they retain at the present time. The change was, of course, due to the disappearance of the brown globules. I think there can be no doubt that the two colours in this case would be found to belong to two different allelomorphic pairs, if they could be tested from the point of view of their hereditary behaviour.

In passing now to a consideration of the third connection between Mendelism and microscopy, which is provided by the possibility of using certain microscopic organisms for experimental work, we are entering upon a more speculative field. So far as I know nothing has yet been done in this direction. There are, however, several reasons why microscopic creatures might be found useful for work on Mendelian lines, provided, of course, that they are bisexual, and not too small to prevent the isolation and control of individuals. Their small size would make it possible to carry on extensive experiments in a small space and in a very inexpensive way. Most of them, also, are very quick and prolific breeders, and many generations could be obtained in the course of a year. Then, with regard to the simultaneous study of the germ-cells and body characters, it would probably be found that they would provide much better material than larger animals and plants. Lastly, it would be of the highest theoretical importance to trace the course of heredity of particular characters in cases where parthenogenesis occurs, and such cases can, of course, most easily be found among microscopic animals.

On the other hand, there are evidently special difficulties connected with the employment of microscopic animals for the purpose indicated. Necessarily they would have to be examined under the microscope, and this would probably involve some increase in the labour of recording the results, and certainly some additional risk of injuring valuable specimens. There is also some uncertainty as to the limits of local and seasonal variation in many cases, and this might make the selection of characters suitable for observation a rather troublesome matter. Again, the conditions necessary for the healthy development of microscopic animals in captivity is not a subject about which very much is known, although there seems no reason why the commoner and hardier species should not be reared in such quantities and as long as desired. But the main difficulty would be that of discovering the forms which would give fertile hybrids, for there are here no records to serve as a guide such as exist for domesticated animals and plants. It is not even known for certain whether hybrids can be obtained, let alone fertile hybrids. Attempts have, to be sure, been made to get hybrids between different species of microscopic animals, but without positive result, so far as I know. Some years ago I made an unsuccessful effort to obtain a cross between *Cyclops serrulatus* and *C. prasinus*. and Richard, I believe, tried the same thing with *C. fuscus* and *C. albidus*. Häcker also has more recently experimented with *Diaptomus gracilis* and *D. denticornis*, but again without success. Nevertheless, there are no grounds for thinking that crosses are impossible. On the contrary, it is suspected that, even under natural conditions, crosses may sometimes occur. For example, a peculiar form of *Cyclops* (*C. bistriatus*, Koch = *C. distinctus* of Richard, Schmeil, etc.), which is evidently very closely related to *C. fuscus* and *C. albidus*, certainly looks as if it might be a hybrid between these two species. It possesses some characters of *C. fuscus*, such as the fine setae on the inner sides of the tail-fork, and to some extent also the dark coloration, while it resembles *C. albidus* in having only a plain knife-like ridge on the last joint of the first antennae and in having divergent ovisacs. The latter, although not quite so divergent as in *C. albidus*, are very different from the adpressed ovisacs of *C. fuscus*. Whether it is a hybrid or not has never been definitely determined, and it would be a useful piece of work to follow the development of its progeny, as would also the parallel endeavour to procure an artificial cross between *C. fuscus* and *C. albidus*.

But the want of success hitherto experienced in obtaining hybrids between microscopic animals may very well be due to the fact that the forms used have been too far apart. It would undoubtedly be better to start with quite closely allied varieties. Among the fresh-water Entomostraca, the group with which I am most familiar, and the one which seems to me to be specially marked out for experimental work on the lines suggested, many such closely related forms occur. For example, the striking black and white form of *Diaptomus laticeps* already mentioned, although so different in appearance, is probably only a sub-variety of the species, and as such would most likely produce fertile progeny if crossed with forms from other Scottish lochs. In this case there would be at least three characters to watch —namely, the blue colour, the brown colour, and the distribution of the colours. In *Cyclops fimbriatus* and its variety *poppei* we have a pair of forms which only differ, so far as is known, in what is probably a single character—the shape and spinous armature of the furcal lobes. Unfortunately, in this particular case, the variety is very rare. Somewhat similar cases of forms practically differing only in single characters are, however, also to be found in commoner species, as among the varieties, sub-species, species, or whatever they may be, grouped under the names of *Cyclops strenuus* and *Cyclops serrulatus.* Again, among the Daphnids there are several very closely related forms, which are nevertheless not merely due to local or seasonal influences. I think the common *Daphnia pulex* and *D. obtusa* are such a pair, also *Ceriodaphnia reticulata* and its variety *serrata*, and *Ceriodaphnia quadrangula* and its variety *hamata*. With these Cladocerans, of course, a complication arises owing to the normal occurrence of many generations of parthenogenetic females interpolated between the sexual generations; but, as already pointed out, this would really add to the interest of the experiments, and, in order to save time, it is not impossible that the number of the asexual generations might be reduced by artificial means. A low temperature would probably do this, for it is known from the researches of Ekman that in the arctic regions the asexual generations may not be more than one or two, even in species which in temperate regions normally produce very many more.

In the above suggestions regarding the utilisation of microscopic animals for experimental work on heredity I have only referred to the Entomostraca, but it is quite possible that other groups could also be pressed into service. The Aphides, for example, would probably furnish material for such work (they have already been used for some important studies on the germ-cells, the results of which seem to distinctly favour the idea of segregation of characters), and some of the larger Rotifers, such as *Asplanchna* and *Hydatina*, might very well be considered in this connection. The Hydrachnids, which at first sight seem to offer some possibilities from this point of view, are, I am afraid, ruled out of court by the fact that they pass through a peculiar series of active and resting stages, rendering it impossible to rear them to the adult form. If points of difference could be made out in the larvae of nearly related forms, however, something might be accomplished even here.

The principal aim of this paper has now been accomplished, for we have given some consideration to Mendel's own work, to the recent developments on the same lines, and to the connection of the ideas so evolved with microscopical investigations. But before concluding I would like to point out quite briefly the bearings of Mendelism on some of the current notions about heredity, variation, and evolution.

According to a very prevalent conception, a "pure" race can only be one whose ancestors for a great many generations have never been crossed with any other race, and have never been known to produce characters other than those peculiar to the race. According to Mendel's conception of gametic purity, however, it is evident that, so far at least as certain characters are concerned, a pure race can originate at any point, even in the first generation from hybrids. The one thing essential for the production of a pure race is that germ-cells bearing only factors for similar characters should unite, and this, as Mendel showed, can take place when hybrids are interbred as well as when pure forms are mated. So far, then, from each organism necessarily transmitting some influence from all its ancestors for many generations back, as would be the case if the commonly received idea were correct, it may not in some cases even transmit characters which appeared in one of its own parents. The practical importance of this in connection with the rapid fixing of useful characters is self-evident.

So far as variation is concerned, Mendel's law certainly supports the idea that this is a term covering many different classes of facts. In the first place, the acceptance of the law leads directly to a still more strenuous insistence upon the distinction between variations due to alterations in the germ-plasm and those due to the reaction of the body of an organism to its environment, taking the latter term of course in its widest sense. It is with the former that Mendel's law is concerned, because it is only such that are capable of transmission. The variations produced by the environment, the fluctuating or oscillating variations—flexuations, as they have been recently called—are certainly of great importance in any given population at any given time, but they are not the determining factors for further evolution. As they may, however, in some cases—wherever size is involved, for example—closely approximate to variations which really are the expression of germinal differences, it is a proceeding not altogether free from danger to base conclusions entirely upon measurements of large numbers of individuals taken at random, without inquiry as to their gametic constitution, as has sometimes been done by those who follow purely biometric methods of investigation. Again, in the light of the work done in connection with Mendel's law, it is quite certain that even among the variations actually arising from definite factors in the germ-plasm, further analysis is required. Some of these variations are apparently entirely new mutations, to use De Vries' term, produced we know not how; some are due to recombinations of previously existing independent factors; and some seem to be caused by the influence of one factor upon another.

The bearing of Mendelism upon our ideas of the process of evolution may not be at once apparent, but a very little consideration will show that the conception of separable unit characters, based upon definite factors in the germ-plasm, must have a very close relation to the differences existing between various species which it is the endeavour of all theories of evolution to explain. Instead of such differences being brought about by the suppression of innumerable intermediate stages, as is usually supposed, the Mendelian ideas support the view that they may have been due to a comparatively small number of distinct changes in the germ-plasm corresponding to more or less well-marked differences in the organisms; or in other words they are favourable to the doctrine of discontinuity in the origin of species. To prevent possible misunderstanding it may be pointed out that this is entirely a question of the way in which material is provided for natural selection to work upon, and has nothing to do with natural selection itself, about the importance of which there can be no possible doubt.

The foregoing views as to the bearing of Mendelism on fundamental biological problems naturally depend for their justification very largely upon the extent to which Mendel's law applies. This, however, is still an unsolved problem. For many characters in many plants and animals, including man, the law seems to be demonstrably true, but as regards a much larger number of characters it is not known at present whether they follow it or not, and it is the task of present-day investigators to throw light on this matter. But, quite apart from whether his law be ultimately proved to be very limited in its sphere of influence, or whether it be found to be of universal application, we still owe a very great deal to the work of Mendel. He has given to horticulturists and breeders a working hypothesis which will certainly prove of the greatest value in the rapid production and fixing of new varieties. For example, Hurst has shown incidentally, in the course of his experiments carried out in accordance with Mendelian principles, that eight of the named fancy breeds of rabbits can be obtained from a cross between a "Belgian hare" and a "white Angora," so that if by accident these races were entirely lost they could be replaced at any time without difficulty. When the uncertainty involved in producing pure races by the usual methods is remembered, this result is certainly a triumph. To biologists Mendel has opened up a new field of experimental work the importance of which it is very difficult to overestimate. He has shown, in fact, how the thin end of the wedge may be inserted into what has hitherto been one of the most refractory of biological problems. Finally, to all scientific workers, but especially to those who pursue scientific studies rather as a recreation than a profession, Mendel has set a fine example of patient investigation carried out with perfectly simple materials.

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ON THE STUDY OF THE MYCETOZOA.

By A. E. Hilton.

(*Read June 15th*, 1906.)

A little over ten years ago, in one of those extempore lecturettes which often prove more instructive than formal papers, Dr. Karop called our attention to the group of organisms which, for eighty years past, has been known to science as Myxogastres, Myxomycetes, or Mycetozoa. Fourteen months later this was followed by an admirable "Note on Mycetozoa" by Mr. Jeremiah Slade, an old member of our Club, who died last year. This appears in the Quekett Journal for November, 1897. Afterwards, chiefly, I think, from 1899 till 1901, attention was given to the subject by Mr. Dennis and Mr. Filer, this resulting in numerous exhibits, among the most interesting of them being some which showed the remarkable streaming movements of plasmodia. Since then, so far as I know, very little in regard to the Mycetozoa has been done by our Club, and it is because we now have a number of new members that I revive the matter in the present paper.

For the benefit of those who are unacquainted with the group, and have not seen the specimens shown by me at our meetings during the last few months, I may explain that the Mycetozoa are diminutive organisms, distributed nearly all the world over, which are found in moist places, generally on rotting wood, leaves, grass, moss, fungi, ferns, or other vegetable substances in a state of decay. They are noticeable only in the sporangial or spore-bearing stage, when they range in size from $\frac{1}{50}$ to $\frac{1}{5}$ in. in height, and $\frac{1}{125}$ to $\frac{1}{4}$ in. in diameter, the more usual dimensions being roughly a height of about $\frac{1}{10}$ in., and a diameter of about $\frac{1}{50}$. From these measurements there are great divergences in certain species; and the general appearance of sporangia may be best suggested by describing them as looking something like minute mushrooms or other fungi, of various shapes and colours. With the exception of this sporangial stage, the phases in the history of the Mycetozoa can only be followed by careful observation and the use of the microscope. Briefly, the life-cycle is this. Large numbers of spores, so small as to be usually only about $\frac{1}{2000}$ in. in diameter, rupture while immersed in water, and jelly-specks are liberated, which are simply pieces of protoplasm, each with a single nucleus and two or three vacuoles. These jelly-specks, or swarm-cells, as they are called, assume, first, an amoeboid form, and then a shape resembling flagellate infusoria, free-swimming, with a jerky, dancing motion, and feeding on bacteria. Presently, numbers of these swarm-cells, after a process of multiplication by encystment and division, coalesce into a larger jelly-mass, called a plasmodium; and it is this characteristic which is peculiar to the Mycetozoa, distinguishing them from all other groups of organisms with which they might otherwise be classified. The plasmodium, after slowly creeping about, in or upon decaying vegetable substances, and increasing in bulk by the ingestion of whatever suitable pabulum it meets, ultimately comes to a standstill, concentrates its energies, and throws up sporangia, which form and scatter a new generation of spores, to commence the life-history afresh. The process is varied in different species, and there are further cell-divisions and resting-stages at certain times; but this may be taken as an approximate general description of the life-cycle, without, for the moment, going into details.

The evolution of the ideas concerning these organisms is reflected in the names by which they have been known. At first they were cautiously named Myxogastres—*i.e.* slime-stomachs—doubtless in reference to the plasmodia merely; but afterwards, for a long period, they were more pronouncedly called Myxomycetes, slime-mushrooms or slime-fungi, thus taking into account both the plasmodial and sporangial stages. They were then commonly classified with the Gasteromycetous Fungi, as though their vegetable nature were indisputable; but about fifty years ago a closer acquaintance with the swarm-cells caused them to be renamed Mycetozoa, mushroom-like or fungus-like animals, in recognition of relations with low forms of animal life. A variation of these ideas was expressed by the name Myxothallophyta, meaning slime-frond or slime-branch plants; possibly in allusion to the frond-like or branching forms, sometimes assumed by the creeping plasmodia. That name, however, has died out; and until the true nature of the organisms is finally determined, the correct name cannot be fixed. Even the name Mycetozoa, fungus-like animals, must be regarded as distinctive, to distinguish them from vegetables, rather than as descriptive, to include them in the animal kingdom. The difficulty of grouping them properly along with other organisms is so great, that it has even been suggested that we may have to divide nature into four kingdoms instead of three, to make a separate kingdom for their accommodation. The time for that, however, is not yet.

With this introduction I now address, more particularly, those of our members, especially new ones, who are undecided as to what line of microscopical research to follow. Those who are already specialising in other directions, with excellent results, will, I am sure, forgive me if I seem, for the time being, to advocate one line of investigation at the expense of others. All will admit that concentration is essential to achievement; and in a Club like this, whatever path we choose for ourselves, we have the great advantage of side-glimpses of the various lines of research followed by other members. We can take a lively interest in their departments, while specialising in our own way.

To you, then, who are undecided, let me say, first, that the Mycetozoa present a subject for study more easily grasped than many other subjects of inquiry. For example, if you turn to botany, the way is bestrewn with so bewildering a variety of facts, so vast a bibliography, and so formidable a terminology, that, unless you restrict yourself to a very narrow section, you are likely to be lost in its mazes; while entomology presents more embarrassing features still. Of insects there are already about 300,000 species on the lists, several thousand new species are being described annually, and a probable estimate of the total number of existing species is said to be 10,000,000! Compared with these the study of the Mycetozoa, with their less than 50 genera, and 300 species, is a simple, waistcoat-pocket study, compact and convenient. To business men, who want their hobby to be recreation, not a toil, this is a consideration.

