

Observations on Freshwater Rhizopods, with some Remarks on their Classification. By G. S. WEST, M.A., F.L.S., Professor of Natural History at the Royal Agricultural College, Cirencester.

[Read 16th April, 1903.]

(PLATE 13.)

SINCE my first communication to the Linnean Society on the subject of freshwater Rhizopods, in 1901, I have had the opportunity of examining a considerable amount of material from some of the outlying districts of the British Isles, and several animals of this class have come under my notice concerning which I can find no previous mention. Two of these are undescribed species of the genus *Hyalosphenia*, one is a species of *Sphenoderia* with a prettily constructed shell, and another is a strange nude form referable to Cienkowski's genus *Nuclearia*.

Rhizopods are almost cosmopolitan in their distribution, and few animals exhibit a wider range of variation. In many cases it is almost impossible to define clearly their specific differences, and little attention has been given in the past to the study of the variation of the more abundant forms.

Altitude appears to have little effect on most species of Rhizopods, as they occur in abundance in suitable localities up to several thousands of feet above the sea-level. Leidy* has collected them at 10,000 ft. in the Uinta Mountains; and I have observed *Trinema enchelys* in collections from the Chilian Andes at 11,000 ft. There is apparently no restriction of special forms to alpine or subalpine situations†, although a few species, such as *Assulina seminulum* and *Heleopera petricola*, are most frequent in elevated districts, and a few others seem to have a preference for low-lying ponds and ditches.

In examining a large number of collections from the West of Scotland, it was noticed that Rhizopods were relatively less abundant in the Outer Hebrides than on the mainland of Sutherland and Inverness. As the collections numbered more than 500, and were fairly representative, this feature, although

* Leidy, Freshw. Rhiz. N. Amer. 1879, p. 13.

† This is also fairly evident from the lists of alpine and subalpine Rhizopods recorded from Sweden and Finland by Lagerheim. Cf. Geol. Fören. Förhandl. 1902, Bd. xxiii. Häft. 6, no. 209, pp. 471-472.

possibly quite accidental, is deserving of notice. The following species were observed from the Outer Hebrides :—

From Lewis :—*Nuclearia conspicua*, *Amœba proteus*, *Cochliopodium bilimbosum*, *Arcella vulgaris* and var. *gibbosa*, *Centropyxis aculeata*, *Diffugia constricta*, *D. pyriformis*, *D. acuminata*, *D. Solowetzskii*, *D. corona*, *D. globulosa*, *Nebela collaris*, *N. flabellulum*, *N. carinata*, *Heleopera petricola*, *Quadrula symmetrica*, *Euglypha alveolata*, *E. ciliata*, *Sphenoderia lenta*, *Assulina seminulum*, *Trinema enchelys*, *Cyphoderia ampullacea*.

From Harris :—*Vampyrella lateritia*, *Pelomyxa palustris*, *Amœba verrucosa*, *Dactylosphærium radiosum*, *Cochliopodium bilimbosum*, *Arcella vulgaris*, *A. discoides*, *Centropyxis aculeata*, *Diffugia pyriformis*, *D. globulosa*, *Nebela flabellulum*, *Quadrula symmetrica*, *Hyalosphenia platystoma*, *Euglypha alveolata*, *E. ciliata*, *E. cristata*, *Trinema enchelys*, *Pamphagus hyalinus*.

From North Uist :—*Dactylosphærium radiosum*, *Arcella vulgaris*, *Centropyxis aculeata*, *Diffugia pyriformis*, *D. acuminata*, *E. globulosa*, *Nebela collaris*, *Trinema enchelys*, *Euglypha ciliata*, *Quadrula symmetrica*.

From South Uist :—*Amœba verrucosa*, *Dactylosphærium radiosum*, *Arcella vulgaris* and var. *gibbosa*, *Centropyxis aculeata*, *Diffugia constricta*, *D. pyriformis*, *D. acuminata*, *Nebela collaris*, *Euglypha ciliata*, *Sphenoderia lenta*, *Trinema enchelys*.

From Benbecula :—*Amœba proteus*, *Arcella vulgaris*, *Diffugia globulosa*, *D. pyriformis*, *Euglypha alveolata*, *E. ciliata*, *Trinema enchelys*.

The two following species were collected on St. Mary's, Scilly Islands, and add to the distribution of British Rhizopods :—*Amœba verrucosa* and *Diffugia globulosa*.

