EXPLANATION OF PLATE IX,

Illustrating Mr. Sydney H. Vines' Account of Professor Strasburger's Observations on Protoplasm.

Figs. 1, 2, 3, 4, and 6, after Strasburger.

Fig. 5, after Hofmeister.

Figs. 1—3, and 6, Vaucheria sessilis.

Fig. 1.—Nearly mature zoogonidium in its case. Prepared with alcohol. × 240.

Fig. 2.—Anterior portion of same, in fresh state. × 600.

Fig. 3.—A portion of the ectoplasm with cilia, osmic acid. × 600.

Fig. 6.—Portion of a zoogonidium which had been induced to form a second cellulose membrane; fresh state. × 600.

Figs. 4 and 5.—Æthalium septicum (Myxomycetes).

Fig. 4.—Portion of a plasmodium in process of retraction; fresh state × 600.

Fig. 5.—Portion of a plasmodium in process of retraction. × 200.

MEMOIRS.

Résumé *of* Recent Contributions *to our* Knowledge *of* "Freshwater Rhizopoda." Part IV. Compiled by Wm. Archer, F.R.S. (With Plate VIII.)

Monothalamia (*Monostomata*) Lobosa (*continued*).

Pseudochlamys patella, Clap. et Lachmann[1] = *Amphizonella flava*, Greeff[2] (Pl. VIII, figs. 1—3).

There can be little doubt that the not uncommon rhizopod identified by Hertwig and Lesser as above is indeed one and the same with Claparède and Lachmann's form, and, with not less doubt, is also identical with that erroneously called *Amphizonella flava* by Greeff.[3]

The test possesses ordinarily a hollow, dorsally convex discoid figure, somewhat like *Arcella vulgaris*, but a great deal smaller, its upper or convex side equally and evenly arched. Its colour at the middle is of a brownish yellow (resembling in tint that of the contents of many diatoms) mostly gradually fading off to the margins, which may be quite colourless; but I have myself frequently seen examples in which the change was abrupt and quite irregular. This colour resides in the test itself. The median portion of the test is thicker, and it gradually thins off to the margin. In many specimens an arcella-like facetting or punctate appearance can be readily made out, gradually disappearing towards the margin; but in many others this cannot be at all discovered when it has a more or less smooth, but not a glossy, aspect. I believe the appearance of "facetting" or "shagreening" is due to little rounded, closely posed, scattered scrobiculi.

Ordinarily the test appears of watch-glass shape, that is, deeply concave on one side and correspondingly convex on the other; the outer or convex side it is which bears the

[1] Claparède and Lachmann, 'Etudes sur les Infusoires et les Rhizopodes,' p. 443.
[2] L. c. p. 100, t. iii, f. 1.
[3] Greeff, 'Archiv. f. Mikr. Anat.,' Bd. II, p. 329, t. xviii, f. 19.

markings. In empty tests (much more frequently met with, so far as I can see, than still retaining the sarcode body) this really appears to me all that is left—at least, all that can be seen. But in the living examples, as Hertwig and Lesser were the first to point out, the concave side is closed, all but a median central opening, by a delicate and hyaline continuation of the test completing the external resemblance to an Arcella. Unlike Arcella, however, not only (when the rhizopod is living) this lower part of the test appears capable of undergoing alteration of figure—sometimes drawn in at the middle, sometimes prominent (like, as say Hertwig and Lesser, "the stomach of a Medusa"), but also the whole test can assume various, by no means inconsiderable, alterations of figure, even so much that the two opposite parts of the periphery of the disc of the test may become bent downwards or doubled towards each other so as almost to touch. When in this temporary position such an example would very much resemble Greeff's figure of the supposed form of "Amphizonella" which he called "*A. flava*." It almost seems as if the stolon-like sarcode processes passing from the body-mass, and inwardly attached to the angle of the test, acted as "muscles" in causing its contraction, and that on the withdrawal of the force it recovers its normal form by virtue of its own elasticity.

The body-mass does not fill the test, but sends off several of those "stolon-like" sarcode processes to the (inner side, of course, of the) periphery of the test, similar to Arcella and Difflugia. The protoplasm is minutely granular, and (near the margin) usually show several contractile vacuoles and a median nucleus. Hertwig and Lesser record that between the test and the body-mass occur some coarsely granular pigment of the colour of "diatomin." Without venturing to contradict so accurate observers, I would myself merely suggest that this colour seems to reside wholly in the test; it is quite as deep, and even brighter in empty tests, as when the organism is living.

I have several times watched a living example with the hope of seeing the projection of the finger-like pseudopodia described by Hertwig and Lesser, but have never seen this, possibly due to their being very short, that is, not extending beyond the periphery of the shell, as, indeed, those authors describe.

The only mode of reproduction observed by Hertwig and Lesser is by encysting, the body-mass becoming balled together into a spherical figure, the result of which they could not follow out. I have also noticed an encysted state,

but the contents had not assumed a globular figure, but had become condensed in the "top" of the shell, and enclosed by a wall on the upper side adapted to the figure of its interior, and in the lower of equal convex figure, so that on the whole the "spore" (so to call it) had acquired the figure of a thick doubly convex lens. (See Plate VIII, fig. 3.)

As originally described by Claparède and Lachmann, the test was said to form a simple disc, capable, however, of altering its figure and becoming folded; thus, according to them, the concave or lower side of the test was wholly open.

