

On some New and Little-known British Freshwater Rhizopoda.
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HOPKINSON, F.L.S.)

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(PLATE 26.)

IN my investigation of the Rhizopodous fauna of this country I have met with numerous forms, chiefly in the lowland districts of Cheshire, and in Epping Forest, Essex, which do not appear to have been yet recorded as British, and some which are new to science. Mid-Cheshire contains low-lying areas of bog or morass, the home of many rare plants, both phanerogamic and cryptogamic. These places are always richest in Rhizopoda. Testaceous forms occur in considerable abundance, in wet *Sphagnum*, and amongst the rootlets of such mosses as *Philonotis fontana* and *Aulacomnium palustre*, the conditions favourable to their development being for the most part constant. The genera represented are *Diffugia*, *Nebela*, *Hyalosphenia*, *Heleopera*, *Quadrula*, and others of the lobose type, whilst the Euglyphina occur also in great variety and perfection. Most remarkable, perhaps, are some naked reticularian Rhizopods, of which one is described herein under the generic name *Penardia*. A second, and closely allied form, may be referable to the same genus, but its place cannot be determined without further study.

Mid-Cheshire is remarkable for the number of old marl-pits which are thickly scattered over extensive districts. These harbour rhizopodous life in great variety. *Pseudochlamys patella*, *Microgromia socialis*, *Vampyrellæ*, and numerous forms of *Amœba*, besides various species of *Acanthocistis* and other Heliozoa, luxuriate amongst the surface-vegetation; whilst the ooze abounds in *Pelomyxa palustris* and *P. villosa*, associated in two or three localities with *Mastigamœba aspera*, E. Schulze, and a variety of testaceous forms, such as *Arcella* and *Centropyxis*. One of the most remarkable species met with in the summer of 1903 was the *Amœba* described under the name of *A. pilosa*, sp. nov. *Diffugiella apiculata*, gen. et sp. nov., is the type of another proposed new genus, of which the pseudopodia are a distinguishing feature. This and a new species of *Vampyrella* were from the same locality, near Barking, Essex.

With regard to the distribution of the Rhizopoda generally, no definite law seems to prevail. Species inhabiting our own bogs and pools are common alike to Arctic and Temperate regions. Forms of *Leoguereusia* recorded from such widely separated localities as the Rocky Mountains and New South Wales do not vary in any essential feature from British examples. Neither climate nor altitude seems to affect them. The Rhizopodous fauna of the Eastern and Western Hemispheres is practically identical.

Few, if any, species can be said specially to affect alpine situations. The only ones, in my own experience, less common in lowland than in alpine districts are *Ditrema flavum*, Arch. (= *Amphitrema flava*, Penard*), and *Amphitrema stenostoma*, Nüsselin† (*A. Wrighteanum*, Arch., in part.). These scarce forms were met with on Cader Idris. Archer, however, discovered them in different localities in Ireland, which can hardly be described as alpine or sub-alpine.

Professor G. S. West, in his interesting record of the plankton of the Scottish lochs, mentions a number of species occurring in deep water. Most of them (*Clathrulina*, of course, being an exception) are denizens of *Sphagnum* bogs. The open waters of a lake can hardly be considered their natural home. It is quite conceivable, however, that they may have been washed out of the *Sphagnum* and other mosses growing on the banks, or conveyed by currents from the shallow waters of the lake-margins.

Some observations on new and little-known forms of Heliozoa must form the subject of another paper.

Class RHIZOPODA.

Order AMŒBINA.

Family LOBOSA.

Genus AMŒBA, Ehrenberg.

AMŒBA PILOSA, sp. nov. (Pl. 26. fig. 8.)

Animal resembling an average-sized *A. villosa*, with the same pale-bluish or neutral-tinted finely granular endoplasm, and containing, as in that species, a variety of food-corpuscles, mostly

* 'Faune Rhizopodique du Bassin du Léman,' 1902, p. 538.

† Zeitschr. für wiss. Zool., Bd. xl.

green, together with refringent yellowish or brownish oil-like globules. Nucleus pale, situated in the anterior region; contractile vesicles one or more.

