antapical spines. Accessory left spine with a short apex traversing the margin of the longitudinal furrow. Length (without spines) 50μ, rarely 70μ; breadth 35–40μ, rarely 50μ. Spines 20–22μ long. Fauré-Fremiet describes it as right-handed, attaining a length of 86μ and a breadth of 62μ.

Atlantic, Flemish coast, Brittany coast.

Peridinium Balticum (Levander) Lemmermann.

Text-figure 42c.

Paulsen, 1908; Nordisches Plankton, p. 65.

This species is said to have six precingulars, and therefore does not properly belong to Peridinium.

The description shows it to be somewhat similar to *Kryptoperidinium foliacum*, having very weakly developed plates, an enormous plate in front of the epitheca (resembling the seventh precingular in that species) and a red stigma, besides apparently having a very narrow longitudinal furrow on the left of the ventral area; the cell is flattened dorso-ventrally.

Cell circular, dorso-ventrally flattened, very weakly divided into plates. Epitheca broad and larger than the hypotheca. Girdle weakly left-handed. Longitudinal furrow flat and short. No spines present. Epitheca with only six end-plates. Chromatophores small, golden-brown. Below the longitudinal furrow a red stigma. Length 22–30μ. (Paulsen.)

Finnish coast.

Peridinium exiguum Cleve (Paulsen, 1908, p. 109) is a peculiar form recorded by Cleve from Plymouth with curiously serrated antapical horns. It is, however, impossible to place this species, which is probably abnormal and has never occurred again.

Genus **Minuscula** gen. nov.

This new generic name is offered to include the peridinian described by Paulsen (1904) as *Glenodinium bipes*, and later (1905) by Pavillard as *Peridinium minusculum*. It is certainly not a Glenodinium, as its theca is divided into distinct plates, and from their arrangement, as given by Pavillard (1917) and confirmed by myself, it is not a true Peridinium, the plate formula being *4′ 3a 6″ 5‴ 2⁗*; that is to say, with one precingular plate less than in Peridinium. The sixth precingular is very large and occupies the position of 6 and 7 together; the first precingular is also very large and runs in between postcingulars 2 and 3 and antapical 1. Only one species known :—*M. bipes* Paulsen.

Minuscula bipes (Paulsen) (1904).

Plate XXIX, figures 3a and 3b.

Glenodinium bipes Paulsen, 1908, p. 25.
Peridinium minusculum Pavillard, 1905.
Peridinium minusculum Pavillard, 1917.

Cell minute, flattened dorso-ventrally. Epitheca triangular, with pointed apex ending in a conspicuous apical horn surrounding a long apical pore. Hypotheca shorter than the epitheca, ending in two long, solid antapical horns, the two antapical plates with conspicuous pores. Girdle slightly right-handed, excavated, with very narrow lists. First apical of the Metaperidinium type, the second anterior intercalary occupying a position between the precingulars 3 and 4. Cell contents colourless. Length with spines ca. 23–35μ (Paulsen); less in the English Channel and Mediterranean forms. Neritic.

Greenland, Iceland, Baltic, North Sea, Bosphorus, Flemish coast, Mediterranean, English Channel. Common at Plymouth.

Genus Coolia Meunier (1919).

This genus was created by Meunier for a most peculiar form found abundantly in the waters round Nieuport, Flanders, especially in the oyster beds. It is unlike any known dinoflagellate. Cell very much lens-shaped in ventral view, with an oblique axis. Girdle equatorial, excavated, slightly left-handed. Sulcus not reaching antapex. Apex far back, antapex forward. Theca covered with lines of small dots. Plate arrangement very irregular, composed of 16 plates (according to Meunier, who admits that this may not be accurate), of which 11 belong to the epitheca, 5 to the hypotheca. Epitheca apparently has 8 precingulars and 3 apicals, one of the latter on the left being pierced by a large apical pore. There seems to be no antapical plate. Interpreted as above, the plate formula is *3′ 8″ 5‴ 0⁗*. It is possible, however, that the large seventh precingular is an apical.

Coolia monotis Meunier (1919).

Text-figure 43.

With the characters of the genus. Length 32μ (calculated).
From oyster beds and waters round Nieuport, Flanders.

Genus Pyrophacus Stein (1883).

Cell flattened from above downwards and of the shape of a bi-convex lens. Epitheca and hypotheca equal. Narrow girdle, indented. Longi-

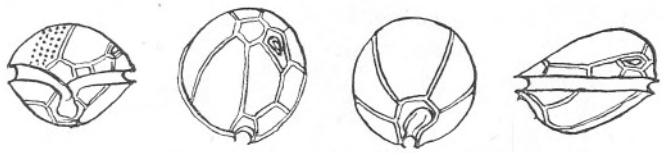


FIG. 43. *Coolia monotis* Meunier.
32μ long (calculated), Nieuport, Flanders. After Meunier.

tudinal furrow short. Plate formula *5–7 apicals, no anterior intercalaries, 9–12 precingulars, 9–12 postcingulars, 3–4 antapicals.* Several small plates in the ventral area. Numerous greenish yellow chromatophores. Reproduction by spore formation, two spores being formed within the theca and set free by the girdle opening.

Only one species known, *Pyrophacus horologicum* Stein.

Pyrophacus horologicum Stein (1883).

Plate XXIX, figures 4a–4c.

Paulsen, 1908; Nordisches Plankton, p. 67.

Cell lens-shaped. Theca weakly sculptured, with fine poroids. Intercalary striae narrow or very broad. Length ca. 40μ; breadth ca. 74–90μ. Oceanic, but comes fairly close inshore occasionally.

Warm seas, Bosphorus, English Channel.

Paulsen regards it as a sub-tropical species seldom brought in by the Gulf Stream in the North; but it also occurs in the Baltic, and is quite common near Plymouth outside the Sound.

All the specimens, even the smallest from Plymouth, had 9 precingulars, 5 apicals, 3 antapicals and 9 postcingulars, and apparently Lindemann's from the Bosphorus (advance reprint, 1923) is the same. These agree with Stein's small form, which he believes to be young; but ours are fully grown, as they have cysts inside. The form with 12 pre- and postcingulars and 7 apicals may thus be another species.

Genus **Oxytoxum** Stein (1883).

Cell elongated, club-shaped to spindle-shaped. Girdle deep and broad, near to the front end so that the epitheca is shorter than the hypotheca. Hypotheca often pointed; sometimes the epitheca also. Ventral area short, often much reduced. No apical pore (with the possible exception of *O. Belgicae* Meunier). Plate formula *5 apicals, 5 precingulars, 1 antapical*, or *5′ 5″ 5‴ 1⁗*. Theca with longitudinal or transverse ridges, and often poroids. Very few in the Northern area.

Species :—*Oxytoxum sphaeroideum* Stein, *O. gladiolus* Stein, *O. scolopax* Stein, *O. Milneri* Murray and Whitting, *O. diploconus* Stein, *O. Belgicae* Meunier, *O. reticulatum* (Stein).

Oxytoxum sphaeroideum Stein (1883).

Text-figure 44a.

Paulsen, 1908; Nordisches Plankton, pp. 68–69.

Hypotheca egg-shaped, behind pointed or blunt. Precingulars sharply bent so that the seams lie in furrows. Epitheca rounded or conical, or

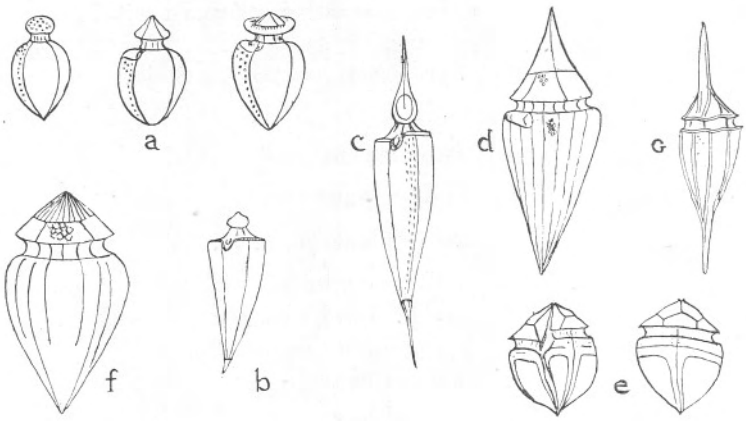


FIG. 44.

a. *Oxytoxum sphaeroideum* Stein.
(?) Size. From Paulsen, 1908 ; after Stein.

b. *Oxytoxum gladiolus* Stein.
(?) Size. From Paulsen, 1908 ; after Stein.

c. *Oxytoxum scolopax* Stein.
(?) Size. From Paulsen, 1908 ; after Stein.

d. *Oxytoxum diploconus* Stein.
(?) Size. From Paulsen, after Stein.

e. *Oxytoxum Belgicae* Meunier.
(?) Size. Kara Sea. After Meunier, 1910.

f. *Oxytoxum reticulatum* (Stein), Bütschli.
(?) Size. From Paulsen, after Stein.

g. *Oxytoxum Milneri* Murray and Whitting.
× 290. After Murray and Whitting.

with a furrow at the base. Theca with distinct poroids (or pores ?) in rows. Size (?).

South Atlantic species. Seldom found in the Gulf Stream region.

Oxytoxum gladiolus Stein (1883).

Text-figure 44b.

Paulsen, 1908; Nordisches Plankton, p. 69.

Cell shaped like a tusk. Hypotheca deeply conical, acutely or weakly pointed. Epitheca round or pointed in front. Theca smooth. Small species. Size (?).

South Atlantic species. Rare in the Gulf Stream region.

Oxytoxum scolopax Stein (1883).

Text-figure 44c.

Paulsen, 1908; Nordisches Plankton, pp. 69–70.

Cell spindle-shaped, acutely pointed at each end. Hypotheca very long, ending in a thread-like point, with sometimes a swelling at the base of the point. Epitheca bulbous, with a thin pointed apex. Length up to 112μ.

Tropical Atlantic. Rare in the north in the Gulf Stream region; Mediterranean, Indian Ocean.

Oxytoxum Milneri Murray and Whitting (1899).

Text-figure 44g.

Paulsen, 1908; Nordisches Plankton, p. 70.

Cell spindle-shaped, pointed at both ends, the apical point abrupt. Hypotheca conical, gradually merging into a blunt or acute point. Theca with poroids (or pores ?) and longitudinal ribs. Length up to 131μ.

Sub-tropical Atlantic, Mediterranean. Rare in Northern waters.

Oxytoxum diploconus Stein (1883).

Text-figure 44d.

Paulsen, 1908; Nordisches Plankton, pp. 70–71.

Cell bi-conical. Hypotheca long and pointed; epitheca short and pointed, with concave sides. Theca with numerous longitudinal ribs and poroids (or pores ?). Length ca. 64μ.

Southern Atlantic species. Rare in the Gulf Stream region in the North.

Oxytoxum Belgicae Meunier (1910).

Text-figure 44e.

Cell an elongated oval, with convex sides. Epi- and hypotheca conical. Epitheca about half as long as the hypotheca. Plates with fine punctures and striations with smooth borders. Length (?).

Kara Sea. (Meunier.)

Oxytoxum reticulatum (Stein) Bütschli (1885).

Text-figure 44f.

Paulsen, 1908; Nordisches Plankton, p. 72.

Cell a long oval, pointed behind. Epitheca short, conical. Theca longitudinally striated and distinctly reticulated. Length (?).

Southern species. Seldom in the North.

Genus Ceratium Schrank.

Cell usually flattened dorso-ventrally, drawn out into hollow horns (usually 3). Girdle left-handed, with lists. Theca composed of plates. Plate formula *4′ 5″ 5‴ 2⁗*. Ventral area, of several plates, taking up the greater part of the ventral face; the longitudinal furrow in its left side with the flagellar pore. Epitheca with a long apical horn with an apical pore at the top. Hypotheca is typically drawn out into two hollow side horns, the left horn formed by the two antapical plates, the right formed by the postcingulars 4 and 5. Chromatophores numerous yellow plates. Nutrition holophytic. Reproduction by cell division (fission), the theca splitting obliquely and each half forming new plates. Chain formation may take place and, rarely, spore-formation. Supposed sexual reproduction has been described by Zederbauer (1904) and by Entz, jun. (1907), in *Ceratium hirundinella*, and a few other doubtful cases have also been noted. Division usually takes place at night and in the early morning (see p. 147). Heteromorphic chains sometimes occur; that is to say, the individuals at one end of the chain are quite different from those at the other.

Jörgensen (1910) has divided the Ceratia into four sub-genera—Poroceratium, Biceratium, Amphiceratium and Euceratium. The first which has no apical horn, does not occur in our area. The species are referred to his monograph (1911) for synonymy. For details of distribution of the Northern forms, see Jörgensen (1908).

Species:—Sub-genus Biceratium.

Ceratium hirundinella (O. F. Müller), *C. candelabrum* (Ehrenberg), *C. furca* (Ehrenberg), *C. lineatum* (Ehrenberg), *C. minutum* Jörgensen.

Sub-genus Amphiceratium.

Ceratium extensum (Gourret), *C. fusus* (Ehrenberg).

Sub-genus Euceratium.

Ceratium tripos (O. F. Müller), var. *Baltica* Schütt, forma *subsalsa* Ostenfeld, forma *hiemale* Paulsen, var. *Atlantica* Ostenfeld, forma *neglecta* (Ostenfeld), *C. compressum* Gran, *C. azoricum* Cleve, *C. bucephalum* (Cleve), var. *heterocampta* Jörgensen, *C. gibberum* Gourret, forma *sinistra* Gourret, *C. platycorne* v. Daday, *C. lamellicorne* Kofoid,

C. macroceros (Ehrenberg), *C. horridum* Gran, *C. longipes* (Bailey), *C. arcticum* (Ehrenberg) Cleve, *C. reticulatum* (Pouchet) Cleve.

Sub-genus Biceratium (Vanhöffen) Gran.

Cell with an apical horn (in all the Northern forms), two hind horns, exceptionally three (*C. hirundinella*), normally shut at the tips, backwardly directed behind, parallel or diverging, the right smaller, seldom curved, rarely shorter than half the left. Epitheca (including horn) mostly much longer than the hypotheca, only in short and broad short horned forms (*C. candelabrum*) as long or a little shorter.

Ceratium hirundinella (O. F. Müller) (1786).

Plate XXX, figure 1, Text-figure 45a (see p. 144).

Paulsen, 1908; Nordisches Plankton, pp. 87–88.
Jörgensen, 1911, p. 14.

Cell strongly flattened dorso-ventrally. Apical horn long and thin Two or three hind horns, usually three, the extra horn on the left. Theca spiny and coarsely reticulate. Very variable species. Breadth* 42–80μ. Resting spore triangular, with a spine at each angle (Text-figure 45a).

Fresh water; also in brackish water in the Baltic. Common throughout Europe into Asia.

Entz, jun. (1924), has observed chain formation in this species, and also describes interesting cases of the sticking together of two individuals ("coupling").

Ceratium candelabrum (Ehrenberg) (1859).

Plate XXX, figure 2, Text-figures 45b and 45c.

Paulsen, 1908; Nordisches Plankton, p. 88.
Jörgensen, 1911, p. 16.

Cell depressed, thick, broader than high. Epitheca merging rather abruptly into a long apical horn which is sometimes curved, sometimes straight. Hypotheca much depressed on the right, somewhat triangular. Hind horns slightly diverging or nearly parallel. Girdle lists strongly developed, with spines. Ridges and pores on the theca. Sometimes wing-like lists. Very variable. Breadth 55–70μ.

* The breadth here and throughout the genus is the breadth across the girdle, ventral view; the total length, when given is from the top of the anterior spine to the hind end of the posterior horns, except when otherwise stated.

Widely distributed in all warm seas. Also rarely from Denmark, Skaggerak, Atlantic.

The variety *dilatata* (Gourret) has the body strongly compressed, much broader than high. All the horns usually long and bent (in the type straight), the hind horns more or less diverging. In warm seas, more widely distributed than the type. This variety forms chains, the individual behind fitting into the one in front by the apical horn, which

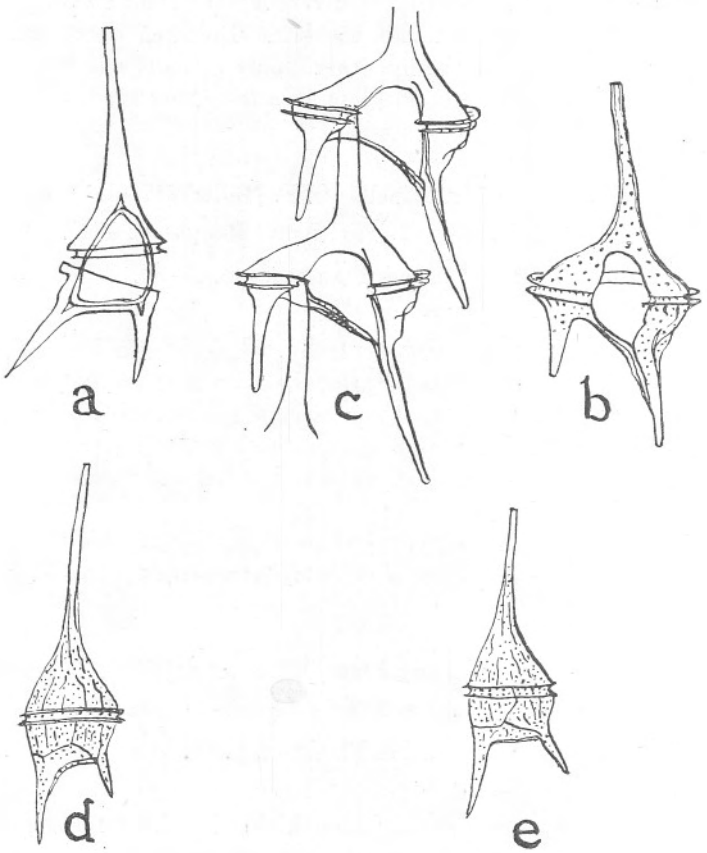


FIG. 45.

a. *Ceratium hirundinella* (O. F. Müller).
With resting spore. After West, 1916.

b, *c*. *Ceratium candelabrum* (Ehrenberg).
b. Type. Berguelostrom. After Jörgensen.
c. var. *dilatata*, in chain.
Straits of Gibraltar. After Jörgensen.

d, *e*. *Ceratium lineatum* (Ehrenberg).
d. × 280. South of New York. After Jörgensen, 1913.
e. Bergen, Norway. After Jörgensen, 1913.

fits into a special groove (Text-figure 45c). These chains are formed by cell division, and the individuals hold together in this way with a loose union.

Ceratium furca (Ehrenberg).

Plate XXX, figure 3.

Paulsen, 1908; Nordisches Plankton, pp. 89–90.
Jörgensen, 1911, p. 17.

Cell elongated. Epitheca evenly narrowing and drawn out into a longer or shorter apical horn. Hind horns parallel or somewhat diverging, the left longer and stronger than the right, which is about half the length of the left. Both horns more or less sharp, commonly toothed, the left most conspicuously. The type is regarded by Jörgensen as the sub-species *Berghii* (Lemm.), which is the Northern form, the sub-species *eugrammum* (Ehrenberg) occurring only in warm seas. Breadth (in type) 30–50μ.

Temperate cold-water form. Northern temperate Atlantic to English Channel, Baltic, Northern waters. Rare in Polar stream.

Ceratium lineatum (Ehrenberg) (1854).

Text-figures 45d and 45e.

Jörgensen, 1911, p. 22.

Ceratium tripos f. *lineata* Paulsen, 1908; Nordisches Plankton, pp. 88–89.

Small species, much longer than broad, the girdle a little behind the middle. Epitheca triangular, with nearly straight sides, which usually make an angle of about 55° with one another. Apical horn produced, somewhat narrower at the apex, long. Hypotheca trapezoidal. Hind horns straight, more or less diverging to almost parallel, the right $\frac{1}{3}-\frac{2}{3}$ the length of the left. Theca with conspicuous lines and pores. Breadth 25–47μ.

Northern form of the temperate and cold Atlantic. Common on the European coast, especially in the North Sea and Norwegian Seas; also on the American side north of the Gulf Stream.

The species recorded from Plymouth in 1917 (Lebour) is *C. minutum*.

Ceratium minutum Jörgensen (1920).

Plate XXX, figure 4.

Ceratium eugrammum Kofoid, 1907b.

Very small species. Epitheca in ventral view, somewhat triangular and abruptly narrowing to a slender, usually straight apical horn. Hypotheca tapering, with almost straight or slightly convex sides. Hind horns

nearly parallel, usually very slightly diverging, the longer one (the left) shorter than the hypotheca, the right about half the length of the left: both acute and slightly denticulated. Breadth 23–35μ, usually 25–28μ. Theca with ridges and lines and distinct pores.

Pacific from Alaska to San Diego, English Channel (Plymouth), coast of Brittany to Straits of Gibraltar, Mediterranean.

Kofoid's figure from the Pacific has much slenderer horns than the Plymouth specimens. This species occurs sometimes in numbers at Plymouth and outside.

Sub-genus Amphiceratium (Vanhöffen).

Cell long and narrow; not, or only slightly, flattened dorso-ventrally. Right hind horn very small, often rudimentary or absent, the left very long and strongly developed, so that the hypotheca with the horn is about as long as the epitheca with the apical horn, sometimes still longer. Horns normally closed at the tips.

Ceratium extensum (Gourret).

Text-figure 46a.

Paulsen, 1908; Nordisches Plankton, p. 91.
Jörgensen, 1911, p. 28.

Very long species. Epitheca long and narrow, gradually merging into a long straight, narrow apical horn. Right horn absent. Breadth 23–30μ. Total length more than a millimetre, as long as 1·75 mm. or more.

Warm waters. Rarely in the Northern Atlantic.

Ceratium fusus (Ehrenberg) (1859).

Plate XXXI, figure 1.

Paulsen, 1908; Nordisches Plankton, pp. 90–91.
Jörgensen, 1911, p. 29.

Epitheca long and regularly narrowing into a long apical horn almost evenly broad or narrowing towards the apex, usually regularly and weakly bent towards the dorsal side, sometimes straight. Hypotheca narrowed, longer than broad. Left hind horn long, usually bent dorsally distinctly but regularly, seldom quite straight. Right horn rudimentary or absent, mostly forming a short point, rarely appearing as a short narrow pointed horn. Breadth 15–30μ. Total length 300–600μ.

Northern seas, very common. Also a narrow smaller form in warmer seas.

This species is one of the commonest organisms causing phosphorescence in the sea.

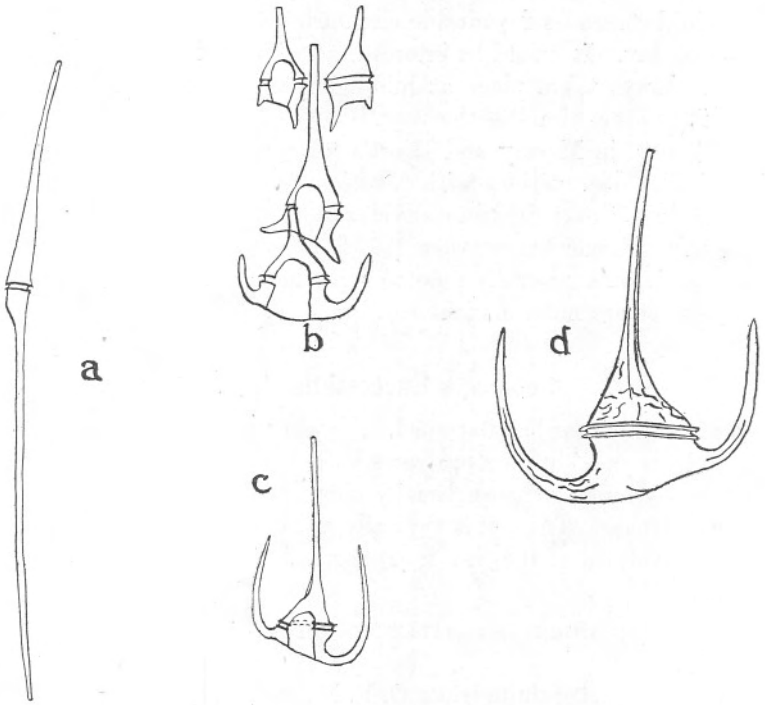


FIG. 46.

a. *Ceratium extensum* (Gourret).
× 100, Gibraltar. After Jörgensen, 1913.

b. *Ceratium tripos* (O. F. Müller), chain formation.
Baltic. After Lohmann, 1908.

c. *Ceratium tripos*, var. *Baltica* f. *hiemale* Paulsen.
× 66.6, Kattegat. After Paulsen, 1908.

d. *Ceratium tripos*, var. *Baltica* f. *subsalsa*.
× 186.6, Bergen. After Jörgensen, 1913.