Seeing the capacity for folding and unfolding, as well as the retraction and projection of the hyaline and delicate "lower" (oral) wall of the test, it is possible that a form which I have met with may but represent a phase of the same species. But whilst the test of the latter when empty and *dead* seems always to present a deep watch-glass-like figure (that is, when viewed laterally or from the edge, forming externally a broadly and equably rounded arch), the present, in the same condition (viewed also laterally), presents a figure not unlike that of a very shallow *hat* with a narrow *rim*, or that of a round "baking-dish"—the upper contour only gently convex, then suddenly depressed and again somewhat suddenly widening out to form the rim. The former, when viewed dorsally, shows the disc more or less gradually fading off in colour towards the periphery, or if the transition from coloured to hyaline be rather sudden, it is irregular, whilst in the latter the transition is always abrupt and sharply limited, and circular in contour. In fact, the colour in the latter is restricted to the elevated portion, the border or rim (of the "hat" or "dish") being colourless and hyaline; hence in this "dorsal" view the median portion of the disc is often seen to be encircled by a tolerably sharp ring of higher colour, itself again immediately surrounded by the colourless rim, which fact is due to the observer seeing through a greater thickness of substance just at the place where the sudden descent of the contour from the slightly convex median disc takes place down to the outer hyaline border. I think this form also seems to be of somewhat smaller dimensions than the other; greatest diameter, 0·0015″, of the median coloured part of the disc (viewed dorsally) 0·0013″. If we may assume that, when the shell becomes abandoned by the living sarcode, and hence no longer acted upon by the locomotive or other movements of the organism, it then is unrestrictedly free to assume what may be called its normal

figure, it is possible we may justly enough regard the form here drawn attention to as specifically distinct from that of Claparède and Lachmann; but for the present I would not venture to pronounce any more decided opinion; it is quite possible it will be refound in the future by other better judges.

Pyxidicula operculata (Ehr.), = *Arcella patens* (Clap. et Lachm.[1]) Carter.[2]

This rhizopod, as described by Hertwig and Lesser, is furnished with a test, dorsally, of the form of a highly convex watch-glass, curved inwards below at the periphery all round, so as to leave a median pseudopodial opening; its colour of a brownish yellow, though sometimes colourless, and covered externally by irregularly scattered, very minute roughnesses ("von unregelmässig vertheilten feinsten Höckerchen bedeckt"); the pseudopodia (seldom, however, showing themselves) are conical, like those of an Arcella; one evident nucleus and a few contractile vacuoles are present.

This form I do not myself as yet know; its separation generically from *Pseudochlamys patella* seems to be based on its external "Höckerchen" or granulations as compared to the "shagreening" or scrobiculi (?) of the latter.

Hyalosphenia lata, Eilh. Schulze[3] (Pl. VIII, fig. 5).

Under the above name a lobose Monothalamian sarcodine is recorded by Professor E. Schulze, which he relegates to a genus founded by Stein for a form discovered by him near Prague. There appears to be no figure extant of Stein's original species, *Hyalosphenia cuneata*, Stein. It is thus described[4] (as quoted by Schulze): "Test oval, much flattened in front in a cuneiform manner, truncate at the frontal end, without lip-like margins, everywhere glassy, pellucid, and colourless, without any trace of polygonal impressions. From the narrow opening always but a single finger-like pseudopodium is projected. The animal can abruptly and quickly become retracted to the bottom of the test, whereby all connection with the orifice of the test is done away with."

The foregoing is sufficiently vague, both as regards the form of the test or the nature of the body. Assuming it to

[1] Claparède and Lachmann, 'Etudes,' &c., p. 446.
[2] Carter, 'Ann. Nat. Hist.,' vol. iii, p. 31.
[3] Schulze, in 'Schultze's Archiv f. Mikr. Anatomie,' Bd. XI, p. 335, t. xviii, f. 15—18.
[4] Stein, 'Sitzungsberichte der Wissench.,' Jan., 1875.

have a nucleus, and knowing its pseudopodium to be finger-like—that is, "lobose"—we would have before us, as it were, a *Difflugia*, but with a test not only devoid of any reticulated marking or special structure, but also without the superposition of any foreign objects (arenaceous particles, &c.). Possibly a "Difflugian" of such a character would really deserve to be kept apart, as well from such a type as Quadrula, on the one hand, as from such as (say) *Difflugia pyriformis* or *D. oblonga* on the other; but in that case it would become a question as to how we should deal with those Difflugian forms with a kind of partially hyaline and corrugated or more or less reticulated appearance of the test (not absolutely pellucid, smooth, homogeneous, and "structureless," as in Hyalosphenia); such, for instance, as *Difflugia triangulata*, Lang (a most marked and decided species); *Difflugia carinata*, Archer, &c.; at any rate, although I have not, I believe, seen either form, I should venture *ad interim* to think the genus Hyalosphenia is justifiable.

Schulze's new species, too, has a thin, membranous, pellucid, and quite structureless chitinoid test; but it is pyriform, laterally compressed, at the narrow "oral" end abruptly truncate; its length 0·06 mm., greatest breadth 0·035 mm., scarcely quarter this breadth at the "mouth," greatest thickness 0·015 mm.; end view (seen from behind) elliptic, with the apices somewhat produced and broadly rounded; contour of mouth (seen from the front) narrow elliptic; its margin very slightly thickened. The body-mass does not completely fill the test, to which it is united by a number of stolon-like sarcodic processes, as in Quadrula, Pseudochlamys, and others: at the mouth it is in close connection with the test; the author never perceived, unlike the form described by Stein, any sudden retraction of the body into the interior of the test. The homogeneous clear plasma is pervaded by many pretty nearly equal-sized pale globules or granules; a globular nucleus is posed towards the posterior end, enclosing a few comparatively large dark-looking globular nucleoli, whose number may reach as many as six, or even more. Beside and somewhat in front of the nucleus occur usually two pulsating vacuoles. Any food materials lie in the median region of the body in front of the nucleus. The pseudopodia are finger-like, ordinarily only one, but sometimes two or three; they are permeated by extremely minute granules, of which a movement could be seen, especially in the axial region of the longer pseudopodia.

