

Observations on some New and Little-known British Rhizopods.

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(PLATE 9.)

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DURING the examination of Rhizopod material collected from different localities in England and Scotland during the past few years, several interesting species have been obtained which I believe have not received previous notice as occurring in this country, and it seems desirable to put them on record. Some of these species are quite common in certain localities, while others, again, are apparently particularly rare, and do not seem to have been observed since they were originally described some years ago. Others, again, though repeatedly observed by their original discoverer, have not been met with by other naturalists. Further and more extended systematic work in this country will probably show that these last are more common than we at present believe.

COCHLIOPODIUM GRANULATUM, Penard. (Plate 9. figs. 1 & 2.)

Penard, 'Faune rhizopodique' &c. p. 194.

In a collection of sediment containing *Amæbæ*, *Pamphagus*, &c., considerable numbers of this fine Rhizopod occurred. They were of large size, up to 80 or 100 μ , and in an active state. When disturbed the protoplasmic body is retracted and completely enclosed within the flexible test. In the active state a large mass of protoplasm flows out from the test, forming a broad expansion and giving off numerous pseudopodia. In this state the body plasma shows two distinct regions.

The included posterior part is greyish and granular, enclosing a distinctly-seen nucleus, which contains one or more "nucleoli," and in the largest specimens many "nucleoli." Diatoms, green Algæ, and other food-bodies are enclosed in large numbers.

The extruded portion is relatively large in bulk. It is clear and hyaline, much vacuolated, and contains a great number of minute, oval, highly refractive bodies in very active movement. These occur in smaller numbers within the inner protoplasm, where they seem to be less active. Vacuolisation is sometimes so marked that the boundaries between the vacuoles are only rendered visible by the presence of these bodies.

The pseudopodia are numerous and hyaline, often branched, and in most cases obtuse. The protoplasm also exhibits wave-like outbursts. The test is flexible, deformable, and in the active animal in the form of a hemispherical

dome, with upturned margin. The margin is more flexible than the rest of the test and presents an irregular rim, generally outwardly and upwardly curved. In the retracted animal the "mouth" becomes completely closed.

The test exhibits a double contour with cross-striations. Under high powers, in surface view it shows numerous dots of different sizes, which take up stains (kresyl-blau and neutral-red), while the rest of the test remains unstained. In optical section the cross-striations are seen to correspond with the surface dots, which are, in fact, the ends of the cylindrical or rather double-cone-shaped structures of dense nature traversing a less dense non-staining matrix (Pl. 9. fig. 1 a).

Many young minute individuals were observed, identical with the large forms except that the nucleus contained one central chromatin body surrounded by a clear zone.

NEBELA BARBATA, Leidy. (Plate 9. figs. 3 & 4.)

Leidy, in Proc. Acad. Nat. Sci. Philad. 1876, p. 119.

Leidy, 'Freshw. Rhizop. N. America,' 1879, p. 159.

West, G. S., Journ. Linn. Soc., Zool. xxviii. (1901) p. 323.

Compare Cash, 'Brit. Rhizop. and Heliozoa,' vol. ii. 1909, p. 113.

Leidy first described this species from examples taken from sphagnum in N. America, and although it possesses very definite characters, it has since frequently been confused with other species, and it is probable that very few naturalists have really seen it.

Dr. Penard, in 'Faune Rhizop.' p. 363, regarding the "cilia" or spicules of Leidy's description as probably parasitic growths, considers *N. barbata* as identical with Taránek's *N. americana* and discards Leidy's name as less suitable. Cash again (p. 113), both in his description and figures (pl. 27. figs. 5 & 6), confuses *N. barbata* with quite another form, which probably is to be identified with *N. tubulata*, Brown, but he gives also, as a text-figure, a drawing by West, which correctly shows *N. barbata*, taken in Llyn Llydaw, N. Wales. *N. barbata* has been found by the present writer in considerable numbers in Blea Tarn, Westmorland, a small tarn receiving drainage from sphagnum; and the individuals quite conform to Leidy's description.