Ceratium fusus is widely distributed in the Channel. Gough (1905) made some exceedingly interesting observations on the division and rate of growth. He took a series of samples 10 miles S.W. $\frac{1}{4}$ S. of the Eddystone, July 1st and 2nd, 1903, at intervals of two to three hours.

"Until 11 p.m. all the specimens observed had both horns fully developed and nearly equally long. At 12.55 a.m. one individual in every 160 had very recently divided; the others were still unchanged. At 3.30 a.m. 70% of the specimens present had one long and one short horn; in other words, about half the individuals present at 1 a.m (53·8%) must have recently divided. After 7 a.m. no further new divisions were observed, and the new horns were longer than those seen in the previous sample. At 9.30 a.m. all specimens seen had both horns of equal growth. The rate of division for each cell would thus be once

every two days under favourable circumstances. The 1st of July had been a hot day. It would be interesting to know if the cell division of *C. fusus* always takes place at midnight, and how rapid the rate of growth is at other times of the year."

Gran (1912), in Murray and Hjort's "Depth of the Ocean," p. 374, makes similar observations with *Ceratium tripos*, and it appears to be fully established that Ceratium divides at night.

In a more recent paper Allen (1922) brings evidence to show that "whereas diatoms generally tend to reproductive activity at night . . . dinoflagellates are not thus inclined."

Sub-genus Euceratium Gran.

Cell broad, more or less flattened. Always two hind horns present, of which at least one, but almost always both, are bent forward. The right horn is rarely much reduced, usually about the same length as the left, sometimes longer. The cell is typically anchor-shaped. Horns may be (1) normally closed at the tips or (2) normally open at the tips.

(1) Horns normally closed at the Tips.

Ceratium tripos O. F. Müller (1777).

Plates XXXII, a, b and c; XXXIII. Text-figure 46, b, c and d.

Paulsen, 1908; Nordisches Plankton, pp. 77–80.
Jörgensen, 1911, p. 35.

Fairly large species. Body about as broad as it is long. Epitheca rather flattened, commonly almost twice as broad as it is long, the left side contour a little convex, the right strongly so. Hypotheca as long as the epitheca or a little longer, the left side contour usually more or less strongly concave. All the horns strong, the apical horn usually broader below than the others, and the right hind horn usually conspicuously more weakly developed than the left. Hind horns at the apex diverging somewhat, but the right least. Sometimes the right horn is parallel with the apical horn or, rarely, somewhat converging towards it. The left horn can also be parallel with the apical horn or converge slightly towards it. Plate structure very strong. Usually the theca has strong longitudinal lines, often anastomosing. Pores conspicuous. Lists may also be present. Very variable species. The hind horns closed at the tips, which are pointed. Jörgensen divides *C. tripos* into two common varieties :—

Variety 1. *Baltica* Schütt (1892).

Hind horns conspicuously unlike, diverging, the right smaller, mostly

about as long as the body, at the base more or less abruptly bent, especially the right, in the distal part almost in a straight line and nearly parallel with the apical horn. The left hind horn longer and stronger, mostly regularly bent, diverging from the apical horn. Hind margin of the cell a little swollen or almost a straight line. Breadth 60–80μ or rarely more.

Very common in the Northern Atlantic, Baltic, Kattegat and Skaggerak, North Sea, Norwegian Seas, English Channel. Also North American coast in cold water, east and west of the Florida stream.

Two forms are differentiated of this variety :—

(a) Forma *subsalsa* Ostenfeld (1903)
(var. *subsalsa* Paulsen, 1908, p. 79).

Hind horns conspicuously unlike, parallel or a little converging ; the right smaller, longer than the body, bent from the base, in the distal part a straight line, and often converging somewhat towards the apex or parallel with it. Left hind horn of the same shape, with the apex parallel with the apical horn, slightly converging. Hind margin of the cell at most a straight line, not conspicuously swollen. Breadth 72–74μ.

Distribution—as in var. *Baltica*.

(b) Forma *hiemale* Paulsen (1907) (1908, p. 80).
,, ,, Jörgensen, 1911, Text-figure 66c.

Like the preceding form, but with longer hind horns, which are paralle with each other in front or a little converging, but otherwise can be differently directed. The apices of the hind horns are often somewhat bent out.

Distribution like the preceding form. On the Norwegian coast in winter and early spring.

Variety 2. *Atlantica* Ostenfeld (1903).

Plate XXXIII.

Paulsen, 1908, p. 78.
Jörgensen, 1911.

Hind horns usually of the same size, similarly bent as in the preceding form, more or less diverging at the apices. The right hind horn is distinctly longer than the body, at the tip parallel with the apical horn or usually a little diverging, the left also parallel or diverging. Sometimes, but rarely, is the right hind horn longer than the left, but then usually distinctly narrower. Hind contour convex and swollen. Many different forms, partly with long apical horns and short hind horns, partly with

short apical and relatively long hind horns. Also the width between the tips of the hind horns varies much, and these forms show a great variation in the presence of wing-like lists.

The chief form is *neglecta* (Ostenfeld) Paulsen.

Hind horns slightly dissimilar, the right somewhat smaller. Hind contour of the cell almost imperceptibly merging into the horns, convex. Apical horn very broad at the base and with several large toothed wing-like lists. This is possibly to be regarded as an old large form. Breadth 75–93μ.

Var. *Atlantica* and f. *neglecta* very commonly distributed in the North Atlantic, Norwegian west coast, English Channel. Common at Plymouth.

Chain formation is common in *Ceratium tripos*, and it is in this species that the heteromorphic chains are most conspicuous. A *Ceratium tripos* of the ordinary form divides up into a chain, gradually forming individuals less and less like itself until the end cell is more like a stunted *Ceratium furca*. A chain of such individuals shows a typical *C. tripos* at the base, gradually merging through forms like *C. lineatum* and finally to a form like a stunted *C. furca*. These latter are apparently distinguishable from such true species as *C. lineatum*, *C. furca* and their allies (see Jörgensen, 1911, p. 38), as they bear the marks of division, are thicker in the body, and the hind horns, especially the right, are strongly directed ventrally. Also the structure of the plates is different.

These forms are known especially from waters of a low salinity such as the Baltic (Lohmann, 1908). They are regarded by Jörgensen as probably degenerate forms.

Ceratium compressum Gran (1902).

Text-figure 47a.

Paulsen, 1908; Nordisches Plankton, p. 81.
Jörgensen, 1911, p. 39.

Cell strongly flattened; all the horns in about the same plane. Epitheca high, with weakly convex to almost straight sides, which make an unusually acute angle with one another (about 60° or less), gradually merging into a very strongly developed broad apical horn. Hind horns broad, equally bent, narrowing towards the tips, where they are nearly parallel, but the left horn diverges a little from the apical horn, while the right usually converges slightly. Right hind horn smaller than the left. Theca with numerous strong ridges irregularly anastomosing; strong spine lists along the apical horn, and smaller lists on the hind horn and the hind margin. Breadth 56μ.

Rare; temperate North Atlantic, Norwegian Seas.

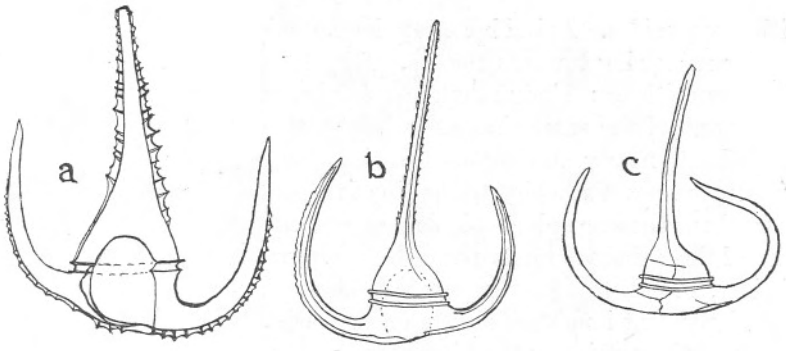


FIG. 47.

a. *Ceratium compressum* Gran.
× 280, Norwegian Sea. After Jörgensen.
b. *Ceratium bucephalum* (Cleve).
(?) Size. West coast of Norway. After Jörgensen, 1899.
c. *Ceratium bucephalum* var. *heterocampta* Jörgensen.
(?) Size. West coast of Norway. After Jörgensen, 1899.

Ceratium azoricum Cleve (1900).

Text-figure 48.

Paulsen, 1908; Nordisches Plankton, p. 76.
Jörgensen, 1911, p. 47.

Cell short, with short horns. Hind margin rounded and merging gradually into the hind horns which are bent ventrally, the right smaller

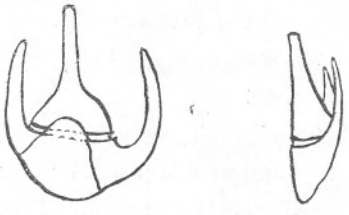


FIG. 48. *Ceratium Azoricum* Cleve.
× 250. Ventral side view. After Cleve.

than the left. Total length (from tip of apical horn to base of hypotheca) 88–130μ.

Sub-tropical seas, occasionally brought into the north.

Ceratium bucephalum (Cleve) (1897).

Text-figure 47, b and c.

Paulsen, 1908; Nordisches Plankton, pp. 76–77.
Jörgensen, 1911, p. 47.

Rather small species, body longer than broad. Epitheca rather long,

with convex sides. Apical horn very long, straight or curved at the base, usually narrowing towards the tip. Hypotheca not, or a little, shorter than the epitheca ; hind margin merging into the hind horns, which are strong and of the same size, or the right usually a little smaller, both much bent, nearly straight at the tips, sometimes longer, sometimes shorter, but never reaching to the tip of the apical horn. All three horns lie in about the same plane and converge usually distinctly at the apices. Two of the horns are rarely parallel. Sculpture of the theca usually not distinct, but there are often low lists along the apical horn, and short irregularly bent longitudinal lists on the body. The sides of the apical horn and the outside of the hind horns are often toothed, but never on the hind margin. Breadth 54–64μ. Greatest length (from tip of apical horn to end of hypotheca) 240μ.

Northern temperate species. North Sea and Norwegian Seas, Skaggerak and Cattegat, English Channel. Also in the northern and eastern part of the Florida Stream and coast of America.

Var. *heterocampta* (Text-figure 47c) Jörgensen, 1899 (*Ceratium heterocamptum* Paulsen, 1908, pp. 76–77). Like the type, but with the right hind horn so strongly bent inwards that the length is almost perpendicular to the apical horn. Length ca. 176μ.

Warm seas. Common on the west coast of Norway.

Ceratium gibberum Gourret (1883).

Text-figure 49a–49c.

Paulsen, 1908 ; Nordisches Plankton, p. 75.
Jörgensen, 1911, p. 49.

Large but short-horned species with thick body, little flattened. Epitheca low, left margin almost straight. Apical horn more or less bent below to the left, then almost straight, rather long, narrower towards the tip, provided below with short wing-like lists, which are often strengthened by transverse ribs. Hypotheca much longer than the epitheca, with a very oblique left margin. Hind margin strongly convex and more or less swollen out, the swelling not merging into the horns. Left hind horn strong, regularly bent at the tip, almost parallel with the apical horn. Right hind horn weaker and usually shorter, of very variable form ; always strongly bent forwards and ventrally, from the base outwards, then bent dorsally, either almost straight and more or less converging towards the apical horn, or strongly and obliquely bent towards it or even sometimes behind it. Structure of theca very variable ; large pores and irregularly anastomosing lists, which are either high and form few large meshes, or more rarely are numerous and form small reticulations.

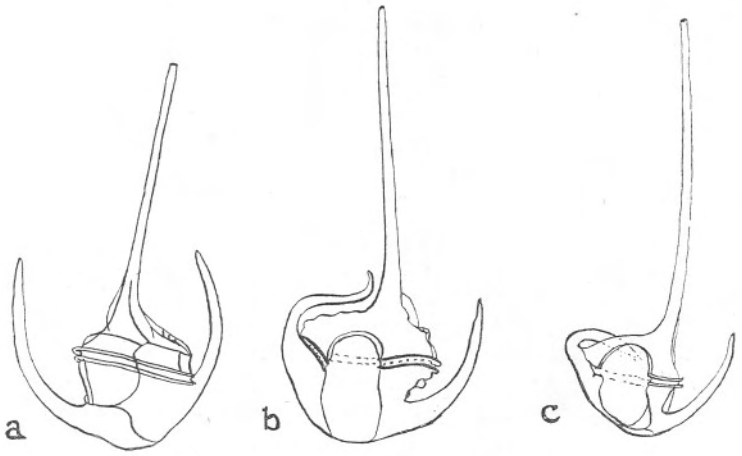


FIG. 49. *Ceratium gibberum* Gourret.

a. From Florida stream, East American coast.
b. var. *sinistra*, East coast of Spain.
c. (?) Size, var. *sinistra*, Gibraltar Straits.
} After Jörgensen 1911.

The form *sinistra* of Gourret has the right hind horn first directed ventrally, then bent towards the dorsal side and almost at a right angle to the apical horn, or even behind it, again bent back at the thin tip. Breadth 71–105μ.

Warm-water species, widely distributed. Seldom in the North and English Channel.

Ceratium platycorne von Daday (1888).

Text-figures 50a and 50b (see p. 154).

Paulsen, 1908; Nordisches Plankton, pp. 74–75.
Jörgensen, 1911, p. 58.

Body much longer than broad. Epitheca long and narrow, with not very convex sides. Hypotheca shorter than the epitheca, with straight or weakly concave sides. Hind margin somewhat convex, on both sides distinct from the horns. Apical horn rather long, straight or weakly bent, narrow towards the tip. Hind horns very strongly developed, alike at the base and at the body level bent forwards into broad flat plates which bend inwards on the inner side. Right hind horn from its origin directed a little forward. The similar bases of the hind horns are very short, much shorter than the very broad plate-like part. Sculpture usually inconspicuous, but there are some longitudinal ridges, and on the hind border spiny lists which run up the outside of the hind horns as far as about the middle, like fine seams. Breadth 48–64μ.

Rare warm-water species, sometimes in the North brought by the Gulf

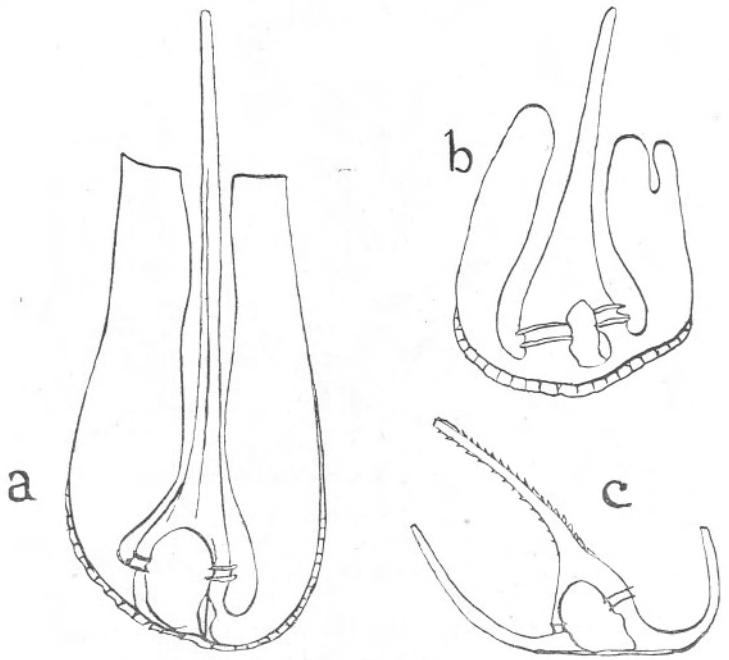


FIG. 50.

Ceratium platycorne v. Daday.

a. × 280, Atlantic Ocean. After Jörgensen, 1913.
b. (?) Size. From Paulsen, 1908 ; after Daday.
c. *Ceratium longipes* (Bailey) Gran.
× 150. After Ostenfeld, 1903.

Stream. In Paulsen's figure (1908) from v. Daday the left hind horn is bifurcate.

Ceratium lamellicorne Kofoid (1908).

Plate XXXIV, figure 1.

Jörgensen, 1911, p. 58.

Very similar to *C. platycorne*. Epitheca not so narrow ; hind horns narrower, similar at the base for a fairly long way, then broadening, but usually only to $1\frac{1}{2}$–2 as broad as at the base. These broad parts of the hind horns have their inner margins rather far away from the body, usually only a little longer to twice as long as the narrow base. Apical horn at the base not specially broad. The left hind horn is at its origin only slightly directed behind. Sometimes the left hind horn is bifurcate and then correspondingly broadened. Structure sometimes very strong ; distinct pores and rather numerous strongly developed bent ridges. Wing-like lists frequent. Horns usually short. Breadth 42–51μ.

South and North Atlantic, Azores, South-west Spain, Mediterranean, Indian Ocean, South Africa, California. A rare visitor in the North. Found occasionally at Plymouth.

(2) Horns normally open at the Tips.

Ceratium macroceros (Ehrenberg) (1840) Cleve.

Plate XXXV.

Paulsen, 1908; Nordisches Plankton, pp. 81–82.
Jörgensen, 1911, p. 63.

Medium-sized, long-horned species, the side horns open at the tips. Body very thick and concave, longer than broad. Epitheca not very deep, broad and depressed, with concave sides. Hypotheca somewhat longer than epitheca, with strongly oblique left side. Hind margin almost straight, on both sides making an oblique angle with the hind horns. Apical horn long, broad at the base, straight or slightly bent. Hind horns first diverging behind, then rather suddenly bent forward, diverging more or less from one another and from the apical horn; later they make a broad bow and are at the tips nearly or quite parallel with the apical horn. The right hind horn has its origin somewhat behind the girdle and is strongly ventrally directed. Theca sculpture strong, rather numerous irregularly bent longitudinal ridges and large pores. At the bends the hind horns are usually heavily toothed. Breadth 45–57μ.

A temperate Northern species, rather widely distributed in the North Atlantic, especially in the North Sea and neighbouring waters (Skaggerak, Kattegat), Norwegian Seas, English Channel. Also in the colder waters on the American side.

Sub-species *Gallicum* Kofoid is a smaller and slenderer species occurring in warmer seas.

Ceratium horridum Gran (1902).

Plate XXXIV, figure 2.

Ceratium intermedium Paulsen, 1908; Nordisches Plankton, p. 83.
Ceratium intermedium Jörgensen, 1902, 1911, p. 83.
Ceratium horridum Jörgensen, 1920.

Rather small or medium-sized species, short-horned and robust. Epitheca deeply triangular, with weakly convex sides. Hypotheca rather longer than the epitheca. Hind margin distinctly indented on the right, not distinctly on the left, almost straight or slightly convex, on the right making a more or less distinct angle with the hind horn. Apical horn in the lower third strongly developed and often slightly bent, usually straight towards the tip. Left hind horn directed obliquely to the left behind, then bent forward and either converging or diverging from the

apical horn. The right hind horn from its origin slightly directed behind, then bent forward and running nearly parallel to or slightly diverging from the apical horn. Theca sculpture not very apparent, but sometimes there are irregular ridges usually heavily toothed along the bends of the hind horns and the apical horn. Very variable species. Jörgensen (1911) includes several forms hitherto regarded as separate species under the name *C. horridum*, which Gran divides into a Northern and a Southern form. The present description refers to the Northern form, which amongst others includes Paulsen's form *frigida* and *C. batavum*. Breadth 42–47μ.

A Northern temperate form from the English Channel to the north of Norway, North Sea, Skaggerak, Baltic, Norwegian Seas.

Paulsen (1907) describes a long-horned form *frigida* in spring from the North Sea and the Kattegat.

Ceratium longipes (Bailey) (1854) Gran.

Plate XXXI, figure 2, Text-figure 50c.

Paulsen, 1908; Nordisches Plankton, pp. 85–86.
Jörgensen, 1911, p. 84.

Medium-sized or rather small species, with strongly bent apical horn. Epitheca almost triangular, with strongly convex left and less convex right side. Hypotheca longer than epitheca, usually distinctly broadened behind, which gives the whole body a triangular appearance. Hind margin usually not, or very little, sunk in, the left more distinctly than the right coming off at an angle from the hind horn, usually a little convex. All horns strong, towards the tips very narrow, open. Apical horn more or less strongly bent. Left hind horn first obliquely directed behind, then similarly bent forward. The right hind horn usually a little longer, at its origin directed almost straight, then quickly bent forward. The tips of the apical and right horns usually about parallel or converging slightly; the tips of apical and left horn diverging. The hind horns are usually shorter than the apical. Theca sculpture usually strong, numerous coarse ridges and pores present. Along the apical horn and the convex outer parts of the hind horns the lists are more or less toothed. Very variable species. Breadth 51–57μ.

A North Atlantic form which inhabits the rather cold water mixing between the Arctic Stream and the temperate water of the Atlantic. English Channel northwards. Common at Port Erin, Isle of Man.

Jörgensen recognises two varieties:—var. *Baltica* Ostenfeld (1903), a very large form with thick apical horn with toothed lists, and var. *ventricosa* Ostenfeld (1903), which is more like *C. horridum* in some ways, but has the much bent apical horn.

Ceratium arcticum (Ehrenberg) Cleve.

Plate XXXI, figure 3.

Paulsen, 1908; Nordisches Plankton, pp. 86–87.
Jörgensen, 1911, p. 85.

Medium-sized species with horns very far apart, otherwise similar to *C. longipes*. Body as broad as long, or even a little broader. Epitheca with very convex sides. Hypotheca much longer than the epitheca, left side almost straight, not obliquely placed, but parallel to the girdle and about parallel to the lower part of the apical horn. Hind margin somewhat convex, not sunk in. The apical horn strongly bent as in *C. longipes*. Left hind horn at the base obliquely directed behind (but less obliquely than in *C. longipes*), uniformly bow-shaped, but rather slightly bent. Right hind horn springing almost straight, but bent forward slightly. Apical horn strongly bent. The three horns strongly diverging, the apical and right horn least. Theca sculpture generally very strong, numerous irregularly bent ridges present. Along the apical horn and the convex sides of the hind horns are usually relatively broad, spiny or strongly toothed wing-like lists. On the hind margin are three usually distinct, ridged lists, of which the left is the largest. Breadth 48–60μ.

Cold-water form. Common in the Newfoundland Bank, northern Norwegian Seas and North Atlantic; rare on the west coast of Norway and North Sea. Occasionally in the English Channel and Irish Seas. Also rarely as far south as Gibraltar and the Azores, Japan.

Ceratium reticulatum (Pouchet) Cleve.