The posterior extremity is produced into a delicately fringed expansion of faintly granular ectoplasm, in which are usually one or two clear vacuoles, the external outline being irregular and occasionally lobate. Including this posterior expansion, the entire body of the animal is closely beset with rigid hair-like processes, or spicula, radiating outwards, and resembling those which clothe the membranous test of *Cochliopodium vestitum*. This latter character distinguishes *A. pilosa* from all other forms of *Amæba*. Locomotion is effected by lobular expansions of the ectoplasm, anterior or lateral. As in *A. proteus* or *A. villosa*, the pseudopodia may originate at any point on the body-surface, but have never been observed to become digitate.

Dimensions: length about 180μ ; average breadth 50μ .

In ponds at Chelford, Cheshire, amongst the matted foliage of *Utricularia* and a species of water *Ranunculus*; also at Fearnhead, Lancashire, in similar situations, 1903.

It is difficult to explain either the origin of the spicula which invest the body of this *Amæba*, or their mode of attachment to the soft protoplasmic surface over which they are very evenly, and at the same time thickly, distributed. Immediately a pseudopodal lobe is formed, the cil-like processes flow over it from the surrounding surface.

This organism was usually found associated with *Mastigamæba aspera*, E. Schulze. The Fearnhead examples presented some differences of habit, though agreeing in the pilose character. They were probably older individuals. The spicula were usually stouter and darker in colour; the endoplasm was denser; the posterior appendage was absent, and the animal was more sluggish in its movements.

GENUS MASTIGAMÆBA, *Eil. Schulze*.

MASTIGAMÆBA ASPERA, *E. Schulze*, Archiv für mikr. Anat. Bd. xi. p. 588, t. xxxv. ff. 1-3. (Pl. 26. figs. 3, 4.)

In various localities in Cheshire and Lancashire; Chelford, Northen Etchell's, Fearnhead, 1903.

Dimensions: length, when fully grown, $150-250\mu$; greatest breadth 100μ .

The facial aspect of *Mastigamæba aspera* is totally different

from that of *Amœba proteus* or *A. villosa*. It attracts attention at once by its strikingly refringent ectoplasm. Besides this distinctive feature the organism is remarkable for the possession of an anterior flagellum, 0·06 to 0·08 mm. long, according to Hertwig and Lesser, which these authors rightly describe as "a very fine filament of equable but hardly definable character, and considerable refractive power." It is "not diminished at the apex, but ends as if abruptly cut off." In all the Cheshire examples met with this organ was so transparent and so fine as to be with difficulty distinguished; in some it was imperceptible; but in every case, where seen, it was in a constant state of activity, so much so that it was impossible to bring it into focus at once throughout its whole length. The organ was not used for purposes of locomotion. The movements of the animal are truly amœboid; although very young and small examples were seen to effect a slight jerky movement from side to side.

Usually two contractile vacuoles may be seen embedded in the densely granular endoplasm, in the posterior region—one on each side of the body. The entire body-surface has the remarkable peculiarity, in adult individuals, of being covered, more or less, with a thin stratum of extremely minute bacilliform bodies, probably siliceous, and secreted during growth. Sometimes these are hardly perceptible, and in young individuals they are either absent or few in number.

The body of *Mastigamœba aspera* often assumes an irregularly spherical or elliptical shape, with radiating pseudopodia of variable length, in which condition the animal presents a totally different appearance from that of the same individual *en marche*. It then closely resembles the figures of *Dactylosphærium vitreum*. The resemblance, indeed (aided by the refringent character of the protoplasm), is so striking, that one can hardly avoid the conclusion, as was long ago suspected, that the two are phases of the same organism. In what may, for convenience, be called the *D. vitreum* phase, *Mastigamœba aspera* never exhibits a flagellum. An individual is figured (fig. 4) in which, though here concealed, this organ was distinctly visible so long as the animal was in its normal condition—that is to say, *en marche*. Frequently small and apparently young examples are met with which preserve the *D. vitreum* form, and exhibit only superficial changes, for considerable periods. In recovering from this condition the

animal thrusts out, first, the frontal lobe, with its flagellum, which is followed immediately by thin transparent pseudopodia, two or more on either side. These anterior pseudopodia are more mobile, as a rule, than the lateral ones, and are likewise more pellucid, because less thickly covered with bacilliform spicula.