N. barbata has a slightly compressed, flask-shaped test, with a cylindrical neck expanding very slightly at the mouth. This latter is oval, often with an irregular margin, and never possessing thickened lips or lateral notches. The test is transparent and generally covered with circular discs, sometimes slightly overlapping each other, with occasionally a few irregular flakes or sand-grains. The fine needle-like spicules are rigid and sharp-pointed, about 12 μ long, and project from between the plates. They occur scattered in large numbers on all sides of the test (*i. e.* they are not restricted to the lateral margins, as in many species of Rhizopod). These cils bear no

relation whatever to parasitic fungi, and can in no way compare with those shown in Penard's figure ('Faune rhizopod.' p. 356) and which are described as "short obtuse hyaline needles." The protoplasm is like that of *Nebelas* generally. Within the fundus it is crowded with yellowish food-bodies and diatom frustules, while within the neck a comparatively narrow band of clear protoplasm passes to the mouth, where it expands to the full width of the neck, and generally gives rise to one or two pseudopodia.

Size: length of test $100\ \mu$; breadth $44\ \mu$; width of neck $14\ \mu$; length of cils about $12\ \mu$.

NEBELA TUBULATA, *Brown*.

Nebela militaris, var. *tubulata*, Brown, in Journ. Linn. Soc., Zool. xxx. (1910) p. 365, pl. 50. figs. 9 & 10.

From the examination of individuals found in the English Lake District, this form was previously described as a variety of *N. militaris*, Penard. Since that time I have had opportunities of examining many specimens from different localities, including Stanage (Derbyshire), Duddon Valley (Lancashire), Scawfell and Helvellyn (Cumberland), Ben Ledi (Perthshire), Glen Shee (Perthshire), Stranraer (Wigtownshire)*. The characters are always quite distinctive and the animal shows little tendency to variation, and no transitional forms connecting it with *N. militaris* are met with. I therefore now regard it as an independent species.

In Cash's monograph, vol. ii. pl. 27. figs. 5 & 6 are named and described as *N. barbata*, Leidy. This is obviously an error, and the figures probably are to be identified as referring to *N. tubulata* (see remarks under *N. barbata*, *supra*, p. 78).

NEBELA SCOTICA, sp. nov. (Plate 9. figs. 5-8.)

This Rhizopod was found in large numbers in sphagnum gathered from the middle slopes of Ben Ledi (Perthshire) in August 1910. The test is compressed, and in shape broadly pyriform, with rounded dome, which contracts abruptly into a short thick neck with lateral margins narrowing slightly to the borders of the mouth. In narrow view the dome is rounded, and the sides slope gradually to the mouth with only very slight concavity. The mouth is broadly elliptical with an irregular margin and no lateral notches. The surface of the test is somewhat variable, and sometimes inclined to irregularity. It is covered with transparent, colourless scales, occasionally almost rounded, at other times irregular in shape, of very variable size, and sometimes distinctly overlapping, with smaller scales overlying the corners where three or four scales meet (Pl. 9. figs. 8 *a* & 8 *b*).

* For the distribution in Scotland of this and other species of Rhizopoda, see my paper in the Ann. Scot. Nat. Hist. 1911, pp. 226-232.

All the plates appear corroded and the corners rounded, and cannot be confused therefore with mere foreign grains. Their general appearance and arrangement suggest *N. dentistoma* and *N. vitrea*, from which, however, this species differs in other respects. The mouth-scales are frequently larger than the others, and by their shape give the irregular margin to the mouth-opening. The protoplasm is similar to that of *Nebela* generally. The individuals were frequently found encysted. The cysts were spherical and filled with granular matter. The mouth of the test was invariably closed by a laminated diaphragm, formed across the narrowed part of the test, while the mouth itself generally contained debris.

Size: length 78–82 μ ; breadth 57–59 μ ; thickness 40 μ ; mouth 18–19 μ .

Though this species is remotely like *N. collaris* in shape, it cannot be confused with it; the characters of the mouth and of the test are quite different. It appears more closely related to *N. dentistoma* or *N. vitrea*.