Text-figure 51 (see p. 158).

Paulsen, 1908; Nordisches Plankton, pp. 82–83.
Jörgensen, 1911, p. 86.

Large and very long-horned form. Body concave, about as long as broad, or a little longer. Epitheca not very deep, rather low (short), with slightly convex sides. Left side of the hypotheca nearly straight. All three horns very long, slender, thin-walled and bent in different directions, none lying in the body plane. Hind margin convex, on both sides of the hind horns indented, but not forming a distinct angle with them, not, or only slightly, sunk in. Apical horn nearly straight or rather strongly bent, directed ventrally for the first third, then bent back. Left hind horn at the base directed slightly behind, then strongly bent forwards, then nearly straight and converging towards the apical horn and also ventrally directed. Right hind horns issuing from a little behind the girdle, only directed at a right angle towards the apical horn, drawn out to a slender end, usually directed dorsally and forward. Theca

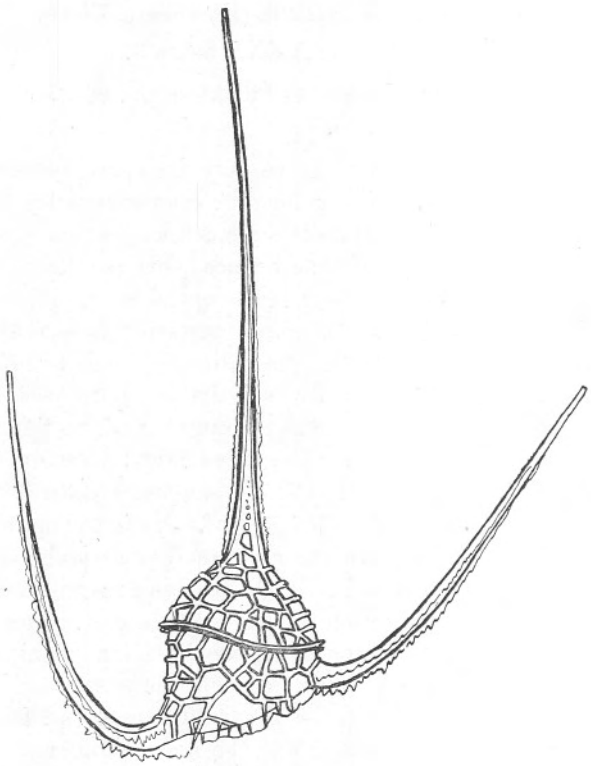


FIG. 51. *Ceratium reticulatum* (Pouchet) Cleve.
× 186. English Channel. From drawing by Mrs. Sexton.

reticulated by large crossing ridges. Proximal part of the hind horns usually with spiny lists and a large spiny list along the hind margin. Breadth 75–85μ.

Warm-water species. Atlantic, Indian Ocean, Mediterranean, Florida Stream, English Channel.

Jörgensen recognises two forms: f. *contorta* Lemmermann (1900) and f. *spiralis* Kofoid (1907).

FORMS WITH NO APPARENT GIRDLE.

Genus **Podolampas** Stein.

Cell somewhat pear-shaped. In front drawn out into a more or less distinct apical horn that ends in an apical pore. Girdle not apparent, but probably fused with the adjacent precingular plates. In the ventral area lies the flagellar pore. Two strong antapical spines support transverse wings, the left being the continuation of the wing of the ventral

area. The plates (Text-figure 53), as worked out by Kofoid (1909) for *P. elegans*, are *2 apicals, 1 anterior intercalary, 6 precingulars, 3 postcingulars, 4 antapicals*, or *2′ 1a 6″ 3‴ 4⁗*. The Northern members of the genus have not been so minutely investigated. Pores highly differentiated and correlated, with much internal differentiation and distribution and movements of the plasma.

Species :—*Podolampas palmipes* Stein, *P. bipes* Stein.

Podolampas palmipes Stein (1883).

Text-figure 52a.

Paulsen, 1908; Nordisches Plankton, p. 92.

Cell a long pear-shape, narrow, in front gradually narrowing into a slender horn. Left antapical spine much longer than the right. Wings of the spines fused with one another. Transverse seam (representing the girdle) often broad. Length ca. 80–100μ.

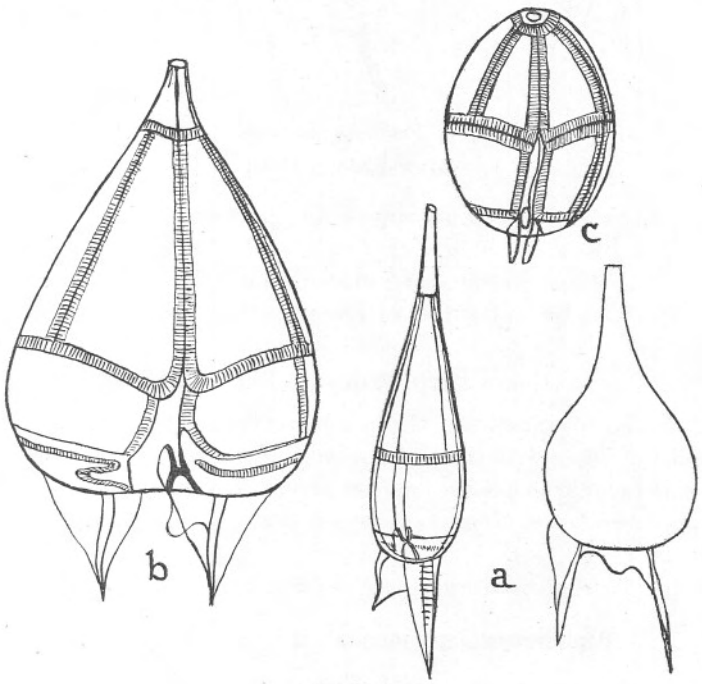


FIG. 52.

a. *Podolampas palmipes* Stein.
Left, after Stein. Right, after Schütt.

b. *Podolampas bipes* Stein.
After Stein.

c. *Blepharocysta splendor-maris* Ehrenberg.
After Stein.

Sub-tropical, Atlantic species, often brought to the North by the Gulf Stream.

Podolampas bipes Stein (1883).

Text-figure 52b.

Paulsen, 1908; Nordisches Plankton, pp. 92–93.

Cell broadly pear-shaped, in front slightly drawn out into a short horn.

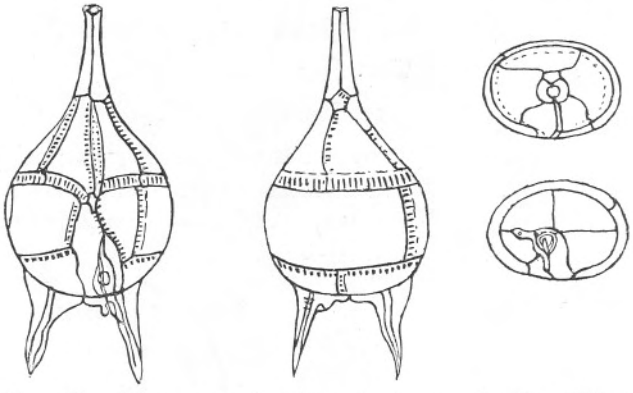


FIG. 53. Diagram of *Podolampas elegans*, showing plates. After Kofoid, 1909.

Antapical spines about equal, the wings not fused. Intercalary striae broad. Length ca. 86–107μ.

Tropical species. Pacific and Indian Oceans, Mediterranean. Seldom in the North, as far as the Bay of Biscay.

Genus **Blepharocysta** Ehrenberg.

Cell circular to ellipsoidal. Girdle apparently absent as in Podolampas, but probably fused with the precingulars. No furrow. Ventral area with furrows between which is the flagellar pore. Plate formula : *2 apicals, 1–2 anterior intercalaries, 6 precingulars, 3 postcingulars, 3* (?) *apicals,* or *2′ 1–2a 6″ 3‴ 3⁗* (?).

One species :—*Blepharocysta splendor-maris* Ehrenberg.

Blepharocysta splendor-maris Ehrenberg (1873).

Text-figure 52c.

Paulsen, 1908; Nordisches Plankton, p. 93.

Cell oval. Ventral area narrow. Oar-like processes conspicuous at the antapex. Theca punctured. Intercalary striae broad. Length ca. 52–56μ.

Warm seas. Stein records it from Heligoland.

APPENDIX

METHODS OF COLLECTING AND EXAMINING DINOFLAGELLATES

To collect marine dinoflagellates a tow-net is used made of very fine silk (180 strands to the inch), the catch being rinsed into a glass jar and examined alive under the microscope. The naked forms do not bear preservation as a general rule, as they are excessively delicate ; but those which possess a theca can be preserved in 5% formalin or in Fleming's solution (by adding 10 cc. of strong Fleming solution—15 vols. 1% chromic acid, 4 vols. 2% osmic acid, 1 vol. glacial acetic acid—to 250 cc. of the sample).

A very good way of collecting the smaller species is to take a dip in the sea with a glass bottle and centrifuge part of it. A small hand centrifuge is quite sufficient for this purpose. The centrifuge tubes should be pointed at the ends, so that the bulk of the water may be poured away after centrifuging, leaving at the base of the tube the solid matter, including any dinoflagellates, which may then be pipetted off on to a glass slide. Each tube should hold about 10 cc., two or four being used at one time, and the sample centrifuged for from 5–10 minutes.

Special water bottles are used for procuring specimens of sea-water from various depths.

The water up estuaries may often be green or brown from the presence of dinoflagellates, which can then be collected in thousands by one dip with a cup or small jar.

On sandy beaches green or brown patches left by the tide should be examined for the sand-loving forms, which may occur in millions in such situations.

All material should be examined first alive whenever possible. This is the only satisfactory method for the naked forms, and examination of the samples should be undertaken as soon as possible after capture, as they are so delicate that the smallest accident kills them, and very often a specimen whilst under observation will collapse altogether.

For examination of the plates of the thecate forms the specimens should be treated with a suitable reagent to clear away the cell contents and, if possible, loosen the plates from one another. Eau de Javelle is good for this ; caustic potash is also used. Stains may be used with the

potash or separately, aniline dyes being best. Personally I have found Trypan Blue, used alone, to be excellent. It stains the theca a clear blue and shows up the sutures between the plates in a perfect manner, esp ecially in the thin-walled species such as *Kryptoperidinium foliaceum*, where no structure can be made out at all without treatment.

Simple cultures of holophytic dinoflagellates can be made in filtered sea-water, using Petri dishes or small flasks. Oxyrrhis can be cultured by giving it diatoms (Nitzschia) to eat. The colourless forms are usually more difficult, although small purely saprophytic species will live and multiply if given a small piece of decaying matter, such as a piece of mollusk.

Some species can be kept for days in a drop of water if prevented from drying up, and much of the life-history of such forms as *Gymnodinium lunula* can be followed through various phases of division.

LITERATURE

ALLEN, W. E. 1922. Quantitative Studies on Inshore Marine Diatoms and Dinoflagellates of S. California.
Univ. Cal. Pub. Zoology, XXII, No. 5.

BAILEY, J. W. 1855. Notes on New Species and Localities of Microscopic Organisms.
Smithsonian Contr. Knowl., Washington, VII.

BARROWS, A. L. 1918. The Significance of Skeletal Variations in the Genus Peridinium.
Univ. Cal. Pub. Zoology, Vol. 18, No. 15.

BERGH, R. S. 1881. Der Organismus der Cilioflagellaten.
Morph. Jahrb., Leipzig, 7.

BORGERT, A. 1898. Beiträge zur Kenntnis des in *Sticholonche zanclea* und Acanthometridenarten vorkommenden Parasiten (Spiralkörper Fol. Amoebophrya Köppen).
Zs. Wiss. Zool., Leipzig, Bd. 63.

BREEMEN, P. J. VAN. 1905. Plankton van Noordzee en Zuiderzee.
Tijdschr. Ned. Dierk. Ver., Helder, 1905.

BROCH, H. J. 1908. Planktonstudien an der Mündung der Ostsee im Juli, 1907.
Göteborg.

—— 1910. (*a*) Die Peridinium—Arten des Nordhafens (val di Bora) bei Rovigno im Jahre 1909.
Arch. Protistenkunde, XX, Jena.

—— 1910. (*b*) Das Plankton des schwedischen Expedition nach Spitzbergen, 1908.
K. Svenska Vet.—Ak. Handl., Stockholm, 45, No. 9.

BÜTSCHLI, O. 1873. Einiges über Infusorien.
Arch. Micr. Anat., IX, Bonn.

—— 1885. Dinoflagellata (Bronn's Klassen und Ordnung des Thier-Reichs), Leipzig and Heidelberg.

CHATTON, E. 1920. Les Péridiniens parasites.
Arch. Zool., Paris, T. 59, March.

CIENKOWSKI, L. 1881. Bericht über eine Exkursion ins weisse Meer im Jahre 1880 (in Russian).
Trav. Soc. Nat., Petrograd, XII, 1.

CLAPARÈDE AND LACHMANN. 1858–61. Études sur les infusoires et les rhizopodes, 2.
Mém. Inst. Nat. Genève, V, VI, VII.

CLEVE, P. T. 1897. A Treatise on the Phytoplankton of the Atlantic and its Tributaries.
Upsala.

—— 1900. Notes on some Atlantic Plankton Organisms.
K. Svenska Vet. Ak. Handl., Stockholm, 34, No. 1.

DADAY, J. von. 1888. Systematische Uebersicht der Dinoflagellaten des Golfes von Neapel.
Termt. Közl., Budapest, XI.

DANGEARD, P. 1923. Coloration vitale de l'appareil vacuolaire chez les Péridiniens.
C. R., Acad. Sci., Paris, T. 177, No. 20.

DIESING, K. M. 1866. Revision der Prothelminthen.
SitzBer. Ak. Wiss., Wien, 52.

DOGIEL, V. 1906. Beiträge zur Kenntnis der Peridineen.
Mitt. Zool. Stat, Neapel, Bd. 18.

DUJARDIN, F. 1841. Histoire Naturelle des Zoophytes, etc.
Suites à Buffon. (Paris, Roret.)

EHRENBERG, C. G. 1839. Ueber noch jetzt zahlreich lebende Thierarten der Kreidebildung und den Organismus der Polythalmien.
Abh. Ak. Wiss., Berlin.

—— 1840. Beobachtung von 274 Infusonienarten.
Bericht über Verhandl. d. Berliner Akad. d. Wissens.

—— 1859. Über des Leuchten und über neue mikroskopische Leuchthiere des Mittelmeeres.
Monatsber. der Berliner Akad. d. Wissensch.

—— 1873. Die das Funkeln und Aufblitzen des Mittelmeeres bewerkenden unsichtbar Kleinen Lebensformen.
Festschrift z. Feier d. 100 Jährigen Bestehens d. Ges. Naturforsch. Freunde zu Berlin, 1–4.

ENTZ, G. 1906. Beiträge zur Kenntnis des Planktons.
Res. Wiss. Erf. des Balatonsees, Wien.

—— 1907. A Peridenéak szervezetéröl (Die Organisation der Peridinien).
Különlenyomat az állattani Közleměnyak, Budapest, VI, 1.

—— 1921. Ueber die mitotische Teilung von *Ceratium hirundinella*.
Arch. Protistenkunde, Bd. 2, 3 ; Hft. 3.

—— 1921–24. On Chain Formation in *Ceratium hirundinella*.
Biologica Hungarica, Vol. I, f. 3.

FABRE-DOMERGUE. 1889. Note sur une nouvelle forme de Colpode (*C. Henneguyi*) et sur un Flagelle pelagique.
Ann. de Micrographie I, 1888–89.

FAURÉ-FREMIET, E. 1908. Études descriptive des Péridiniens et des infusoires Ciliés.
Ann. Sci. Nat. (Zool.), Paris, N.S., T. VII.

—— AND PUIGANDEAU, O. 1922. Le Microplankton de la Baie de la Croisic.
Bull. Soc. Zool., Paris, T. XLVII.

—— —— 1923. Le Microplankton de la Baie de la Croisic, II, Genre Dinophysis Ehrbg.
Bull. Soc. Zool., Paris, T. XLVIII.

FORTI, A. 1922. Ricerche sur la flora pelagica (fitoplancton) di Quarto dei Mille (Mare Ligure).
R. Comitato Talassografico italiano, Mem. XCVII.

GOURRET, P. 1883. Sur les Péridiniens du Golfe de Marseille.
Ann. Mus. Hist. Nat., Marseille ; Zoology I.

GRAN, H. H. 1900. Hydrographical-biological Studies of the North Atlantic Ocean and the Coast of Nordland.
Rep. Norweg. Fisheries and Marine Investigations, I, No. 5

—— 1902. Des Plankton des norwegischen Nordmeeres.
Rep. Norweg. Fisheries and Marine Investigations, II, No. 5.

—— 1915. The Plankton Production in the North European Waters in the Spring of 1912.
Bull. Plank. for 1912. Cons. Perm. int. p. l'Explor. de la Mer Copenhagen.

HALL, R. P. 1924. Binary Fission in *Oxyrrhis marina* Dujardin.
Univ. Cal. Pub. Zoology, Vol. XXVI, No. 16.

HERDMAN, W. A. 1911. On the Occurrence of *Amphidinium operculatum* Clap. and Lach., in vast quantity at Port Erin, Isle of Man.
J. Linn. Soc. Zool., London, Vol. XXXII, No. 212.

HERDMAN, C. E. 1921. Dinoflagellates and other Organisms causing Discoloration of the Sand.
Trans. Liverpool Biol. Soc., 35.

—— 1922. Notes on Dinoflagellates and other Organisms causing Discoloration of the Sand at Port Erin.
Trans. Liverpool Biol. Soc., 36.

—— 1923. Notes on Dinoflagellates and other Organisms causing Discoloration of the Sand at Port Erin, III.
Rep. Oceanography Department of the University of Liverpool.

—— 1924. Notes on Dinoflagellates and other Organisms causing Discolouration of the Sand at Port Erin, IV.
Trans. Liverpool Biol. Soc., 38.

HIRASAKA, R. 1922. A Case of Discoloured Sea water.
Annot. Zool. Jap., Tŏkyo, Vol. X, Art. 15.

HOVASSE, R. 1923. Les Péridiniens intracellulaires—Zooxanthelles et Syndiniums—chez les Radiolaires coloniaux. Remarques sur la reproduction des Radiolaires.
Bul. Soc. Zool., Paris, T. XLVIII, 4–5.

HUITFELD-KAAS, H. 1900. Die Limnetischen Peridineen in norwegischen Binnensee.
Vid. Skr. I, Math-naturw. Klasse, Christiania.

JOLLOS, V. 1910. Dinoflagellatenstudien.
Arch. Protistenkunde ; Jena, Vol. XIX.

JORGENSEN, O. 1918. Occurrence of *Amphidinium operculatum* at Cullercoats.
Rep. Dove Marine Laboratory for 1918.

JÖRGENSEN, E. 1899. Protophyten und Protozoen im Plankton aus der Norwegischen Westküste.
Bergens Mus. Aarb., VI.

—— 1911. (*a*) Die Ceratium Eine Kurze Monographie der Gattung Ceratium Schrank.
Biol. Supp. zur Intern. Rev. Hydrobiol., Leipzig, 2nd Ser.

JÖRGENSEN, E. 1911. (*b*) Ceratium, in Résumé des Observations sur le Plankton des mers explorés, 1902–08.
Bull. trim. du Conseil perm. intern. p. l'explor. de la mer, II, Copenhagen.

—— 1912 or 1913. Bericht über die von der schwedisches hydrographisch—biologischen Kommission in dem schwedischen Gewässern in den Jahren 1909–10 eingesammelten Planktonproben.

—— 1920. Mediterranean Ceratia.
Rep. on the Danish Oceanographical Expedition, 1908–10.

—— 1921. Mediterranean Dinophysiaceae.
Rep. on the Danish Oceanographical Expedition, 1908–10.

KARSTEN, G. 1906. Das Phytoplankton des Atlantischen Oceans nach dem Material der deutschen Tiefsee Expedition, 1898–99.
Deutsche Tiefsee-Exp., 1898–99, Bd. II, 2 Teil.

KLEBS, G. 1912. Ueber Flagellaten und Algenähnliche Peridineen.
Verh. Naturhist, Heidelberg, N.F., Bd. 11.

KOFOID, C. A. 1907 (*a*) On *Ceratium eugrammum* and its related species.
Zool. Anz., Leipzig, Bd. XXXII, No. 1.

—— 1907. (*b*) The Plates of Ceratium, with a Note on the Unity of the Genus.
Zool. Anz., Leipzig, Bd. XXXII, No. 7.

—— 1907. (*c*) Dinoflagellates of the San Diego Region, III, Description of New Species.
Univ. Cal. Pub. Zoology, III, No. 13.

—— 1907. (*d*) The Structure and Systematic Position of Polykrikos Bütsch.
Zool. Anz., Leipzig, Bd. XXXI, Nos. 9/10.

—— 1907. (*e*) New Species of Dinoflagellates.
Bull. Mus. Comp. Zool., Cambridge, Mass., Vol. I, No. 6.

—— 1909. (*a*) The Morphology of the Skeleton of Podolampas.
Arch. Protistenkunde, Jena, XVI.

—— 1909. (*b*) On *Peridinium Steinii* Jörgensen, etc.
Arch. Protistenkunde, XVI.

—— 1911. Dinoflagellata of the San Diego Region. IV. The Genus Goniaulax, etc.
Univ. Cal. Pub. Zoology, Vol. 8, No. 4.

KOFOID, C. A. AND MICHENER. 1912. On the Structure and Relationships of *Dinosphaera palustris* (Lemm.).
Univ. Cal. Pub. Zoology, 11.

—— AND SWEZY. 1921. The Free-living Unarmoured Dinoflagellata.
Mem. of the Univ. of California, V.

KÖPPEN, N. 1894. *Amoebophrya Stycholonchae* nov. gen. et. sp. (Corps spiral de Fol).
Zool. Anz., XVII.

KÜSTER. 1908. Eine Kultivierbar Peridineae.
Arch. Protistenkunde, 11.

LEBOUR, M. V. 1917. The Peridiniales of Plymouth Sound from the Region beyond the Breakwater.
J. Mar. Biol. Ass., Plymouth, XI, 2.

—— 1922. Plymouth Peridinians, I, II, III.
J. Mar. Biol. Ass., Plymouth, XII, 4.

—— 1923. Plymouth Peridinians, IV.
J. Mar. Biol. Ass., Plymouth, XIII, 1.

LEMMERMANN, E. 1896. Zweiter Beitrag zur algenflora des Plöner Seengebietes.
Forsch. Biol. Stat. Plön., Part 4, Berlin.

—— 1900. Peridiniales aquae dulcis et submarinae.
Beitz. z. Kennt. d. Planktonalgen. Hedwigia 39. Beibl. N. 4.

—— 1902. Des Phytoplankton des Meeres. II Beitrag.
Abh. Naturw. Ver., Bremen, XVII.

—— 1904. Das Plankton schwedischer Gewässer.
Ark. Botanik, Bd. 2, No. 2, Stockholm.

—— 1910. Beitrage zur Kenntnis der Plankton.
Algen. XXX. *Peridinium trochoideum* (Stein), Lemm. nob.
Arch. Hydrobiol., Stuttgart, V. 4.

LEVANDER, K. M. 1894. *Peridinium catenatum*, n.sp. Eine Kettenbildende Peridinee im Finnischen Meeresbusen.
Acta Soc., Fauna Flora, Fenn., Vol. X, 9.

—— 1894. Materialen zur Kenntnis der Wasserfauna in der Umgebung von Helsingfors, mit besonderer Berucksichtigung der Meeresfauna. I. Protozoa.
Acta Soc., Fauna Flora, Fenn., Vol. XII, 2.