Some Northern Etchells examples, examined last year, presented a remarkable variation from the type. This variation may or may not be permanent. Should such differences as were noted prove, on further examination, to be persistent, they may justify the constitution of this form into a new species (*M. cestriensis*, MS.). The animals were smaller and more slender, and their anterior pseudopodia were narrower and more elongated, than those from Chelford. But the chief point of difference lay in the possession of a posterior appendage, comparable to that of *Amœba villosa*, though of different structure. It took the form of a circular expansion of ectoplasm, finely granular in substance and more or less transparent, containing usually two or more small non-pulsating vacuoles, and beset with conical or acute, radiating, and persistent pseudopodia. A few minute spicula could sometimes be detected about the surface of the appendages, whilst they were absent from other parts of the body, or few and scattered. The nuclear mass, always occupying an anterior position, and often partially hidden by the densely granular protoplasm, was more angular in outline than in other examples; and the flagellum was almost invariably active, seeming to perform the function of a tentacle. A wider band of comparatively clear ectoplasm was also noted.

FAMILY RETICULOSA.

Genus GYMNOPHREYS, *Oienkowsky*.

GYMNOPHREYS COMETA, *Oienkowsky*, Archiv für mikr. Anat. xii. (1876) p. 31, t. 5. f. 25; *Blochmann*, Die mikros. Thierwelt des Süßwass. (1895) p. 14, t. i. f. 9.

Examples of this apparently very rare organism occurred in *Sphagnum* from Lindow Common, Cheshire, in 1903. They presented some variation from the published figures, but not of such a character as to admit of doubts as to their identity. The body was more spherical than oval—often with projections from the surface-outline; and whilst the longer pseudopodia emanated from opposite poles, sometimes a few shorter lateral

ones were formed. The pseudopodal filaments were extremely fine, extended into the surrounding medium to distances often five or six times the diameter of the body, and anastomosed sparingly. The protoplasm of the body-mass and pseudopodia was colourless, or pale and faintly granular. Some of the finer filaments—usually simple ones—were exceedingly mobile.

The organism has since been met with more abundantly elsewhere.

Genus *PENARDIA*, gen. nov.

Body when at rest roundish or ovoid; at other times expanded and, during progression, exceedingly mobile; the endoplasm a deep chlorophyllous green, with a marginal band of ectoplasm; the pseudopodal filaments slender, branching and anastomosing, ultimately forming a widely-spreading network. The ectoplasm greyish, granular; the finer filaments faintly granular, colourless. Nucleus inconspicuous or absent; contractile vesicles (one or more) usually near the periphery of the endoplasm.

PENARDIA MUTABILIS, sp. nov. (Pl. 26. figs. 1, 2.)

Body when at rest roughly ovoid, with almost inert branching and anastomosing pseudopodia projected from the surface; the central mass opaque or semiopaque, without definite structure. When *en marche* the animal becomes exceedingly mobile, expanding, elongating, and contracting incessantly, and throwing out a widely-extending network of pseudopodia which are used for the capture of prey.

In this mobile state the body is flattened out and becomes transparent, exhibiting a central mass (having a well-defined general outline) of a bright green colour, consisting apparently of a great number of minute oval bodies, closely compacted, but, so far as is known, without a nucleus. The hyaline ectoplasm is of varying width and is but slightly granular, changing with the pseudopodal movements.

Dimensions: length of body, irrespective of pseudopodia, 130 to 200 μ , or more; breadth variable. Diameter when at rest averaging 80 μ .