NEBELA BIGIBBOSA, *Penard*.

Penard, in Mém. Soc. phys. et hist. nat. Genève, 1890, p. 161; and Revue Suisse de Zool. 1905, p. 600, pl. 13. figs. 16–19; 'British Antarctic Expedition Reports,' vol. i. pt. vi. p. 240.

N. bigibbosa was originally described by Dr. Penard from material gathered at Wiesbaden. The same observer has more recently reported it from Valais, Spitzbergen, and from Vancouver and Victoria, but it never seems to have been found by other workers. The present writer has found it at High Lodore (Cumberland) and again in Glen Eagles (Perthshire), on both occasions amongst ground moss (not sphagnum). It is readily distinguished, not only by its general form but especially by the presence of two tube-like connections passing between the broad faces of the test. Active individuals were found on both occasions.

CAPSELLINA TIMIDA, sp. nov. (Plate 9. figs. 9–13.)

This species was first discovered amongst moss growing on walls at Ecclesall, Sheffield, in November 1909. Later it also occurred amongst damp moss taken from the outside of a water-trough, also at Ecclesall, in which situation it has repeatedly been found since. In May, 1910, it was found amongst moss gathered at High Lodore, Derwentwater (Cumberland).

The body is ovoid, with a slight narrowing towards the mouth end, and with regularly rounded posterior extremity. It is compressed, more or less, and in extreme cases to almost half its width. The body is covered with a perfectly smooth, clear, transparent membrane. So far as observed it does not undergo deformation, but it seems sufficiently flexible to allow of this. Even under high powers the test appears to be structureless. There is no second external envelope of foreign matter, as is the case with *C. bryorum*, Penard. The structure and characters of the mouth agree perfectly with

Penard's description of that species. In the broad view of the animal, it shows a straight line running at right angles to the end of the body, due to the tight compression of the two incurved lips. In partial side view, two curved lines crossing one another represent the edges of the lips, which in narrow view disappear; while an end view shows a straight line stretching nearly across the test. In most cases the mouth was closed tightly by compression of the lips (as may be inferred from the difficulty in getting stains to penetrate), but in one or two small individuals from High Lodore the lips were separated (see Pl. 9. fig. 12). Whether this is a natural state it is difficult to say.

The protoplasm fills the whole space within the test. It is colourless or greyish and contains many inclusions. Immediately within the membrane is a layer of brilliant droplets, of small size and highly refractive (oil). The general protoplasm contains many minute granules, together with larger food-bodies, including small green Algæ and even diatoms of considerable size. They show various stages of digestion and vary from yellowish to brownish. The size of the food-bodies observed demonstrates that the mouth is capable of considerable distension. In respect to the food-bodies this species differs very much from *C. bryorum*.

Several vacuoles occur. They originate in the protoplasm of the body and slowly move towards the mouth end, enlarging at the same time. Then somewhere in the neighbourhood of the mouth they disappear, but the process is not that of a sudden collapse, they seem to become lost gradually.

The nucleus is single, but not readily seen. It appears to contain a single spherical chromatin body, surrounded by a clear space. It is not of specially large size.

As is characteristic of most Rhizopods from the drier mosses, the animals seem remarkably shy under observation and rarely put out their pseudopodia. This may be due in large measure to the unnatural conditions under which they are examined. In the few cases when pseudopodia were seen, a small mass of clear protoplasm was noticed on the outer side of the test in the region of the mouth (which was not observed to be dilated), and from this a single fine filose pseudopodium originated, which by extension and contraction varied greatly in length. It was able to bend upon itself, and even swung round slowly as a whole. The movement of the animal is very similar to that of *Euglypha*, being of a somewhat jerky nature.

The animals have not been observed to divide. The process of division of *C. bryorum*, described by Penard, seems peculiar, in that the outer test is divided longitudinally at the same time as the inner body.