LEVANDER, K. M. 1902. Eine neue farblose Peridinium Art.
Acta Soc., Fauna Flora, Fenn., No. 11, 28 bd.

LINDEMANN, E. 1923. (*a*) Der Bau der Hülle bei Heterocapsa und *Kryptoperidinium foliaceum* (Stein), n.nom. (Advance reprint.)
(Zugleich eine vorläufige Mittheilung.) Botanisches Archiv.

—— 1923. (*b*) Ueber Peridinean einiger Seen Suddeutschlands und des Alpengebietes.
Schriften für Süsswasser—und Meereskunde, Hft. 10.

—— 1924. Peridineen der Konstantinopeler Gewässer.
Botanisches Archiv., 1924, Bd. V, Hft. 34 (Feb.).

LOHMANN, H. 1908. Untersuchungen zur Feststellung des vollständigen Gehaltes des Meeres am Plankton.
Wiss. Meeres, Kiel, N.F., X.

MACARTNEY, J. 1910. Observations upon Luminous Animals.
Phil. Trans. R. Soc., London, 1910, Pt. I.

MANGIN, L. 1911. Modifications de la Cuirasse chez quelques Péridiniens.
Intern. Rev. Hydrobiol., Leipzig, Bd. IV.

—— 1912. Phytoplancton de la croissance du René dans l'Atlantique.
Ann. Inst. Oceanog., Paris.

—— 1913. Sur la flore planctonique de la rade de St. Vaast-la-Hougue, 1908–1912.
Nouv. Arch. Mus. Hist. Nat., Paris, 5^{e} Série. V.

MARSHALL, S. M. 1925. On *Protoerythropsis vigilans*, n.sp.
Q. J. Microsc. Sci., London, N.S. No. 274, Vol. 69, Pt. II.

MERESCHKOWSKY, C. 1879. Studien über Protozoen des Nördlichen Russland.
Arch. mik. Anat., Bonn, XVI.

MEUNIER, A. 1910. Microplankton des mers de Barents et de Kara. Duc d'Orleans : Campagne Arctique de 1907.

—— 1919. Microplancton de la Mer Flamande. 3. Les Péridiniens.
Mem. Mus. Roy. Hist. Nat. Bruxelles 8, No. 1, Brussels.

MÜLLER, JOH. 1841. Ueber den Bau des Pentacrinus caput Medusae.
Abhandl. Ak. Wiss., Berlin.

MÜLLER, O. F. 1777. Zoologiae danicae prodromus. Hauniae.

—— 1786. Animalcula, Infusoria fluviatilia et marina ; opus posthumum cura O. Fabricii. Hauniae.

MURRAY, J., AND HJORT, J. 1912. The Depths of the Ocean. London.

MURRAY, G., AND WHITTING, F. G. 1899. New Peridiniaceae from the Atlantic.
Trans. Linn. Soc., London, 2 Sec., Bot. V.

OSTENFELD, C. H. 1901. Phytoplankton fra det Kaspike Hav.
Videns. Medd. nat. For., Kjöbenhavn.

—— 1903. Phytoplankton from the Sea around the Faroes.
Botany of the Faroes.

—— 1906. Plankton Vegetal. In. Catalogue des espèces, etc. Conseil permanent, etc.
Publications de Circonstance, 33. Copenhagen.

—— 1908. The Phytoplankton of the Aral Sea and its affluents, etc.
St. Petersburg.

—— 1915. A List of Phytoplankton from the Boeton Strait, Celebes.
Dansk. Bot. Archiv. II, No. 4, Copenhagen.

PASCHER, A. 1923. Kleinere Mitteilungen. Neue oder wenig bekannte Protistein VIII. Neue oder wenig bekannte Flagellaten VII.
Arch. Protistenkunde. Jena, Bd. 46, Hft. 1.

PAULSEN, OVE. 1904. Plankton investigations in the Waters round Iceland in 1903.
Medd. Havunders., Kjöbenhavn, Ser. Plankton, Bd. 1, No. 1.

—— 1905. On some Peridiniae and Plankton Diatoms.
Ibid., Bd. I, No. 3.

—— 1907. The Peridiniales of the Danish Waters.
Ibid., Bd. I, No. 5.

—— 1908. Nordisches Plankton, XVIII. Peridiniales.

—— 1911. Marine Plankton from the East Greenland Sea. III. Peridiniales.
Medd. Gronl., Kjöbenhavn, XLIII.

—— 1912. Peridiniales Ceterae.
Bull. Trim, etc., publié par le bureau du conseil perm. int. p. l'expl. de la Mer, résumé planktonique, Part 3, Copenhagen.

PAVILLARD, J. 1905. Recherches sur la flore pélagique de l'étang de Thau.
Trav. Inst. Bot. Univ. Montpellier, Cette.

PAVILLARD, J. 1912. A propos du *Diplopsalis lenticula* Bergh.
C.R. Acad. Sci., Paris, 155. July 8th.

—— 1913. Le Genre Diplopsalis Bergh et les Genres voisins.
Montpellier, July, 1913.

—— 1916. Recherches sur les Péridiniens du Golfe de Lion.
Trav. Inst. Bot. Univ., Montpellier, Cette, S. mixte, Mem 4. March, 1916.

—— 1917. (*a*) Un Flagelle pélagique aberrant, le *Pelagorhynchus marinus*.
C.R. Acad. Sci., Paris, T.164. Jan. 29.

—— 1917. (*b*) Protistes nouveaux un peu connus du Plankton Méditerraneen.
Ibid. June 11.

—— 1921. Sur le *Gymnodinium pseudonoctiluca* Pouchet.
Ibid., T. 172. April 4.

—— 1922. Pronoctiluca et Noctiluca.
Bull. Soc. Bot. France, 69, 4me Série, T. XXII.

PENARD, E. 1891. Les Peridiniaceae du Leman.
Bull. Soc. Bot. Genève 6, 1891.

POUCHET, G. 1883. Contribution à l'histoire naturelle des cilio-flagelles.
J. Anat. Physiol., Paris.

—— 1885. (*a*) Novelle Contribution à l'histoire des Péridiniens marins.
Ibid.

—— 1885. (*b*) Troisième Contribution à l'histoire des Péridiniens.
Ibid.

—— 1887. Quatrième Contribution à l'histoire des Péridiniens.
Ibid.

—— 1892. Cinquième Contribution à l'histoire des Péridiniens.
Ibid.

—— 1894. Plankton (Voyage de *La Manche* à l'île Jan-Mayen et au Spitzbergen). Paris.

SAVILLE-KENT. 1880–82. A Manual of the Infusoria, London.

SCHILLER, JOS. 1918. Kleinere Mitteilungen Ueber neue Prorocentrum und Exuviella arten aus der Adria.
Arch. Protistenkunde, Bd. 38, Hft. 2.

SCHILLING, A. J. 1913. Dinoflagellatae (Peridineae) Die Süsswasser Flora Deutschlands. Hft. III, Jena.

SCHÜTT, FR. 1895. Die Peridineen den Plankton Expedition I. Ergebnisse der Plankton-Expedition, Kiel and Leipzig.

—— 1896. Peridiniales.
Engler u. Prantl. Die Nat. Pflanzenfam. I, B., Leipzig.

STEIN, F. von. 1883. Der Organismus der Infusionstiere III, 2. Die Naturgeschichte der Arthrodelen Flagellaten.
Leipzig.

STORROW, B. 1913. Faunistic Notes.
Rep. Dove Marine Laboratory for 1912.

VANHÖFFEN, E. 1897. Die Fauna und Flora Grönlands.
(Grönland Exp. der Gesellsch. für Erdkunde zu Berlin. II.)

WEST, G. S. 1916. Algae, Vol. I, including Peridinieae.
Cambridge Botanical Handbooks.

WHITEHEAD. 1914. Notes.
Rep. Dove Marine Laboratory for 1913.

WOLOSZYNSKA, J. 1917. New Species of Peridineae, with remarks on the structure of the outer Membrane in Gymnodinium and Glenodinium.
Bull. Acad. Sci., Gracovie, 57, S.B.

WULFF, A. 1916. Ueber des Kleinplankton der Barentssee.
Wiss. Meeresunters., Kiel, N.F., Bd. XIII, Abt. Heligoland, Heft 1.

ZEDERBAUER, E. 1904. Geschlechtliche und ungeschlechtliche Fortpflanzung von *Ceratium hirundinella*.
Bericht d. deutschen Bot. Gesellsch, XXII, Berlin.

PLATES

PLATE I

FIG. 1. *Exuviella marina* Cienk.

(*a b*) 36μ long, Plymouth Sound. (*c*) 42μ long, Port Erin, Isle of Man. (*d*) Port Erin, Isle of Man, encysted and dividing.

FIG. 2. *Exuviella compressa* (Bailey). Ostenfeld.

34μ long, Plymouth Sound.

FIG. 3. *Exuviella perforata* Gran.

22μ long, Plymouth Sound. (*a*) side view. (*b*) ventral view. (*c*) anterior end, much enlarged.

FIG. 4. *Exuviella apora* Schiller.

Yealm Estuary, near Plymouth. (*a*) and (*b*) 16μ long; side and ventral views. (*c*) 22μ long. Alive.

FIG. 5. *Prorocentrum micans* Ehrenberg.

37μ long, Plymouth Sound. (*a*) side view. (*b*) dividing. (*c*) right valve, showing sculpture.

FIG. 6. *Oxyrrhis marina* Dujardin.

33μ long. From culture in Plymouth Laboratory. (*a*) ventral. (*b*) side view. (*c*) from below. (*d*) dividing. (*e*) containing Nitzschia.

PLATE I

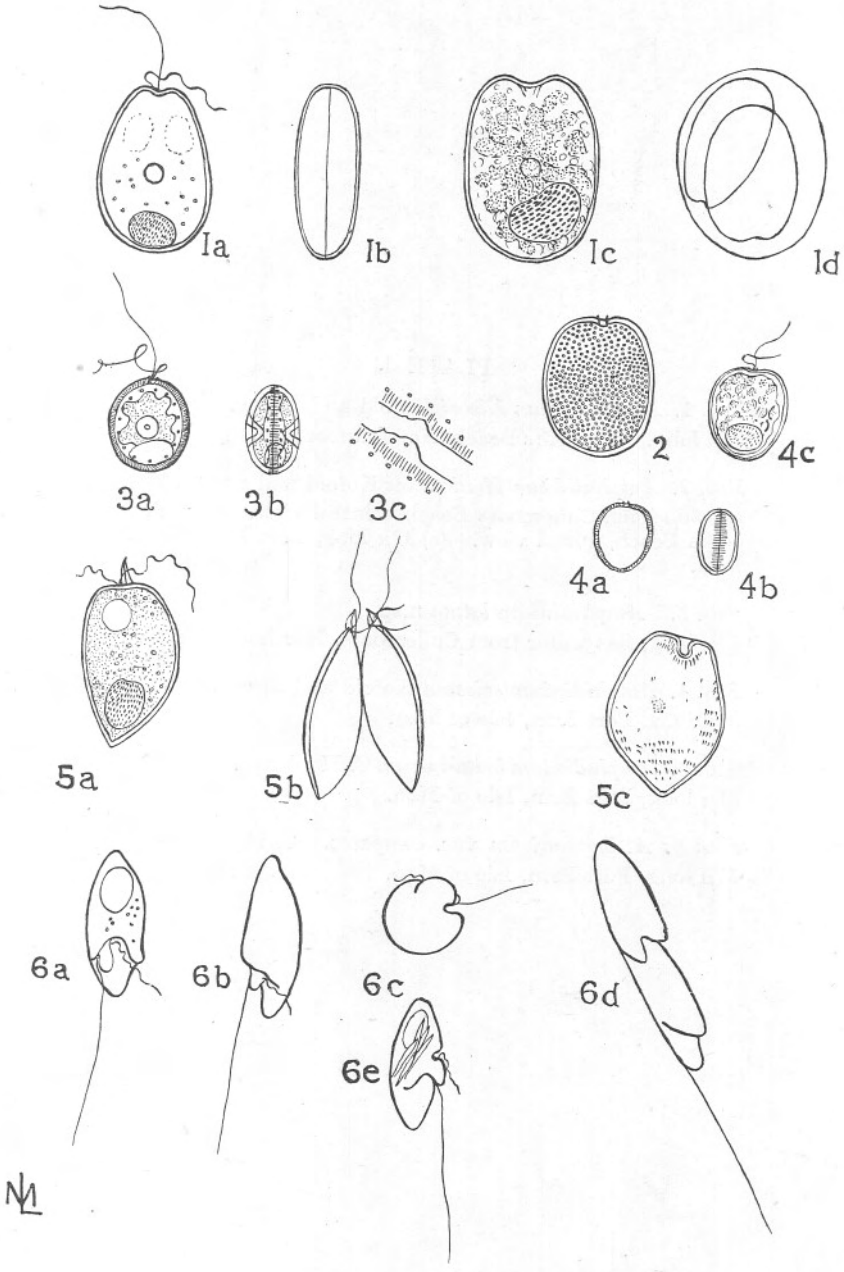


PLATE 11

FIG. 1. *Amphidinium Klebsi* Kofoid and Swezy.
36μ long, Cullercoats Beach, Northumberland.

FIG. 2. *Amphidinium Herdmanni* Kofoid and Swezy.
(*a*) 30μ long, Cullercoats Beach, ventral view. (*b*) Cullercoats Beach, dorsal view. (*c*) 33μ long, Port Erin, Isle of Man.

FIG. 3. *Amphidinium latum* n.sp.
19μ long, Sea water from Cullercoats, Northumberland.

FIG. 4. *Amphidinium scissum* Kofoid and Swezy.
56μ long, Port Erin, Isle of Man.

FIG. 5. *Amphidinium britannicum* C. Herdman.
51μ long, Port Erin, Isle of Man.

FIG. 6. *A. britannicum* var. *compacta*. C. Herdman.
37μ long, Port Erin, Isle of Man.

PLATE II

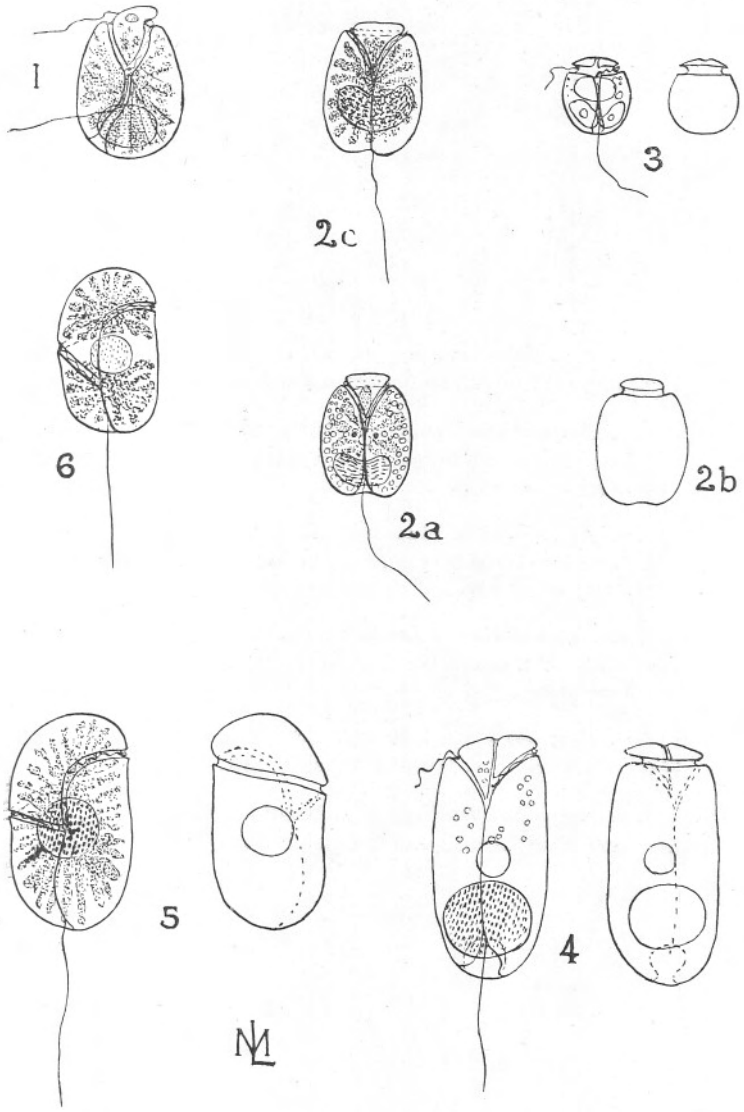


PLATE III

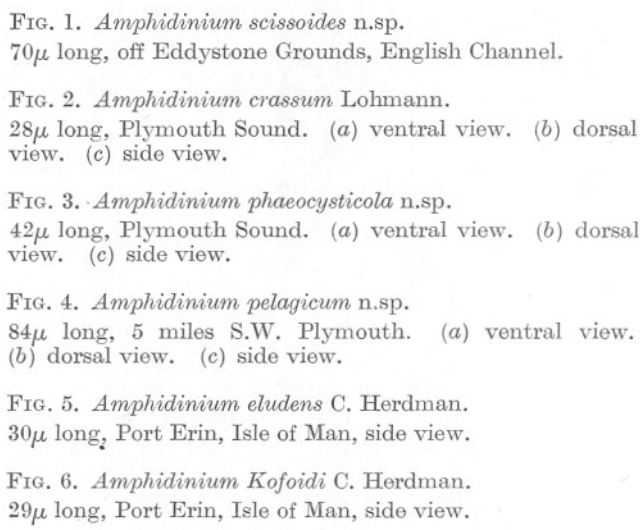


FIG. 1. *Amphidinium scissoides* n.sp.
70μ long, off Eddystone Grounds, English Channel.

FIG. 2. *Amphidinium crassum* Lohmann.
28μ long, Plymouth Sound. (*a*) ventral view. (*b*) dorsal view. (*c*) side view.

FIG. 3. *Amphidinium phaeocysticola* n.sp.
42μ long, Plymouth Sound. (*a*) ventral view. (*b*) dorsal view. (*c*) side view.

FIG. 4. *Amphidinium pelagicum* n.sp.
84μ long, 5 miles S.W. Plymouth. (*a*) ventral view. (*b*) dorsal view. (*c*) side view.

FIG. 5. *Amphidinium eludens* C. Herdman.
30μ long, Port Erin, Isle of Man, side view.

FIG. 6. *Amphidinium Kofoidi* C. Herdman.
29μ long, Port Erin, Isle of Man, side view.

PLATE III

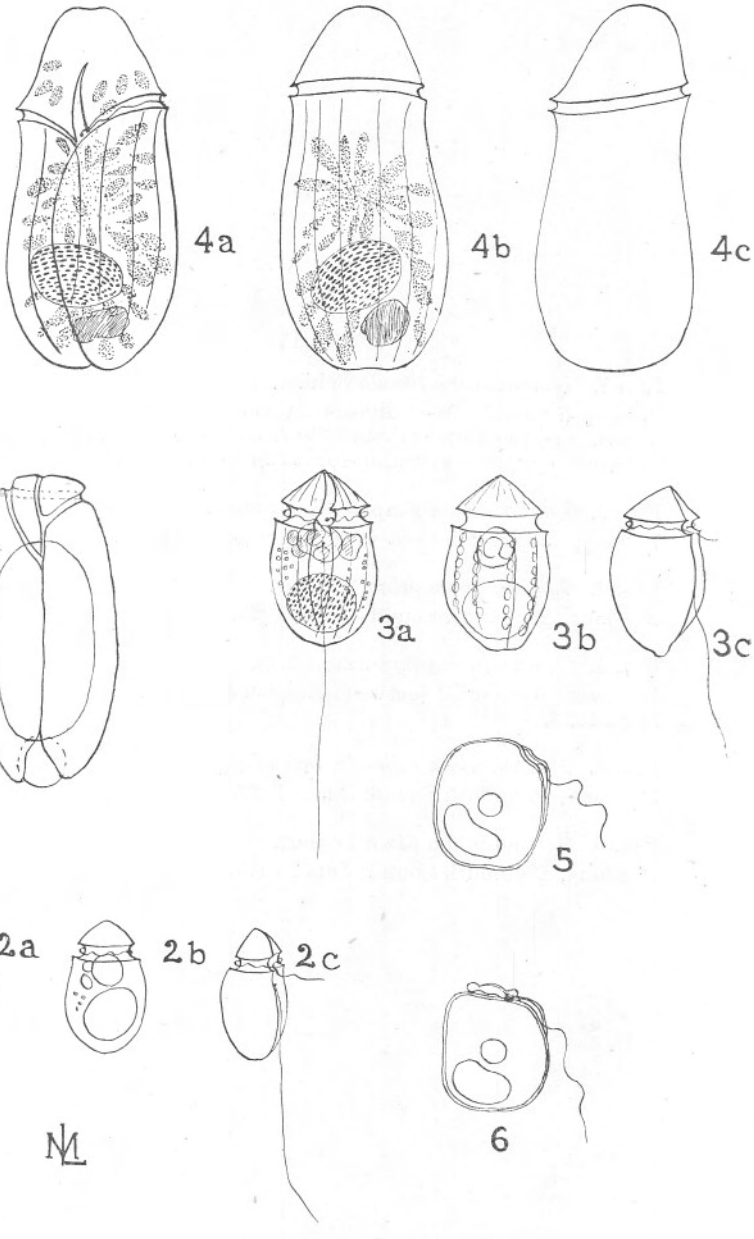


PLATE IV

FIG. 1. *Gymnodinium lunula* Schütt.
Plymouth Sound. (*a–c*) division in round cyst : cyst 80μ across. (*d–f*) semilunar cysts 130μ from tip to tip, showing division. (*g*) free-swimming form 22μ long.

FIG. 2. *Gymnodinium simplex* (Lohmann).
7μ long, culture from sea water, Plymouth Sound.

FIG. 3. *Gymnodinium minor* Lebour.
28μ long, Plymouth Sound, June, 1923.

FIG. 4. *Gymnodinium pygmaeum* n.sp.
14μ long, Station E2 (between English and French coast), May, 1923.

FIG. 5. *Gymnodinium rubrocinctum* n.sp.
52μ long, Plymouth Sound, June, 1923.

FIG. 6. *Gymnodinium filum* Lebour.
51μ long, Plymouth Sound, June, 1923.