Next as to enjoyment. Some do not mind handling spiders, beetles, worms, woodlice, and such-like things; but tastes differ. Charles Kingsley, for instance, lover of nature as he was, had an aversion for spiders which he could never succeed in conquering. One has only, however, to become familiar with the forms and colours of the sporangia of the Mycetozoa, to appreciate the grace and charm of these tiny but beautiful objects.

Now as to procedure. Assuming that you possess a microscope, the outlay, at starting, need only be small. If convenient, you should spend an hour in the Botany Department of the British Museum of Natural History at South Kensington, examining the collection presented by Mr. Arthur Lister. You will then know better what to look for when you hunt for specimens. In any case, you should obtain from the museum a copy of the guide to the collection, price 3*d*., or by post 4*d*. This is well illustrated, gives a good life-history, and contains a classification sufficiently detailed for rough identification of species. A revised edition was issued last year. This can be supplemented, later on, by a copy of Mr. Lister's *Monograph of the Mycetozoa*, price 15*s*., to be obtained at the same place. Meanwhile, a useful little book, *The Mycetozoa*, price 1*s*., by Sir Edward Fry and his daughter, is procurable at the office of "Knowledge," 326, High Holborn. This also is illustrated, contains much information in a popular form, and indicates to some extent the nature of the questions raised by the characteristics which the Mycetozoa present. Mr. Massee's *Monograph of the Myxogastres* is unfortunately out of print, and not easily obtainable. Dr. M. C. Cooke's small volume on *The Myxomycetes* is in the library of the Club.

In seeking for specimens, sharp eyes and patience are great helps. It is not of much use to look for them in extremely cold or very dry weather. The damp recesses of woods, or clearings where there are felled logs, broken branches, or rotting stumps, are among the best hunting-grounds; but wood-yards, straw heaps, fences, and decaying nettle-stalks are also likely places for finding them. If, however, as in my case, eyesight is not keen, and patience is not your chief virtue, you may possibly search time after time and find but little, although specimens may be within easy reach, if you knew just where to light upon them. My own plan is not so much to look for actual specimens, as for pieces of branch likely to produce them. These I take home, keep moist, and examine every few days. Some I place in a small bell-glass aquarium, with about an inch depth of water at the bottom. One end of each piece of wood stands in the water; the other end rests against the side or rim of the glass. Other pieces of wood, bark, moss, leaves, etc., I place in a shallow tin tray. An ordinary baking-tin answers the purpose well. The bottom of the tin I cover with "felting," a fibrous layer commonly placed under carpets to save wear. This, when well wetted, keeps damp some time, and only needs the addition of a little water now and then to keep things moist. At the end of a week or fortnight there are usually some sporangia visible on the wood, moss, or other substances under observation, most frequently of *Comatricha*, but sometimes of *Trichia*, *Arcyria*, or other genera. I have not yet succeeded in getting much variety in this way; but I have been more successful by this means than by searching for specimens direct.

My experience of this method leads me to believe that the terms "dead leaves," "dead wood," etc., by which the textbooks describe the habitat of certain species, must be understood in a somewhat modified sense. Of course, the dead remains of sporangia may be found on substances which are dead beyond all doubt; but between full life and complete death there are gradations, and it is quite likely that, while the sporangia were developing, the substances on which they appeared were rather in an intermediate state of decay than in a condition of absolute lifelessness. It is at least feasible that the disintegrating plasm of the vegetable host furnishes food for the plasmodium of the Mycetozoa, and I find it better to choose substances which appear to have some vitality rather than such as are utterly dead. I may here observe that sporangia, when dry, may in most cases be preserved indefinitely, either in cardboard boxes or in dry cells as microscopic slides.

The present method of classifying the Mycetozoa is based, not upon general features of sporangia alone, but chiefly upon the colour, shape, and marking of spores, and the character of the capillitia, the masses of fine threads or fibres in which the spores are usually embedded. For examining spores and capillitia objectives of at least $\frac{1}{4}$, and preferably $\frac{1}{8}$ or $\frac{1}{12}$ in., are necessary; but the system founded on these minute characters is not wholly satisfactory, because there are many variations, and the images obtained by means of the microscope are often difficult of interpretation. The swarm-cells also require a high magnification, say 600 diameters; and the continuous development of these can be observed by the method known as "hanging drop" cultivation, described by Dr. Karop on page 265 of the Quekett Journal for April, 1902.

In my opening remarks I referred to the streaming movements of plasmodia. These are singularly striking. When a plasmodium is sufficiently large and on the surface of its host, and the plasm is sufficiently free from discolouring matter to be transparent, the interior nuclei, vacuoles, and granules are seen to be flowing, with a rapid, alternate, rhythmic motion, along the principal channels of a network of veins, into which the plasmodium spreads itself as it slowly creeps about in search of food. The flow continues in one direction for a minute and a half or two minutes; then pauses, immediately reverses its course, and flows back again. The streaming in the direction in which the plasmodium is creeping is slightly stronger than the streaming in the opposite direction; but the cause of the phenomenon is obscure. There is probably a tendency on the part of the plasmodium to liquefy interiorly, while becoming thinly membraneous exteriorly; and where the plasm is in contact with surrounding air or water, there are doubtless molecular disturbances, which rapidly, and perhaps rhythmically, alter the surface tension. In this way alternate and opposite dilations and contractions of the membrane may be produced, forcing the liquid contents first one way, then the other. The fact, however, that the whole mass moves along shows that other influences are also at work, disturbing the oscillating equilibrium of the surface tension, and so making progress possible, or even inevitable.

This short excursion into the dynamics of living matter brings me to my main point, which is, that the supreme interest of the Mycetozoa is biological. Of the "origin of life"—if the phrase is permissible, which is doubtful—we have no certain knowledge, perhaps never can have. But neither can we be "contented not to know"; and if ever a clue is obtained to the explanation of the manifestations we call "life," it will probably be furnished by the simplest of living things—not impossibly by those we are considering. Not that the Mycetozoa have left their record in the rocks; they are too frail for fossilisation. Perhaps they have done even better, by preserving, almost unchanged, from remotest times till now, vital forms which existed before organisms which answer to our conceptions of plant and animal had been produced. If that be true, as some have thought, they are not so much the evidence of a borderland between the two kingdoms as survivors of a past epoch, less affected than the majority of other organisms by the forces of evolution. Be that as it may, the problems of biology seem, at least, to be in some measure simplified in the Mycetozoa, by the fact that in their active stages they are practically naked plasm, without many of the conditions which, in more complex organisms, render those problems more obscure and difficult to deal with.

Enough has been said, I think, to show that the Mycetozoa, minute, mysterious, and beautiful as they are, offer an attractive field of research, either as a recreation or a serious study; and if some of our members are led in that direction, the object of this paper will be accomplished.

NOTE ON STEREO-PHOTO-MICROGRAPHY.

By Arthur E. Smith.

(*Read May 18th, 1906.*)

Plates 31—33.

There are several ways of making stereoscopic slides from microscopic objects. The simplest way is by using an excentric "Waterhouse" stop just behind the objective, where there is a short length of additional tube, with a fine slot in one side (Fig. 1). The camera is placed in conjunction with the microscope in the usual way and the object focussed. The excentric stop is then inserted in the slot; this sharpens up the image, and has the effect

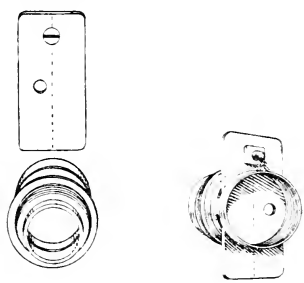

Fig. 1.

of "seeing" the image from only one side of the objective. A negative is now taken. The stop is then reversed and another negative taken. The prints from those negatives are distinctly different and make good stereoscopic pairs. A quarter-plate camera will be large enough, as the two images come practically in the same place. This seeing double with a single lens can be more easily illustrated by a view camera than with a microscope.

Take any view camera with any lens, and put an electric glow-lamp in the camera and focus the filament on a sheet of paper. The image is *single* but somewhat blurred. Now put in front of the lens a "two-eyed" stop, as in the illustration, and two very distinct and sharp images will appear, showing that the two sides of the lens, through the two stops, see the electric filament from different points of view (Fig. 2). If the lamp is outside and focussed on the ground glass the result is the same, but then the images can only be examined by one person at a time.

A curious variation is to have a piece of card with one hole pierced in it, and when the image is focussed, put this stop in front of the lens and move the stop about. The image will *change* with every movement of the stop.

It will now be understood how easy it is to get only two different images through the microscope with the excentric stop.

A second method of obtaining stereoscopic photographs of

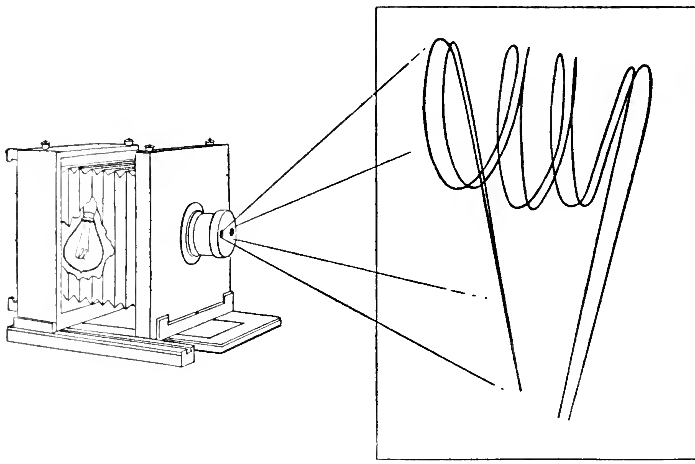

Fig. 2.

microscopic objects is by tilting the object first one way and then the other, and securing a negative in each position. This is suitable for low powers only.

A third method is by moving the object a short distance across the stage and securing a negative at either end of the movement. This necessitates the use of a larger camera, as the images do not come exactly in the same place.

Explanation of Plates 31—33.

Plate 31.

Group of insect eggs, photographed with excentric stop, × 11.

Plate 32.

Diatom, *Navicula lyra*, × 1,500.

Plate 33.

Polycystina, × 150.

NOTE ON *TETRAMASTIX OPOLIENSIS* (ZACHARIAS).

By Charles F. Rousselet, F.R.M.S.

(*Read October 19th*, 1906.)

Plate 34.

In my recently published paper on South African Rotifera,* I mentioned having found this rare species in a pool of a streamlet in the Matopo Hills, Rhodesia. My specimens had to be preserved without examination, so that they were not seen alive, but were found afterwards in the collected material in a fully contracted state. I mentioned that on the occasion of its first discovery by Dr. O. Zacharias in 1897, *Tetramastix opoliensis* was also found fully retracted in preserved material from the River Oder, near Oppeln, in Upper Silesia, Germany, and that no one had yet seen this rotifer in the living state.

After the publication of my paper I received a note from Herr Stanislas Hlava, of Prag, who informed me that he had found *Tetramastix* in September, 1899, in a small pond near Tabór, in Bohemia, when examining plankton of ponds as a student. The species occurred in great abundance then, but has not been seen there since. Fortunately Mr. Hlava made a very good sketch of the living animal, which he has been good enough to allow me to publish in our Journal, and which entirely changes our notion of the affinities of this species.

It will be seen at once from this drawing (Plate 34, Fig. 1) that, instead of being allied to *Notholca longispina*, as was supposed, it really belongs to the family Triarthradae, and the small malleo-ramate jaws (Fig. 3) and two frontal eyes quite agree with this.

The two unequal anterior spines spring from the right and left shoulder and lie close against the body when the animal is swimming, so that its mode of progression through the water is the same as that of *Triarthra longiseta*, swimming with its ciliary wreath and "skipping" from time to time when alarmed. In reality there is no skipping, in the sense of moving forward, as in *Polyarthra*. The bases of the frontal spines are broadened, and when the head of the animal is retracted the spines stand out straight in front and appear to be quite continuous with the integument, showing no sign of being capable of bending down (Plate 34, Fig. 2). The right anterior spine is considerably longer than the left spine. Posteriorly the spines are terminal and originate close together dorso-ventrally (not side by side

* *Journ. R. M. S.*, 1906, pp. 393—414.

laterally, as figured by Zacharias), the dorsal spine being much longer than the ventral spine.

The integument is somewhat stiffer than in the other members of this family, and presents a transition towards the loricate rotifers.

In a previous paper* I have stated my views of the use of the long spines of the Triarthradae, which are of no use for progression, but are certainly protective in character, and prevent their possessors being too readily swallowed by such foes as *Asplanchna*. The long spines also give the animal a greater floating power, so that it does not sink in the water so readily, and enable the creature to maintain itself in the open water with less ciliary effort than would be necessary in the case of a similar rotifer without these appendages.

The general anatomy of *Tetramastix opoliensis* is normal, as can easily be seen from the figure, and requires no remarks on my part. I am glad to be able to describe and figure these additional features, which correct and complete our knowledge of this interesting species.

Tetramastix has, therefore, so far been found three times: in the Oder, near Oppeln (1897); in a pond near Tabór, in Bohemia (1899); and in a pool in the Matopos, Rhodesia (1905).

The measurements of the largest Rhodesian specimen were as follows: body alone, 204 μ ($\frac{1}{125}$ in.); large anterior spine, 374 μ ($\frac{1}{68}$ in.); large posterior spine, 272 μ ($\frac{1}{93}$ in.). Mr. Hlava's specimens seem to have been a little smaller in size, but stouter in body: body alone, 169 μ ($\frac{1}{150}$ in.); large anterior spine, 254 μ ($\frac{1}{100}$ in.); large posterior spine, 169 μ ($\frac{1}{150}$ in.).

I reproduce also the figure of the contracted specimen, drawn by Mr. F. R. Dixon-Nuttall.

Explanation of Plate 34.

Fig. 1. *Tetramastix opoliensis* (Zacharias), latero-ventral view when swimming, × 280; drawn from life by S. Hlava.

„ 2. Do., fully contracted, × 185; a preserved specimen from Rhodesia, drawn by F. R. Dixon-Nuttall.

„ 3. Do., the jaws; drawn by S. Hlava.

* "*Triarthra brachiata*, a New Species of Rotifer, and Remarks on the Spines of Triarthradae." *Journal of the Quekett Microscopical Club*, Vol. 8, November, 1901, pp. 143—145.

NOTICES OF BOOKS.

ELEMENTARY MICROSCOPY: A HANDBOOK FOR BEGINNERS. By F. Shillington Scales, F.R.M.S. $4\frac{3}{4} \times 7$ in. 179 pages, with 77 figures in the text. London, 1905. Baillière, Tindall, & Cox. Price 2s. net.

For a beginner desirous of purchasing a microscope, or of deriving full benefit from an instrument which he may already possess, we can heartily recommend this useful little work. Throughout the book the author has maintained a high standard of clearness in expression and an avoidance of unexplained technical terms—a point of the utmost importance to the uninitiated reader, but one which is, unfortunately, too often overlooked by the expert writer of microscopical textbooks. Nothing concerning the instrument or its accessories which could in any way interest a beginner is omitted, and a short but most useful chapter on the mounting of objects is included. There is also an appendix containing a valuable list of works dealing with microscopic technique in all its phases, a table of apertures, and other useful information. For the tyro desirous of obtaining a stand, chap. iii., dealing with the choice of a microscope, will be found invaluable, pointing out, as it does, the relative merits of the various forms of instruments produced by the best-known makers in a perfectly unbiassed manner and without a trace of objectionable comparison. The low price of this work might lead some to suppose that either the subject-matter or the printing was of an inferior quality, but neither supposition is in the least correct, and we can unhesitatingly compliment both author and publishers upon the production of this useful handbook. F. P. S.