Quadrula symmetrica, Eilh. Schulze,[1] = *Difflugia symmetrica* (Wallich), (Pl. VIII, fig. 6)

is a Difflugian form which, in my opinion, Prof. Schulze was amply justified in taking as the type of a distinct genus, the differential characters of course residing in the test, as the animal portion or sarcode body offers no very tangible distinction from an ordinary Difflugia; there are occult differences, no doubt, else how the wide distinction when "fully formed?" The first to recognise this species seems to have been Dr. Wallich;[2] I have myself met with the same form, though by no means frequently, in various collections, and would have proposed its being considered the type of a distinct genus, especially on my recently finding a further species of the same structure as regards the test. For I would quite agree with the view now expressed by Schulze that only Lobosa, whose habit is to build up or affix foreign particles, should be retained in the genus Difflugia proper. At the same time it is an open question whether all these which do so should be relegated thereto; as for instance the peculiar and remarkable seemingly unique structure of the test of the common form *Difflugia spiralis*, although it often appends externally arenaceous particles, would, I fancy, justify its separation.

In Quadrula the test is formed of hyaline angular plates, apposed laterally and in mutual contact. They are ordinarily square or slightly oblong, but occasionally in some parts of the test they may be triangular, trapezoid, or even more or less irregularly figured, this variation in shape from the square being in order to adapt themselves to the characteristic total figure of the test and so as to leave no mutual intervals or lacunæ. In *Quadrula symmetrica* the test is of a compressed pyriform figure, with straight longitudinal axis, and with a broad elongate neck abruptly but roundly truncated; the transverse view oval; the broad "mouth" offers two "lips" (on a line with the broader sides), each with a convex margin, between which on each side (on a line with the narrower sides of the test) is an intervening hollow. At the broader inflated portion of the test the hyaline component plates are larger and more regularly square in figure; on forming the neck or approaching thereto it is that they diminish in size or alter in figure according to the exigencies of the contour so as still to remain in mutual apposition and at same time build up the characteristic figure of the species.

[1] Schultze's 'Archiv f. Mikr. Anat.,' Bd. xi, p. 329, t. xviii, f. 1—6.
[2] 'Ann. Nat. Hist.,' vol. viii (1864), p. 815.

Normally they may be said to run in longitudinal and transverse series, but they may occasionally run obliquely, or even an abrupt alteration of arrangement may occur, yet on the whole all are nicely posed to produce the symmetrical characteristic external aggregate contour of the test. A greater disturbance of the symmetry of the plates may often take place close to the edge of the "mouth," where, whilst they become smaller in size, they also suffer greater alterations of individual figure so as to become adapted to the peculiar contour, as described, of the frontal opening, the extreme edge of which appears to form a thickened margin. These plates are not very firmly combined, a moderate pressure sometimes suffices to dislocate them, and in abandoned tests one sees often little accidental aggregations of these plates, lying often superposed.

The body-mass and its pseudopodia are like that of an ordinary Difflugia. It does not quite fill the test; often there proceed a few slender sarcode processes therefrom to the test, forming so many attachments; in the posterior end occurs a nucleus with nucleolus, and towards the anterior end may sometimes be seen a few pulsating vacuoles.

Quadrula irregularis, n.s., Archer.

Except in being smaller, corresponding to the smaller test, there is not any distinction to be drawn from the sarcode body, as just described, as regards the form I would here record under the foregoing name, its differences being in the size and figure of the test; still I would not be in the least disposed to regard it as but a *young* form of *Q. symmetrica*. I have taken this form from extremely remote localities, both in Ireland and Scotland, and ever presenting the same features, and I have likewise noticed a single example quite identical with the British specimens on a slide of Nordstedt's, the material having been collected in Italy, the Quadrula accidentally present, indeed, as the slide was put up for a Cosmarium. It is sometimes accompanied by *Q. symmetrica*, but more frequently presents itself alone; it must, however, be accounted rarer by a good deal than the typical species.

This form is smaller than *Q. symmetrica*, quite without any neck, the "mouth" being where a small chord seems, as it were, cut off the globular, or perhaps somewhat compressed test, nor are there any "lips" nor even any evident thickened margin; the mouth seems as it were but a cessation of the component plates, but on the whole subcircular in outline. As in the former, the typical form of the plates is square,

whilst at same time they are even more subject to variation in shape and size, and are often somewhat rudely applied and even in the living animal more prone to become dislocated. They sometimes show a thickened "frame-like" edge which forms a narrow rimlike border, or it may be so extended as to leave but a minute square in the middle, but mostly they are alike throughout. They mostly run in lines longitudinally (taking the "mouth" as the *anterior* end) and transversely at right angles, but sometimes obliquely; still the ordinary contour is ever maintained. This form sometimes showed a few spines comparable to those of a Euglypha, but this rarely; but I could not make out the place of origin of these, whether they occur between the plates (that is, of independent origin), or as processes given off from certain of them (which is more likely). This point would deserve attention should the spiniferous form again present itself.

Difflugia acropodia, Hertwig and Lesser.[1]

Under foregoing name the authors record a well-marked Difflugian of rounded figure which they say is not common (diam. 0·05 mm.). It consists of a homogeneous pellucid membrane, the foreign attached objects for the most part consist of quartz-granules, with sometimes a few diatomaceous frustules, mostly loosely fixed, that is, leaving considerable irregular intervals, though sometimes more crowded and completely covering the test. But the greatest distinction of the present from other species of Difflugia is in the form of the pseudopodia, which are not blunt finger-like prolongations, but form long more or less distinctly conical plates, running into variously lobed and subdivided shapes, always rather acutely pointed at the apices; sometimes one may run out long and comparatively thin (as it were subulate), almost resembling a pseudopodium of an Actinosphærium, but here the pseudopodia are always homogeneous, never granular. They fitfully branch, and on contact may occasionally anastomose, even as they ramify with the tendency to become flattened out, or two may appear to coalesce by the running up between of a membrane-like continuation of plasma, soon to be retracted or modified in contour, so fluent is the movement of this form and so manifold the changes of its pseudopodial region. Sometimes, indeed, a finger-like projection can be seen amongst those described, but the authors seem inclined to regard this rather as indications of

[1] Hertwig and Lesser, loc. cit., p. 117, t. ii, f. 6.

abnormal changes brought about by the gradual evaporation of the water during observation.