The systematic position of *Vampyrella* and allied genera has long been a matter of considerable doubt. It seems clear that the two genera *Vampyrella* and *Nuclearia* are very closely allied, on account of their structure and the nature of their pseudopodia, even though the latter genus does not possess the curious red pigment found in the protoplasm of *Vampyrella*. It seems equally clear that they can hardly be retained in Lankester's 'Proteomyxa,' a group instituted to include a number of genera concerning which more information was required. The long pseudopodia of *Vampyrella* are straight, often radiating, and always considerably attenuated towards a fine apex; they are frequently branched, and the branching takes place almost

invariably near their broad bases. The same is true of Cienkowski's *Nuclearia*; but in several other genera which were included in the 'Proteomyxa,' such as *Protomyxa*, Haeckel, and *Biomyxa*, Leidy, the pseudopodia are anastomosing and often very irregular; they are bent and of variable width, exhibiting none of the rigidity shown by the straighter pseudopodia of *Vampyrella* or *Nuclearia*. The entire animals can be likened unto a *Gromia* without its shell, whereas such is not the case in *Vampyrella* or *Nuclearia*.

The nuclei of the different forms of Rhizopods are very similar and exhibit little variation in structure. The characters of the nucleus are to my mind of much less importance in these animals than might at first be imagined, and are of little classificatory value. It is difficult to see how such a uniformity of character as is exhibited by the nuclei of Rhizopods could be utilized as a basis of classification. The nucleus may also be absent in some species of a genus, although present in others (cf. *Cochliopodium minutum*).

Considering the foregoing facts, it appears advisable to remove the two genera *Vampyrella* and *Nuclearia* from the 'Proteomyxa,' chiefly on account of the nature of their pseudopodia, and place them in a separate order of the class Rhizopoda—the order 'Vampyrellida'*. By the establishment of this order the freshwater Rhizopods fall under four orders, which are characterized as follows:—

Order 1. Proteomyxa. Nude Rhizopods which in the amœboid condition possess an irregular mass of body-protoplasm, often reticulate, and anastomosing pseudopodia of considerable irregularity.

e. g. *Biomyxa*, Leidy; *Gymnophrys*, Cienk.

Order 2. Vampyrellida. Nude Rhizopods which in the amœboid condition possess a body-protoplasm of more or less definite form, frequently globular or often elongated; with straight attenuated pseudopodia, often branched at the base.

e. g. *Vampyrella*, Cienk. (incl. *Leptophrys*, Hertwig and Lesser); *Nuclearia*, Cienk. (incl. *Heliophrys*, Greeff).

* Cf. G. S. West, "Some British Freshw. Rhiz. and Heliozoa," Journ. Linn. Soc., Zool. xxviii. 1901, pp. 308 & 333.

Order 3. **Amœbœa.** Nude Rhizopods which in the amœboid condition possess a very irregular mass of body-protoplasm; pseudopodia lobose, varying in form from mere undulations of the surface to elongate blunt processes (rarely attenuated and acute), sometimes branched, but never reticulate.

e. g. *Amœba*, Ehrenb., *Pelomyxa*, Greeff, *Dactylosphærium*, Hertwig & Lesser.

Order 4. **Testacea.** Rhizopods in which the body-protoplasm is enclosed in a shell of variable construction; pseudopodia blunt and lobose or thread-like and attenuated to fine points, often branched and rarely reticulate.

e. g. *Diffugia*, Leclerc, *Arcella*, Ehrenb., *Euglypha*, Dujardin, *Pamphagus*, Bailey, *Diplophrys*, Barker, &c., &c.

The following is a systematic account of some of the most interesting Rhizopods I have recently examined.

Class RHIZOPODA.

Order Vampyrellida.

Genus NUCLEARIA, Cienkowski.

1. NUCLEARIA CONSPICUA, sp. n. (Pl. 13. figs. 16-19.)

Protoplasmic body subglobose or angularly rounded; protoplasm undifferentiated, granulose, containing numerous large vacuoles, with a single large spherical nucleus which exhibits a punctate appearance; pseudopodia fairly numerous, stout, rigid, generally with one or two branches which are a little divergent and attenuated to fine points.

Diameter of body 83-120 μ ; length of pseudopodia 17-54 μ .

Hab. In boggy pools, Lewis, Outer Hebrides.