METHODS IN PLANT HISTOLOGY (2nd edition). By Charles J. Chamberlain, A.M., Ph.D. 6 × 8¾ in. 261 pages, with 87 figures in the text. Chicago, 1906: The University of Chicago Press. London: T. Fisher Unwin. Price 10*s.* 6*d.* net.

This work deals, in a very practical manner, with the preparation of plant tissues for microscopical examination. The book consists of two parts. The first is confined to general methods, section cutting, stains and their uses, embedding materials, mounting media, etc. The second half deals with special cases, typical and well-known plants being selected, and concise directions being given for the preparation and examination of their more important structures. The author also gives some very useful hints as to how the student may grow his own specimens, undoubtedly a splendid idea. The figures are, as a rule, clear and good. The section dealing with diatoms is certainly disappointing. The author states, truthfully enough, that "the siliceous shells of diatoms are among the most beautiful objects which could be examined with the microscope," and promptly refers to a figure which is not in the least suggestive of beauty. The preparation of fossil diatomaceae, involving as it does processes of considerable difficulty, the author might well have been excused had he omitted altogether. Unfortunately he attempts to deal with it in something less than two hundred words. We heartily sympathise with any one who essays to clean such diatomaceous earths as those of Oamaru, Hakodadi, Santa Monica, etc., by the method recommended. F. P. S.

A TEXTBOOK OF FUNGI. By George Massee. 5 × 7½ in. 426 pages, with 141 figures in the text. London, 1906. Messrs. Duckworth & Co. Price 6*s.* net.

An educational, up-to-date handbook on Fungi at a moderate price has long been a desideratum with the students of these curious plants. Fungology has, of late years, progressed with great rapidity, and a considerable demand has arisen for a handy and reliable work of reference. We are glad that such a work is now available; still more so that it has been produced by Mr. Massee, for assuredly no one is better qualified to undertake this somewhat difficult task. Mr. Massee's name as the author of a book is not only a guarantee of accuracy, but it leads us to expect much in the matter of completeness and lucidity. In the work now under consideration these expectations are fully justified. The value of the book from an educational standpoint is greatly enhanced by the insertion of numerous references to works treating of the particular branch of the subject dealt with in the preceding section. The figures are well drawn, and the printed matter is far more readable than one would think possible, considering the technical nature of the subject under discussion. We can cordially recommend this volume to any one desirous of acquiring a knowledge of the fungi, especially of the obscure, but highly important, microscopic forms.

F. P. S.

THE CAMBRIDGE NATURAL HISTORY, vol. i. By Marcus Hartog, M.A., Igerna B. J. Sollas, B.Sc., S. J. Hickson, M.A., F.R.S., & E. W. MacBride, M.A., F.R.S. 6 × $8\frac{3}{4}$ in. 671 pages, with 296 figures in the text. London, 1906. Macmillan & Co. Price 17*s.* net.

Vol. i. of *The Cambridge Natural History* has at length appeared, and fully maintains the high standard of excellence attained by the several volumes which have already been published. It consists of four parts, dealing respectively with (1) Protozoa, (2) Porifera (Sponges), (3) Coelenterata and Ctenophora, and (4) Echinodermata. The Protozoa are treated on to the extent of 162 pages, with 62 figures. Great prominence is given to the structure and life-histories of certain species rather than the enumeration and brief description of a large number, and this course we consider highly preferable in a work of this description. Sponges naturally occupy a comparatively small proportion of the volume—78 pages, with 61 figures. The subject, however, is treated with thoroughness and efficiency, and forms an excellent introduction to this somewhat neglected branch of marine zoology. Coelenterata and Ctenophora occupy 180 pages, with 61 figures; and the Echinodermata, forming by far the largest section, complete the volume. The whole work is thoroughly scientific and up-to-date. Anatomical and morphological characteristics have received careful and generous treatment, and each section forms a most reliable textbook of the subject upon which it treats. The illustrations are not, as a rule, elaborate, but are uniformly good, and serve their purpose admirably. They are almost entirely gleaned from other works, but the selection shows great care and discrimination.

F. P. S.

PROCEEDINGS

OF THE

QUEKETT MICROSCOPICAL CLUB.

At the meeting of the Club held on March 16th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on February 16th were read and confirmed.

Messrs. P. Murrell, H. J. Baker, G. Vogeler, B. J. Capell, and C. E. Heath, jun., were balloted for and duly elected members of the Club.

Before proceeding with the business of the evening the President said he regretted to have to announce to the meeting the sudden death, on March 6th, of an old and esteemed member, Mr. J. J. Vezey, F.R.M.S. Mr. Vezey was elected a member of the Club on May 23rd, 1879, and held the office of Hon. Treasurer, 1892-99.

Mr. C. D. Soar, F.R.M.S., then gave a lecture, with a number of interesting lantern illustrations, entitled, "Notes and Observations on the Life-History of Fresh-water Mites."

Mr. A. D. Michael, F.L.S., referred to the extreme difficulty of following the life-history of this family, the host having to be kept alive as well as the parasite. He mentioned the case of an observation of an embryo of another family of the same order (Acarina), which was octopod, one pair of legs being somewhat rudimentary, and asked if anything similar had been noticed in the Hydrachnidae.

Mr. Soar stated that such a case, if it existed in the Hydrachnidae, had eluded his observation; but he would in future look out specially for any evidence in support of it.

At the meeting of the Club held on April 20th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on March 16th were read and confirmed.

Messrs. J. H. Jeffery, John Weeks, S. F. Morgan, T. L.

Burrell, R. H. Herbert, W. J. Ormston, R. P. Couch, and F. S. Worthington were balloted for and duly elected members of the Club.

Mr. F. P. Smith (Hon. Editor) brought forward two papers dealing with microscopic spiders. The first, entitled "The Spiders of the *Diplocephalus* Group," concluded the revision of the sub-family Erigoninae, so far as British specimens were concerned, except as to a few intermediate forms—*e.g.* the genus *Hilaira*, which would be treated at some future date. The second paper was a catalogue of the more important literature dealing with Erigonine spiders. In this catalogue nothing had been given beyond the date, name of author, and name of the publication in which the paper appeared. Other information, such as the exact titles, the pages and plates, etc., of the papers might have been included, but as the interest in such a catalogue must be restricted to a small number of workers, the demand for further details was not considered sufficient to justify the expenditure of the greatly increased space that a complete bibliography would have necessitated. Mr. Smith went on to say that, in endeavouring to conform as far as possible with the wishes of the Club in matters relating to the Journal, he, as Hon. Editor, had at various times taken steps to ascertain the views of individual members, and all seemed unanimous in the desire for as large a Journal and as many plates as possible. He pointed out, however, the impossibility of having a large Journal unless members did their share by contributing papers suitable for publication. The bringing forward of long, technical papers might even leave matters in a worse state than before, inasmuch as it might cause members to refrain from submitting short non-technical notes, fearing that they might be insufficiently advanced for publication. He wished to strongly impress upon those present that, although advanced papers might be regarded as the skeleton necessary for the support of the Journal, such papers were but the bones, and sometimes very dry bones—the flesh and blood being supplied by the less technical papers, which appealed to a far wider circle of readers. Members were specially asked to do their best in this matter, and it was hoped that the forthcoming somewhat large Journal, with a hundred pages and nine plates, would inspire them with a determination to maintain the standard, and, if possible, to advance as far beyond it as finances would permit.

A paper by Mr. J. M. Coon was taken as read. It described a new finder for the microscope which can be used on any instrument, and will "find" on any stage, whether mechanical or with sliding bar or spring clips.

Mr. H. Taverner, F.R.M.S., read a paper on "A Simple Method of taking Stereo-Photo-Micrographs and mounting the Prints without cutting."

The Hon. Secretary read a paper by Mr. W. P. Dollman, of Adelaide, on "A Simple Method of producing Stereo-Photo-Micrographs." The method employed is similar to that first adopted by Mr. Taverner, but subsequently abandoned by him.

Mr. J. Rheinberg, F.R.M.S., read a paper "On Stereoscopic Effect and a Suggested Improvement in Binocular Microscopes." A detailed comparison was given of the causes of stereoscopic effect with unaided vision and with the microscope, attention being specially directed to the points where they were similar and where dissimilar. Monocular vision, as well as binocular vision, was discussed in both instances, and it was shown that, under all circumstances, there were most important differences—one fact on which great stress was laid being that, in dealing with microscope images seen stereoscopically, we are dealing with an object of which one layer only is in true focus, and all other layers more or less out of focus. In the construction of microscope objectives, attention has been chiefly concentrated on the formation of a perfect image of one plane of an object at a time; but for good stereoscopic images it was necessary to consider the relative perfection of other planes at the same time. In adapting the monocular instrument to make it a binocular by using the two halves of the objective to form the two eye-pictures, this seemed to have been overlooked. By the use of such semicircular apertures to form a picture, all layers out of true focus were represented by semicircular diffusion discs in the image—a most undesirable shape; but by altering the effective apertures to circular ones by means of stops placed over the objective, considerable improvement in clearness could be effected.

The paper was accompanied by an exhibition of the various forms of binocular microscopes to which reference was made, including the Greenough binocular with two objectives and the Abbe stereoscopic eye-piece. Objects were shown under the Wenham and Stephenson forms of binoculars, with and without the stops suggested, and the improved general definition of the image in the former case was very noticeable. Besides several large diagrams, by the help of which the paper was explained, special photo-micrographs by Mr. Taverner served to illustrate various points dealt with.

Owing to the lateness of the hour, discussion was deferred to the next meeting, and, after votes of thanks to the authors of the various papers, the meeting was adjourned.

At the meeting of the Club held on May 18th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S , President, in the Chair, the minutes of the meeting held on April 20th were read and confirmed.

Messrs. E. Ayerst Davies, G. Churchouse, W. Martin, J. I. Pigg, F.R.M.S., and E. Cuzner were balloted for and duly elected members of the Club.

Dr. Eugène Penard, of the University of Geneva, was nominated by the Committee to fill a vacancy in the list of Honorary Members.

Mr. A. E. Smith read a note on "Stereo-photo-micrography," exhibiting a number of very effective stereo-photo-micrographs obtained by the methods described, ranging from low-power work of 10 diameters up to 1,500 diameters—the highest power successfully used.

Mr. Conrady, referring to Mr. Rheinberg's paper read at the previous meeting, said that he would like to make a few remarks on a peculiarity of microscopical images which Mr. Rheinberg had mentioned—viz. that when two objects of exactly the same size were placed at different distances from the object-glass (but within range of its "depth of focus"), the more distant one was not always depicted as the smaller, but did sometimes actually yield the larger image. The explanation of this strange anomaly was to be found in Professor Abbe's theory of the "iris" and "pupils" of optical systems.

As a rule there was in every optical system *one* aperture which limited the diameter of the cones of rays which were allowed to pass from any point in the object to the conjugate point in the image. Thus, in photographic lenses, the iris-diaphragm represented this limiting aperture, whilst in microscope-objectives it was usually formed by the shoulder against which one of the lenses was mounted. On account of its precise analogy with the iris of the human eye, Professor Abbe called this particular aperture the iris of an optical system, and then went on to show the importance of its position in determining the action of optical instruments.

Little more than a few hints were to be found in the usual books, but he would try to show how the position of the iris affected microscopical perspective. As a diminution of the size of

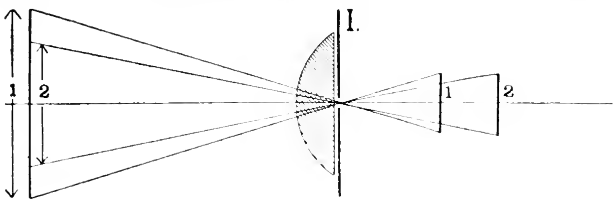

Fig. 1.

the iris would only cause a *sharpening* of those parts of the image which corresponded to points of the object not in exact focus, without altering the *size* of the image, it was permissible to consider the centre of the iris as if the latter were really a mere pinhole. If they now referred to Fig. 1 they would notice that here the iris was practically in contact with the object-glass—the latter being represented by a simple lens. Tracing the image of

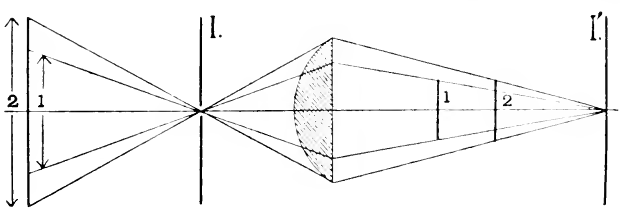

Fig. 2.

two equal-sized objects, 1 and 2, they would find that in this case the nearer object yielded the larger image, in accordance with the ordinary rules of projection. If they now turned to Fig. 2, where the iris I was placed well behind the lens—in fact, behind the upper focal plane—they would find a totally different state of affairs. A pinhole so placed could only pass rays which had crossed in the conjugate point I'. Now, drawing such rays from I' through the extremities of the equal-sized objects 1 and 2, they would find the images 1 and 2 reversed in size as compared with the case first considered; in other words, a microscope-objective would give the anomalous perspective mentioned by Mr. Rheinberg whenever the limiting aperture was placed behind the upper focal plane.

There was a very important intermediate case between those illustrated in Figs. 1 and 2—namely, that represented in Fig. 3, where the iris was placed exactly *in* the upper focal plane, the consequence being that it could only pass bundles of rays which had been parallel to the optical axis before entering the object-glass, with the necessary consequence that an object would

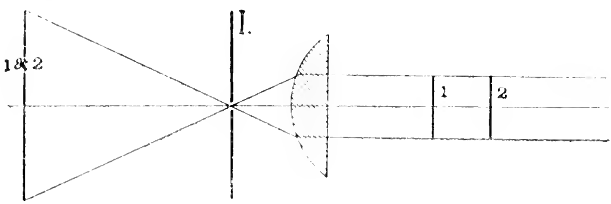

Fig. 3.

produce a definite and unchangeable size of image at any one distance behind it. Change of focus would only affect the sharpness, but not the size of the image. Professor Abbe was the first to point out the value of this arrangement for measuring instruments, and introduced the term "telecentric" for object-glasses with the limiting stop in this particular position.

Time would not allow him to enter more deeply into this extremely interesting subject, but he might say that it was not difficult to see that a state of affairs as shown in Fig. 2—which was the *usual* thing with all except the longest-focus object-glasses—would lead to that peculiar form of distortion which caused a sphere to assume the form of an egg with the pointed end towards the observer, an appearance well known to most workers with binocular microscopes.

Mr. D. J. Scourfield, F.R.M.S., in introducing the subject of "Mendelism and Microscopy," gave a short account of Gregor Mendel and his work, relating how this Austrian monk, who afterwards became Abbot of Brünn, worked on steadily for some ten years, making experiments upon the hybridisation of peas; how in 1865 he published his results, and gave the explanation of them which is known as Mendel's Law of Heredity; and how this most important paper was completely forgotten until its rediscovery, independently, by three botanists, De Vries, Correns, and Tschermak, in 1900. Details of some of Mendel's experiments were given. The lecturer went on to demonstrate the relationship between Mendelism and microscopical work, pointing out the value of microscopical investigation in the ordinary experiments with large organisms, and also suggested that many microscopic creatures, such as the Entomostraca, would make excellent subjects for experimental work.