PLATE IV

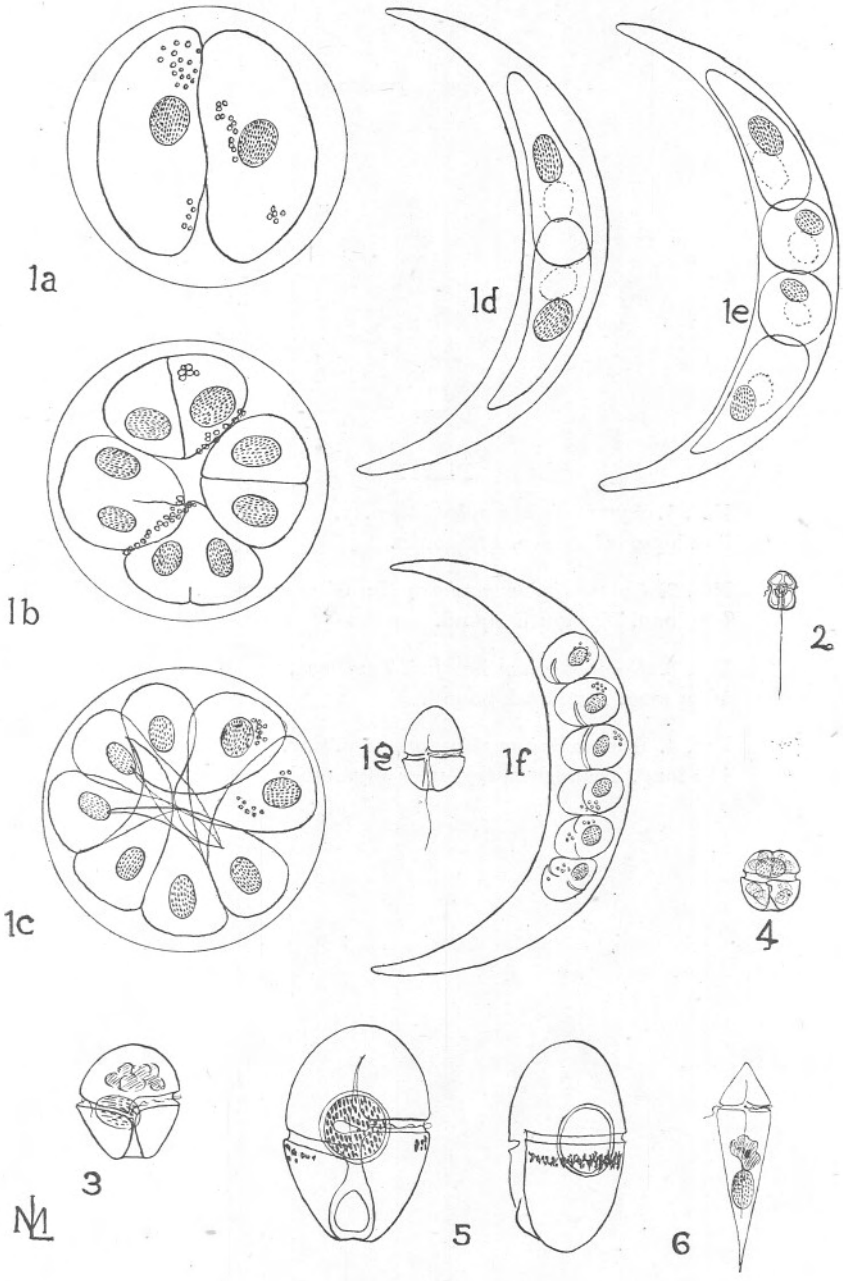


PLATE V

FIG. 1. *Gymnodinium splendens* n.sp.
54μ long, off Penlee, Plymouth.

FIG. 2. *Gymnodinium conicum* Kofoid and Swezy.
60μ long, Plymouth Sound.

FIG. 3. *Gymnodinium Lebourii* Pavillard.
100μ long, Plymouth Sound.

FIG. 4. *Gymnodinium minutum* nom. nov.
14μ long, Yealm Estuary, near Plymouth.

PLATE V

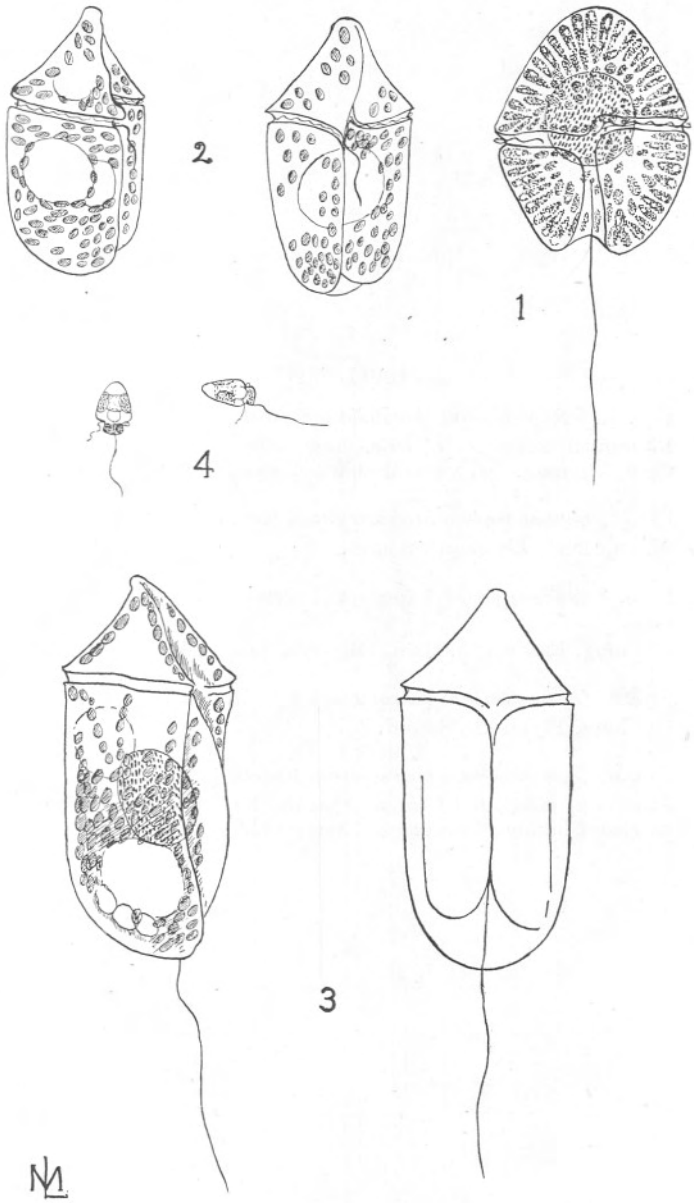


PLATE VI

FIG. 1. *Gymnodinium rhomboides* Schütt.
Plymouth Sound. (*a*) side view, 40μ long. (*b*) dorsal view, 30μ long. (*c*) ventral view, enclosed in cyst 42μ long.

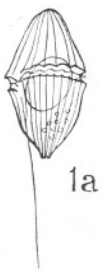
FIG. 2. *Gymnodinium heterostriatum* Kofoid and Swezy.
ca. 40μ long, Plymouth Sound.

FIGS. 3 (variety) and 4 (normal). *Gymnodinium hyalinum* n.sp.
39μ long, English Channel, Polperro, Looe. May, 1923.

FIG. 5. *Gymnodinium achromaticum* Lebour.
78μ long, Plymouth Sound.

FIG. 6. *Gymnodinium abbreviatum* Kofoid and Swezy.
84μ long, English Channel, Station N1, at entrance to English Channel, 10 metres. May, 1922.

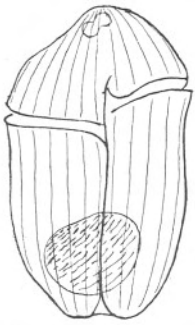
PLATE VI



1a

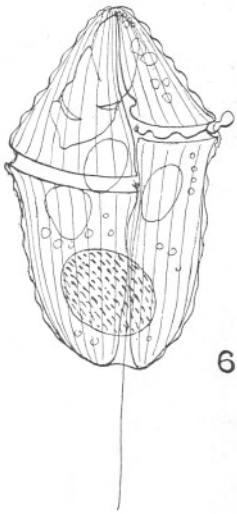
1b

1c



5

4



6

3

2

PLATE VII

FIG. 1. *Gyrodinium falcatum* Kofoid and Swezy.
84μ long, outside Plymouth Sound. Dec., 1921.

FIG. 2. *Gyrodinium lingulifera* n.sp.
39μ long, outside Plymouth Sound. May, 1923.

FIG. 3. *Gyrodinium calyptoglyphe* n.sp.
Plymouth Sound. July, 1923. (*a*) 30μ long, ventral view.
(*b*) 28μ long, side view.

FIG. 4. *Gyrodinium glaucum* (Lebour).
56μ long, off Eddystone Grounds. May, 1923.

FIG. 5. *Gyrodinium bepo* (Schütt).
56μ long, Cawsand Bay, Plymouth. July, 1920.

FIG. 6. *Gyrodinium britannia* Kofoid and Swezy.
168μ long, off Rame Head, Plymouth.

PLATE VII

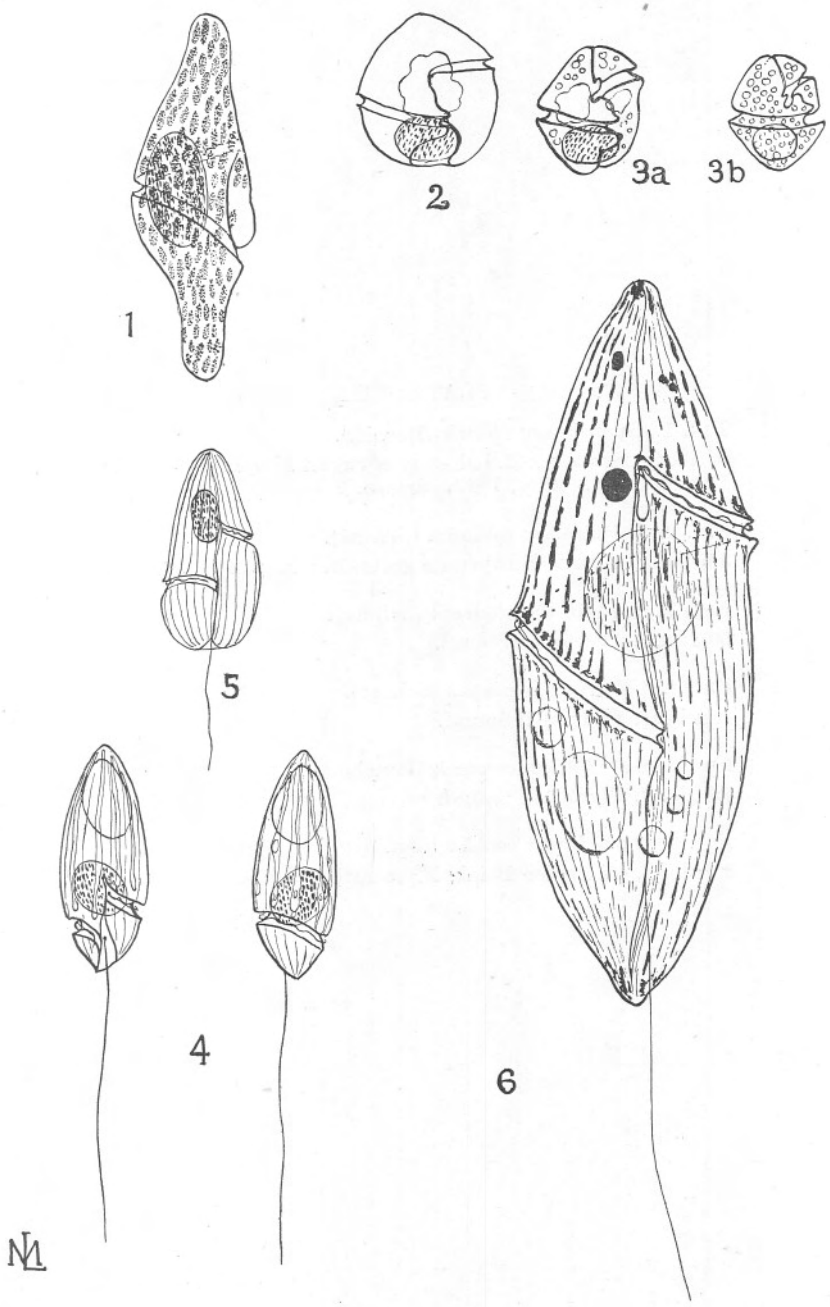


PLATE VIII

FIG. 1. *Gyrodinium spirale* (Bergh.).
98μ long, Station E.2, half-way between Plymouth and the French coast. May, 1923, surface.

FIG. 2. *Gyrodinium opimum* (Schütt).
50μ long, outside Eddystone grounds. May, 1923.

FIG. 3. *Gyrodinium obtusum* (Schütt).
50μ long, Plymouth Sound.

FIG. 4. *Gyrodinium pingue* (Schütt).
45μ long, Plymouth Sound.

FIG. 5. *Gyrodinium crassum* (Pouchet).
75μ long, Plymouth Sound.

FIG. 6. *Gyrodinium cochlea* n.sp.
55μ long, off Penlee Point, Plymouth. June, 1923.

PLATE VIII

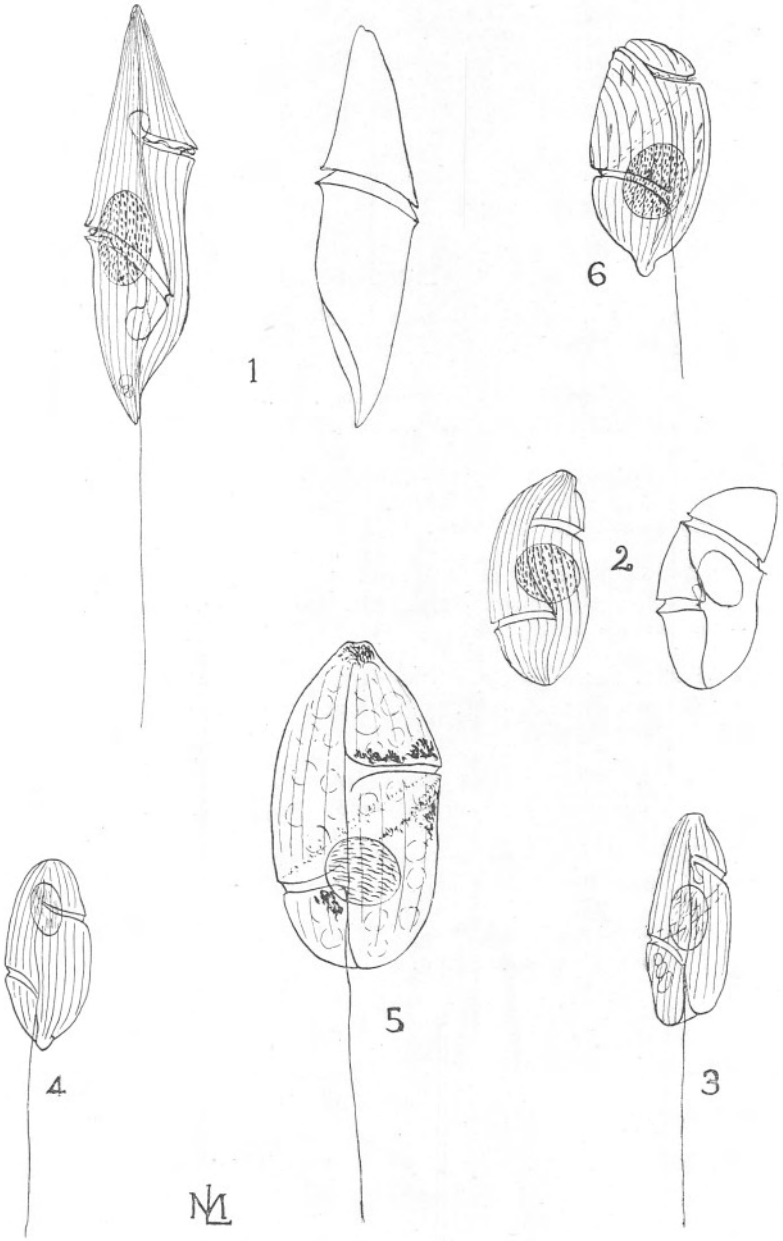


PLATE IX

FIG. 1. *Cochlodinium Schuetti* Kofoid and Swezy.
52μ long, Plymouth Sound.

FIG. 2. *Cochlodinium helicoides* nom. nov.
36μ long, Eddystone, N.W. 1 mile. May, 1922.

FIG. 3. *Cochlodinium helix* (Pouchet).
32μ long, Plymouth Sound. July, 1923. (*a*) ventral. (*b*) dorsal. (*c*) side view.

FIG. 4. *Cochlodinium pupa* n.sp.
39μ long, Plymouth. July, 1923. (*a*) and (*c*) side views. (*b*) ventral view.

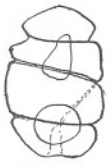
FIG. 5. *Cochlodinium vinctum* Kofoid and Swezy.
42μ long, Eddystone W. by N. 3 miles, surface. (*a*) ventral. (*b*) dorsal view.

FIG. 6. *Cochlodinium achromaticum* n.sp.
43μ long, outside Plymouth Sound. May, 1923.

FIG. 7. *Cochlodinium pulchellum* Lebour.
35μ long, Plymouth Sound.

FIG. 8. *Cochlodinium Brandti* (Wulff).
56μ long, Plymouth Sound.

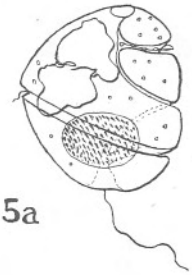
PLATE IX

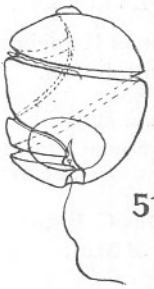

4a

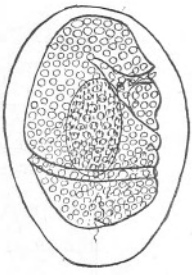

4b


4c


2


5a


5b

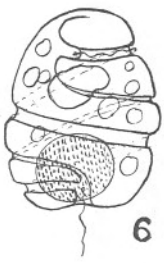

1


3a


3b


3c


8


6


7

PLATE X

FIG. 1. *Torodinium robustum* Kofoid and Swezy.
57μ long, outside Plymouth Sound.

FIG. 2. *Polykrikos Schwarzi* Bütschli.
(*a*) 100μ long, Plymouth Sound. (*b*) nematocyst 19μ long from larger specimen, Plymouth Sound.

FIG. 3. *Polykrikos Lebourae* C. Herdman.
56μ long, Port Erin, Isle of Man.

FIG. 4. *Protopsis simplex* n.sp.
74μ long, Plymouth Sound.

FIG. 5. *Nematodinium armatum* (Dogiel).
Plymouth Sound. (*a*) 36μ long, free-swimming form, ventral view. (*b*) 28μ long, encysted, dividing.

FIG. 6. *Pouchetia polyphemus* (Pouchet).
75μ long, off Eddystone.

PLATE X

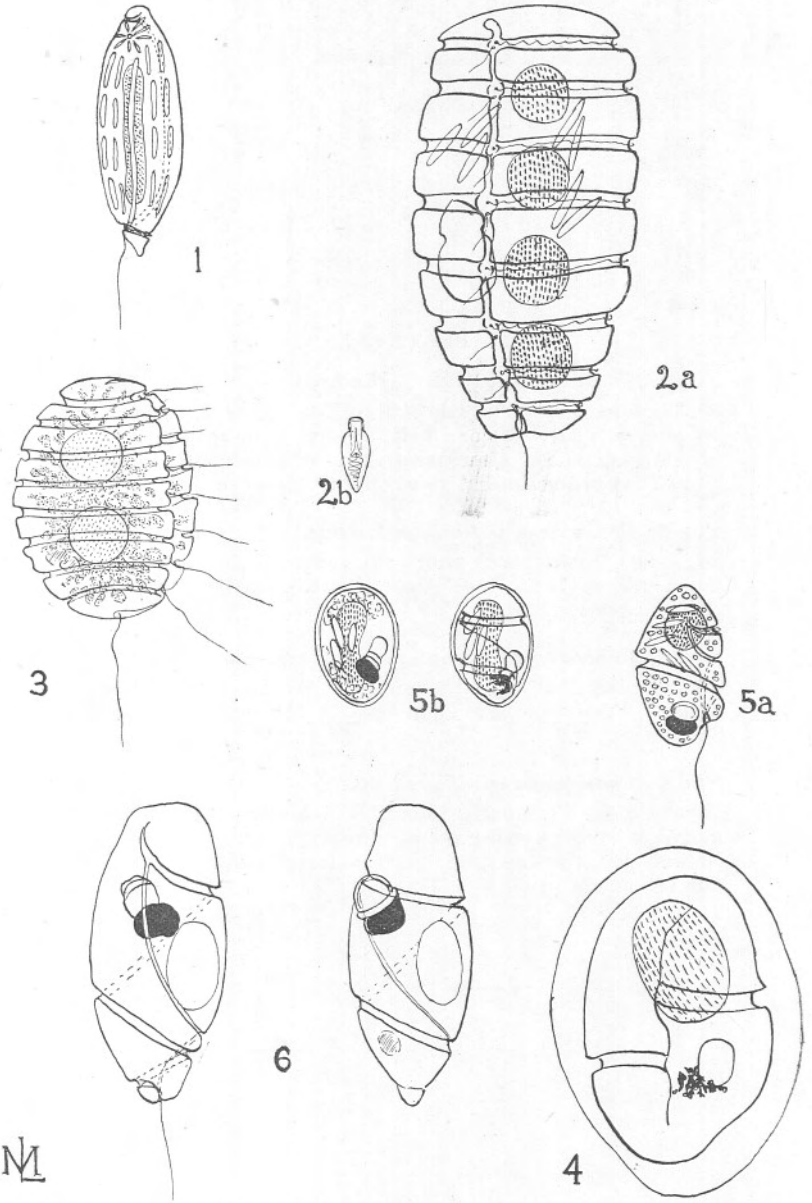


PLATE XI

FIG. 1. *Phalacroma Kofoidi* C. Herdman.

30–33μ long, Port Erin, Isle of Man. (*a*) and (*e*) side views. (*b*) ventral view. (*c*) one half, treated with trypan blue. (*d*) showing theca after treatment with eau de Javelle. (*f*) and (*g*) ventro-lateral view, slightly anterior.

FIG. 2. *Phalacroma pulchellum* Lebour.

26μ long, Plymouth Sound. (*a*) ventral. (*b*) side view. (*c*) megacytic form. (*d*) treated with acid. (*e*) the two halves separated.

FIG. 3. *Phalacroma rotundatum* (Clap. and Lach).

(*a*) 39μ long, Plymouth Sound. (*b*) 48μ long, lately divided, Eddystone, S.W. 3 miles. (*c*) 45μ long, Plymouth Sound.

FIG. 4. *Phalacroma irregulare* n.sp.

55–56μ long, Plymouth Sound. All lately divided with megacytic border still present. (*a*) with part of left longitudinal list missing. (*b*) perfect longitudinal list. (*c*) antero-ventral view.

PLATE XI

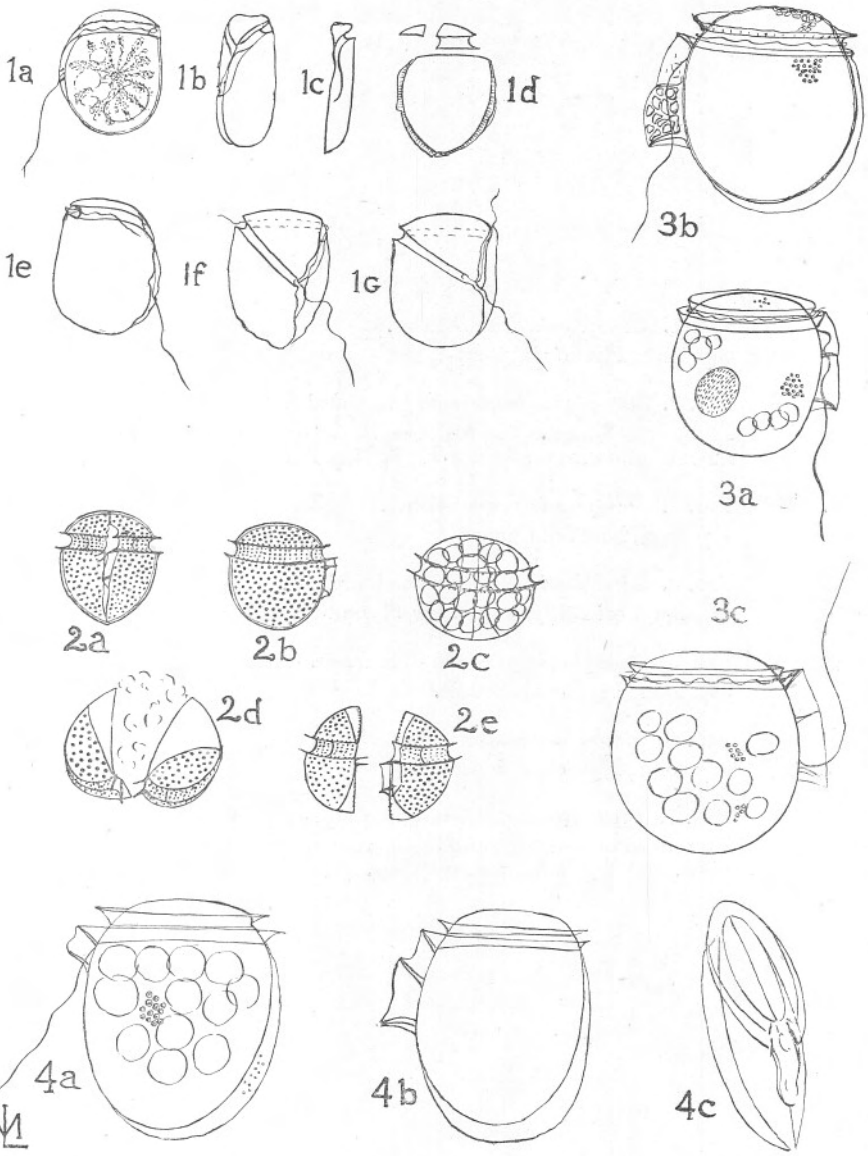


PLATE XII

FIG. 1. *Dinophysis acuta* Ehrbg.
54μ long, Plymouth Sound.