In some individuals the body protoplasm takes on a different appearance. It becomes broken up into numerous spherical bodies of about 3μ diameter, which completely fill the test. This condition may possibly be connected with reproduction. In collections kept for some time, the protoplasm

gradually retracted from the test, became more spherical in form, and the nucleus became more visible (Pl. 9. fig. 11). This may have been preparatory to encystment.

The size of the animal varies slightly. Large specimens (adults) generally were about $34\ \mu$ long, $27\ \mu$ wide, and $18\ \mu$ thick, but smaller individuals were common.

It is interesting to notice that this species was discovered and examined before the author received a copy of Penard's paper describing the only other known species of the genus.

EUGLYPHA BRYOPHILA, sp. nov. (Plate 9. figs. 14–15.)

At different times, amongst the drier mosses of woods, from districts as widely separated as Monsall Dale (Derbyshire), Port Patrick (Wigtownshire), Glen App (Ayrshire), and Kincardine O'Neil (Aberdeenshire), I have met with examples of a *Euglypha* which seems to me sufficiently characteristic to merit specific rank.

The test is very regular in form and subject to no marked variation. It is compressed and in broad view elongated oval, with rounded dome, and lateral margins gradually narrowing with even curvature to the borders of the mouth. In narrow view the dome is somewhat pointed and the lateral margins run in almost straight lines to the mouth. The outline is very even, and may compare with that of *E. levis*, Perty.

The mouth is almost circular and bordered by six plates, each having one blunt rounded central tooth, with a minute lateral tooth on each side, often very difficult to distinguish (Pl. 9. fig. 14a). The plates of the test are distinctly marked, are elliptical in shape, and arranged as in *E. alveolata*, but with some slight irregularity towards the mouth.

The crown of the test carries a cluster of four or five long, sharp, curved spines, of a nature similar to those found in *E. cristata*, Leidy.

The protoplasm is quite normal.

Size: length $50\ \mu$; breadth $23\text{--}25\ \mu$; thickness $16\text{--}17\ \mu$; mouth $9\ \mu$; spines about $16\ \mu$ or more.

I was at first inclined to regard this as a variety of *E. cristata*, Leidy, owing to the presence of the cluster of spines, but this is the only respect in which the two forms are similar. *E. cristata* is quite peculiar amongst *Euglyphæ* in being very slenderly built and having a distinctly tube-like uncompressed form, with a very characteristic arrangement and appearance of the plates of the test. In none of these characters does the present species resemble it. Further, it is very unlikely that a variety of a species normal to sphagnum, which occurs in dry moss, would be of more robust build.

Dr. Penard, in 'Mém. Soc. phys. et hist. nat. Genève,' 1890, pl. 9. figs. 91 & 92, figures two individuals as broad forms of *E. cristata* which

might be identified with *E. bryophila*, but he makes no reference to this form in his later works.

PLACOCYSTA JURASSICA, Penard. (Plate 9. figs. 16-18.)

Penard, in *Revue Suisse de Zool.* 1905, p. 611, figs. 29 & 30.

This species has not previously been reported from England*. It occurred in comparatively small numbers in sphagnum gathered near Harrop Tarn (Cumberland) in May 1910, and again in sphagnum obtained near Stranraer (Wigtownshire) in September 1910.

P. jurassica differs from the more common *P. spinosa*, Leidy, in its smaller size (72-76 μ), its greater breadth in proportion to its length, its less compressed form, and especially in the character of its spines. These are not restricted to the margins of the test as they are in *P. spinosa*, but are distributed over its whole surface, though less numerous towards the middle of the broad faces. In form they are not broad flattened blades, but are fine "cils" like those of many species of *Euglypha*. They arise from the test at the points of junction of three plates (Pl. 9. fig. 18). (Penard's figure shows some of the spines arising from the middle of the plates themselves. This I have never seen.) At such points the cementing material is thickened in the form of a raised ring, in the central depression of which the "cil" is implanted. These rings appear as dots under low magnification, but under the higher powers their real character is demonstrated. Each ring would represent "le coussinet chitineux," which Penard describes in *P. spinosa*. In places, two or three spines arise together and then two or three annular formations occur in juxtaposition. The plates are much less regularly arranged, and are comparatively smaller and more numerous, than in *P. spinosa*. None of the individuals found were active.