The Secretary announced that Mr. Rousselet had been elected by the Committee to fill the vacancy in their list of Vice-Presidents caused by the death of Mr. J. J. Vezey, F.R.M.S., and the appointment was greeted with applause.

At the meeting of the Club held on June 15th, Dr. E. J. Spitta, F.R.A.S., F.R.M.S., President, in the Chair, the minutes of the meeting held on May 18th were read and confirmed.

Mr. E. R. Newmarch was balloted for and duly elected a member of the Club. Dr. E. Penard, of Geneva, was also elected an Honorary Member.

Mr. J. T. Holder described an old microscope which had been kindly sent for exhibition by Mr. W. R. Reeves, of Liverpool. It was made by Andrew Pritchard, of Fleet Street, author of *The History of the Infusoria*, etc., in 1846. Some six objectives are provided, ranging from 2 in. to $\frac{1}{18}$ in., and there are several eye-pieces, one of which is provided with a micrometer. Lieberkuhn reflectors and polarising apparatus are fitted, and the stage possesses a safety attachment, and has a mechanical movement in one direction only. The coarse adjustment is so well made that it is possible to focus the $\frac{1}{8}$ and $\frac{1}{18}$ in. objectives by its aid alone. Mr. Holder suggested that this is more than could be said of the coarse adjustment of some modern stands.

Mr. A. E. Hilton read a paper, "On the Study of the Mycetozoa." The life-history of a typical form was minutely described, and illustrated by means of beautifully executed drawings. The lecturer also gave a great deal of useful information of a practical nature, and, in concluding, said that he hoped enough had been said to show that the Mycetozoa, minute, mysterious, and beautiful as they are, offer an attractive field for research, either as a recreation or as a serious study.

Mr. L. O. Grocock said the group was named Mycetozoa, in 1858, by De Bary, who then thought that amoeboid movement was peculiar to the animal kingdom. Ten years later, however, he was forced to admit that it was common to both animals and plants. Most authorities now, especially abroad, preferred the term Myxomycetes. For continuous observation the speaker preferred a modification of the "hanging drop" method described. He took a glass ring about $1\frac{1}{4}$ in. in diameter and 1 in. in height. This, cemented to a slip, was filled about three-quarters full with water and the "hanging drop" placed above. Care had to be taken to sterilise the water; but food material must be provided for the spores. He had found fragments of gum very good; he had some recollection of a plate in a very old number of *Science Gossip* illustrating a fossil form of the group from the coal measures.

A visitor, Mr. J. M. Coon, asked, by permission of the President, if Mr. Hilton had considered the nuclei of the Mycetozoa. They are described as of three sizes—very large, medium, and small "nuclear bodies." The two former are generally only described as "nuclei," and the latter "nuclear bodies." He had observed these in the plasmodia of *Badhamia*, *Fuligo*, and other forms, and in the sclerotium and the immature sporangia of *Badhamia*. He suggested that the larger of these bodies may not be true nuclei, as the chromatic material is so regularly distributed within the membrane, and he had not yet observed it condensed, as is usual in the resting stage of nuclei, and as it is in the case of the two smaller nuclei. Neither had he observed in the case of the larger "nuclei" the mitotic spindles of nuclear division, whereas in respect of the middle size nucleus he had seen very large numbers, and, speaking with reserve, he thought he had also observed it in smaller nuclei. He had never seen the chromatin material in the larger bodies condensed to an equatorial plate nor forming "asters," but had occasionally observed an appearance as of open chromosome loops. Mitosis for spore formation appears to take place some hours after the forming of sporangia, and previous to the colour of the sporangia changing from that of the plasmodium. With regard to the cultivation chamber, he suggested moss spread on the bottom of a glass dish as an alternative which had several advantages.

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(Elected February 1904.)

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Rev. W. H. DALLINGER, LL.D., F.R.S., F.R.M.S., etc., etc.	„ 1890-1-2.
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*J. G. WALLER, F.S.A.	„ 1896-7.
JOHN TATHAM, M.A., M.D., F.R.M.S.	„ 1898-9.
GEORGE MASSEE, F.L.S.	Feb. 1900-1-2-3.

* Deceased.

HONORARY MEMBERS.

Date of Election.	
Jan. 24, 1868.	Arthur Mead Edwards, M.D., 423, Fourth Avenue, Newark, New Jersey, U.S.A.
July 26, 1872.	Professor Hamilton L. Smith, President of Hobart College, Geneva, New York, U.S.A.
July 23, 1880.	F. H. Wenham, C.E., The Beacon, Goldsworth, near Woking.
Nov. 24, 1882.	Dr. Veit B. Wittrock, Professor at the Royal Academy of Sciences, and Director of the Museum of Natural History, Stockholm, Sweden.
Feb. 17, 1893.	Robert Braithwaite, M.D., F.L.S., F.R.M.S., (*Past President*), 26, Endymion Road, Brixton Hill, S.W.
Feb. 17, 1893.	M. C. Cooke, M.A., LL.D., A.L.S. (*Past President*), 53, Castle Road, Kentish Town, N.W.
Feb. 17, 1893.	T. Charters White, M.R.C.S., L.D.S., F.R.M.S. (*Past President*), 6, Wellington Villas, Stopford Road, Jersey.
Mar. 19, 1897.	B. T. Lowne, M.D., F.R.C.S., F.L.S., etc. (*Past President*), The Cedars, Crondall, near Farnham, Surrey.
May 18, 1906.	Dr. Eugène Penard, The University, Geneva.

LIST OF MEMBERS.

Date of Election.

Feb. 16, 1906. Abson, Herbert, 19A, West Square, St. George's Road, Southwark, S.E.

Feb. 16, 1906. Akehurst, Sydney Charles, 60, Bowes Road, Palmer's Green, N.

Feb. 19, 1904. Allardice, Lieut. Wm. McDiarmid, c/o Messrs. Sir C. M. McGregor, Bt., & Co., 25, Charles Street, St. James's Square, London, S.W.

Nov. 16, 1900. Allcock, J. F., "Brambletighe," Cambridge Road, Wanstead, Essex.

April 18, 1890. Allen, J. M., F.R.M.S., 11, Gray's Inn Square, W.C.

June 16, 1905. Allwood, Selwyn H., Jackson Town P.O., Jamaica, W. Indies.

Dec. 15, 1899. Angus, H. F., Enderley, Bushwood, Leytonstone.

Nov. 18, 1898. Armitage, Frederick, 7, Lansdowne Road, Tottenham, N.

Feb. 17, 1905. Asals, John, 67, Cairo Road, Walthamstow, N.E.

Feb. 22, 1889. Ashe, A., Roman Villa, Laurie Square, Romford, Essex.

June 16, 1899. Austin, Henry, 13, Blakeley Cottages, East Greenwich, S.E.

Dec. 15, 1899. Ayrton, William, "The Cliff," Beccles, Suffolk.

April 17, 1903. Bagshaw, Walter, J.P., Batley, Yorks.

Sept. 26, 1884. Baker, F. W. W., F.R.M.S., 313, High Holborn, W.C.

Mar. 16, 1906. Baker, Henry James, 13, Moorgate Street, E.C.

Mar. 21, 1902. Barker, John W., B.Sc., A.R.C.S., 8, Balcaskie Road, Eltham Park, Kent.

Date of Election.	
Mar. 19, 1897.	Barnes, W., 24, Shaftesbury Road, Hornsey Rise, N.
May 25, 1883.	Barratt, Thomas J., F.R.M.S., Bell Moor House, Upper Heath, Hampstead, N.W.
Feb. 16, 1900.	Barrett, R. H., The Homestead, Berkhampsted.
Sept. 27, 1872.	Bartlett, Edward, L.D.S., M.R.C.S.E., 38, Connaught Square, W.
Dec. 19, 1902.	Barton, G. S., F.R.M.S., 114, Harris Street, Camberwell, S.E.
June 16, 1905.	Barton, William Charles, Willeslie House, 43, Rosary Gardens, South Kensington, S.W.
June 17, 1892.	Bates, C., 1, Windsor Road, Denmark Hill, S.E.
Oct. 18, 1895.	Baugh, J. H. A., 63, Cambridge Road, Hammersmith, W.
Jan. 16, 1891.	Baxter, W. E., F.R.M.S., 170, Church Street, Stoke Newington, N.
Dec. 21, 1900.	Beardsmore, T. S., 41, Hill Street, Hinckley.
Nov. 26, 1875.	Beaulah, John, Raventhorpe, Brigg.
July 25, 1884.	Beck, C., F.R.M.S., 68, Cornhill, E.C.
June 19, 1891.	Beck, Horace C., F.R.M.S., Lister Works, Dickenson Street, Kentish Town, N.W.
Mar. 28, 1884.	Beetham, A., The Warren Lodge, Old Shirley, Southampton.
Feb. 16, 1906.	Bestow, Charles H., 43, Upper Clapton Road, N.E.
Oct. 23, 1868.	Bevington, W. A., F.R.M.S., "Avondale," Coleraine Road, Blackheath, S.E.
Jan. 20, 1899.	Bird, Richard, 15, Woodstock Street, W.
June 16, 1905.	Blair, William Nisbet, 23, West Hill, Highgate, N.
May 19, 1899.	Blood, Maurice, M.A., F.C.S., F.R.M.S., 16, Alexandra Road, Kingston Hill, Surrey.
Nov. 17, 1905.	Bonser, Thomas Edward, 10, Croxted Road, West Dulwich, S.E.
Oct. 20, 1893.	Boyes, William Benjamin, F.R.M.S., P.O. Box 1923, Johannesburg, Transvaal.
April 15, 1898.	Braine, Woodhouse, F.R.C.S., 67, Wimpole Street, Cavendish Square, W.
Nov. 17, 1905.	Bremner, John Unthank, 277, King Street, Hammersmith, W.

Date of Election.	
Mar. 21, 1902.	Brook-Fox, F. G., Ringmore Vear, Kingsbridge, South Devon.
Feb. 17, 1905.	Brooks, Howard, Cedarhurst, St. Albans.
Dec. 19, 1890.	Brough, J. R., 29, Alexandra Villas, Finsbury Park, N.
Nov. 17, 1905.	Brown, Charles H., Post Office, Stanley, Tasmania.
Jan. 28, 1887.	Browne, E. T., B.A., F.R.M.S., 141, Uxbridge Road, W.
Mar. 18, 1904.	Brushfield, N. W., 118, Melody Road, Wandsworth Common, S.W.
Jan. 15, 1892.	Bryce, D., 37, Brooke Road, Stoke Newington Common, N.
Jan. 20, 1905.	Burnell, Charles Edward, 29, High Street, Shepton Mallet.
April 20, 1906.	Burrell, T. Leonard, 22, Fairbridge Road, Upper Holloway, N.
Feb. 19, 1904.	Burton, James, 11, Ulysses Road, West Hampstead, N.W.
Jan. 15, 1904.	Butcher, Lewis, 82, Barn Mead Road, Beckenham, Kent.
Feb. 19, 1904.	Butterworth, Arthur Cyrus, 137, Fordwych Road, West Hampstead, N.W.
June 21, 1901.	Buttifant, George H., 17, South Vale, Blackheath, S.E.
June 14, 1865.	Bywater, W. M., F.R.M.S., "Invicta," 33, Telford Avenue, Streatham Hill, S.W.
April 15, 1904.	Caffyn, Charles Henry, 32, Falkland Road, Hornsey, N.
June 18, 1897.	Campbell, Colney, 234a, Wightman Road, Hornsey, N.
Dec. 21, 1900.	Campbell, William, Berhampur, Moorshedabad District, Bengal.
Mar. 16, 1906.	Capell, Bruce John, 10, Castelnau, Barnes, S.W.
Jan. 20, 1905.	Carrington, John, P.O. Box 48, East London, South Africa.
Mar. 20, 1903.	Casebourne, T. H. "Troas," Ramsden Road, Friern Barnet, N.

Date of Election.

June 17, 1892. Chaloner, G., F.C.S., 30, Weston Park, Crouch End, N.

Mar. 17, 1905. Chapman, David Leighton, 100, Tooley Street, S.E.

Mar. 22, 1878. Chester, The Very Rev. the Dean of, The Deanery, Chester.

Dec. 18, 1891. Cheyne, A. M., 16, Coleman Street, E.C.

Nov. 27, 1874. Chippendale, George, 1, Clarendon Terrace, Kemp Town, Brighton.

Dec. 18, 1896. Chipps, F. W., 201, Castelnau, Barnes, S.W.

Jan. 20, 1905. Christie, John, Henleighs, Kingston Hill, Surrey.

May 18, 1906. Churchouse, I., 30, Natal Road, Bowes Park, N.

Jan. 19, 1906. Clarke, William Roger, 18, Gayton Road, Hampstead, N.W.

May 15, 1903. Cleave, A. H. W., 57, South Norwood Hill, S.E.

Mar. 17, 1905. Clemence, Walter, Farringford, Walton-on-Thames.

Oct. 21, 1904. Conrady, Alexander Eugen, F.R.A.S., F.R.M.S., 23, Flanchford Road, Stamford Brook, W.

Nov. 18, 1904. Cooper, Arnold W., J.P., Richmond, Natal.

May 28, 1869. Cottam, Arthur, F.R.A.S., Furze Bank, Durleigh Road, Bridgwater.

April 20, 1906. Couch, Robert Percy, 338, City Road, London, E.C.

Jan. 18, 1901. Cox, Thomas N., jun., 104, Tressillian Road, Brockley, S.E.

Jan. 15, 1904. Cox, William, 113, Manor Road, Brockley, S.E.

June 19, 1903. Coxhead, G. W., Leamington House, Rookwood Road, Stamford Hill, N.

Dec. 20, 1901. Craig, Thomas, F.R.M.S., 597, Sherbrooke Street West, Montreal, Canada.

Nov. 21, 1902. Cressey, Dr. G. H., Oak Manor, Tonbridge.

Aug. 28, 1868. Crisp, Frank, LL.B., B.A., F.R.M.S., *V.P. and Treas. Linnean Society*, 5, Lansdowne Road, Notting Hill, W.

Feb. 16, 1900. Crossland, R. E., A.R.I.B.A., "Lyndhurst," Elsinore Road, Forest Hill, S.E.

Mar. 16, 1894. Culshaw, Rev. George H., M.A., The Rectory, Iver Heath, Bucks.

Date of Election.

April 18, 1902. Cumming, John, 29, Ella Road, Crouch End, N.

June 25, 1880. Curties, C. Lees, F.R.M.S., 244, High Holborn, W.C.

Jan. 16, 1903. Curties, C. L., jun., 244, High Holborn, W.C.

May 18, 1906. Cuzner, Edgar, 36, Trothy Road, Bermondsey, S.E.

Nov. 18, 1904. Dade, Willoughby Dreyer, 6, Montague Road, Richmond.

Feb. 23, 1883. Dallinger, Rev. W. H., LL.D., F.R.S., F.R.M.S., etc. (*Past President*), "Ingleside," Newstead Road, Lee, S.E.