This Rhizopod occurred in considerable profusion amongst numerous Desmids and other Algæ in small pools. The animals are of much larger size than *N. delicatula*, Cienk., or *N. simplex*, Cienk., and the protoplasm is much more vacuolated. There is a single nucleus present in each individual, but no contractile vacuoles were observed. The pseudopodia are protruded irregularly from the surface of the body-protoplasm, often in small clusters. They are broad at the base, generally straight and

much attenuated, and almost always branched. Except for their perfectly smooth exterior and absence of granules, they are very like those present in the genus *Vampyrella*.

This species is a voracious feeder, and many of the individuals were gorged with Desmids. The protoplasm contained no green colouring-matter, the chlorophyll of the Desmids disappearing very soon after ingestion. The pseudopodia were frequently entirely retracted, the animals then remaining in a quiescent state for a long time (fig. 18). In this state they much resembled the quiescent stages of *Vampyrella pedata*, Klein, but could be distinguished by the numerous vacuoles and the absence of the red pigment.

Slight stimulation of the animals, either mechanical or with reagents, caused a contraction of the pseudopodia, so that they became undulated, as shown in fig. 19.

I have previously pointed out that *Heterophrys varians*, Schulze, is identical with *Heliophrys variabilis*, Greeff, and that the animals in question do not belong to Archer's genus *Heterophrys*. I am now quite convinced that both are forms of Cienkowski's *Nuclearia delicatula*, and are Rhizopods which should be placed in the order Vampyrellida.

Genus VAMPYRELLA, Cienkowski.

2. VAMPYRELLA LATERITIA, Leidy, *Freshw. Rhiz. N. Amer.* 1879, p. 253, pl. 45. figs. 10-16.—*Amœba lateritia*, Fresenius, 1856-8.—*Vampyrella Spirogyræ*, Cienk. in *Archiv für mikr. Anat.* i. 1865, p. 218, pls. 12-13. figs. 44-56.

Hab. West of Tarbert, Harris, Outer Hebrides.

Numerous examples were observed amongst various algæ, but all of them were sluggish, and none were observed feeding.

Order AMŒBŒA.

Family LOBOSA.

Genus PELOMYXA, Greeff.

3. PELOMYXA PALUSTRIS, Greeff, in *Archiv für mikr. Anat.* x. 1870, pp. 51-72, pls. 3-4.

Hab. Near Tarbert, Harris, Outer Hebrides.

Not uncommon in boggy pools amongst submerged *Sphagnum*.

Genus DACTYLOSPHERIUM, *Hertwig & Lesser.*

4. DACTYLOSPHERIUM RADIOSUM, *Blochmann, Die mikr. Thierwelt des Süßwass., I. Protozoa* (Hamburg, 1895), p. 14.—*Amœba radiosa, Ehrenb.*

Hab. Gortahork, Co. Donegal, Ireland.

From the above locality a number of curious forms of this Rhizopod were observed in which the pseudopodia were distinctly twisted (fig. 2). This was not merely the condition of one or two pseudopodia of a single individual, but was general among the majority of the specimens. The condition was not brought about by any specially applied stimulation, and, although the pseudopodia exhibited slow movements, they made no attempt to unwind themselves. The same state was noticed and figured by Penard (in *Mém. Soc. Phys. et d'Hist. Nat. Genève*, tom. xxxi. no. 2, 1890, pl. 2. fig. 75) from Wiesbaden.

Diameter of body 16–19 μ ; length of pseudopodia 23–46 μ .

Order Testacea.

Family ARCELLINA.

Genus DIFFLUGIA, *Leclerc.*

5. DIFFLUGIA ACUMINATA, *Ehrenb. Infus.* 1838, p. 131, pl. 9. fig. 3; *Leidy, Freshw. Rhiz. N. Amer.* 1879, p. 109, pl. 13.

Var. AMPHORA, *G. S. West, in Journ. Linn. Soc., Zool.* xxviii. (1901), p. 319.—*D. amphora, Penard, in Mém. Soc. Phys. et d'Hist. Nat. Genève*, tom. xxxi. no. 2, 1890, p. 139, pl. 13. figs. 55–65.

Some strange forms of this variety were observed from Y Foel Fras, N. Wales, in which large numbers of the empty cells of *Chlorobotrys regularis*, Bohlin, were incorporated with the shell. They were certainly the most extraordinary Rhizopod-shells I have ever examined. The cells of the alga are globular and the cell-walls are siliceous, and the entire shell of the *Diffugia* appeared to be built up of an accumulation of the empty cells of the unicellular alga. Length of shells 260–290 μ .