Amongst *Sphagnum* in a small swamp in Epping Forest, on the right of the road leading to Copped Hall Lodge, from the Epping highway, associated with colonies of *Microgromia socialis* and with *Pompholyxophrys punicea*, Arch., &c., 1901.

The animal did not occur abundantly in the locality mentioned,

but all the individuals met with had the features described sufficiently well-marked. One was observed to be feeding on a species of rotifer, which was very plentiful in the same gathering. During the inception of one of these the body of the *Penardia* underwent considerable changes; it became congested and opaque, and the unoccupied pseudopodia, where not withdrawn into the general mass, were comparatively inert. After feeding, the animal would remain stationary, or with very little movement, usually for a considerable time.

Order VAMPYRELLIDA.

Genus VAMPYRELLA, *Cienkowski*.

VAMPYRELLA FLABELLATA, sp. nov. (Pl. 26. figs. 5, 6.)

Plasmodium very mobile, most frequently appearing as an ovoid or double convex elongated body, narrowed at the extremities, each extremity furnished with short pseudopodal filaments, mostly capitate. A few fine, elongated, straight (but inconstant) pseudopodia are sometimes projected from the body-surface. Not unfrequently the entire organism becomes remarkably elongated, as though a tapering pseudopodium had been thrust out from one side (fig. 6). This is induced by the adhesion of the plasma to some foreign object, whilst the animal continues its forward movement, the effect being to draw it out to a fine point, the frontal outline meanwhile becoming fan-shaped and fringed with short capitate rays, with which a few longer and finer non-capitate filaments are intermixed. In all the examples met with the body was pale, with little or none of the reddish colour characteristic of the *Vampyrellæ*.

Dimensions: length of the ovoid body 60–70 μ ; average breadth about 20 μ . Length when elongated, from the convex frontal margin to the pointed extremity, 100 μ or over.

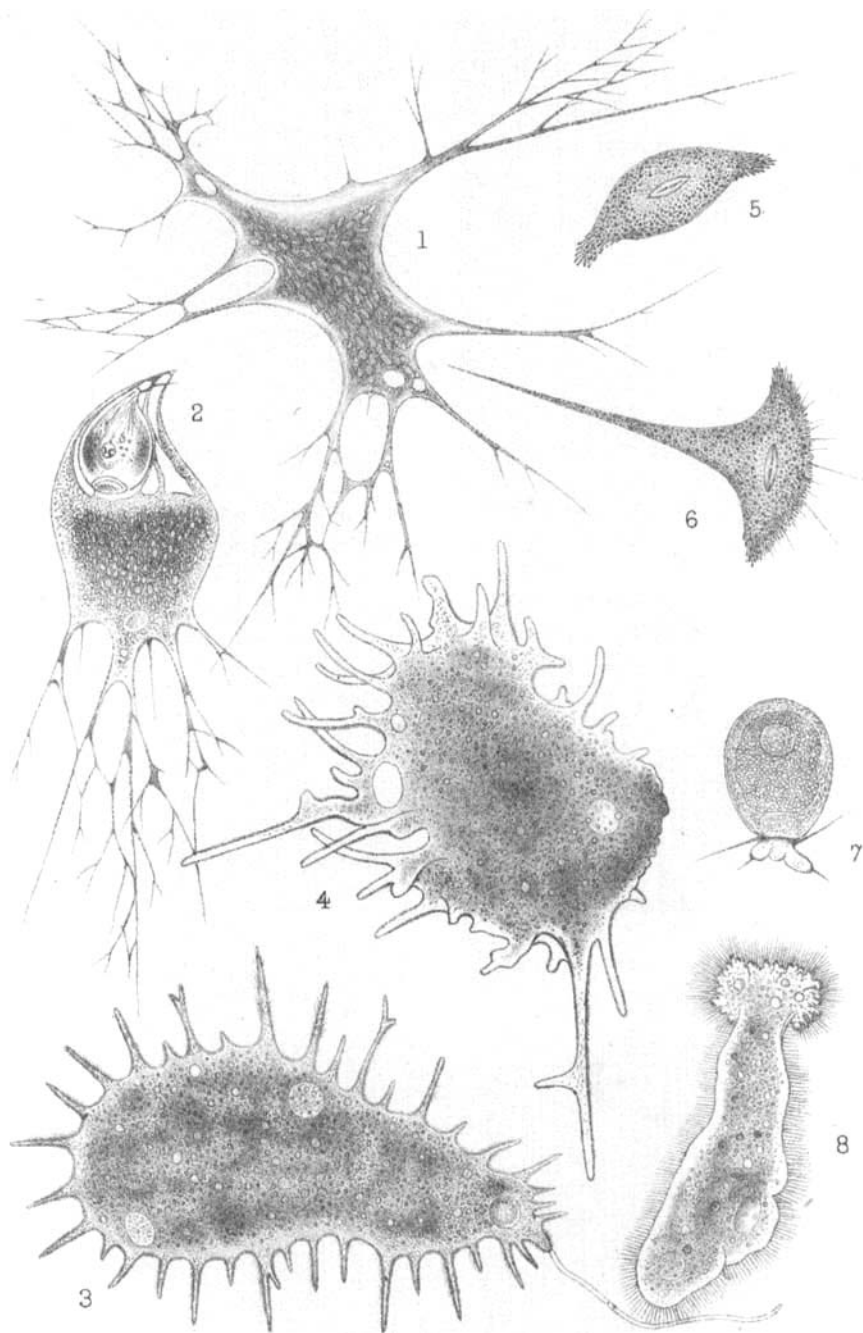
In a broad and sluggish stream crossed by the Barking and Purfleet highway, about a mile from Barking, Essex, associated with *Diffugiella*, &c., amongst surface-vegetation: Aug. 1901.