SPHENODERIA MACROLEPIS, Leidy. (Plate 9. fig. 19.)

Leidy, 'Freshwater Rhizopods of N. America,' 1879, p. 232 and text-fig.

So far as I have been able to discover, no records of this species occur since Leidy's time. It must be one of the rarest species of Rhizopod.

Several individuals occurred, however, in sphagnum gathered near Stranraer (Wigtownshire) on September 1910. They are quite characteristic and cannot be confused with any other species.

Leidy describes the test as compressed, with a broad neck gradually extending from the body and terminating in the oblique elliptical mouth. The broad faces are occupied mainly by a pair of large hexagonal plates, from which the neck extends below.

* I find that Mr. W. Evans, in his Presidential Address to the Roy. Phys. Soc., Edin. 1906 (published 1909), notes *P. jurassica* as found by Mr. J. Cash in sphagnum from the Pentland Hills.

This is, indeed, the superficial appearance. When, however, the plates are examined with great care, it is seen that they are not, in fact, hexagonal. They are, in reality, more or less strongly bent, elliptical plates, with long axis lying transversely, and the upper and lower edges forming almost straight lines. They are overlapped slightly by the very strongly bent oval lateral plates, which cover the margin of the test. The result is the appearance of hexagons.

The mouth margins are without covering plates and are very flexible, often becoming folded back during manipulation.

The test is much broader in proportion than that of *S. lenta*.

Size: length 27 μ , breadth 20 μ .

AMPHITREMA WRIGHTIANUM, *Archer*.

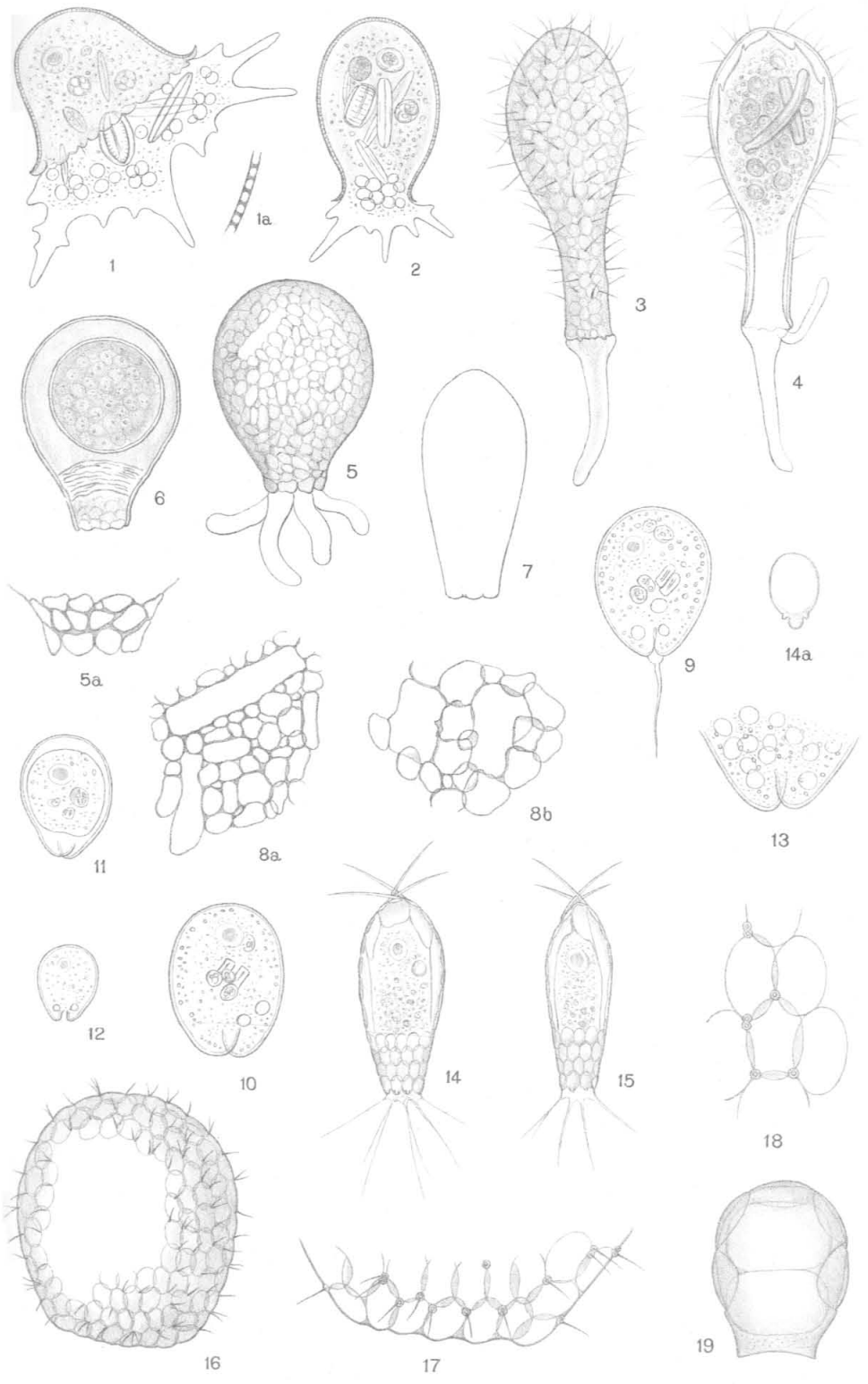
Archer, in Quart. Journ. Micro. Soc. n. s. ix. 1869.