6. DIFFLUGIA SOLOWETZKII, *Mereschk.; Levander, 'Material zur Kenntniss der Wasserfauna in der Umgebung von Helsingfors,' Acta Soc. pr. Fauna et Flora Fennicæ*, xii. no. 2, 1894, p. 18,

pl. 1. fig. 13.—*D. elegans*, *Penard*, *l. c.* p. 140, pl. 4. figs. 4–11.—*D. acuminata*, *Ehrenb.*, var. *elegans*, *G. S. West*, in *Journ. Linn. Soc., Zool.* xxviii. (1901) p. 319, pl. 28. figs. 11–12.

Hab. Rhiconich, Sutherland.

It seems probable that this *Diffugia* retains its characters sufficiently well to be regarded in the light of a species. The attenuated apex is always bent at a considerable angle from the longitudinal axis and is invariably perforated. The size of the shell is also much less than the average size of *D. acuminata*, *Ehrenb.*

Genus NEBELA, *Leidy*.

7. NEBELA DENTISTOMA, *Penard*, *l. c.* p. 162, pl. 6. figs. 98–100; pl. 7. figs. 1–5.—*G. S. West*, in *Journ. Linn. Soc., Zool.* xxviii. (1901) p. 322.—*N. crenulata*, *Cash*.

Hab. Lund's Fell, N. Yorkshire; amongst mosses.

Genus HYALOSPHENIA, *Stein*.

8. HYALOSPHENIA PLATYSTOMA, sp. n. (Pl. 13. figs. 3–6.)

Rather small; shell ovoid in front view, with a semicircular apex and a widely truncate base, consisting of a colourless, transparent, chitinous membrane; sides of shell slightly convex and mouth very wide; in side view, shell narrowly ovoid, with no trace of a constriction towards the apex, slightly notched at the mouth. Protoplasmic body held in position by several fine strands passing to the inner surface of the shell, inferior part clear, superior part granular and filled with food-particles; pseudopodia two, short and lobose; nucleus dorsal and prominent; contractile vacuoles not observed.

Length of shell 40–42 μ ; breadth of shell 28–32 μ ; breadth of mouth 21–26 μ ; thickness of shell 14–15 μ .

Hab. Near Tarbert, Harris, Outer Hebrides.

Numerous active specimens of the above species were observed in a collection from a *Sphagnum*-bog. The small size of the shell and the extremely broad mouth are features which easily distinguish it. In the side view, there is no trace of a constriction towards the apex of the shell, and there is a distinct line of demarcation between the lower part of the body-protoplasm, which gives origin to the pseudopodia, and the upper granular portion.

The species stands nearest to *H. minuta*, Cash (Trans. Manchester Micr. Soc. 1891, p. 49, pl. 11. figs. 3-4), but the form of the shell is different, the mouth being much broader and more truncate, and the body-protoplasm and pseudopodia exhibit rather different characters.

9. *HYALOSPHENIA INCONSPICUA*, sp. n. (Pl. 13. figs. 7-11.)

Very minute; shell thin, of a reddish-brown colour, in front view with an almost circular outline, the basal portion being slightly protracted to form a short neck; mouth small and truncate; in side view, shell ovate-elliptical in form, with a notched mouth. Protoplasmic body occupying only about half the cavity of the shell and furnished with a small nucleus; with one short pseudopodium; contractile vacuoles not observed.

Length of shell 14·5-17 μ ; breadth of shell 12·5-16 μ ; breadth of mouth 6·5-7·7 μ ; thickness of shell 8·6 μ .

Hab. Lough Gartan, Co. Donegal, Ireland.

This minute *Hyalosphenia*, which is considerably smaller than any other known species, was observed in quantity from the above locality in May 1901. The almost circular outline of the shell and the reddish-brown colour are characteristic. The animals were very sluggish, and only protruded one small pseudopodium.

Family EUGLYPHINA.

Genus EUGLYPHA, Dujardin.

10. *EUGLYPHA CRISTATA*, Leidy, in *Proc. Acad. Nat. Sci. Philad.* 1874, p. 226; *Freshw. Rhiz. N. Amer.* 1879, p. 218, pl. 37. figs. 1-4.

Length of shell (without bristles) 65-104 μ ; breadth 27-31 μ .