Jan. 16, 1903. Damant, Lieut. Guybon, R.N., Lammas, Cowes.

Mar. 22, 1878. Darke, Edward, 46, Hilldrop Crescent, Holloway, N.

Jan. 19, 1906. Dauncey, Rev. Albert Augustus, 26, Ulundi Road, Westcombe Park, Blackheath, S.E.

Mar. 15, 1895. Daunou, F., 1, Shirley Villas, Westbrook, Margate.

June 16, 1905. Davies, Daniel, 98, Algernon Road, Ladywell Lewisham, S.E.

May 18, 1906. Davies, E. Ayerst, 124, Croydon Road, Anerley, S.E.

Jan. 19, 1906. Davies, Perceval Eckton, Abbeydale, Marmora Road, Honor Oak, S.E.

Nov. 23, 1888. Davis, H. R., Thistleton House, 1, Clissold Road, Stoke Newington.

Jan. 18, 1901. Davis, Thomas John, F.R.M.S., 62, Sale Street, Rose Hill, Derby.

Feb. 15, 1895. Davis, T. Sebastian, F.R.M.S., 199, South Lambeth Road, S.W.

Mar. 17, 1905. Dean, Frank, 10, Lansdowne Road, Holland Park, W.

May 17, 1901. Deeley, George P., Moushall, Amblecote, Brierley Hill, Staffordshire.

April 19, 1895. Delcomyn, Theo. A., F.R.M.S., "Feldheim," Wimbledon Common.

Nov. 17, 1893. Dennis, A. W., 12, Brownlow Road, Dalston, N.E.

Date of Election.	
Mar. 22, 1889.	Dick, J., 39, Lowman Road, Holloway, N.
June 17, 1892.	Dixon-Nuttall, F. R., F.R.M.S., "Ingleholme," Eccleston Park, near Prescot, Lancashire.
Mar. 17, 1899.	Downs, Arthur, 2, Woodside Villas, Ulverston Road, Walthamstow.
Nov. 15, 1901.	Druett, C. R., 302, Uxbridge Road, W.
Jan. 19, 1906.	Duffield, Ernest James, 29, Selwyn Avenue, Richmond, Surrey.
June 19, 1891.	Earland, Arthur (*Hon. Secretary*), Reading Villa, Denmark Street, Watford.
Jan. 16, 1903.	Ebbage, H. E., 14, Orchard Road, Kingston-on-Thames.
Sept. 25, 1868.	Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.
Dec. 16, 1904.	Edge, Rev. Silas, 3, Pagoda Avenue, Richmond, Surrey.
Feb. 21, 1902.	Edwards, Thomas Jarvis, 9, St. Lawrence Road Brixton, S.W.
May 26, 1876.	Emery, Charles, 10, Barrington Road, Crouch End, N.
April 17, 1896.	Enock, F., F.L.S., F.R.M.S., F.E.S., 42, Salisbury Road, Bexley, Kent.
Feb. 28, 1879.	Epps, Hahnemann, 95, Upper Tulse Hill, Brixton, S.W.
Nov. 20, 1903.	Escudier, John L., 8, Woodstock Road, Chiswick, W.
Nov. 17, 1905.	Evans, Morris B., 33, Lady Margaret Road, Southall, Middlesex.
Feb. 15, 1901.	Eyre, Frederick W., Inland Revenue, Somerset House, W.C.
Feb. 17, 1899.	Fairholme, H. W., Blenheim Mansions, Queen Anne's Gate, S.W.
July 25, 1873.	Fase, Rev. H. J., M.A., "Broadview," 37, Beechcroft Road, Upper Tooting, S.W.
June 16, 1893.	Filer, Frank E., 122, Stockwell Park Road, Brixton, S.W.

Date of Election.	
Feb. 19, 1904.	Finlayson, David, 11, Trinity Road, Wood Green, N.
July 26, 1867.	Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh House, Highbury New Park, N.
Mar. 20, 1896.	Fletcher, S. W., M.D., Pepperill, Massachusetts, U.S.A.
Nov. 23, 1888.	Flood, W. C., 55, Aubert Park, Highbury, N.
Jan. 20, 1899.	Foucar, Alexander L., "Beaulieu," 20, St. John's Park, Blackheath, S.E.
June 23, 1871.	Freeman, H. E., Walcot, Limes Avenue, New Southgate, N.
Jan. 18, 1901.	Freeman, Rev. Richard, M.A., Whitwell Vicarage, Reepham, Norfolk.
Oct. 21, 1904.	Freeman, Walter Bell, 200, Brecknock Road, N.
Dec. 16, 1898.	French, Archibald J., 10, Radford Road, Lewisham, S.E.
June 20, 1902.	Fullard, Alfred F.
May 20, 1898.	Fuller, Frederick, M.A., LL.D., 9, Palace Road, Surbiton.
Nov. 21, 1902.	Fuller, William, 1, Selwood Villas, Salisbury Road, New Malden, Surrey.
May 15, 1903.	Gabb, G. H., F.C.S., 43, Charlotte Street, Fitzroy Square, W.
Dec. 15, 1905.	Gardner, Edward Lewis, 18, Craven Road, Harlesden, N.W.
Jan. 20, 1899.	Gardner, William, F.R.M.S., 292, Holloway Road, N.
Dec. 16, 1904.	Garnett, Theodore, M.A. Oxon., South Bank, Grassendale, Liverpool.
Nov. 18, 1904.	Gibbs, Henry James, 63, Leigham Court Road, Streatham, S.W.
May 17, 1901.	Gladding, Harold, 9, St. Stephen Street, Port Elizabeth, Cape Colony.
Jan. 17, 1902.	Gleason, Louis R., F.R.M.S., 420, Uxbridge Road, Shepherd's Bush, W.
Feb. 16, 1906.	Glover, Samuel, Hill Crest, North Road, St. Helen's, Lancashire.

Date of Election.

April 26, 1872.	Goodinge, J. W., F.R.G.S., 10, Gower Street, Bedford Square, W.
Jan. 16, 1903.	Gordon, Rev. W. H., "Woodcroft," Fareham, Hants.
Nov. 17, 1899.	Green, E. E., Royal Botanic Gardens, Peradeniya, Ceylon.
Jan. 16, 1903.	Green, H. O., 13, Sunnyside Road, Ilford.
Nov. 20, 1903.	Griffiths, A. B., Ph.D., 78, Stockwell Park Road, S.W.
Nov. 18, 1898.	Grocock, L. O., 142, Oakfield Road, Penge, S.E.
May 17, 1895.	Groves, H., F.L.S., 21, Sibella Road, Clapham Rise, S.W.
Nov. 18, 1904.	Guppy, Robert John Lechmere, Kinersly, Port of Spain, Trinidad, W. Indies.
Feb. 19, 1904.	Gurney, Robert, Longmoor Point, Catfield, Great Yarmouth.
Sept. 28, 1888.	Hall, T. F., 39, Gloucester Square, Hyde Park, W.
Feb. 20, 1903.	Hall, W. D., "Monte Rosa," Stradella Road, Herne Hill, S.E.
Feb. 21, 1902.	Halsey, John, 15, Carlisle Street, Soho Square, W.
Oct. 22, 1886.	Hampton, W., 38, Lichfield Street, Hanley, Staffordshire.
May 19, 1905.	Harris, Charles Poullet, 98, Lower Addiscombe Road, Croydon.
Jan. 18, 1895.	Harrison, A., F.R.M.S., "Delamere," Grove Road, South Woodford, Essex.
May 17, 1901.	Harvey, Sidney, F.I.C., F.C.S., Watling House, Canterbury.
Nov. 18, 1904.	Harvey, William Edward, 222, Barcombe Avenue, Streatham Hill, S.W.
Mar. 28, 1879.	Hawkins, C. E., 23, Dalebury Road, Upper Tooting, S.W.
Feb. 15, 1901.	Headley, F. W., Haileybury College, Hertford.
Mar. 16, 1906.	Heath, Charles Edward, 66, Herne Hill Road, Herne Hill, S.E.

Date of Election.

Jan. 19, 1906.	Heath, Charles Emanuel, 66, Herne Hill Road, Herne Hill, S.E.
Aug. 23, 1872.	Hembry, F. W., F.R.M.S., Langford, Sidcup, Kent.
April 20, 1906.	Herbert, Robert Henry, 32, Fairmead Road, Holloway, N.
Feb. 26, 1886.	Hewlett, R. T., Lyddon House, Avenue Road, Southfields, S.W.
Dec. 20, 1901.	Hicks, Frederick H., Belmont Villas, Wallington, Surrey.
Feb. 17, 1899.	Hill, Edward J., Ladyfield, Dumfries, N.B.
Nov. 17, 1893.	Hill, Edwin Ernest, F.R.M.S., 3, Trevor Villas, Horn Lane, Woodford Green, Essex.
Nov. 15, 1895.	Hilton, A. E., 21, Ashmount Road, Upper Holloway, N.
Jan. 18, 1895.	Hinton, E., 11, Cornwallis Avenue, Lower Edmonton, N.
Jan. 19, 1906.	Hobbs, Frank William, "Ruthven," Dorlcote Road, Wandsworth Common, S.W.
Nov. 18, 1898.	Hofmann, O., 29, Margaret Street, Regent Street, W.
Dec. 15, 1893.	Holder, J. T., 72, Bousfield Road, St. Catherine's Park, S.E.
Feb. 26, 1875.	Holford, Christopher, 5, Northumberland Avenue, Upper Richmond Road, Putney, S.W.
Dec. 15, 1905.	Holgate, Thomas, 1 Wyneham Road, Herne Hill, S.E.
Feb. 16, 1906.	Hoole, Arthur S., 59, Chancery Lane, W.C.
Nov. 26, 1880.	Hopkins, Robert, Shern Villa, Walthamstow, Essex.
Jan. 15, 1904.	Hopkinson, John, F.L.S., F.G.S., F.R.M.S., Weetwood, Watford.
Oct. 26, 1866.	Horncastle, Henry, "Lindisaye," Woodham Road, Woking.
April 21, 1893.	Hornsby, E. W., jun., 25, Old Change, E.C.
April 15, 1898.	Hounsome, John, 4, Flamborough Street, Stepney, E.
May 22, 1874.	Hovenden, C. W., F.R.M.S., Chester House, Mount Ephraim Road, Streatham, S.W.

Date of Election.

April 26, 1867. Hovenden, Frederick, F.R.M.S., "Glenlea," Thurlow Park Road, West Dulwich, S.E.
Nov. 19, 1897. Howard, Arthur, 60, Palace Gardens Terrace, W.
Oct. 19, 1894. Howard, R. N., M.R.C.S., F.R.M.S., The Cape Copper Co., Port Nolloth, Namaqualand, Cape Colony, South Africa.
Oct. 19, 1894. Hughes, F., Wallfield, Reigate.
May 28, 1886. Hughes, W., 32, Heathland Road, Stoke Newington, N.
Dec. 20, 1901. Hurrell, Harry Edward, 25, Regent Street, Great Yarmouth.

April 18, 1902. Imboden, Walter, 1, Hornton Street, Kensington Gardens, W.
May 24, 1867. Ingpen, J. E., F.R.M.S., St. John's, Wrotham Road, Broadstairs.
Feb. 16, 1906. Inwards, Richard, 20, Bartholomew Villas, Kentish Town, N.W.
Mar. 19, 1897. Isenberg, A. L., 39, Cadogan Place, S.W.

Mar. 17, 1905. Jaffe, Alfred, Cloona, Eastbourne.
June 14, 1865. Jaques, Edward, B.A., 27, Fairfax Road, Bedford Park, Chiswick, W.
Apr. 20, 1906. Jeffery, John Hugh, 10, Daysbrook Road, Streatham Hill, S.W.
Sept. 18, 1891. Johnson, W., F.R.M.S., 188, Tottenham Court Road, W.C.
Nov. 17, 1905. Jones, Arthur Morley, 11, Eaton Rise, Ealing, W.

Nov. 17, 1905. Karleese, Benjamin, The Dell, Barnt Green, Worcestershire.
May 23, 1873. Karop, G. C., M.R.C.S., F.R.M.S., etc. (*Vice-President*), 198, Holland Road, Kensington, W.
Feb. 20, 1903. Kent, F. J., 7, Fortnam Road, Upper Holloway, N.

Date of Election.

July 25, 1884. Kern, J. J., "Fern Glen," Selhurst Park, South Norwood, S.E.

Nov. 18, 1904. Kew, H. Wallis, 9, Queen's Road, Bromley, Kent.

May 17, 1901. Kingsford, T. G., 1, Fortescue Villas, Stafford Road, Wallington, Surrey.

Nov. 20, 1903. Kirkaldy, G. W., F.E.S., Department of Agriculture and Forestry, Honolulu, Territory of Hawaii.

May 17, 1901. Kirkman, Hon. Thomas, M.L.C., F.R.M.S., Croftlands, Esperanza, Natal.

May 19, 1905. Kitchin, Joseph, "Ingleneuk," 14, Brackley Road, Beckenham, Kent.

Mar. 22, 1889. Klein, S. T., F.R.A.S., F.L.S., F.R.M.S., "Hatherlow," Raglan Road, Reigate.

Feb. 20, 1903. Klingler, E. W., 25, Jackson Road, Holloway, N.

Feb. 17, 1905. Lambert, Charles Alexander, Bank of New South Wales, Warwick, Queensland.

Nov. 21, 1902. Langton, W. H., 677, Holloway Road, N.

Nov. 17, 1905. Laughton, Herbert Furnell, 24, Oakley Square, N.W.

June 17, 1904. Lawrence, Frederick George, c/o Lionel Samson & Son, Cliff Street, Fremantle, West Australia.

June 17, 1904. Laws, John, "The Hall" Nurseries, Watford.

Mar. 16, 1900. Lawson, Peter, F.R.M.S., "Jesmond Dene," 87, Finlay Street, Fulham, S.W.

June 25, 1869. Layton, C. E., 17, Cornwall Terrace, Regent's Park, N.W.

Oct. 21, 1904. Lee, Major-Gen. Henry Herbert, "The Mount," Dinas Powis, near Cardiff.

Jan. 20, 1905. Lees, Rev. Frederick Clare, 24, Mornington Road, Bow, E.

Nov. 21, 1902. Leonard, Edward, "Cranbrook," Waterloo Park, near Liverpool.

Nov. 17, 1905. Levett, Rev. Robert Kennedy, Ingram Gate, Thirsk, Yorkshire.

Nov. 25, 1887. Lewer, J. J., 20, Crossfield Road, Belsize Park, N.W.

Date of Election.

April 27, 1866. Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 41, The Park, Ealing, W.

June 26, 1868. Lindley, W. H., jun., 29, Blittersdorffs Platz, Frankfort-on-Maine.

June 16, 1905. Littleboy, Arthur E., 8, Fulham Park Gardens, Fulham, S.W.

Mar. 20, 1891. Lloyd, H. W., 51, St. Augustine's Road, Camden Square, N.W.

Jan. 20, 1905. Lord, John Percival, St. Omer, Malden Road, New Malden.

Nov. 24, 1866. Lovibond, J. W., F.R.M.S., Lake House, Salisbury.

Feb. 16, 1906. Lunn, John Horace, 11, Church Street, Tower Bridge Road, S.E.

May 21, 1897. Mackenzie, James, 12, Cavendish Road, Brondesbury, N.W.