From this it will be seen that this remarkable form offers a peculiar exception to the general character of the Lobose pseudopodia. As well as thin and broad protoplasma-plates occur almost linear, branching and anastomosing processes, pointing to the pseudopodia of the truly "rhizopodous" forms.

But whilst this is so, I venture to think without myself knowing the form, but judging from the graphic figure, that this is an unmistakeably distinct species from every other, and whilst the resemblances pointed out no doubt are there, there is still *no identity* of any of the pseudopodia of this form (as depicted) with those of any other freshwater form.

Notwithstanding the apparently favorable conditions the authors were unable to gain any insight into the structure of the body-mass.

Monothalamia Rhizopoda.

Microgromia socialis (Arch.), Hertwig = *Gromia socialis* (Archer) (Pl. VIII, fig. 8).

This minute and interesting Monothalamian has been made the subject of a prolonged study, and of a most valuable memoir by Dr. Hertwig, too long, indeed, to do more than give a brief epitome of his results. It is long since I myself discovered my great and radical error in taking the great agglomerations or colonies, in which this species sometimes occurs in mutual combination, as representing an independent rhizopod of a different genus, but I do not see that I so greatly erred in referring the form to the genus Gromia; in fact, as I have mentioned, the tendency of observers in this field seems to me to be to make too many genera, at same time there is probably, as Hertwig considers, sufficient reason in the present instance to justify the step.

Hertwig points out that the smooth and pellucid test presents a bilateral symmetry owing to the slight diversion to one side of the prominent portion forming the very short necklike oral extremity, so that thus a left and right, a dorsal and a ventral, side may be distinguished, but so slight is this deviation that it might be readily overlooked, as indeed I formerly did. Viewed from an end the test appears circular. When forming a dense and large cluster (my supposed "Cystophrys") the constituent individuals of a group radiate, with the oral end inward and become seen with the rounded posterior end outward, which explains my original error of supposing I had before me a group of closed spherical "cells."

Hertwig announces that the hyaline smooth test does not become coloured either by iodine, nor by it along with sulphuric acid, and that it does not become altered under mineral acids or alkalies; but whether it contains any siliceous constituent he would leave undecided.

Not only is the test thus bilaterally symmetrical but the body-mass also; it is sharply contoured and of a "retort-shape," of which the "neck" passes out through the oral opening, broadening out there into contact with the test, the only place indeed where such occurs; from the necklike part are given off the pseudopodia (as originally correctly described by myself) and this portion, as in similar forms, Hertwig denominates the "pseudopodial stem."

Sometimes the body all but fills the test, sometimes it occupies only a small portion of the cavity—seemingly partly dependent on degree of nutrition, partly on reproductive conditions (as will be seen). Hertwig's description of the sarcode body and nucleus seems to agree with my own. A single or double contractile vesicle of variable size occurs in the anterior part of the body, the contractions very slow and uncertain.

The pseudopodia are also described by Hertwig pretty much as I did, with the exception, of course, that the complete fusion of these into a common matrix—the "Cystophrys state"—was wrongly interpreted by me; in this state they project around more or less irregularly from the common matrix, and the rarity of the mutual inosculation of the ultimate branches in this condition must be attributed solely to the radiating arrangement preventing their coming into mutual contact. But if they come into contact they will inosculate, and even whole bundles of them can exceptionally do so and form a long protoplasm-plate at one side; but usually, indeed, they are shorter in the Cystophrys-state than in the ordinary more or less isolated condition. Hertwig rightly states the current within the pseudopodia to be a very slow one, especially as compared to the vigorous flow in those of a *Gromia fluviatilis*. Hertwig dwells on the remarkable up-and-down fitful progress, alternately from one individual to another, by way of the uniting pseudopodia, of masses of plasma, containing granules—a proof of the intimate organic relations of the individuals composing a colony.

The author mentions the success with which, for a time at least, he had been able to preserve examples of this organism in a tolerably natural appearance by the application of osmic acid (1 per cent.); the pseudopodia collapsed only a little, became somewhat varicose, the granules becoming blackish, and the anastomoses remaining—still they lost the resistance of life, floating aimlessly in the water, hanging around the colony like hairs. The application of iodine gave far more unfavorable results.

The author notes that the food captured by this rhizopod is mostly such as is already undergoing decay; rarely do they incept living organisms, but on one occasion he saw a Vorticella captured, and at another some alga-spores. To myself this form appears not to be at all a "hungry" one.

The author's attention was largely directed to the gaining a knowledge of the development of this form. Hertwig first refers to the long-since expressed views founded on the observations of Carter, Wallich, and Greeff, especially of the latter in his *Amœba terricola*, where the so-called nucleus was supposed to be a reproductive organ, which by a breaking up into a number of solid, sharply bounded bodies, and escape of these into the general parenchyma of the body, and in some way combining with certain spermatozoa-like bodies already there, gave rise to so many germs. Carter, on the other hand, formerly supposed that the nucleus gave rise to spermatozoids, whilst the ovula were formed in the surrounding protoplasm; afterwards, as regards *Difflugia pyriformis*, coming more to the views of Greeff, regarding the sexual character of the reproduction as expressed in the "conjugation," a view foreshadowed by Claparède and Lachmann, who regarded the nucleus as a "glande sexuelle."

Bearing these views in mind, the author applied himself especially to a study of the nucleus in this form to see if any evidence should be afforded, demonstrative of its sexual significance; and he believes he has come to the certain result that neither in the formation of new colonies nor in the progress of growth does any process take place other than simple cell-division, in unison with the lowliness of the whole group as simple unicellular organisms.

To arrive however, at any conclusion it was requisite to discover (1) the mode in which new colonies are produced, and (2) the mode of growth of a colony already begun.