FIG. 2. *Dinophysis acuminata* Clap. and Lach.
Plymouth Sound. (*a*) 51μ long. (*b*) 38μ long, showing nucleus and chromatophores. (*c*) 44μ long, dividing.

FIG. 3. *Dinophysis ovum* Schütt.
45μ long, English Channel.

FIG. 4. *Dinophysis lenticula* Pavillard.
43μ long, off Eddystone, near Plymouth.

FIG. 5. *Dinophysis punctata* Jörgensen.
33μ long, Plymouth Sound.

FIG. 6. *Glenodinium danicum* Paulsen.
28μ long, Plymouth Sound.

FIG. 7. *Protoceratium reticulatum* Clap. and Lach.
Plymouth Sound. (*a*) and (*b*) 56μ long, ventral and dorsal view. (*c*) 28μ long, ventral view.

PLATE XII

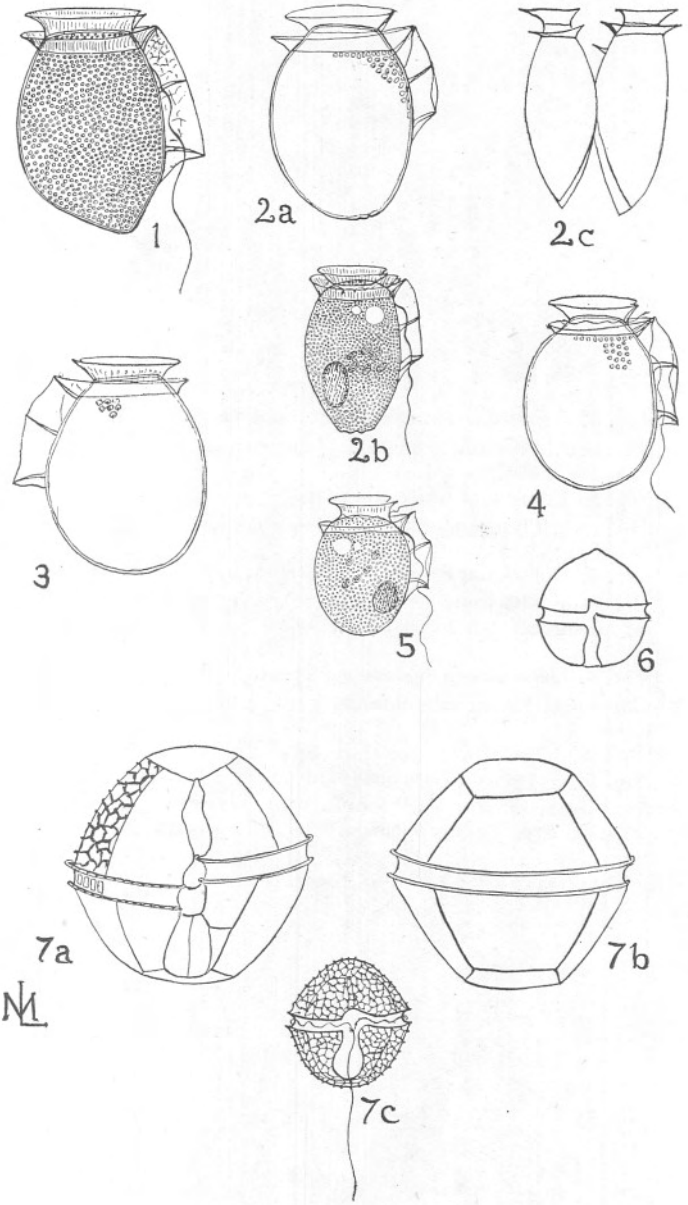


PLATE XIII

FIG. 1. *Goniaulax spinifera* Clap. and Lach.
36μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal.

FIG. 2. *Goniaulax unicornis* n.sp.
28μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal.

FIG. 3. *Goniaulax orientalis* Lindemann.
28μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

FIG. 4. *Goniaulax polygramma* Stein.
45μ long, Plymouth Sound. (*a*) and (*c*) ventral. (*b*) dorsal.

FIG. 5. *Goniaulax Diegensis* Kofoid.
56μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

PLATE XIII

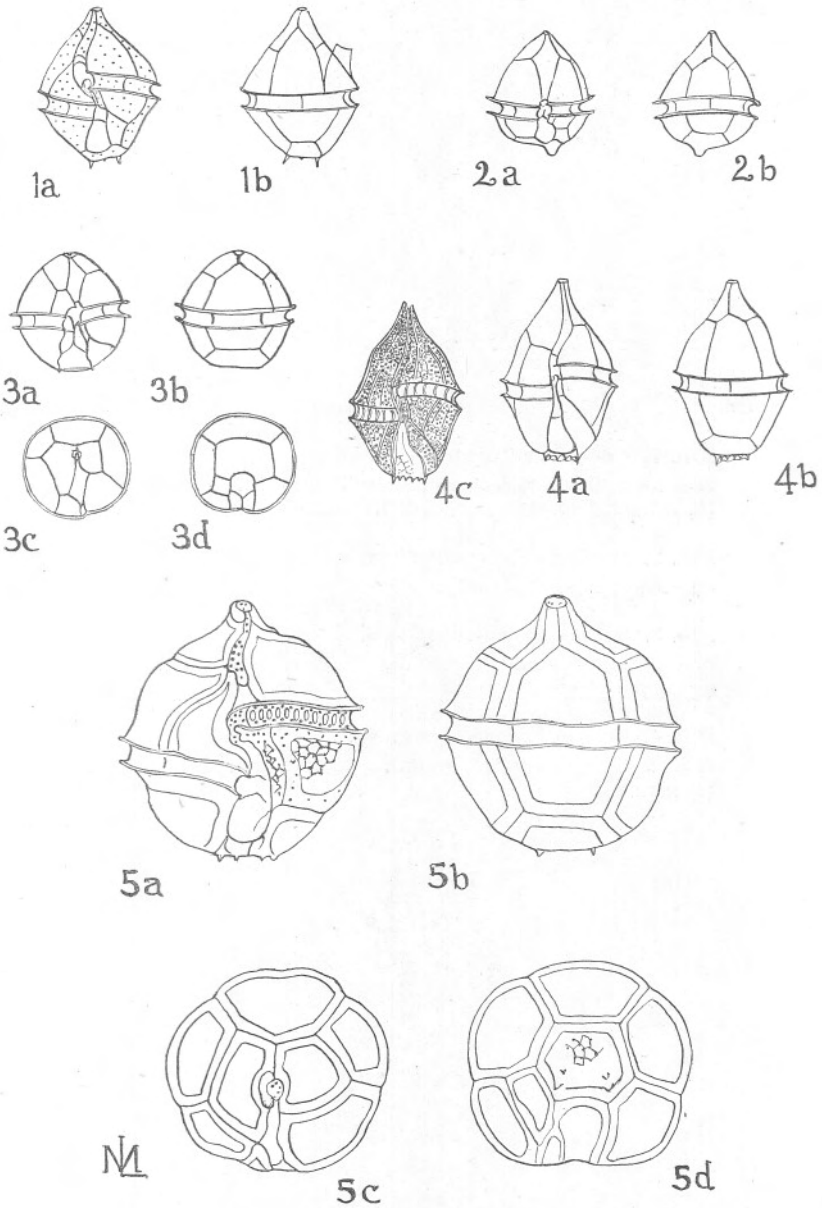


PLATE XIV

FIG. 1. *Goniaulax Tamarensis* n.sp.
36μ long, Tamar Estuary, near Plymouth. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

FIG. 2. *Goniaulax triacantha* Jörgensen.
42μ long, Yealm Estuary.

FIG. 3. *Goniaulax polyedra* Stein.
42μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) hypotheca. (*d*) epitheca.

FIG. 4. *Goniaulax longispina* n.sp.
56μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) side.

PLATE XIV

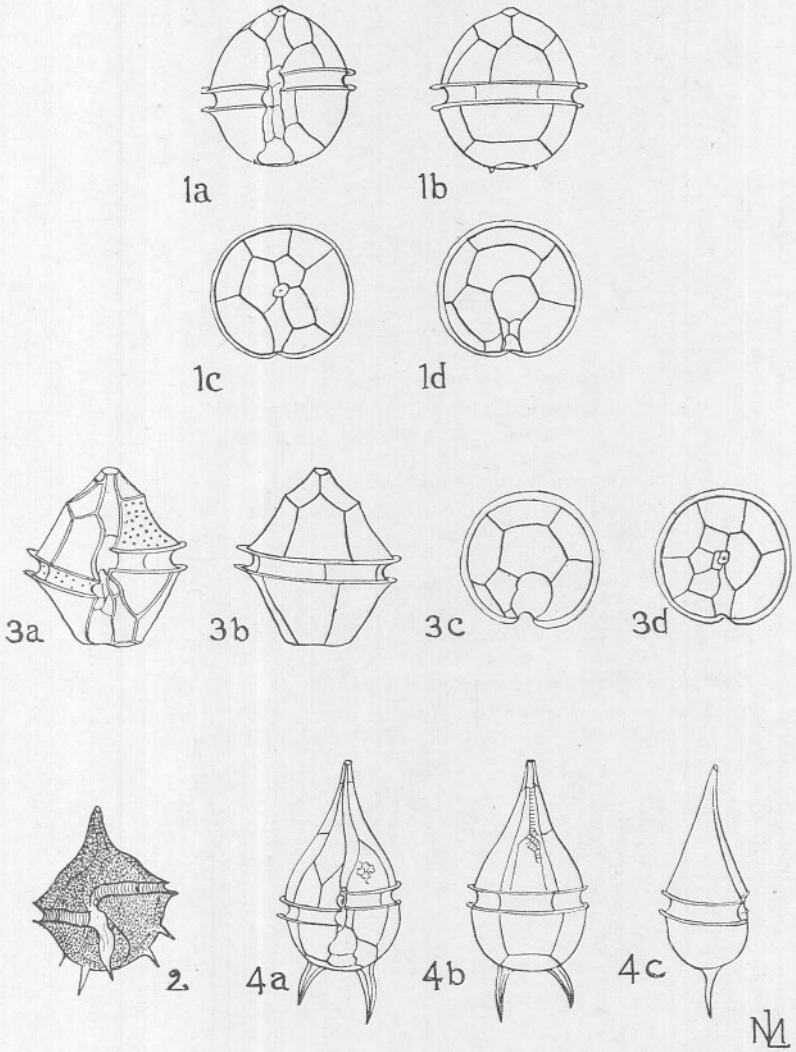


PLATE XV

FIG. 1. *Diplopsalis lenticula* Bergh.

40μ broad, outside Plymouth Sound. May, 1921. (*a*) apical view. (*b*) antapical. (*c*) ventral. (*d*) dorsal. (*e*) side.

FIG. 2. *Diplopeltopsis minor* Lebour.

52μ broad, Plymouth Sound. Feb., 1921. (*a*) apical. (*b*) antapical. (*c*) ventral. (*d*) dorsal. (*e*) side view.

FIG. 3. *Peridiniopsis asymmetrica* Mangin.

66μ broad, outside Plymouth Sound. May, 1921. (*a*) apical. (*b*) antapical. (*c*) ventral. (*d*) dorsal. (*e*) side view.

FIG. 4. *Peridiniopsis rotunda* Lebour.

28μ broad, Plymouth Sound. June, 1921. (*a*) apical. (*b*) antapical. (*c*) ventral. (*d*) dorsal. (*e*) side view.

PLATE XV

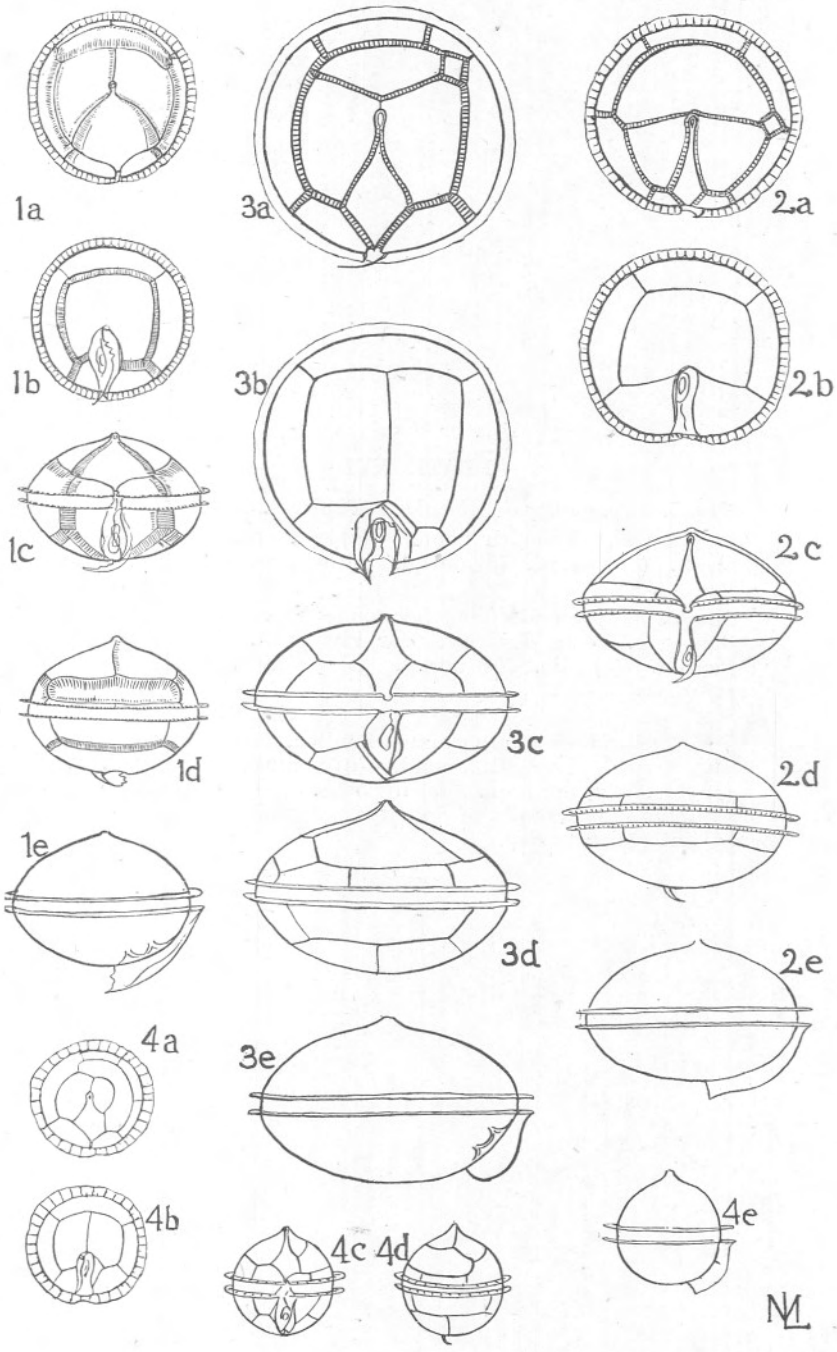


PLATE XVI

FIG. 1. *Diplopsalopsis orbicularis* (Paulsen).
42μ across, Plymouth Sound. (*a*) epitheca. (*b*) hypotheca. (*c*) ventral. (*d*) dorsal. (*e*) abnormal epitheca.

FIG. 2. *Kryptoperidinium foliaceum* (Stein).
33μ long, Yealm Estuary, near Plymouth. (*a*) and (*c*) ventral. (*b*) side. (*d*) dorsal. (*e*) epitheca. (*f*) hypotheca.

FIG. 3. *Peridinium monospinum* Paulsen.
40μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) side. (*d*) epitheca. (*e*) hypotheca. (*f*) with spore escaping. (*g*) details of longitudinal wing and spines. (*h*) intercalary striae.

PLATE XVI.

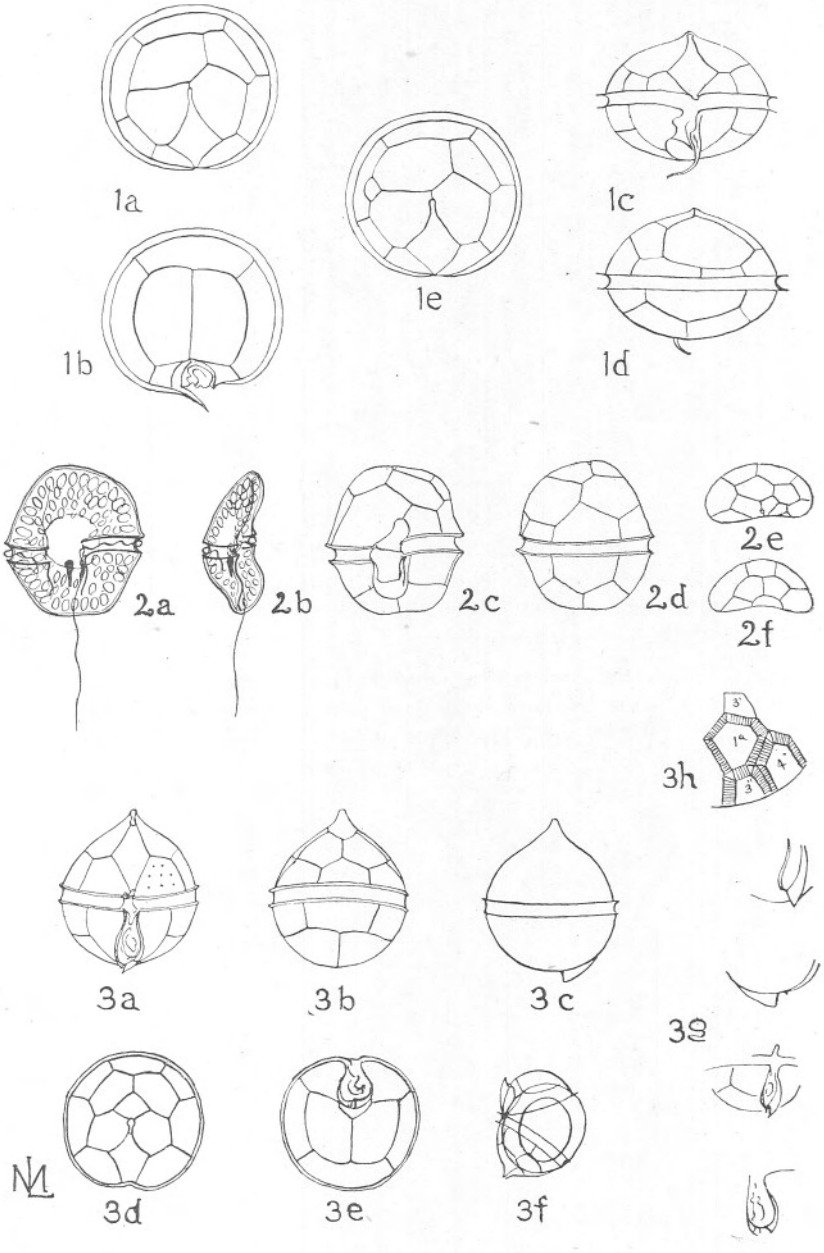


PLATE XVII

FIG. 1. *Peridinium avellana* Meunier.

42μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca. (*e*) side view. (*f*) intercalary striae.

FIG. 2. *Peridinium Thorianum* Paulsen.

57μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca. (*e*) and (*f*) various views on smaller scale.

PLATE XVII

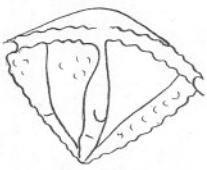
1a

1b

2e

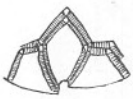
1c

1d

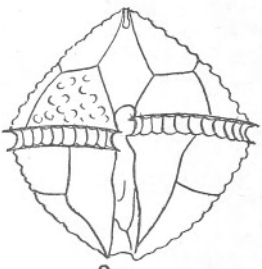


2f

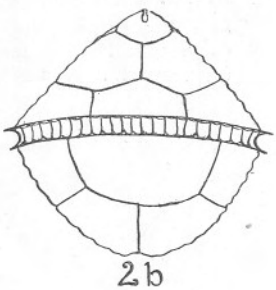
1e



1f

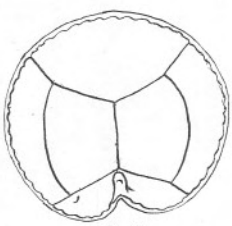


2a



2b

2c



2d

PLATE XVIII

FIG. 1. *Peridinium excentricum* Paulsen.

45μ across, Plymouth Sound. (*a*) dorsal. (*b*) ventral. (*c*) epitheca. (*d*) hypotheca.

FIG. 2. *Peridinium triqueta* (Stein).

28μ long, from culture in sea water, by Dr. Allen, Plymouth. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca. (*e*) various stages in division. (*f*) showing cell contents.