Hab. Rhiconich, Sutherland; frequent. Also near Tarbert, Harris, Outer Hebrides.

Some of the examples were very rounded at the apex, but others were more attenuated towards the apex, and also furnished with a slight neck at the base.

Genus SPHENODERIA, Schlumberger.

11. *SPHENODERIA PULCHELLA*, sp. n. (Pl. 13. figs. 12-15.)

Shell ovoid or ellipsoid, in vertical view circular, composed of

six longitudinal rows of widely hexagonal plates, 8 or 9 plates in each row, with a short cylindrical neck at one pole; mouth circular, often with an irregular border; plates transparent, chitinous, colourless or pale yellow; body-protoplasm protruding some three or four delicate thread-like pseudopodia.

Length of shell 33–42 μ ; diameter of shell 21–25 μ ; diameter of mouth 5–7.8 μ .

Hab. Glenties and near Lough Machugh, Co. Donegal; and east of Recess, Co. Galway, Ireland.

Living specimens of this pretty little Rhizopod were only observed from Glenties, Co. Donegal. From the other localities only empty shells were seen, but these are unmistakable.

It is nearest to *S. macrolepis*, Leidy, but is easily distinguished by its larger size, smaller mouth, and by the six equal rows of plates. In most cases the short neck was cylindrical, but a few specimens were seen in which it was slightly compressed. The form of the shell and the arrangement of the plates at once distinguish it from *S. lenta*, Schlumberg.

Family GROMIINA.

Genus PAMPHAGUS, *Bailey*.

12. PAMPHAGUS HYALINUS, *Leidy*, *Freshw. Rhiz. N. Amer.* 1879, p. 194, pl. 33, figs. 13–17.—*Arcella?* *hyalina*, *Ehrenb.*, 1838.—*Gromia hyalina*, *Schlumberger*, 1845.—*Lecythium hyalinum*, *Hertwig & Lesser*, 1874.

Hab. Sligachan, Skye; abundant in pools.

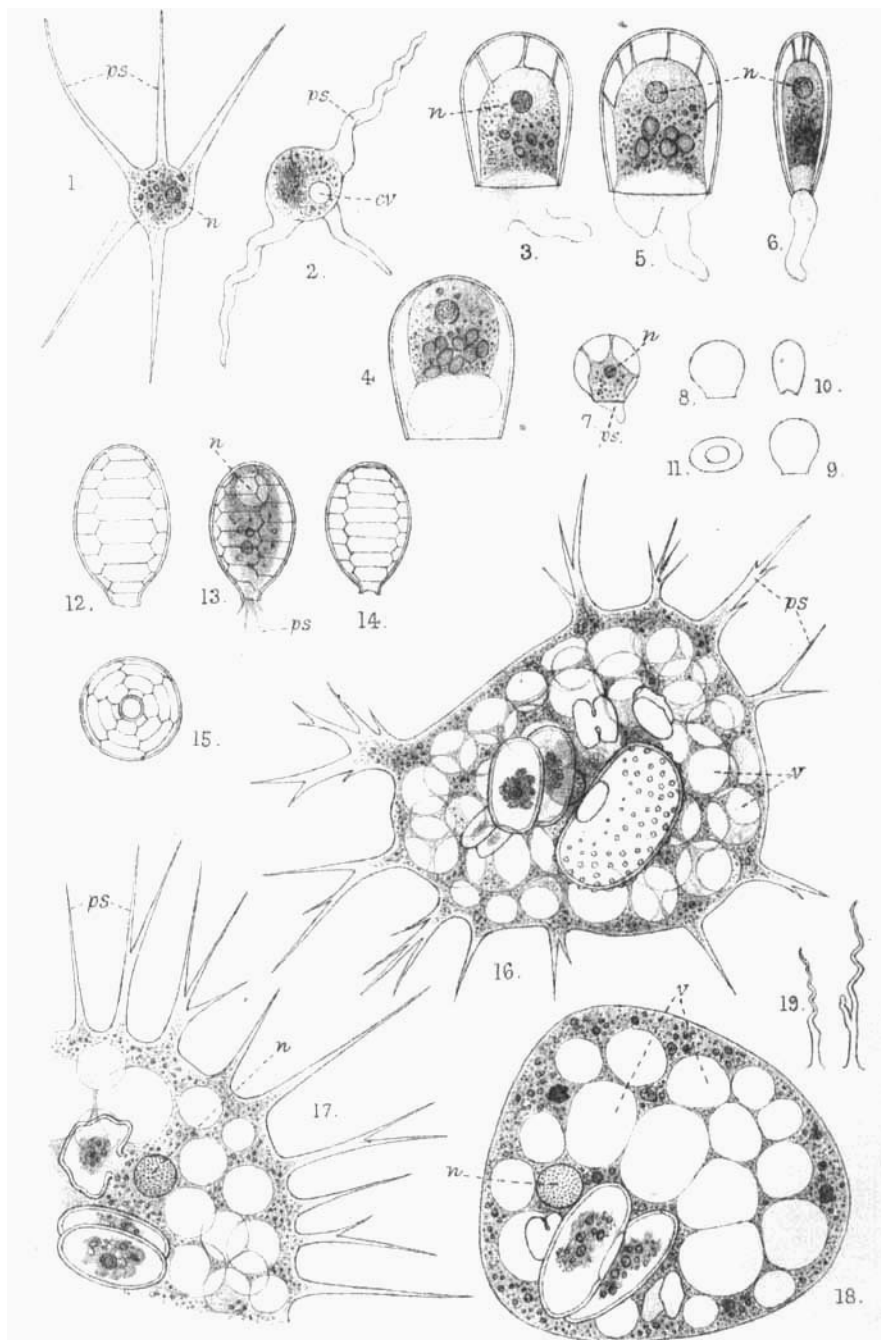
The animals were all somewhat elongate, about 40–50 μ in length and 26–29 μ in breadth, and the pseudopodia were extended more than is usual for this species, reaching a length of 73 μ .