May 25, 1883. Mainland, G. E., F.R.M.S., 14, The Norton, Tenby, South Wales.

Feb. 17, 1905. Mann, Walter Clarkson, 37, Manor Park Road, Harlesden, N.W.

June 17, 1898. Marks, Kaufmann J., F.R.M.S., 9, Randolph Gardens, N.W.

Feb. 15, 1895. Marshall, William John, F.R.M.S., 3, Ellingham Road, Shepherd's Bush, W.

Mar. 20, 1896. Martin, Herbert Sydney, F.R.M.S., 10, Arngask Road, Catford, S.E.

April 15, 1904. Martin, Victor Callingham, 8, Amherst Avenue, Ealing, W.

May 18, 1906. Martin, William, "Kethlen," Burgh Heath, Epsom, Surrey.

Nov. 18, 1898. Massee, G., F.L.S., Royal Gardens, Kew.

April 26, 1867. Matthews, G. K., St. John's Lodge, Beckenham, Kent.

Jan. 15, 1892. Maw, W. H., F.R.M.S., F.R.A.S., 18, Addison Road, Kensington, W.

Feb. 15, 1895. Measures, John W., M.R.C.S., L.S.A., 5, Exe View Terrace, Exmouth.

May 19, 1905. Melhuish, Frank H., National Debt Office, Old Jewry, E.C.

Date of Election.

Jan. 20, 1905. Mence, William Henry Dison, Ouse Villa, St. Ives, Hunts.

May 19, 1893. Merlin, A. A. C. Eliot, F.R.M.S., British Consulate, Volo, Greece.

May 19, 1905. Metcalf, John, jun., New Court, St. Swithin's Lane, E.C.

July 27, 1877. Michael, A. D., F.L.S., F.R.M.S. (*Vice-President*), The Warren, Studland, near Wareham, Dorset.

Mar. 20, 1896. Micklewood, G. R., 36, Nelson Road, Hornsey, N.

Nov. 18, 1904. Mignot, Ernest Arthur, 518, Holloway Road, London, N.

May 17, 1901. Miles, John P., 34, Tyrrell Road, East Dulwich, S.E.

July 7, 1865. Millett, F. W., F.G.S., F.R.M.S., Eniscoe, Brixham, Devon.

Jan. 20, 1905. Milne, William, Uitenhage, Cape Colony, South Africa.

Oct. 18, 1901. Moore, Harry, F.R.M.S., 12, Whiston Grove, Moorgate, Rotherham, Yorks.

April 20, 1906. Morgan, Sidney Frank, 95, Hazelbank Road, Hither Green, S.E.

July 26, 1878. Morland, Henry (*Hon. Treasurer*), Cranford, near Hounslow.

Jan. 16, 1891. Muiron, C., 49, Chatsworth Road, Brondesbury, N.W.

Jan. 19, 1906. Murray, Charles Walter, 52, Marmora Road, Honor Oak, S.E.

Mar. 16, 1906. Murrell, Percy, Portland, Shrewsbury.

June 16, 1905. Myles, James Cellars, 53, Carlyle Road, Manor Park, S. Essex.

Mar. 24, 1876. Nelson, E. M., F.R.M.S., Beckington, Bath.

Mar. 20, 1903. Nelson, E. W., Christ's College, Cambridge.

May 16, 1902. Nevill, Rev. T. J., F.R.M.S., 2, Genoa Road, Anerley, S.E.

April 19, 1895. Neville, James, 55, Gresham Road, Brixton, S.W.

Nov. 25, 1881. Nevins, R. T. G., Pembroke Lodge, Hildenborough, Tonbridge.

Daty of Election.

June 15, 1906. Newmarch, Edgar Ribton, "St. Albans," 54, Upper Walthamstow Road, Walthamstow.

Jan. 26, 1872. Newton, E. T., F.R.S., F.G.S., Florence House, Willow Bridge Road, Canonbury, N.

June 15, 1894. North, The Right Honble. Sir Ford, F.R.S., F.R.M.S. (*Vice-President*), 76, Queensborough Terrace, Bayswater, W.

Feb. 16, 1900. O'Donohoe, T. A., F.R.M.S., 220, Burley Lawn, Leeds.

Jan. 24, 1879. Offord, J. M., F.R.M.S., 62, Gordon Road, Ealing, W.

Dec. 22, 1876. Ogilvy, C. P., F.L.S., Sizewell House, Leiston, near Saxmundham, Suffolk.

Nov. 18, 1892. Orfeur, Frank, F.R.M.S., 91, Effra Road, Brixton, S.W.

April 20, 1906. Ormston, William John, 35, Penn Road, Holloway, N.

Dec. 27, 1867. Oxley, Frederick, F.R.M.S., 1, Dock Street, E.

Dec. 18, 1903. Oxley, F. J., M.R.C.S., 1, Dock Street, E.

Feb. 19, 1904. Page, John William, 13, Crescent Road, Sidcup, Kent.

Mar. 17, 1905. Paine, Daniel George, 19, Cranstone Road, Forest Hill, S.E.

Mar. 20, 1896. Pantin, Henry, "Staplegrove," The Avenue, Beckenham.

Oct. 27, 1871. Parsons, F. A., 15, Osborne Road, Finsbury Park, N.

Dec. 19, 1902. Partridge, H. S., 83, Rendle Road, Streatham, S.W.

Dec. 16, 1904. Patterson, George, The Flat, The Manbre Saccharine Co., Limited, Fulham Palace Road, Hammersmith, W.

July 23, 1886. Paul, R., Holmbush, Cyprus Road, Exmouth, Devon.

Jan. 18, 1901. Paulson, Robert, "Hosey," Cheney Lane, Pinner, Middlesex.

May 24, 1867. Pearson, John, 40, Maida Vale, W.

Date of Election.	
Jan. 20, 1905.	Pearson, Mervyn Charles Hugh, Oatlands, Queen's Gardens, Ealing.
May 20, 1904.	Perks, Frederick John, 48, Grove Park, Denmark Hill, S.W.
Mar. 17, 1905.	Phipps, William Joseph, 25, Grover Road, Bushey, Herts.
May 1, 1906.	Pigg, John Inderwick, "Caxton," Effingham Road, Surbiton.
Feb. 20, 1903.	Pilcher, Charles Frederick, 46, Dunbar Road, Forest Gate, E.
Nov. 15, 1895.	Pillischer, J., F.R.M.S., 88, New Bond Street, W.
Mar. 18, 1904.	Pinkerton, William, 19, Langley Road, Watford.
June 19, 1903.	Piovanelli, Sebastiano C. E., Casa Venier, Fond. Zattere, 783, Venice, Italy.
Nov. 19, 1897.	Pittock, George Mayris, M.B., F.R.M.S., Winton, Whitstable Road, Canterbury.
June 17, 1904.	Plaskitt, Frederic J. W., 27, Great Percy Street, W.C.
Jan. 15, 1904.	Pledge, John H., 115, Richmond Road, Dalston, N.E.
Nov. 23, 1883.	Plowman, T., Nystuen Lodge, Bycullah Park, Enfield.
Sept. 21, 1894.	Pollard, Jonathan, F.R.M.S., 10, Porteus Road, Paddington Green, W.
May 18, 1900.	Poser, M., F.R.M.S., 29, Margaret Street, Regent Street, W.
June 21, 1895.	Poulter, Christopher S., Mount Lodge, Parkhurst Road, Bexley, Kent.
Mar. 21, 1890.	Pound, C. J., F.R.M.S., Bacteriological Institute, Brisbane, Queensland.
Feb. 17, 1899.	Powell, Arthur, 28, Stafford Terrace, Kensington, W.
May 17, 1901.	Powell, David, M.A., F.R.M.S., 17, Warwick Mansions, Cromwell Crescent, Earl's Court, S.W.
July 7, 1865.	Powell, Thomas H., F.R.M.S., 14, St. George's Avenue, Tufnell Park, N.
Feb. 16, 1894.	Praill, Edward, 3, Parkhill Road, Hampstead, N.W.

Date of Election.

Feb. 25, 1881. Probyn, Lieut.-Colonel Clifford, 55, Grosvenor Street, W.
Dec. 15, 1905. Pullin, Alfred James, 7, Amhurst Road, N.
May 16, 1890. Pyman, F. H., "Mount Grove," 82, FitzJohn's Avenue, Hampstead, N.W.

Mar. 21, 1902. Quilter, Horace J., Oakleigh, Clarendon Road, Ashford, Middlesex.

Feb. 21, 1902. Radcliffe, William, Warblington, Guernsey.
Jan. 18, 1901. Radley, Percy E., F.R.M.S., 30, Foxgrove Road, Beckenham, Kent.
Nov. 17, 1893. Randell, George J., F.R.M.S., 14, Wavertree Road, Streatham Hill, S.W.
June 24, 1881. Ransom, F., "The Chilterns," Hitchin, Herts.
May 19, 1905. Reeve, James, 58, Seward Road, Hanwell, W.
Mar. 20, 1896. Rheinberg, Julius, F.R.M.S., 16, Coolhurst Road, Crouch End, N.
Sept. 18, 1891. Richards, F. W., 212, Notre Dame Street West, Montreal, Canada.
Jan. 18, 1901. Richardson, John, 14, Townshend Road, Richmond, Surrey.
Jan. 19, 1894. Roberts, Charles Philip, 31, St. Mary's Road, Canonbury, N.
Nov. 21, 1902. Roberts, Martin, M.I.C.E., F.C.S., Mabshill, Epsom.
June 21, 1901. Robertson, H. R., F.R.M.S., Upton Grange, Chester.
Jan. 19, 1906. Robins, Edmund Arthur, "Newlyn," Bedford Terrace, Station Road, Wealdstone, Harrow, R.S.O.
May 20, 1892. Robinson, J., 7, Longlands Road, Sidcup.
Nov. 16, 1900. Rogers, G. H. J., F.R.M.S., 55, King Street, Maidstone.
Jan. 20, 1905. Rogers, William Snow, Greystoke, Farnham Common, Slough.

Date of Election.

Mar. 20, 1903. Rolfe, R. A., "Woodville," Painswick Road, Cheltenham.

Jan. 25, 1884. Rosseter, T. B., F.R.M.S., East Kent Club, Canterbury.

Jan. 26, 1883. Rousselet, Charles F. (*Vice-President and Hon. Secretary for Foreign Correspondence*), Curator R.M.S., 2, Pembridge Crescent, Bayswater, W.

Nov. 18, 1904. Rowley, Frederick Richard, 3, Devonshire Place, Pennsylvania Hill, Exeter.

Dec. 15, 1899. Royle, A. E., 56, St. Kilda's Road, Lordship Road, Stoke Newington, N.

Mar. 21, 1902. Rushton, Charles H., 12, Bedford Park Mansions, Chiswick, W.

April 27, 1888. Russell, J., 16, Blacket Place, Newington, Edinburgh.

Oct. 27, 1865. Russell, James, 10, Shoreditch, E.

Nov. 21, 1902. Sanderson, R. Z., 26, Beaconsfield Road, St. Margaret's, E. Twickenham, Middlesex.

Dec. 19, 1902. Sayers, H. M., Rusper Lodge, 11, Knollys Road, Streatham, S.W.

Jan. 16, 1890. Scherren, H., F.Z.S., 9, Cavendish Road, Harringay, N.

Feb. 18, 1898. Scott, David Bryce, Moncton, New Brunswick, Canada.

June 20, 1890. Scourfield, D. J., F.R.M.S., 63, Queen's Road, Leytonstone, E.

May 20, 1898. Sears, Robert S. W., 1, Lisson Grove, N.W.

Feb. 15, 1901. Sexton, Louis E., L.D.S., 19, Portland Square, Plymouth.

May 26, 1876. Shepheard, Thomas, F.R.M.S., Kingsley, Bournemouth West.

June 19, 1896. Sidwell, Clarence, J. H., F.R.M.S. (*Hon. Curator*), 46, Ashbourne Grove, Dulwich, S.E.

Nov. 23, 1877. Simpson, T., "Fernymere," Castlebar, Ealing, W.

Feb. 17, 1905. Sindall, Robert Walter, 2, Oxford Court, Cannon Street, E.C.

Date of Election.

Oct. 26, 1903. Skorikow, Alexander Stepanovic, Musée Zoologique de l'Académie Impériale des Sciences, St. Petersburg, Russia.

Oct. 23, 1868. Smart, William, 27, Aldgate, E.

May 25, 1866. Smith, Alpheus (*Hon. Librarian*), 14, Leigham Vale, Streatham, S.W.

Oct. 21, 1904. Smith, Arthur Edgar, "Helios," 71, Fox Lane, Palmer's Green, N.

Mar. 25, 1870. Smith, F. L., 3, Grecian Cottages, Crown Hill, Norwood, S.E.

Mar. 17, 1899. Smith, Frank P. (*Hon. Editor*), 15, Cloudesley Place, Islington, N.

Mar. 17, 1905. Smith, Frederick, 5, Devonshire Terrace, East Dulwich Road, S.E.

Nov. 19, 1897. Smith, Herbert Havet, "Levuka," Westcliff-on-Sea.

Nov. 18, 1898. Smith, Thomas J., c/o W. Watson & Sons, 313, High Holborn, W.C.

Jan. 17, 1902. Soames, Rev. H. A., M.A., F.L.S., "Syncroft," Otford, Sevenoaks, Kent.

Jan. 15, 1892. Soar, C. D., F.R.M.S., 37, Dryburgh Road, Putney, S.W.

May 17, 1901. Soutter, Andrew G., "Roseneath," 79, Bethune Road, Stamford Hill, N.

April 21, 1899. Spitta, Edmund J. (*President*), L.R.C.P., M.R.C.S., F.R.A.S., F.R.M.S., 41, Ventnor Villas, Hove, Brighton.

April 21, 1899. Spitta, Dr. Harold, 40, Worple Road, Wimbledon, S.W.

Jan. 15, 1904. Sprague, T. B., LL.D., 29, Buckingham Terrace, Edinburgh.

Sept. 25, 1885. Spriggs, A. T., Bank of England, E.C.

Mar. 18, 1904. Staehler, Max, 29, Margaret Street, W.

Dec. 19, 1902. Stamp, W. B., Elmhurst, Streatham Com., S.W.

April 15, 1904. Stephens, Walter L., "Colomberie," West Bay, Bridport.

Nov. 17, 1899. Stevens, John, F.R.M.S., 50, St. David's Hill, Exeter.

April 17, 1891. Stevens, Col. L., 239, Southwark Bridge Road, S.E.

Date of Election.

Nov. 27, 1885. Stevenson, G. T., "Glencairn," Castelnau, Barnes, S.W.

June 18, 1897. Still, Arthur L., Addington, Croydon.

Nov. 16, 1894. Stokes, William B., 6, New Street, Bishopsgate, E.C.

Dec. 15, 1893. Sturt, Gerald, "Lismore," Cavendish Road, Weybridge.

Jan. 18, 1901. Sully, F. Harold, 1, Twyford Crescent, Acton, W.

June 24, 1870. Swain, Ernest, Little Nalders, Chesham, Bucks.

May 17, 1895. Swan, Michael Edward, 64, Dyne Road, Brondesbury, N.W.

Dec. 17, 1875. Swift, M. J., "Trematon," Acton Lane, Harlesden, N.W.

April 17, 1891. Tabor, C. J., The White House, Knott's Green, Leyton, Essex.