PLATE XVIII

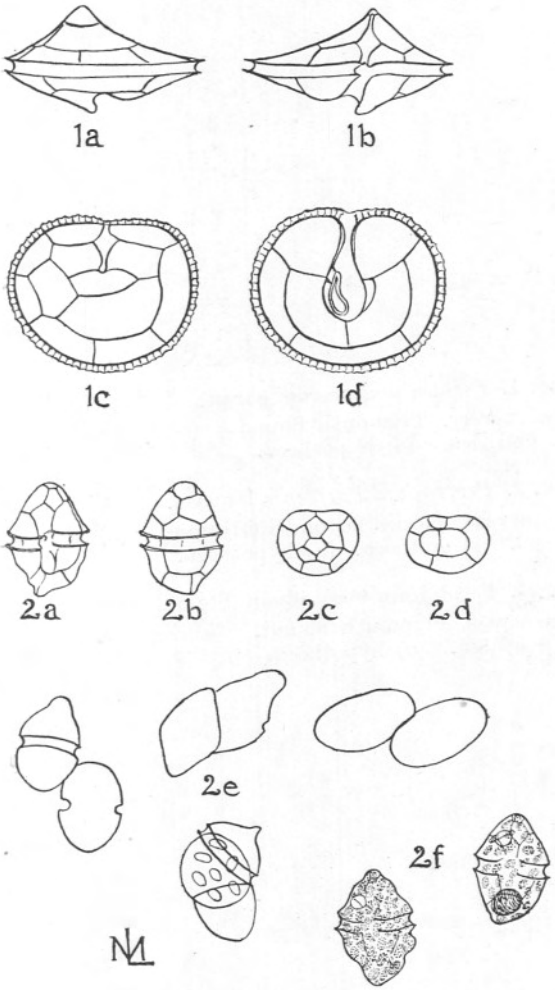


PLATE XIX

FIG. 1. *Peridinium conicum* (Gran).
70μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

FIG. 2. *Peridinium Faeröense* Paulsen.
25μ across, 5 miles beyond Eddystone. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

FIG. 3. *Peridinium trochoideum* (Stein).
28μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

PLATE XIX

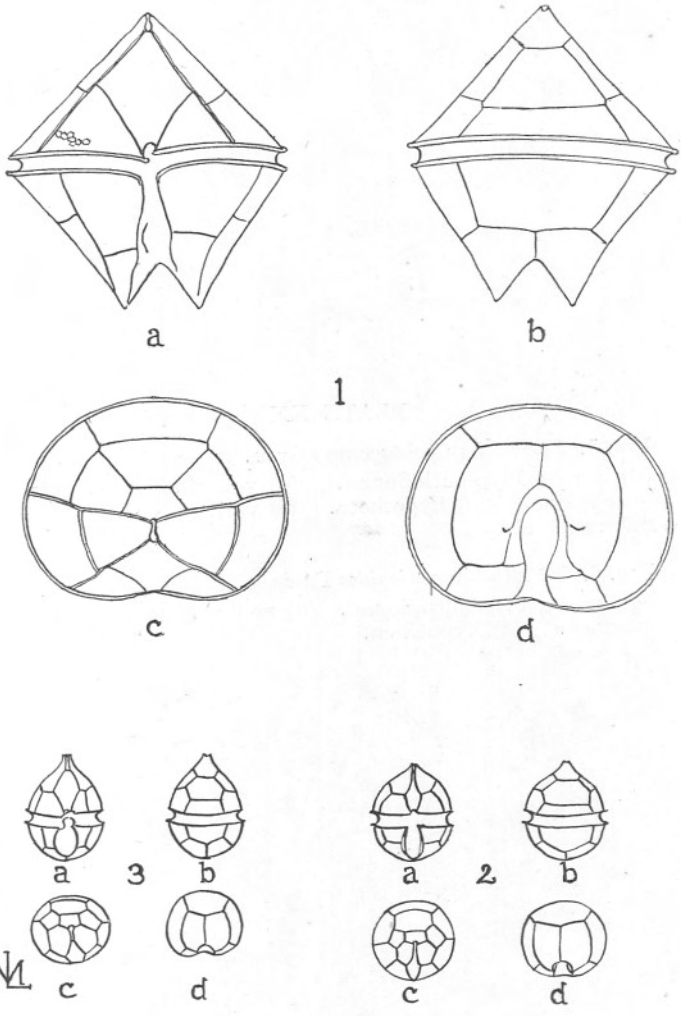


PLATE XX

FIG. 1. *Peridinium pentagonum* Gran.

84μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca. (*e*) various views on a different scale.

FIG. 2. *Peridinium conicoides* Paulsen.

45μ across, Plymouth Sound. (*a*) ventral. (*b*) epitheca. (*c*) dorsal. (*d*) hypotheca.

PLATE XX

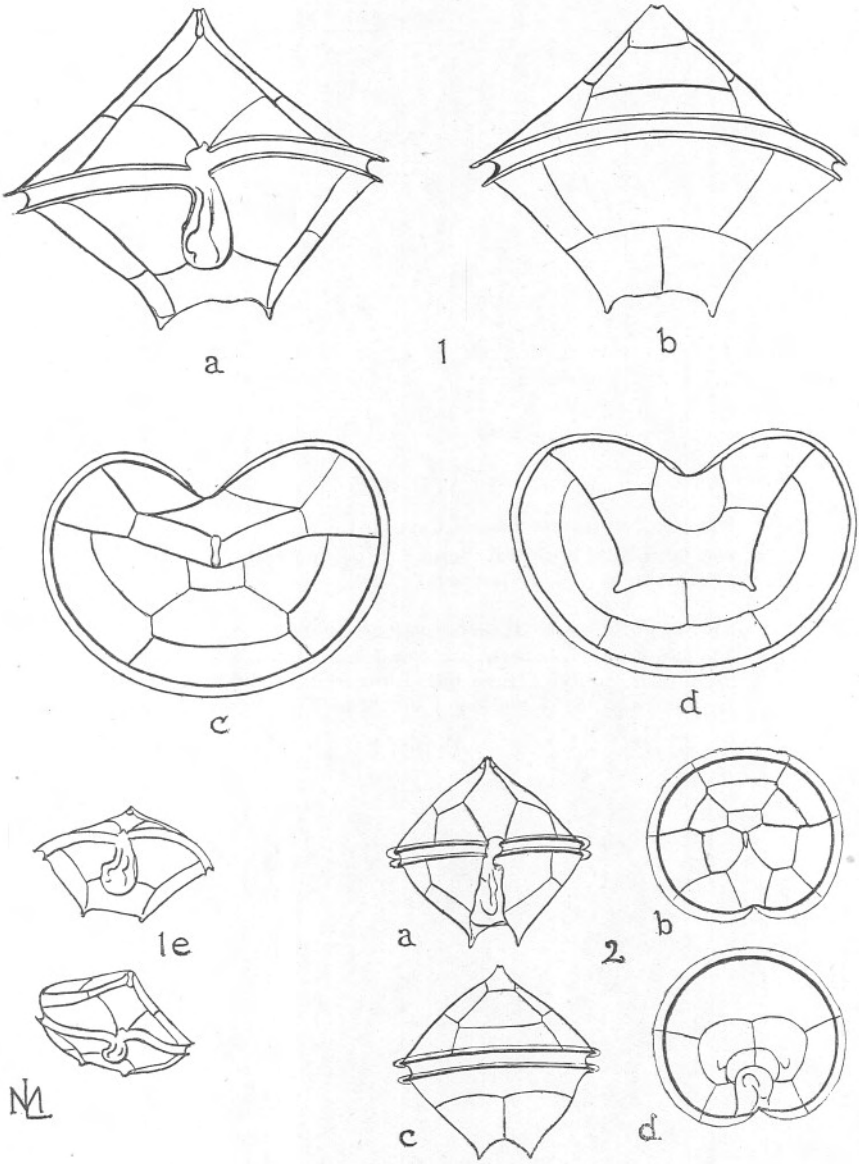


PLATE XXI

FIG. 1. *Peridinium Leonis* Pavillard.

95μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

FIG. 2. *Peridinium Willei* Huitfeld-Kaas.

56μ across, empty theca, without dorsal plates, from beyond Plymouth Sound (these filled in from Schilling, 1913). (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca.

PLATE XXI

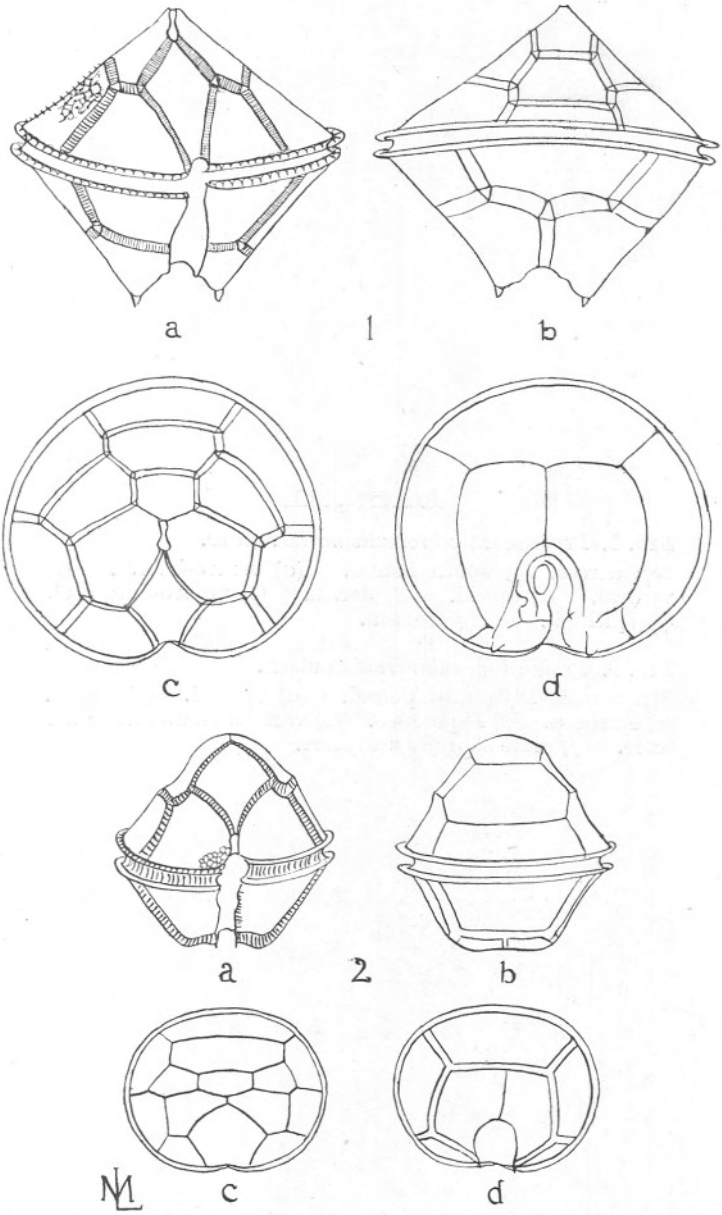


PLATE XXII

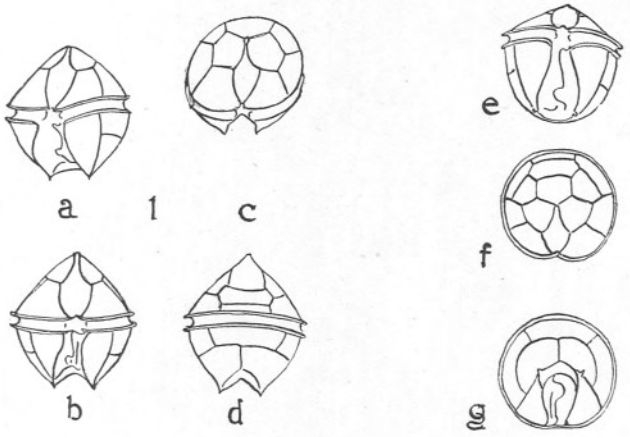
FIG. 1. *Peridinium achromaticum* Levander.

28μ across, Plymouth Sound. (*a*) ventro-lateral. (*b*) ventral. (*c*) apical. (*d*) dorsal. (*e*) ventro-antapical. (*f*) epitheca. (*g*) hypotheca.

FIG. 2. *Peridinium subinerme* Paulsen.

54μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) epitheca. (*d*) hypotheca. (*e*) various views on smaller scale. (*f*) plate showing sculpture.

PLATE XXII



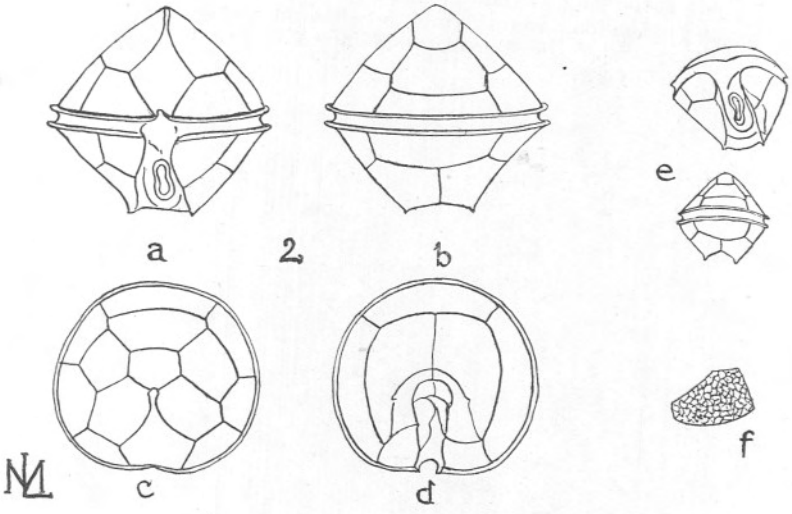


PLATE XXIII

Peridinium depressum Bailey.

(*a*) 180μ long, Atlantic, from the *Scotia* Expedition. (*b–f*) 116μ long, from Plymouth Sound (on a smaller scale). (*b*) ventral. (*c*) dorsal. (*d*) apical. (*e*) antapical. (*f*) side view.

PLATE XXIII

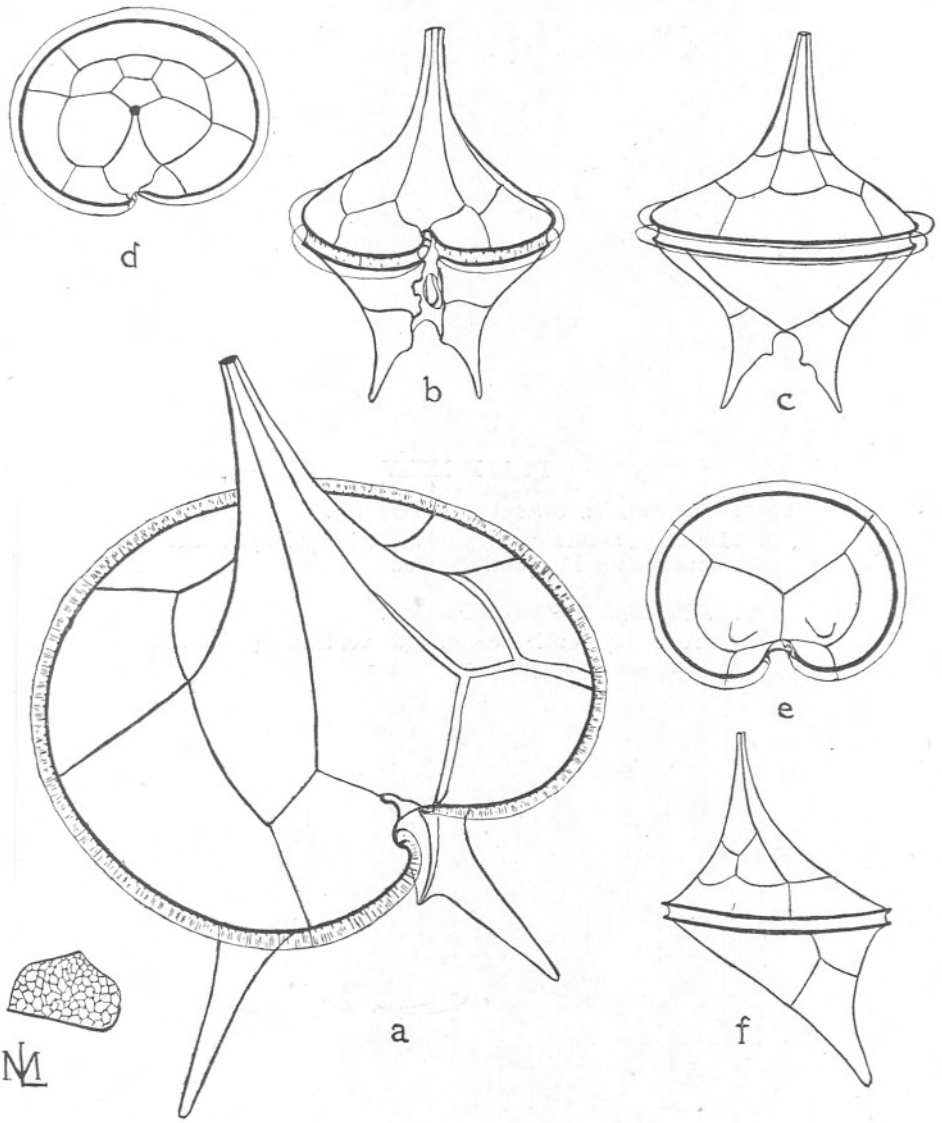
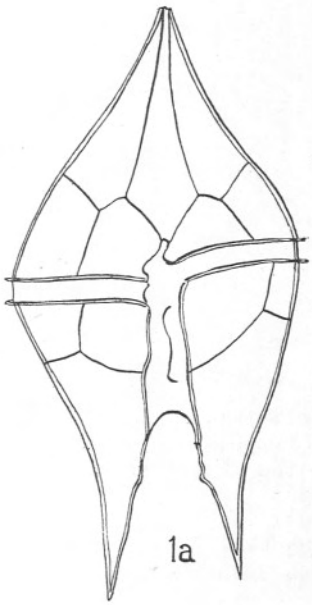


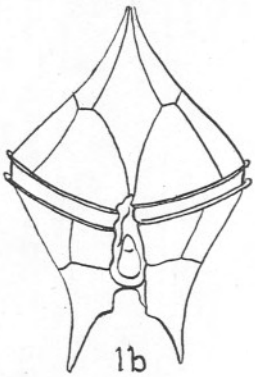
PLATE XXIV

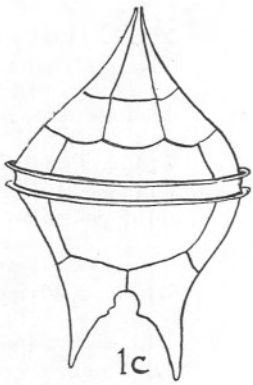
FIG. 1. *Peridinium oblongum* (Aurivillius).
(*a*) 115μ long, ventral view. (*b*) and (*c*) 84μ long, ventral and dorsal views, Plymouth Sound.

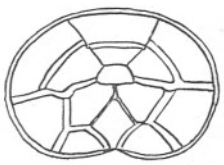
FIG. 2. *Peridinium obtusum* Karsten.
50μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) apical. (*d*) antapical view.

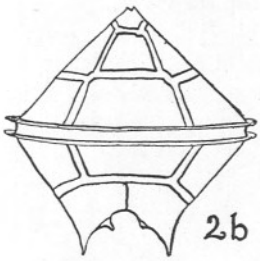
PLATE XXIV

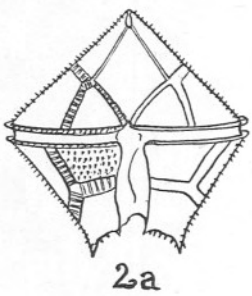












NL 2d

PLATE XXV

FIG. 1. *Peridinium Claudicans* Paulsen.
Plymouth Sound. (*a*) and (*b*) 79μ long, ventral and dorsal views. (*c*) 51μ long, ventral view. (*d*) dorsal, side and hind views on a different scale.

FIG. 2. *Peridinium Granii* Ostenfeld.
49μ long, $\frac{1}{2}$ mile from Eddystone Lighthouse. (*a*) ventral. (*b*) dorsal view.

FIG. 3. *Peridinium mite* Pavillard.
55μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal view.

FIG. 4. *Peridinium Steinii* Jörgensen.
39μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) apical. (*d*) antapical views.

PLATE XXV

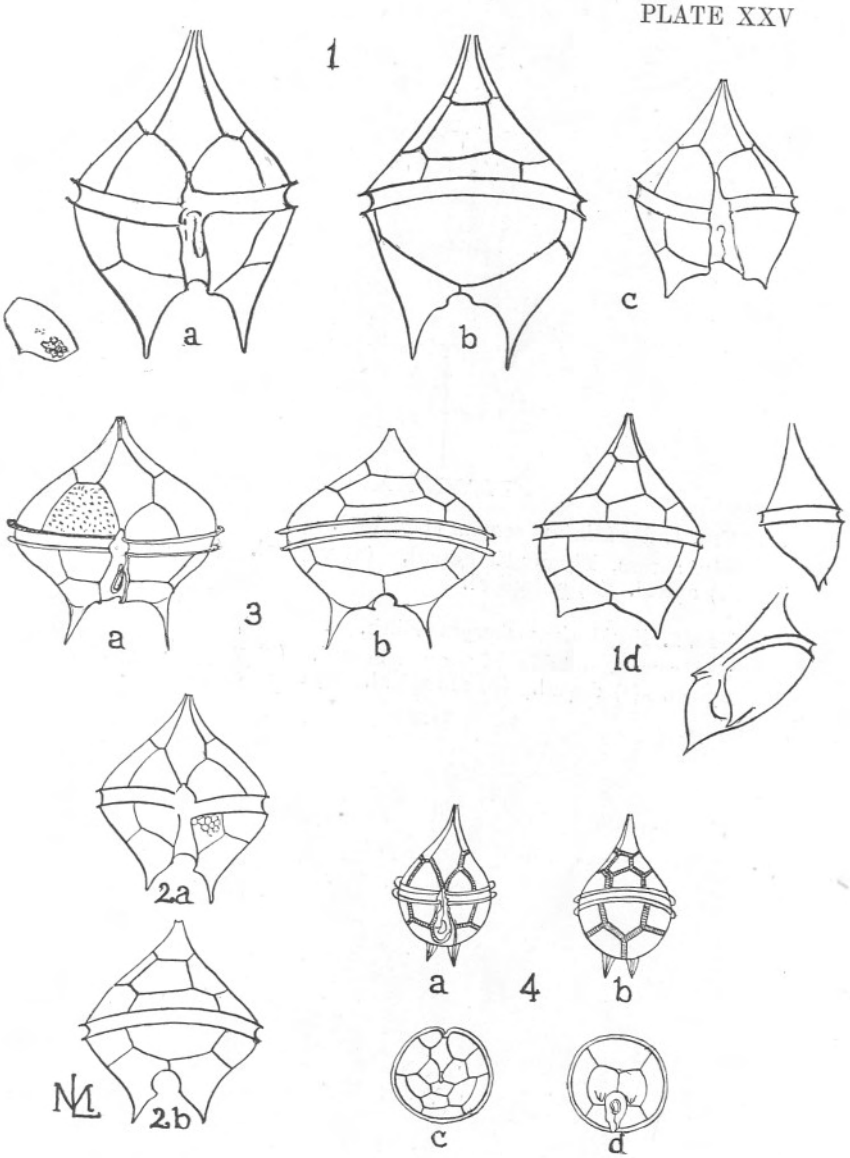


PLATE XXVI

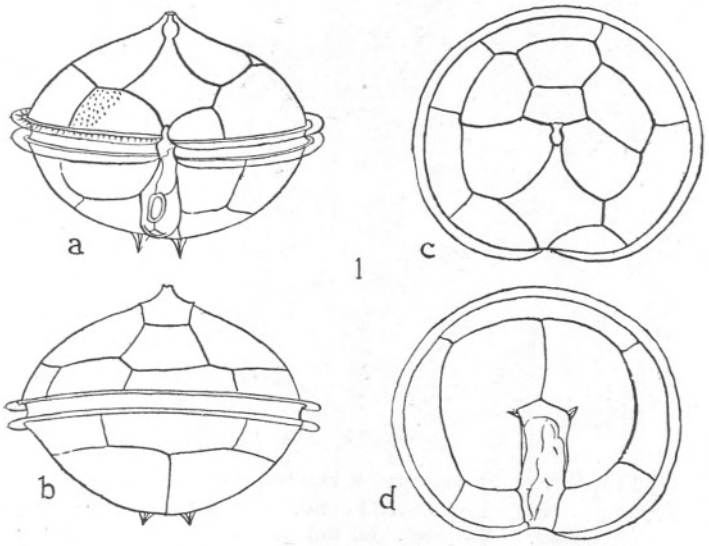
FIG. 1. *Peridinium ovatum* (Pouchet).

64μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) apical. (*d*) antapical.

FIG. 2. *Peridinium divergens* Ehrb.