Family AMPHISTOMINA.

Genus DIPLOPHRYS, *Barker*.

13. DIPLOPHRYS ARCHERII, *Barker*, in *Qu. Journ. Micr. Sci.* 1868, p. 123; *Hertwig & Lesser*, in *Archiv für mikr. Anat.* x. (1874), Suppl. p. 139, pl. 3, fig. 9.

Hab. Loch Gatny, Co. Donegal.



G.S. West del.
F.H. Michael lith.

Mintern Bros. imp.

EXPLANATION OF PLATE 13.

cv=contractile vacuole. *n*=nucleus. *ps*=pseudopodia. *v*=vacuole.

All the figures $\times 520$.

- Figs. 1-2. *Dactylosphærium radiosum*, Blochmann. Two forms; fig. 2, showing spirally-twisted pseudopodia.
- 3-6. *Hyalosphenia platystoma*, sp. n. Figs. 3-5 showing the front view of the shell with its broad aperture; fig. 6, seen from the side. Fig. 4 shows a curiously contracted state of the animal in which the body-protoplasm is closely applied to the dorsal part of the shell.
- 7-11. *Hyalosphenia inconspicua*, sp. n. Fig. 7, living animal, showing pseudopodium and nucleus; figs. 8-11, empty shells. Fig. 11 is the basal view of a shell showing the elliptical mouth.
- 12-15. *Sphenoderia pulchella*, sp. n. Figs. 12, 14, and 15, empty shells; fig. 13, living animal. Fig. 15 is the basal view of the shell, showing the small, round aperture.
- 16-19. *Nuclearia conspicua*, sp. n. Figs. 16 and 17, animals with pseudopodia extended; fig. 18, contracted state of the animal. These animals contain a number of Desmids, the bodies of which have been more or less digested. Fig. 19, two pseudopodia after slight mechanical stimulation.

The *Ingolfiellidæ*, fam. n., a new Type of Amphipoda.

By Dr. H. J. HANSEN (Copenhagen), F.M.L.S.

[Read 7th May, 1903.]

(PLATES 14 & 15.)

THE greatest depth explored by the Danish 'Ingolf' Expedition (during the two summers of 1895 and 1896) was 1870 fathoms, and the Station in question (No. 38) is a little south of the entrance to Davis Strait. In the trawl was obtained slightly more than one litre of mud, which was carefully treated with a sieve covered with silk-gauze. This small portion of bottom-material contained a number of Crustacea new to science, among which were two new aberrant types of very small sessile-eyed Malacostraca. Of one of these forms only a single specimen could be detected; it presents a rather strong resemblance to the Caprellidæ, but it is at once apparent that the pleopods on the long abdomen differ exceedingly from those of every other Amphipod hitherto known. Some years after I found a specimen of an allied species in sieved material procured by