Order CONCHULINA.

Family ARCELLIDA.

Genus DIFFUGIELLA, gen. nov.

Test ovoid; in transverse section circular, composed of chitinous transparent membrane; the body-protoplasm usually



J. Cash del.
A. R. Hammond lith.

West, Newman imp.

BRITISH FRESHWATER RHIZOPODA.

colourless, finely granular; pseudopodia of two kinds—one lobular or digitate, protruding centrally from the mouth of the test, and terminated by a short pointed apiculus; the others (two or more) projected laterally, straight, thin, and tapering.

DIFFLUGIELLA APICULATA, sp. nov. (Pl. 26. fig. 7.)

Test ovoid in lateral view, membranous, smooth; the sides curving evenly from the crown downwards to the mouth. Endoplasm granular, colourless, or with a faint greenish tinge. The nucleus inconspicuous.

Dimensions: length of test $40\ \mu$; greatest breadth $30\ \mu$.

Amongst vegetation, chiefly floating algæ, in the stream above referred to, near Barking, Essex, May 1901.

The abnormal structure of the pseudopodia in this organism is its distinguishing feature. Individuals were kept under observation for a considerable time, and in all cases presented the same characters, showing conclusively that they were not accidental. The form of the mouth could not be made out, the membrane about it being apparently thin and flexible. The central digitate pseudopodia were always more or less active (the apiculus particularly so), whilst the lateral more elongated and acicular ones were comparatively rigid and changed but little.

EXPLANATION OF PLATE 26.

Figs. 1 & 2. *Penardia mutabilis*, gen. et sp. nov. 1, an active individual; 2, the same, after capturing a small rotifer. From Epping Forest. About $\times 350$.

3 & 4. *Mastigamæba aspera*, E. Schulze. 3, an active adult individual, showing the flagellum; 4, another individual—temporary phase—in which the flagellum, though distinctly seen when the animal was active, is concealed. From separate localities in Lancashire and Cheshire. $\times 350$.

5 & 6. *Vampyrella flabellata*, sp. nov. Characteristic phases of a single individual, when active. From Barking, Essex. $\times 500$.

Fig. 7. *Diffugiella apiculata*, gen. et sp. nov. From Barking, Essex. $\times 500$.

8. *Amæba pilosa*, sp. nov. From Chelford, Cheshire. $\times 350$.