In regard to the former question the author, confirming my own record of two nucleated bodies within a single parent test, carries the observation a great deal farther. In a number of individuals of a colony so subdivided into two, he found that one of these portions became changed into a zoospore, which swarmed away from the colony independently. On one occasion he noticed certain individuals containing *two* nuclei, but without having witnessed the act of subdivision into the two daughter individuals.

But it is easy to find examples in which this process is complete, that is, the body of the Microgromia separated into two usually anterior and posterior halves (fig. 8, *a*). Only the former, which is produced into the pseudopodial stem remains in connection with the protoplasmic network of the colony. The posterior segment, which subsequently becomes a zoospore, has now its connection with the mother colony severed, that it is now an independent body. Both together now completely fill the cavity of the test, each having its nucleolated nucleus and contractile vacuole. In this condition the organism may persist for a long time without any perceptible alteration. By-and-by the posterior segment becomes gradually pushed up alongside the anterior one (fig. 8, *b*); amœboid movements ensuing, it slowly makes its exit from the test, as it were guided along by a pseudopodium, the contractile vesicle foremost, the nucleus behind. It maintains for a time its amœboid action, now becoming elongated, now contracted into a globular figure, or here and there lobed (fig. 8, *c*), which play is kept up for about a quarter of an hour; it finally assumes an ovate figure, the end containing the contractile vacuole still in connection with the pseudopodium, the end containing the nucleus outwards. About this time can be noticed a tremulous movement and two flagella which seem fitfully to change place, are seen waving about, but without producing as yet any forward motion (fig. 8, *d*). Their action soon, however, becomes more regular, the zoospore unmoors itself from the pseudopodium of the mother colony and swims away, as an ovate body, with a constantly rotating movement.

The anterior somewhat pointed end now consists of a somewhat homogeneous plasma; it encloses the nucleus and carries the two flagella; the posterior rounded end is richly granuliferous and contains a single or double contractile vacuole. Although the movement of the zoospore is not a rapid one, the author was not ever able to follow it up to its coming to rest; it would always disappear amongst the unavoidable tangle of algæ, &c., taken up in the drop; he therefore could not determine whether it, like the large zoospores of *Clathrulina elegans*, passed directly by retraction of the flagella into a resting state, or whether, like the zoospores emanating from the cysts of that species, they passed through the so-called actinophryan state.

Certain modifications of the mode described might, however, take place. Thus the hinder segment on emergence might assume an actinophryan aspect; the pseudopodia mostly, however, confined to the anterior end; these might sometimes anastomose, and generally resemble those of the

colony; by their slow action the segmented portion became pushed along, dragging after it the pointed hinder vacuole-containing end. The author was able to follow one of these till it came to rest. Becoming ovate, it now developed at the hitherto posterior end a pointed protoplasm-process; inasmuch as this agreed in relative position, as regards nucleus and contractile vacuole, the author was inclined to regard it as the commencement of the pseudopodial stem, but, even after two days' observations of the individual, he could not follow out the formation of the test, manifestly a very slow process.

The substitution of the actinophryan germs for the flagellate zoospores, when, by the light of modern observations, we consider the relation of flagella to pseudopodia, is not in reality very surprising. In the zoospores of Microgromia itself the author had satisfied himself that at first the flagella were temporarily projected and completely retracted only to be reproduced at a new place.

Touching the further question of the growth of the colony, the author was unable to see how from a single individual so originating a second individual becomes developed in connection with it, though doubtless it is by a similar process of self-division. In the course of the author's observations during the summer, he frequently found "Cystophrys" colonies in which in the greater number of the individuals the body was divided into two; the two segments, however, side by side, each with its nucleus and contractile vacuole. In these cases he never had an opportunity to follow the subdivision from beginning to end so as to decide whether the fission took place transversely or longitudinally. From the fact, however, that he noticed so many cases in which the pseudopodial stem was subdivided and the connection of both portions with the colony seemed still maintained, he concluded that the fission was longitudinal. He was, however, able sometimes to see one of these portions slowly make its exit from the test, leaving the other behind; the contractile vacuole in front, the nucleus hindermost. But unlike the zoospores, no amœboid action ensued, the mass remaining globular, near the mouth of the test, and in union with the remaining portion by a broad protoplasmic process (pseudopodial stem); by degrees it assumes the characteristic bilateral symmetry (before described). As regards the formation of the test the author has nothing certain to record.

The author mentions, finally, yet a third modification of this mode of development. In certain colonies, so undergoing subdivision, he noticed several individuals whose test

contained three segments (each with nucleus and contractile vacuole)—one large and two small—their pseudopodial stems in mutual connection; hence they must have arisen by a longitudinal fission of the original body-mass. In several instances the author was able to follow the exit of the two smaller individualised portions, one after the other. For more than an hour the young individuals each crept along a pseudopodium like little Amœbæ, without showing any inclination to become modified into zoospores or to leave the colony. The author was unable to carry this observation any further.

Although an encysted state must doubtless take place during the dry periods of the year, the author did not see any indication of it.

So far as its simple development-history is disclosed by the foregoing observations, there is nowhere any indications of any sexual process. At no point was there any difference in the nucleus observable. The only process observed and described was simple self-division, but the mode of origin of the two nuclei, whether by division or fresh formation, remained to the author in abeyance.

Cienkowski carried out some observations on a form referred by him hereto, and I believe it must be identical with this (although I doubt if Microgromia ever shows the pseudopodia so extremely finely linear and filamentary, and so seemingly homogeneous and granuleless, as he depicts in his figure); he noticed many cases of self-division, mostly longitudinal, but likewise often transverse, and in both cases the one segment emerged from the test as a zoospore, so that he seems rightly to place no value on the circumstance of the fission being longitudinal or transverse. As regards the act of self-division it was always preceded by the appearance of a second nucleus, which he states to *originate independently*, and not by the division of the "mother nucleus;" the plane of subdivision of the body may be oblique or longitudinal. As to the mode of exit, movement and general structure of the zoospore, the author's account agrees with Hertwig's, but he avers that it is a matter of indifference, which segment—the upper pseudopodial-stem-bearing, or the under simply rounded one—may emerge to become the zoospore. He was unable to make out anything definite as to the mode of origin of the colonies, though such seemed to be more abundant in the summer months. (My own opinion is the autumn, often late, is the season in which the Rhizopoda of the freshwaters are most readily to be met with.)