July 27, 1877. Tanqueray, A. C., 16, Palace Street, Buckingham Gate, S.W.

Jan. 19, 1906. Taplin, Bruce, 16, Lordship Park, Stoke Newington, N.

Nov. 28, 1879. Tasker, J. G., 30, Junction Road, Upper Holloway, N.

Feb. 15, 1895. Tatham, John, M.A., M.D., Rathronan Lodge, The Avenue, Berrylands, Surbiton.

Oct. 16, 1896. Taverner, Henry, F.R.M.S., 319, Seven Sisters' Road, Finsbury Park, N.

Mar. 21, 1902. Taylor, F. B., The Bird's Nest, Lyndhurst, Hants.

Feb. 17, 1905. Taylor, Thomas George, Bijou Villa, High Street, Ramsgate.

Dec. 22, 1865. Terry, John, F.R.M.S., 8, Hopton Road, Coventry Park, Streatham, S.W.

Mar. 16, 1894. Teversham, Fred. W., 317, Wightman Road, Hornsey, N.

Feb. 18, 1898. Thelwell, F. W. Watts, "Tresillian," Harlyn Bay, near Padstow, Cornwall.

June 20, 1902. Thomas, R. H., Warwickshire Estate, Hunyani River, Mashonaland.

Feb. 17, 1893. Thorpe, V. Gunson, Fleet Surgeon R.N., Royal Naval Hospital, Plymouth.

Date of Election.

May 16, 1902. Tilling, George, F R.M.S., "Grassmere," Rydal Road, Streatham, S.W.

Dec. 21, 1894. Traviss, Will. R., 44, Huddlestone Road, Willesden Green, N.W.

Nov. 21, 1902. Tryon, B. F. T., Down Hall, Epsom, Surrey.

May 15, 1903. Tupman, G. Lyon, Lt.-Col., F.R.M.S., College Road, Harrow.

June 17, 1892. Turner, C., "Glencoe," Agamemnon Road, West Hampstead, N.W.

June 21, 1901. Tyrrell, E. G. Harcourt, P.O. Box 135, Pietermaritzburg, Natal.

Mar. 16, 1900. Underhill, T. H., M.B., 72, Herne Hill, S.E.

May 16, 1902. Vicarey, William, 10, Northumberland Grove, Tottenham, N.

Mar. 16, 1906. Vogeler, Gustav, 17, Philpot Lane, E.C.

July 25, 1873. Walker, J. S., 6, Warwick Road, Upper Clapton, E.

Jan. 16, 1903. Walker, Wallace O., Belle Vue House, Carey Place, Watford, Herts.

Nov. 20, 1903. Waller, W. T., 15, Atney Road, Putney, S.W.

June 17, 1904. Ward, Montague Wesney, 4, Chepstow Mansions, Bayswater, W.

June 17, 1904. Waterhouse, Alfred N. V., Inanda, Broad Lane, Hampton, Middlesex.

July 24, 1874. Webb, C. E., Wildwood Lodge, North End, Hampstead, N.W.

Oct. 19, 1900. Webb, G. H. D., 111, Clifton Hill, St. John's Wood, N.W.

Feb. 17, 1905. Webb, John Cooper, F.E.S., 218, Upland Road, Dulwich, S.E.

Dec. 21, 1900. Webster, Rev. T., 13, Victoria Road, Exmouth, Devon.

June 16, 1899. Wedeles, James, F.R.M.S., 231, Finders Lane, Melbourne, Australia.

May 24, 1867. Weeks, A. W. G., 36, Gunter's Grove, West Brompton, S.W.

April 20, 1906. Weeks, John, 8, Homefield Road, Bromley, Kent.

Date of Election.	
Feb. 15, 1901.	Wesché, Walter, F.R.M.S., 125, Biddulph Mansions, Elgin Avenue, W.
April 17, 1891.	West, C., "Fernville," Fortis Green, N.
May 26, 1882.	Western, G., F.R.M.S., "Lalbagh," Bushey Park Villas, Park Lane, Teddington.
Nov. 19, 1897.	Weston, Digby St. Aubyn Percy, Lieut. R.N., H.M.S. *Albion*, Channel Fleet.
Feb. 25, 1876.	Wheeler, George, 64, Canonbury Park South, N.
May 17, 1901.	Whiting, Oswald, 24, Lechmere Road, Willesden Green, N.W.
June 25, 1880.	Wickes, W. D., F.L.S., F.R.M.S., 20, Warrior Square, Southend-on-Sea.
Mar. 25, 1881.	Wildy, Arthur, Shord Hill, Kenley, Surrey.
Nov. 23, 1877.	Williams, G. S., 20, Oxford Road, Kilburn, S.W.
April 17, 1903.	Williams, H., Fulham Infirmary, St. Dunstan's Road, Hammersmith, W.
Jan. 19, 1906.	Wilson, Joseph, Hillside, Avon Road, Upper Walthamstow, Essex.
Nov. 18, 1904.	Winter, Frank, A.C.A., F.R.M.S., 16, Market Street, Newcastle-on-Tyne.
May 17, 1901.	Winter, William F. G., "Greenways," Crane's Drive, Surbiton.
Dec. 20, 1895.	Wood, Walter J., F.R.M.S., "Ernecroft," Abbey Road, Grimsby.
Nov. 16, 1894.	Wooderson, Edwin, "Königsfeld," 39, Dartmouth Road, Brondesbury, N.W.
May 19, 1897.	Woodley, Ernest, 84, Jerningham Road, New Cross, S.E.
April 20, 1906.	Worthington, Dr. Francis Samuel, Gordon Road, Lowestoft.
Feb. 21, 1902.	Wyatt, Edward, 27, Sudeley Street, Islington, N.
Jan. 18, 1901.	Wykes, William, 7, Plaistow Park Road, Plaistow, Essex.
Nov. 23, 1888.	Young, G. W., 82, Bridge Road West, Battersea.
Dec. 19, 1902.	Zimmerman, Prof. C., F.R.M.S., Collegio de S. Fiel (Beira-Baixa), Portugal.

NOTICE.

Members are requested to give early information to the Treasurer of any change of residence, so as to prevent miscarriage of Journals and Circulars.

List of Exchanges and of Societies, etc., which Receive the Journal.

American Microscopical Society, c/o Robert H. Wolcott, University of Nebraska, Lincoln, Nebraska, U.S.A.

Bath Ladies Microscopical Society, Miss B. Bryant, 15, Darlington Place, Bath.

Bausch & Lomb Optical Company, Publication Department, Rochester, N.Y., U.S.A.

Bergens Museums Bibliothek, Bergen, Norway.

Berlese, Prof. Antonio, R. Scuola di Agricoltura, Portici, Italy.

Birkbeck Literary and Scientific Institution, Bream's Buildings, Chancery Lane, W.C.

Birmingham Natural History and Philosophical Society, Norwich Union Chambers, Congreve Street, Birmingham.

"Botanical Gazette," University of Chicago Press, Chicago, Ill., U.S.A.

Botanical Society of Edinburgh (The Curator), The Botanic Gardens, Edinburgh.

Botanisches Centralblatt, c/o E. F. Brill, Leyden, Holland.

Brighton and Hove Natural History Society, c/o The Public Library, Brighton.

Bristol Naturalists' Society (The Librarian), 5, Lansdown Place, Clifton, Bristol.

British Association for the Advancement of Science, Burlington House, London, W.

Bureau of Government Laboratories (Acting Librarian), Manila.

Canadian Institute, W. H. Vandersmitten, Esq., Secretary, 46, Richmond Street East, Toronto, Canada.

Concilium Bibliographicum, Zürich-Neumünster, Switzerland.

Croydon Natural History and Scientific Society (The Secretary), Public Hall, Croydon.

Dohrn, Dr. Anton, The Zoological Station, Naples.

"English Mechanic," Clement's House, Clement's Inn Passage, W.C.

Entomological Society, 11, Chandos Street, Cavendish Square, W.

Essex Field Club, Essex Museum of Natural History, Stratford, Essex.

Geologists' Association (The Librarian), University College, Gower Street, W.C.

Herts Natural History Society, c/o Daniel Hill, Esq., "Herga," Watford, Herts.

Historical and Scientific Society of Manitoba, Winnipeg, Canada.

Horniman Museum, Forest Hill, S.E. (The Curator).

Hull Scientific and Field Naturalists' Club, Royal Institution, Hull.

Illinois State Laboratory of Natural History (Library), Urbana, Ill., U.S.A.

Imperial Leopold-Caroline Academy, Halle-on-the-Saale, Germany.

"Knowledge," c/o F. Shillington Scales, Esq., "Jersey," St. Barnabas Road, Cambridge.

Leicester Literary and Philosophical Society (The Secretary), Corporation Museum, Leicester.

Linnean Society, Burlington House, Piccadilly, W.

Literary and Philosophical Society of Manchester (The Librarian), 36, George Street, Manchester.

Lloyd Library, Cincinnati, Ohio, U.S.A.

London Institution (The Librarian), Finsbury Circus, E.C.

Manchester Microscopical Society, J. E. Storey, Esq., 26, Grosvenor Road, Whalley Range, Manchester.

Microscopical Society of Liverpool, Royal Institution, Colquitt Street, Liverpool.

Missouri Botanical Garden, St. Louis, Mo., U.S.A.

Natural History Museum (The Librarian), South Kensington, W.
Natural History Society of Glasgow (The Librarian), 207, Bath Street, Glasgow.
Netherlands Zoological Society, Zoological Station, Helder, Holland.
New York Microscopical Society, c/o Rev. J. L. Zabuskie, Waverley Avenue, Flatbush, L.I., New York, U.S.A.
"Nuova Notarisia," c/o Prof. G. B. De Toni, Université Royale de Modena, Modena, Italy.
"Nyt Magazin for Naturaidenskaberne," c/o Prof. Dr. N. Wille, Botan. Garten, Christiania.

Oberhessische Gesellschaft für Natur- und Heilkunde, Giessen, Germany.

Patent Office Library, 25, Southampton Buildings, Chancery Lane, W.C.
Philadelphia Academy of Natural Sciences, Philadelphia, Pa., U.S.A.
Philippine Exposition Board, Calle General Solano 384, Manila, Philippine Islands.

R. Scuola Superiore di Agricoltura, Portici, Italy.
Royal Dublin Society, Leinster House, Dublin.
Royal Institute of Cornwall, Truro.
Royal Institution, 21, Albemarle Street, W.
Royal Medical and Chirurgical Society, 20, Hanover Square, W.
Royal Microscopical Society, 20, Hanover Square, W.
Royal Society, Burlington House, Piccadilly, W.
Royal Society of New South Wales, Sydney.

Saunders, Sibert, Esq., Springfield House, Whitstable, Kent.
Smithsonian Institution, Washington, D.C.
Société Belge de Microscopie, c/o Mons. A. Castaigne, 28, Rue de Berlaimont, Bruxelles.
Société Botanique Italienne, Florence, Italy.
Society of Arts, John Street, Adelphi, W.C.

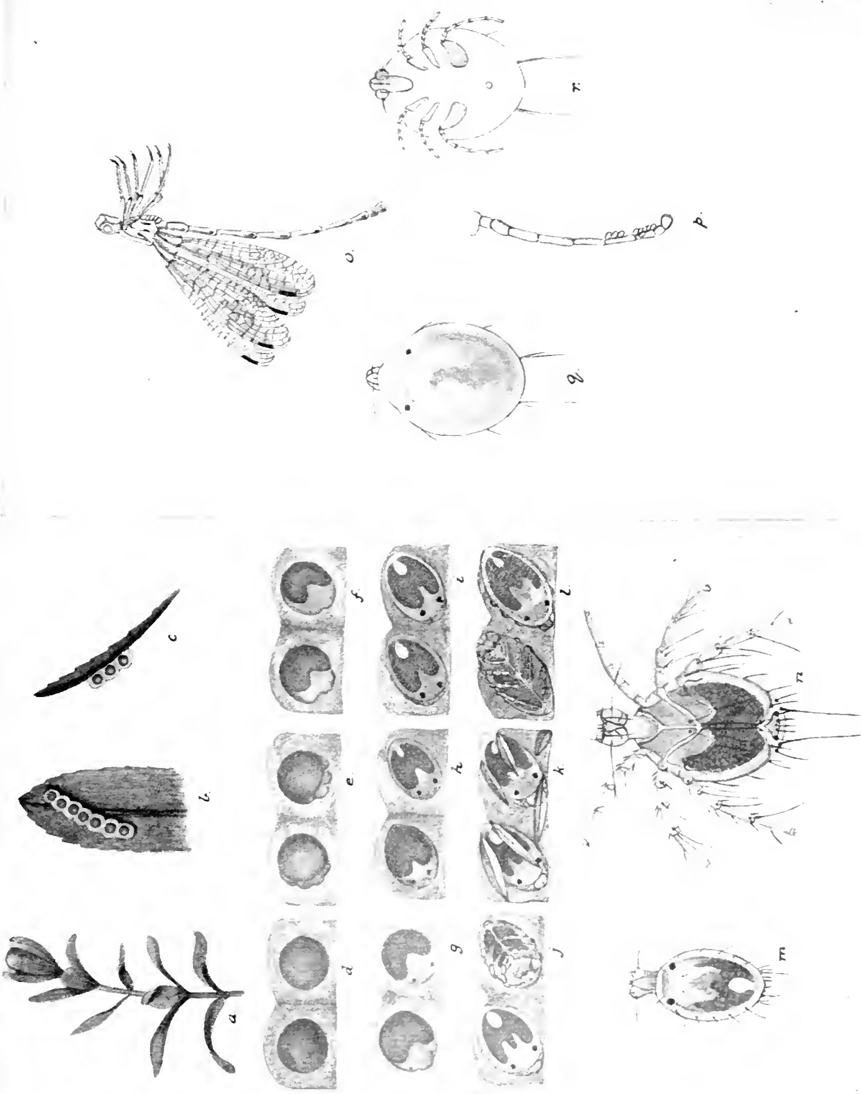
Tempère, Mons. J., Grèz-sur-Loinn, par Bourron, Seine et Marne.

Tyne Side Field Club and Natural History Society (The Librarian), Newcastle-on-Tyne.

Wagner Free Institute, Montgomery Avenue and 17th Street, Philadelphia, U.S.A.

Wisconsin Academy of Sciences, Arts, and Letters (Exchange Secretary), Madison, Wis., U.S.A.

Zacharias, Dr. Otto, Biologische Station, Plön, Holstein, Germany.
Zoologish-botanische Gesellschaft in Wien, Wollzeile 12, Wien, Austria.