Penard, 'Faune rhizopodique' &c. p. 539.

This species occurred in several collections of sphagnum made in Scotland in August and September 1910, *e. g.* Stranraer (Wigtownshire), Ben Ledi (Perthshire), generally associated with *A. stenostoma*, Nüsslin, which seems the commoner species. Dr. Penard found it abundantly in the Jura, but states that until that time it had never been met with since Archer first described it from Ireland. It does not, however, appear to be at all uncommon in Scotland.

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EXPLANATION OF PLATE 9.

- Figs. 1 & 2. *Cochliopodium granulatum*, Penard. $\times 300$. Fig. 1 shows the animal extended and fig. 2 shows it retracted almost within the test. Fig. 1 *a* is part of the test in optical section (more magnified).
- Figs. 3 & 4. *Nebela barbata*, Leidy. $\times 400$. Fig. 3 shows an individual in surface view and fig. 4 in optical section. Blea Tarn.
- Figs. 5–8. *Nebela scotica*, sp. nov. $\times 380$. Fig. 5 shows an active individual; fig. 6 an encysted animal in optical section; fig. 7 is the side view of an empty test in outline. Fig. 5 *a* is the mouth region of fig. 5, $\times 820$; figs. 8 *a* and 8 *b* are portions of the test of two individuals, $\times 820$. Ben Ledi.
- Figs. 9–13. *Capsellina timida*, sp. nov. $\times 640$. Fig. 9 is the side view of an active individual; fig. 10 is the semi-side view of the same; fig. 11 shows an individual (which had been kept for some time) contracting from the test; fig. 12 is a small specimen with open lips (from Lodore); fig. 13 is the mouth region of an individual with highly vacuolated protoplasm, $\times 1000$. All except fig. 12 from Ecclesall (Sheffield).
- Figs. 14–15. *Euglypha bryophila*, sp. nov. $\times 530$. Fig. 14 is the broad view and fig. 15 the narrow view of an active animal. Fig. 14 *a* shows the inner face of a “mouth scale.” Glen App.
- Figs. 16–18. *Placocysta jurassica*, Penard. Fig. 16 is an empty test, $\times 530$. Fig. 17 shows the mouth region, $\times 825$, and fig. 18 a portion of the test, $\times 825$. Near Harrop Tarn.
- Fig. 19. *Sphenoderia macrolepis*, Leidy. $\times 930$. Side view of an empty test. Stanraer.
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