The formation of zoospores thus seems to be bound up with

no particular season; in Microgromia Hertwig found them in spring, Cienkowski late in autumn.

It is quite unnecessary here to dwell on the manifest generic distinctions of this form from the other Monothalamatous monostomatous Rhizopoda—such as Euglypha, Cyphoderia, Trinema, Plagiophrys, Lecythium, Pleurophrys, all again so distinct *inter se*. So distinct indeed *per se* does the rhizopod forming the type of the genus Microgromia appear, that so far as I am concerned I cannot at all recognise this species in the form alluded to, and figured by Schulze[1] and called by this name. The form here in question (*M. socialis*) can by no means be one and the same with "*Difflugia Euchelys*," Ehrenb, or "*Arcella hyalina*," Ehrenb. The most prominent distinctions at first glance are the close application of the body-mass to the test all round, and the long straight but very slightly branched non-granuliferous pseudopodia, and no pulsating vacuole—distinctions which I cannot doubt carry with them essential deep-going specific, even generic, differences. The form no doubt seems to be "social" in habit, but this would be a question of habit merely. It may make a species, possibly a new one, rather of Claparède and Lachmann's genus Plagiophrys.

As regards the genus Gromia, Duj., to which, to say the least, our *Microg. socialis* comes most close, Hertwig bases its generic distinctness on the bilateral symmetry of the test, its firmness and inflexibility; the interspace between the body and the test (though it may at first probably appear but trivial, this is, I fancy, in reality an important character), the single nucleus. All these are specialities of this form, no doubt; but whether they are of generic value as distinguished from the genus Gromia is more, I fancy, a matter of opinion than of any real importance—the rhizopod in question, whether we call it *Gromia socialis* or *Microgromia socialis*, seems to be, *per se*, a very distinct thing. Still I have, on a few occasions, met with even a more minute form, undoubtedly a "Microgromia," but not to be, I think, identified with my original and Hertwig's form. I venture to call it (at least *ad interim*)

Microgromia mucicola, sp. nov. (Pl. VIII, fig. 9).

This I at first found nestling only in the thick mucous matrix of the little alga, which I formerly felt obliged to refer to the genus Dictyosphærium, Näg. (but which is really a Des-

[1] F. E. Schulze, 'Schultze's Archiv für Mikrosk. Anatomie,' Bd. XII, p. 119, t. vi, f. 7—13.

midian of exceptional structure, of which more, it is to be hoped, on a future occasion), under the (provisional) name of *D. constrictum*. This summer, however, I found this rhizopod (in Connemara) for the first time nestling in the mucous investment of the little alga of similar habit, *Cosmocladium Saxonicum*, de Bary. The test is smaller than that of *Microg. socialis*, less pear-shaped, does not appear to offer at least any marked bilateral symmetry, is much more slow in movement and in flow of the granules in the plasma of the pseudopodia. In fact, one has to watch it a long time to notice any alteration, which, however, can be seen by close attention; still I had seen it several times before I thought it was a thing of life at all, so inert is it. I never saw any "Cystophrys" condition, nor even so large groups as even the minor ones of *Microg. socialis*, two only, or at most three, in mutual connection by the pseudopodia. The whitish nucleolated nucleus and very obscure vacuoles are there, as in the other form, whilst occasionally one can see subdivided individuals. Though having so little to communicate on this form beyond the record of its existence, and offering the accompanying effort to convey an idea of its aspect, leaving out of view any attempt to show the thick, sometimes semiopaque and striated,[1] mucus in which it nidulates, I feel quite inclined to believe it will turn out to be in reality specifically distinct.

Plagiophrys sacciformis, Hertwig et Lesser[2] (Pl. VIII, fig. 11).

considerably resembles in figure *Pl. cylindrica*, Clap. et Lachm. Like that species it is irregularly cylindrical, attenuated towards the end, the membranous test irregularly wrinkled and capable of certain slight alterations of figure. As in other forms the body-mass completely fills the test, and

[1] This *striated* appearance of the mucus is due to certain radially but irregularly arranged, if I might so say, *tubular* passages therein, in which lie little more or less elongate Bacilli, or at least short bacillar filaments of "Oscillatoriaceous" nature, when detached by pressure or otherwise, endowed with a spontaneous backwards and forwards *tottering* kind of movement, as mentioned by me in the 'Dublin Microsc. Club Minutes.' Many Desmids and other Algæ besides the two above mentioned are prone to harbour these Bacterian (?) organisms which can sometimes be seen moving up and down inside the tubular passage through the mucus, to and from the body of the alga, and, as has been said, may sometimes ultimately make their way off altogether from beyond the periphery of the mucous envelope. I am not aware whether or not this curious phenomenon has been noticed by other observers.

[2] Loc. cit., p. 114, t. III, f. 3.

consists of a more or less richly granular protoplasm. The authors never noticed any vacuoles, but could readily discern the nucleus, which always appeared, on application of acetic acid, to be homogeneous and a nucleolus could not be perceived.

The pseudopodia are mostly few and homogeneous. In these characters they differ from Claparède's *Pl. cylindrica*, where they are very numerous, and granuliferous. In the present form they are rather quickly projected and withdrawn. The authors give the dimensions as follows: Length, 0·035 mm., breadth at middle, 0·025 mm.; thus considerably smaller than *Plag. cylindrica*.