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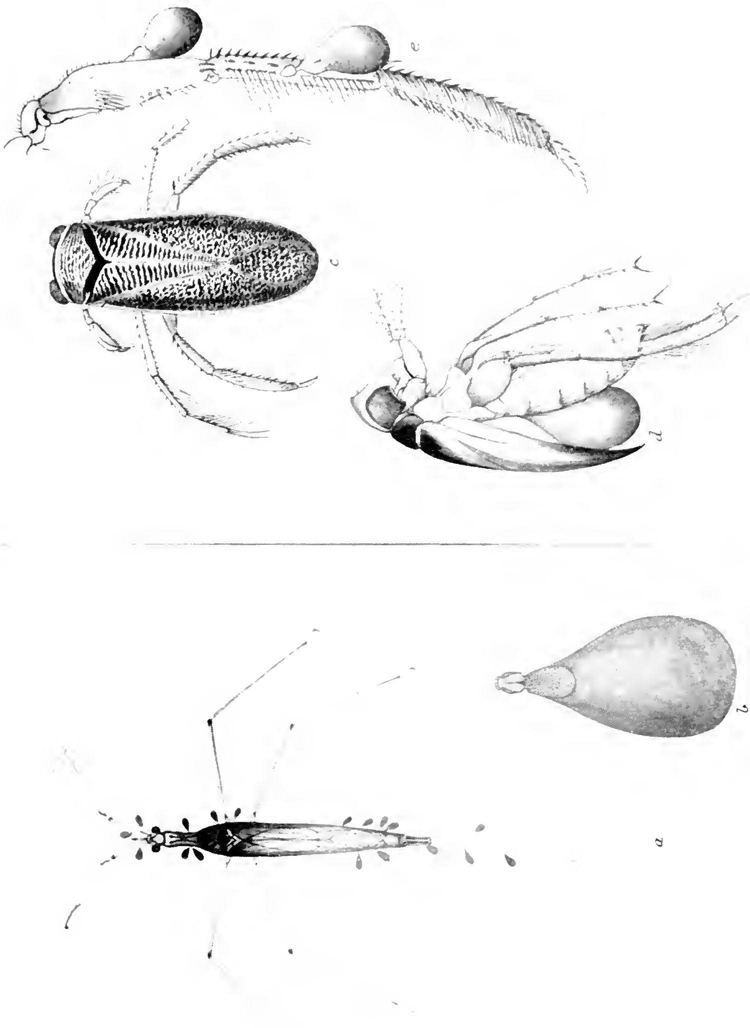

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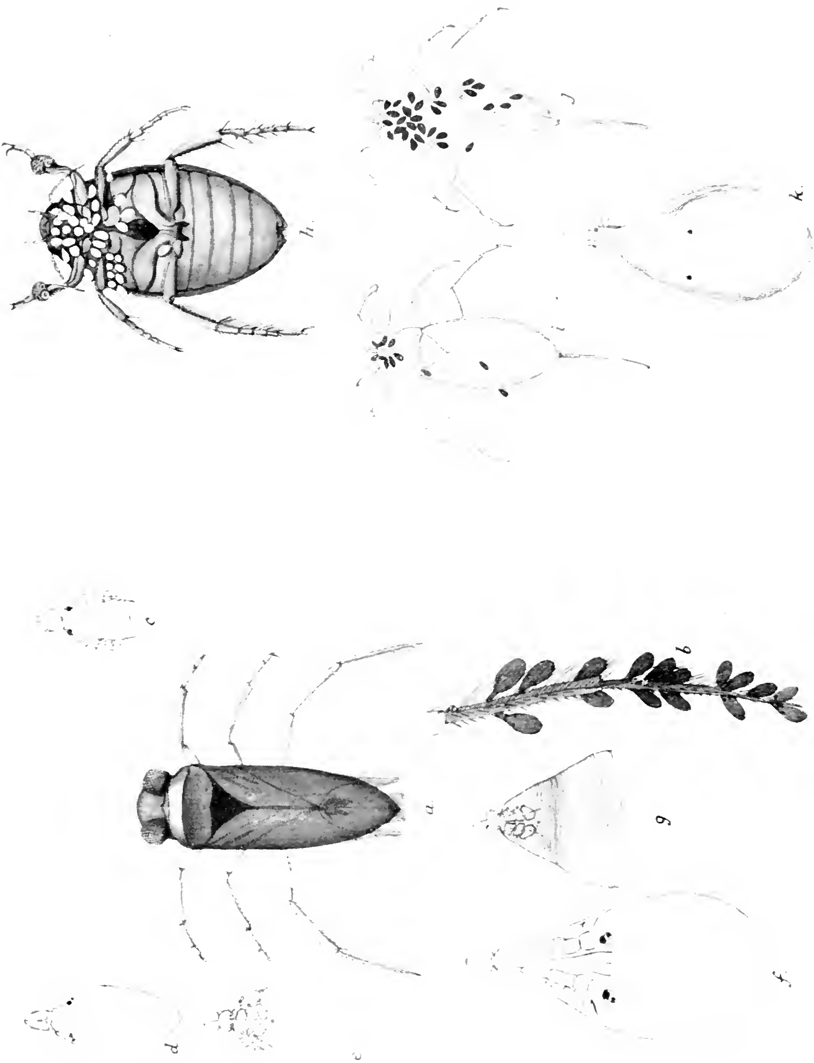

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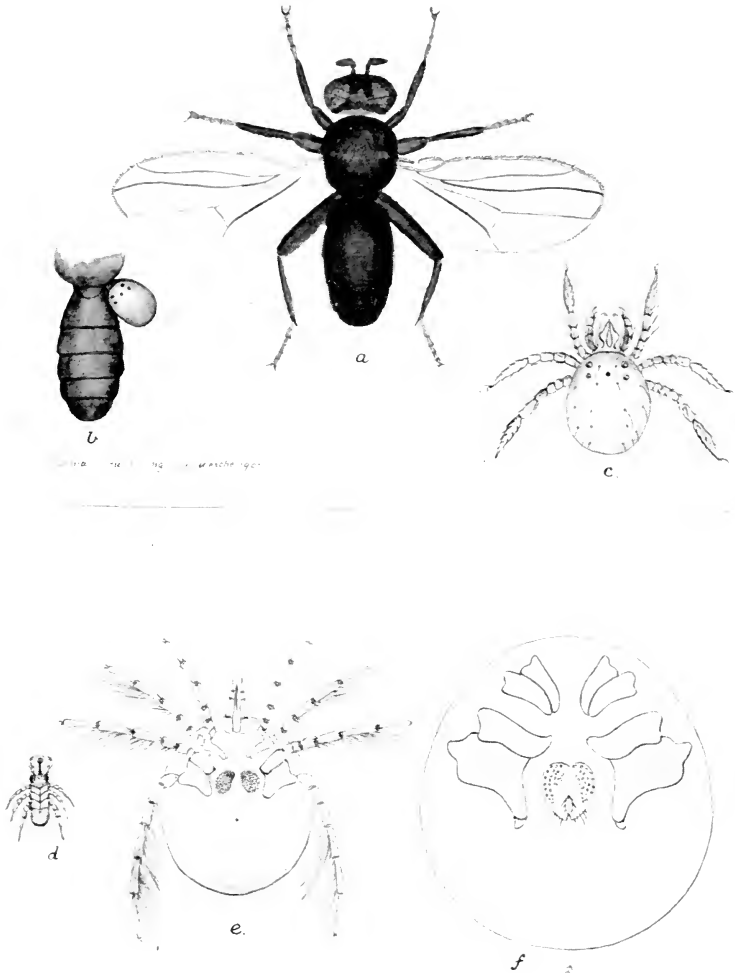
British Water-mites.



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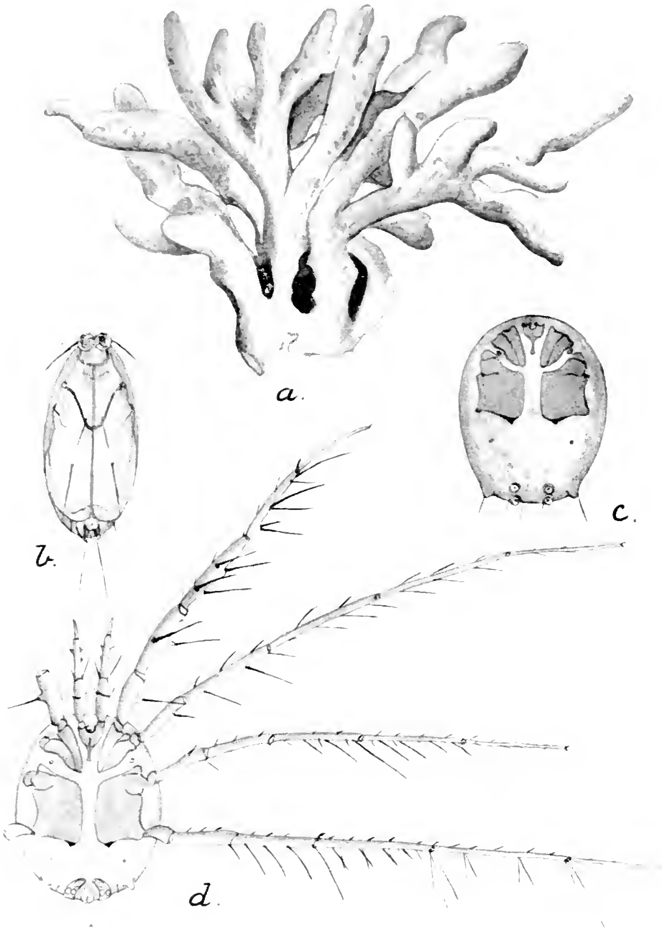
British Water-mites.



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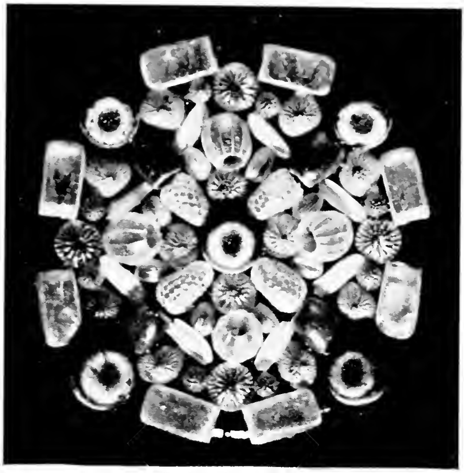
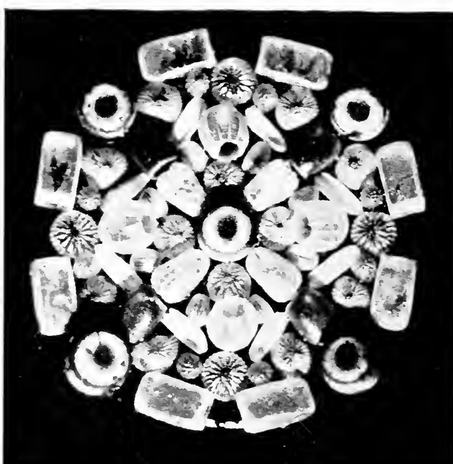
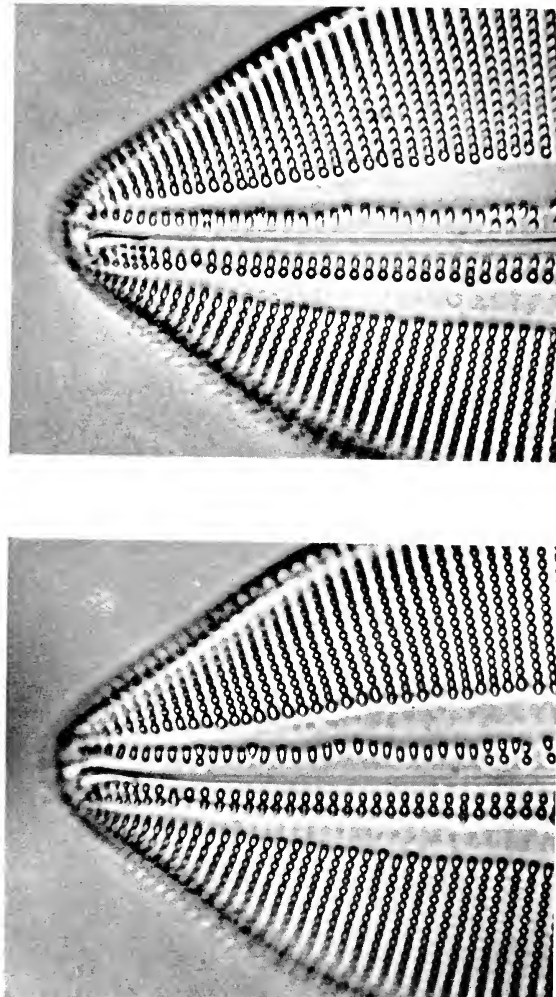
British Water-mites (*Atax crassipes*).





A. E. Smith, *photo.*

Group of Insect Eggs.



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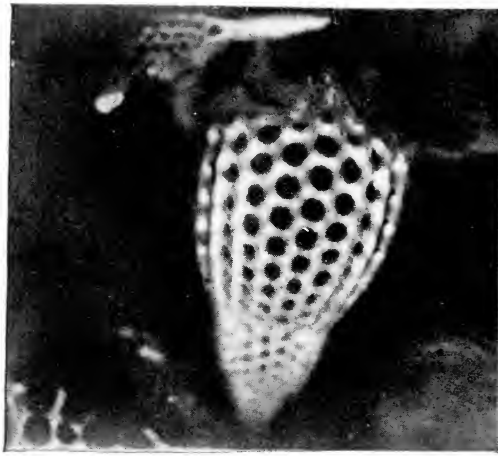
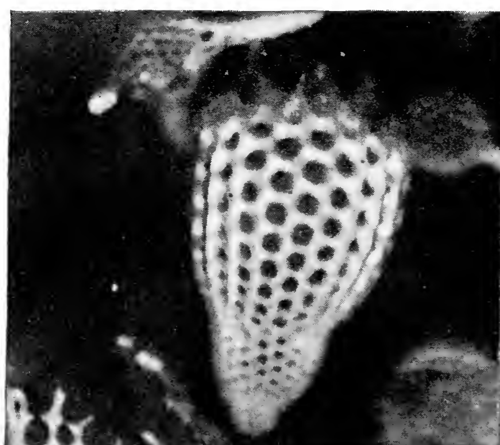
Diatom, *Navicula lyra.*





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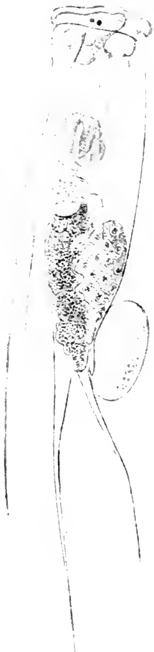
Polycystina.



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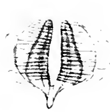

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F. R. Dixon-Nuttall & S. Hlava, *del. ad nat.*

Tetramastix opoliensis (Zacharias).

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THE JOURNAL

OF THE

QUEKETT MICROSCOPICAL CLUB.

EDITED BY

FRANK P. SMITH.

(*It will be understood that the Authors alone are responsible for the views and opinions expressed in their papers.*)

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Notes.

Proceedings, etc.

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and 7 BROAD STREET, OXFORD.

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

FOR 1904–1905, AT

20, Hanover Square, W.,

ON THE

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This CLUB was established in 1865 for the purpose of affording to experienced Microscopists, as well as to Students, regular and frequent opportunities of discussing those special subjects in which they are mutually interested, and also for promoting Field Excursions to the well-known collecting districts around the Metropolis.

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The ORDINARY MEETINGS are held on the *Third* Friday in each Month, except July, August, and September. Business commences at 8 o'clock.

The meetings on the *First* Friday in each month, and on the *Third* Friday in July, August, and September, are for conversation and for the exhibition of objects, from 7 to 9.30 p.m.

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* The ANNUAL GENERAL MEETING will be held on the Third Friday in February of each year, at 8 o'clock, for the Election of Officers and other Business.