Plagiophrys scutiformis, Hertwig et Lesser[1] (Pl. VIII, fig. 10),

is distinguished from the preceding by its peculiar shield-shaped figure, owing to its being so strongly compressed; otherwise as to body-structure, pseudopodia, nucleus, this agrees with the preceding. Its dimensions are greater. Length, 0·06 mm., breadth, 0·04 mm.

I must myself quite agree with the authors in holding this in itself as a distinct species from the foregoing and others.

I perceive by a note appended at the end of their work that the authors do not regard the form I recorded as occurring in this country and referred to *Plagiophrys spherica*, Clap. et Lachm., as truly identical therewith, but as probably the same species as their *Pl. sacciformis*, though they quite agree in my interpretation of its general structure. No doubt our form comes very near *Pl. sacciformis*, nor have I, as little as these authors, as yet been able to recognise in our form the presence of any contracted vacuoles. But the action of such may sometimes be so slow and their size so minute, whilst even their existence may be obscured by the density of the surrounding granular plasma, that their presence or absence is often very difficult of determination. Claparède's and Lachmann's figure is so insufficient, and their description so brief and vague, that the absolute determination of what their species actually may be is sufficiently difficult.

I am glad they too agree with my conjecture that the second form[1] which I drew attention to, and have tried to represent on the same plate, is a distinct species. Having already at large adverted to it, I may only here avail myself

[1] Loc. cit., p. 115, t. III, f. 2.

[2] 'Quarterly Journal of Micr. Sci.,' vol. XI, p. 146. 'Proc. Royal Irish Academy,' ser. ii, vol. i.

of sufficient space to name it *Plagiophrys Hertwigianua*, a liberty taken with the name of that distinguished observer of which I hope he may approve; in which case, indeed, I shall feel that I am greatly more honoured than honouring.

An Account *of* Professor Strasburger's Observations *on* Protoplasm. By Sydney H. Vines, B.A., B.Sc., Fellow and Lecturer of Christ's College, Cambridge.[1] (With Plate IX.)

In spite of the numerous researches which have been undertaken of late years in order to gain some knowledge of the properties and intimate structure of that substance which, from its universal occurrence in living organisms, has been termed the "physical basis of life," and to which Hugo von Mohl gave the name "Protoplasm," our information is still quite insufficient to enable us to form any satisfactory hypothesis upon which the so-called vital phenomena exhibited by this substance might be explained. In these "studies" Professor Strasburger gives some account of his observations in this direction.

Pringsheim,[2] in his work upon the vegetable cell, first described the protoplasm as consisting of two layers,—an external hyaline layer in contact with the cell-wall, and an internal granular layer in contact with the cell-sap, though a lamination of the "primordial utricle" had been previously mentioned by Braun, Göppert, Cohn, and von Mohl. In his former work[3] Strasburger has described a similar differentiation as occurring in cells which are entirely filled with protoplasm. Under these circumstances he suggests that instead of Pringsheim's terms "Hautschicht" (cortical layer), and "Körnerschicht" (granular layer), the terms "Hautplasma" and "Körnerplasma" should be used, of which the nearest English equivalents are perhaps "ectoplasm" and "endoplasm."

A differentiation of the same kind has been found to exist in the protoplasm of cells which do not possess a cell wall. Sachs found the zoogonidia of Vaucheria to consist of a central mass of protoplasm, in which the numerous chlorophyll-grains are imbedded, invested by a layer of hyaline proto-

[1] 'Studien ueber Protoplasma,' Jena, 1876.
[2] 'Pflanzenzelle,' p. 4. 1854.
[3] 'Zellbildung und Zellheilung,' 2 ed. P. 280.

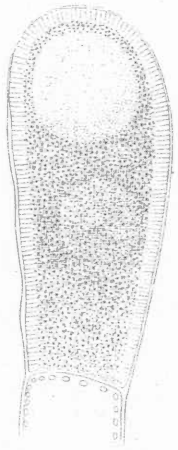


Fig. 1.

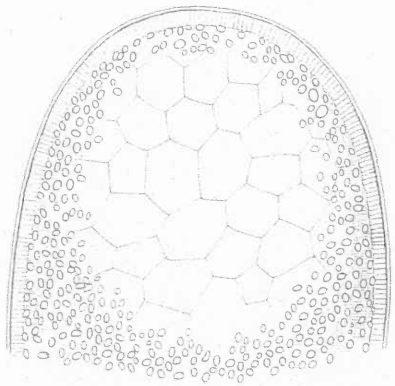


Fig. 2.

Fig. 4.

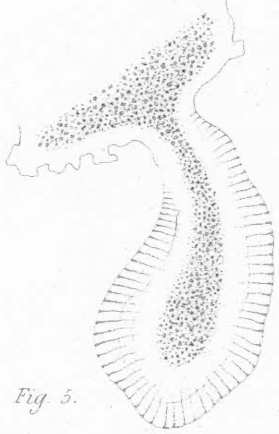


Fig. 5.

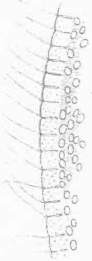


Fig. 3.

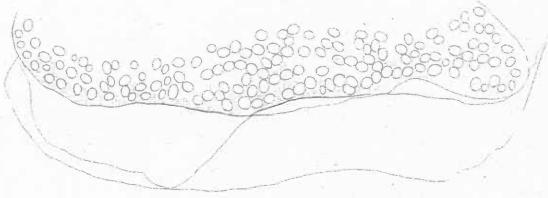
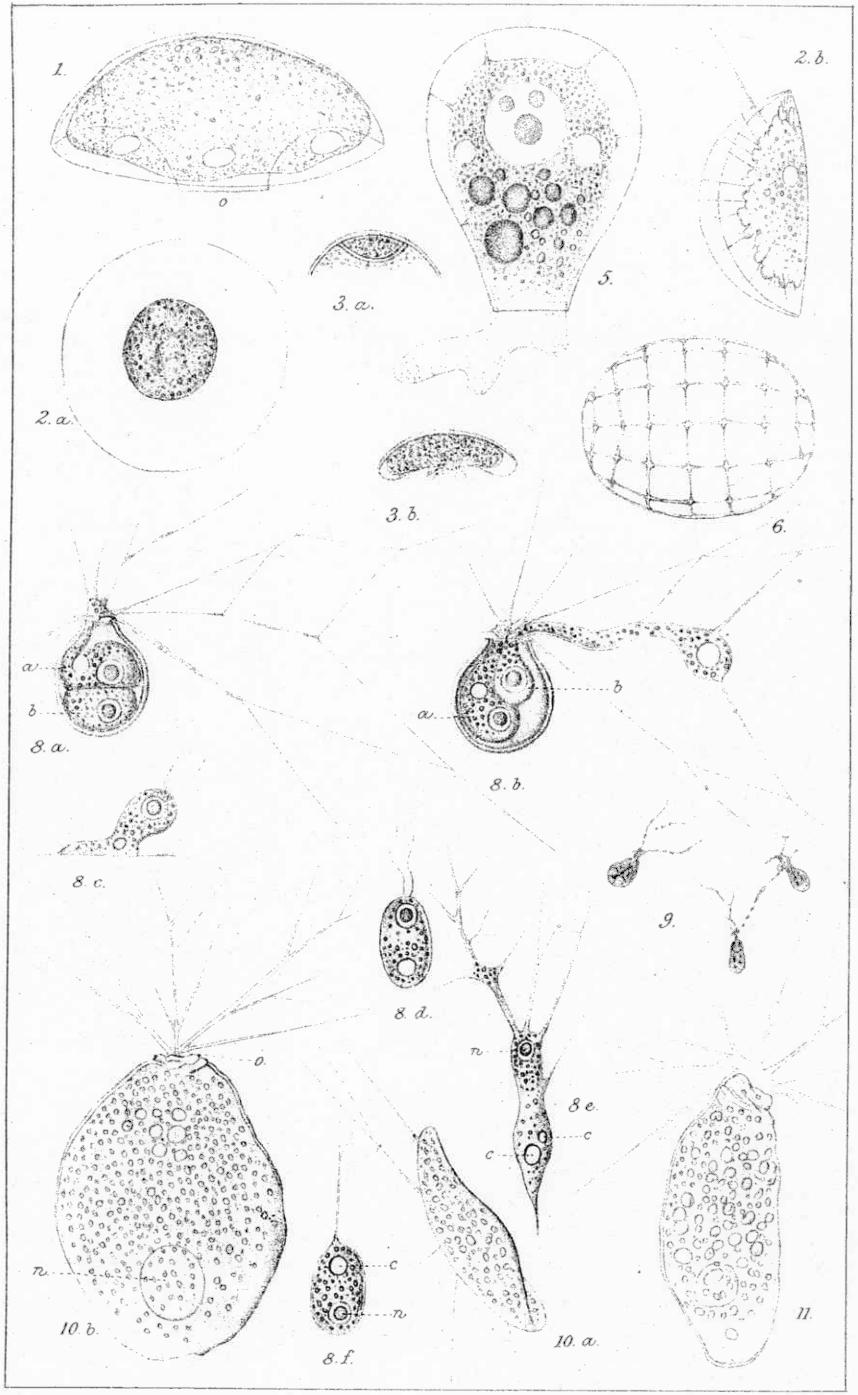


Fig. 6.



F. Huth, Lith^r Edin^r

EXPLANATION OF PLATE VIII,

Illustrating Mr. Archer's Résumé of Recent Contributions to our Knowledge of "Freshwater Rhizopoda."

FIG. 1.—*Pseudochlamys patella*, seen from the side, the delicate membrane forming the oral portion of the test is seen prominent below (*o*). (After Hertwig and Lesser, drawn under "Zeiss. F. Oc. III.")

FIG. 2*a*.—*Pseudochlamys patella*, without processes of attachment or pseudopodia, perfectly at rest, flatly expanded (after F. E. Schulze). × 400. 2*b*. The same, the test folded together, distinct processes of attachment and a single long finger-like pseudopodium (after F. E. Schulze). × 500.

FIG. 3*a*.—"Encysted" state of *Pseudochlamys patella* (seen laterally). × 400. 3*b*. Showing an infolded condition of the lower (oral) portion of the test. × 400. (From Irish specimens.)

FIG. 5.—*Hyalosphenia lata*, F. E. Schulze, viewed from the broad aspect, with a somewhat divided finger-like pseudopodium.

FIG. 6.—Posterior view of *Quadrula symmetrica*.

FIG. 8.—*a*. Development of the zoospores in *Microgromia socialis*, a single individual of the colony transversely dividing into two portions; *a*, the persistent anterior portion; *b*, the posterior portion, which subsequently forms the zoospore; 8*b*, representing the posterior portion, *b*, during its exit; 8*c*, its modification into a zoospore; 8*d*, the zoospore (formed from the portion *b* of fig. 8*a*); 8*e*, the young individual after leaving the mother-colony—at the anterior end the nucleus, *n*—at the posterior the contractile vacuoles, *c*, *c*; 8*f*, the young individual come to rest, the end possessing the contractile vacuole still forms the anterior portion and sends out a protoplasmic process corresponding to the pseudopodial stem.

FIG. 9.—*Microgromia mucicola*, Archer, n. s., three individuals; two show a mutually inosculated pseudopodinm.

FIG. 10.—*a*. *Plagiophrys scutiformis*, Hertw. et Less., *n*, nucleus, *o*, pseudopodial opening; the example is seen from its broader aspect; a formation of vacuoles is seen in the protoplasm, regarded as indicative of impending death; 10*b*, the same seen from the aboral pole.

FIG. 11.—*Plagiophrys sacciformis*, Hertw. et Less., the end possessing the pseudopodial opening contracted in a necklike manner by the infolding of the membranous test.