56μ across, outside Plymouth Sound. (*a*) ventral. (*b*) apical. (*c*) dorsal. (*d*) antapical. (*e*) showing live cell.

PLATE XXVI



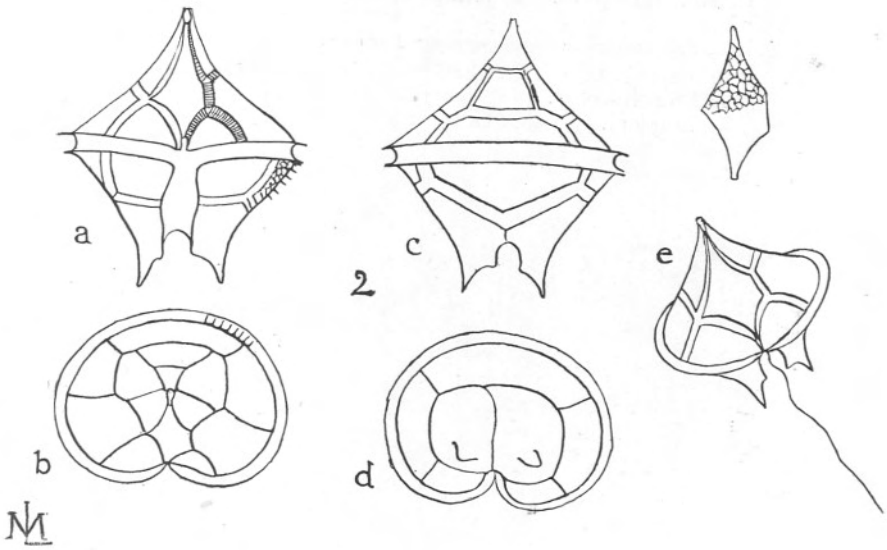


PLATE XXVII

FIG. 1. *Peridinium cerasus* Paulsen.

30μ across, Plymouth Sound. (*a*) alive. (*b*) ventral. (*c*) dorsal. (*d*) apical. (*e*) antapical.

FIG. 2. *Peridinium brevipes* Paulsen.

18μ long, outside Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) apical. (*d*) antapical view.

FIG. 3. *Peridinium sub-curvipes* Lebour.

44μ across, Station E.2, half-way between Plymouth and the French coast. (*a*) ventral. (*b*) dorsal. (*c*) apical. (*d*) antapical. (*e*) side view.

PLATE XXVII

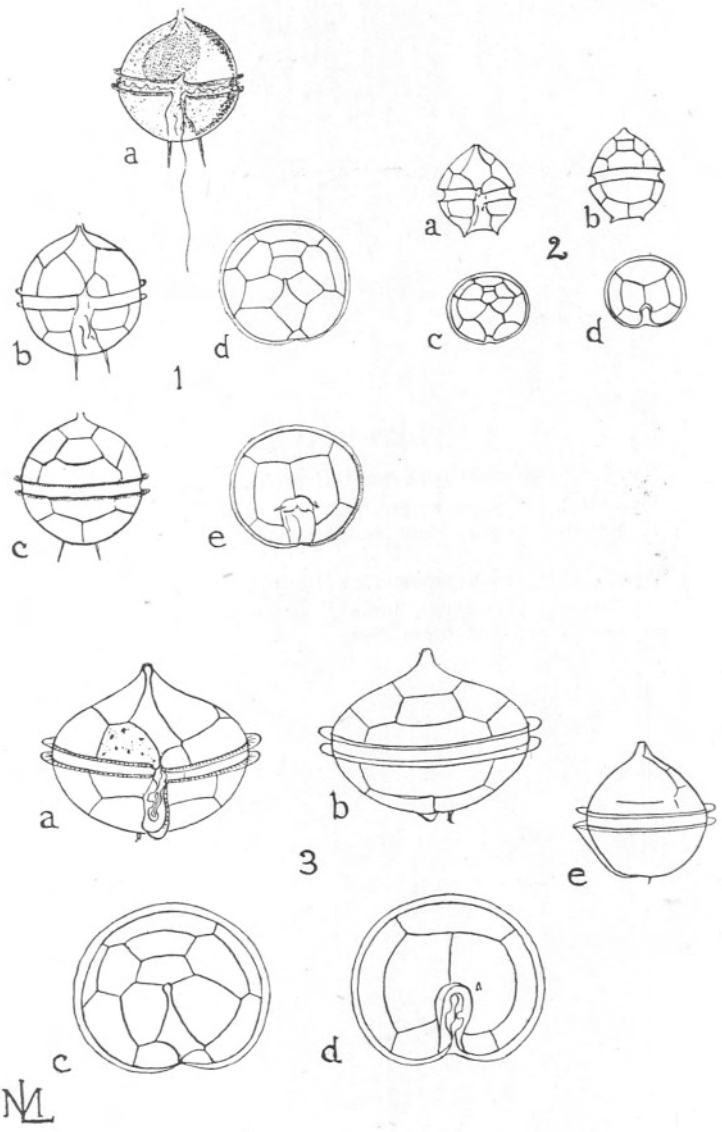
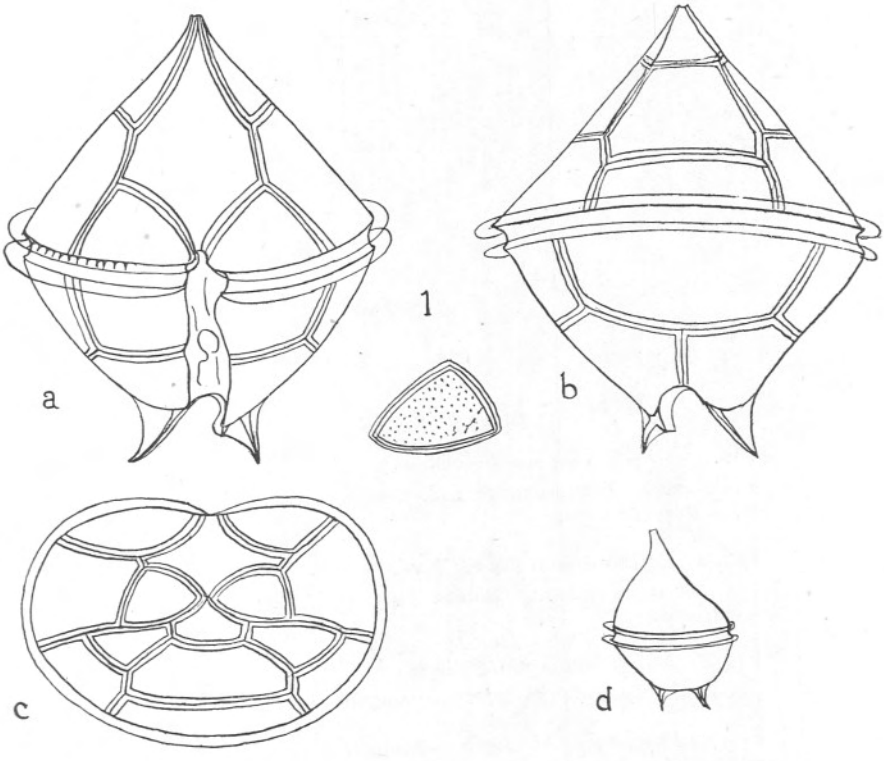


PLATE XXVIII

FIG. 1. *Peridinium pallidum* Ostenfeld.
96μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) apical. (*d*) side view (smaller scale).

FIG. 2. *Peridinium pellucidum* (Bergh).
36μ broad, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) apical. (*d*) antapical view.

PLATE XXVIII



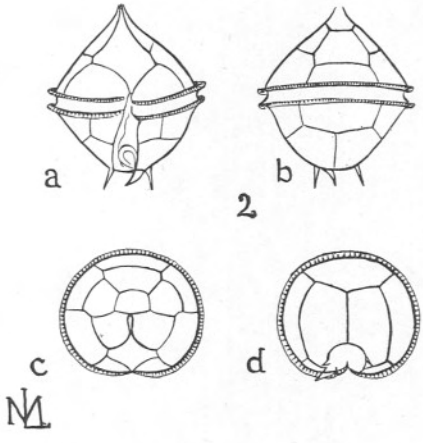


PLATE XXIX

FIG. 1. *Peridinium curvipes* Ostenfeld.

45μ across, Plymouth Sound. (*a*) ventral. (*b*) apical. (*c*) antapical views.

FIG. 2. *Peridinium diabolus* Cleve.

44μ across, Plymouth Sound. (*a*) ventral. (*b*) dorsal. (*c*) apical.

FIG. 3. *Minuscula bipes* (Paulsen).

23μ long, Plymouth Sound. (*a*) ventral. (*b*) dorsal view.

FIG. 4. *Pyrophacus horologicum* Stein.

Plymouth Sound. (*a*) 40μ long, ventral view, with cyst. (*b*) apical. (*c*) antapical view, 84μ by 74μ diameter.

PLATE XXIX

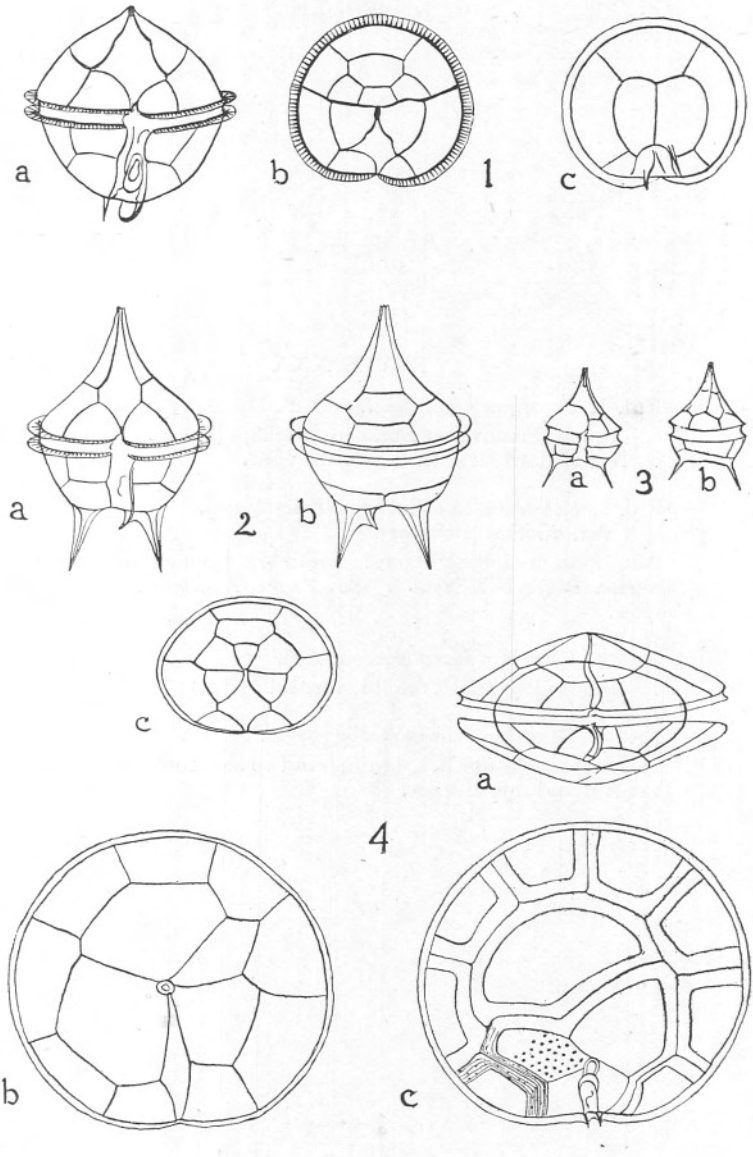


PLATE XXX

FIG. 1. *Ceratium hirundinella* (O. F. Müller).
42μ broad, Freshwater Pond co. Durham (from sample sent by Mr. Millard Griffiths), ventral view.

FIG. 2. *Ceratium candelabrum* (Ehrenberg).
var. *dilatata* (Gourret).
260μ long, including spines. From the stomach of *Clupea aurita*, River Nile (sent by Mr. Paget, Alexandria), dorsal view.

FIG. 3. *Ceratium furca* (Ehrenberg).
150μ long, Plymouth Sound, ventral view.

FIG. 4. *Ceratium minutum* Jörgensen.
28μ across, Station E.1, 14 miles out to sea from Plymouth. Ventral and dorsal view.

PLATE XXX

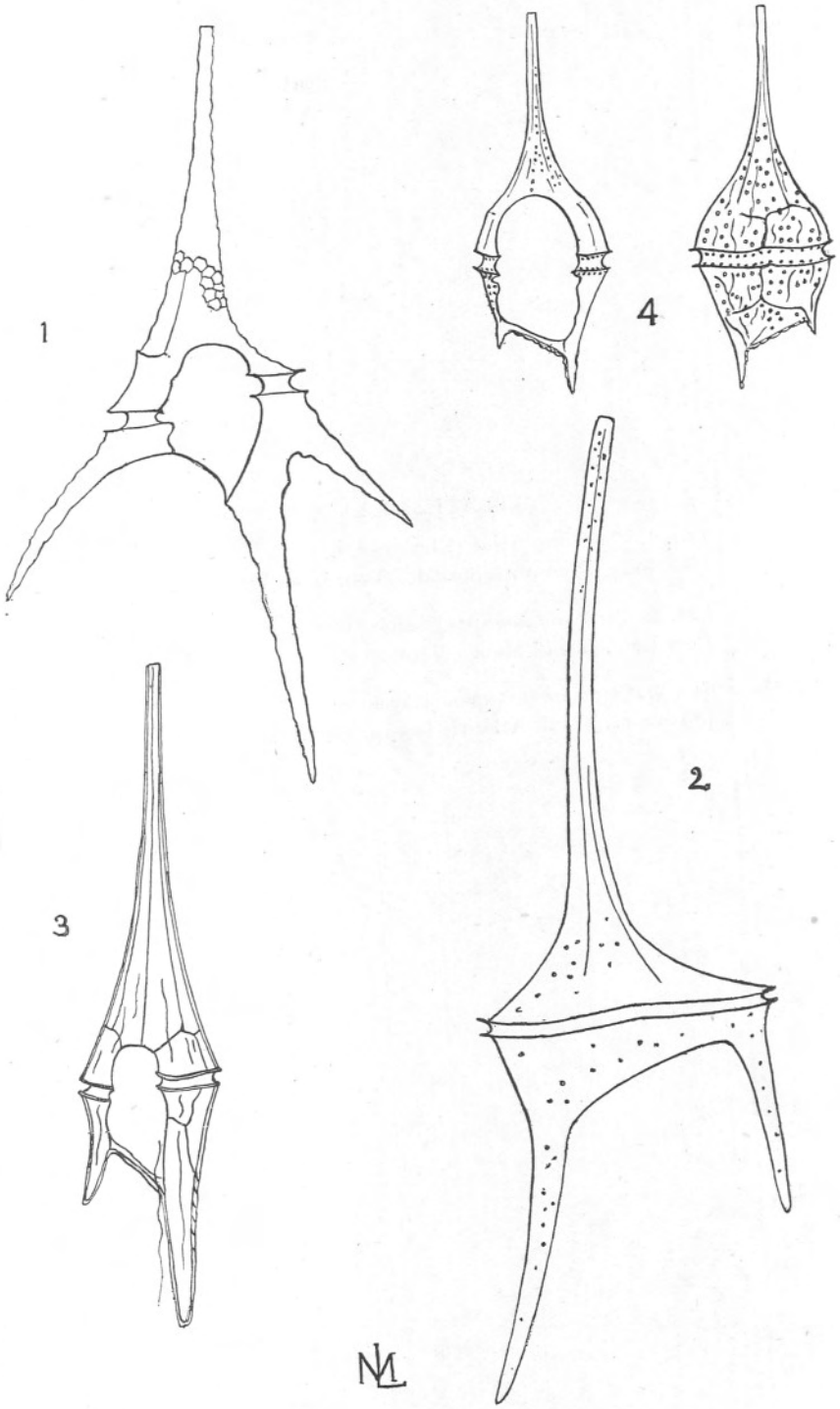


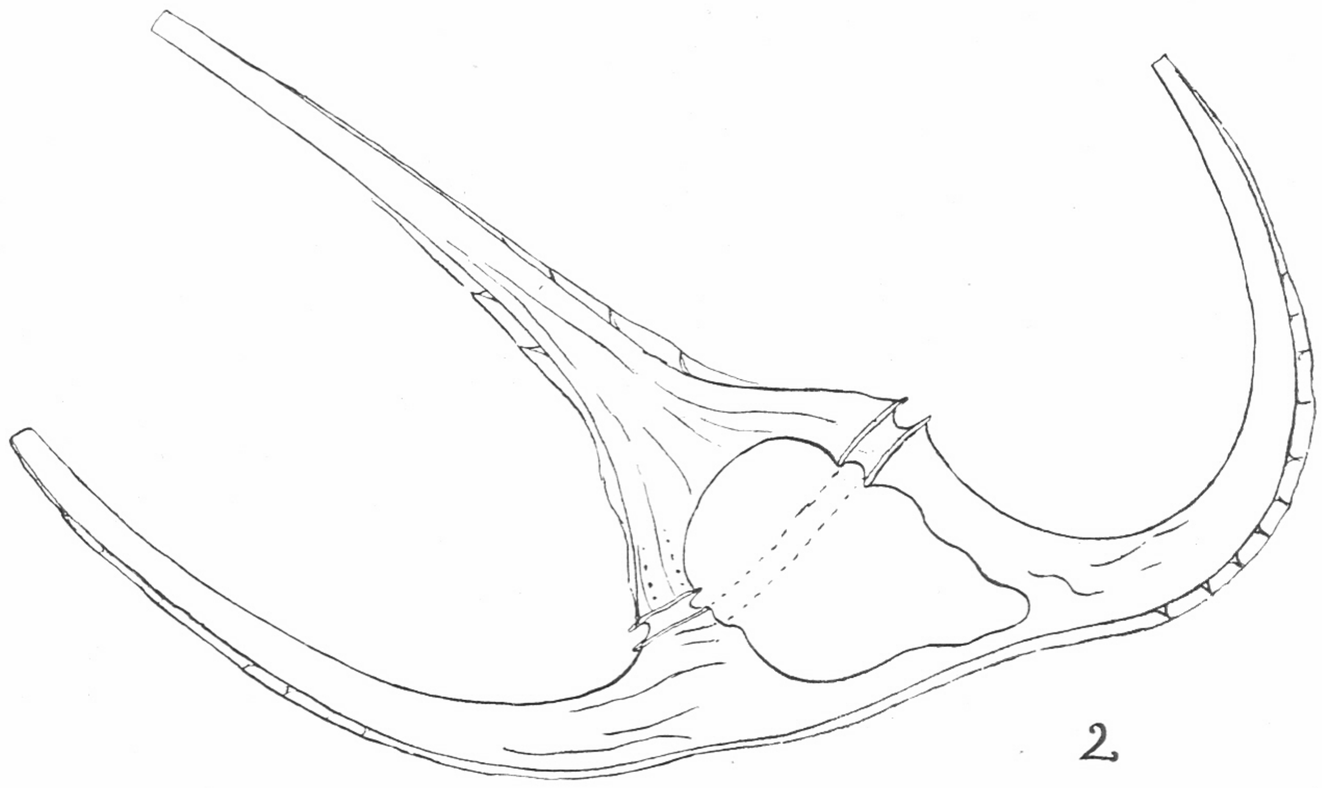
PLATE XXXI

FIG. 1. *Ceratium fusus* (Ehrenberg).
480μ long, Plymouth Sound. Ventral view.

FIG. 2. *Ceratium longipes* (Bailey) Gran.
Port Erin, Isle of Man. Ventral view.

FIG. 3. *Ceratium arcticum* (Ehrenberg).
48μ broad, North Atlantic Ocean, *Scotia* material.

PLATE XXXI



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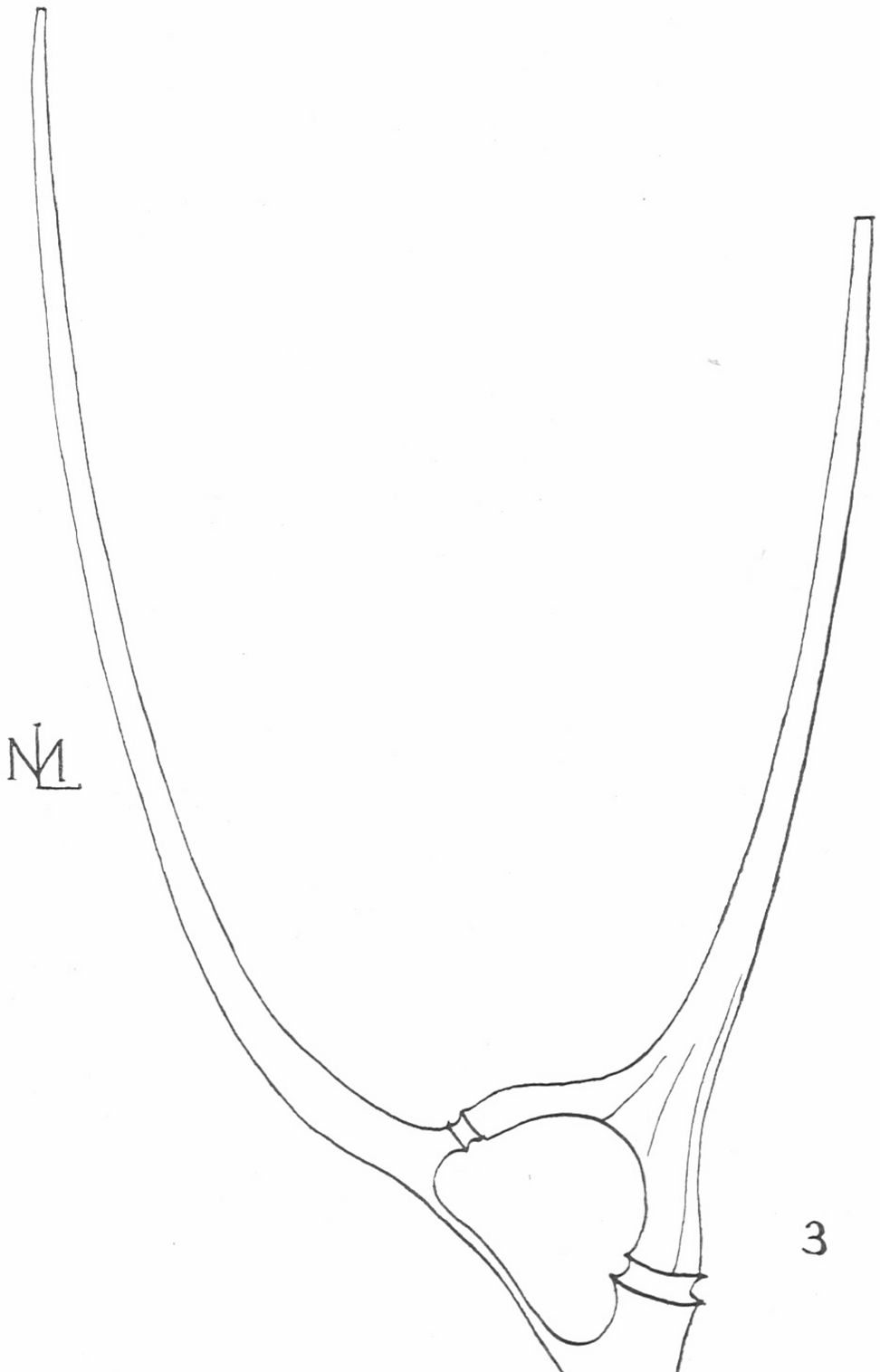

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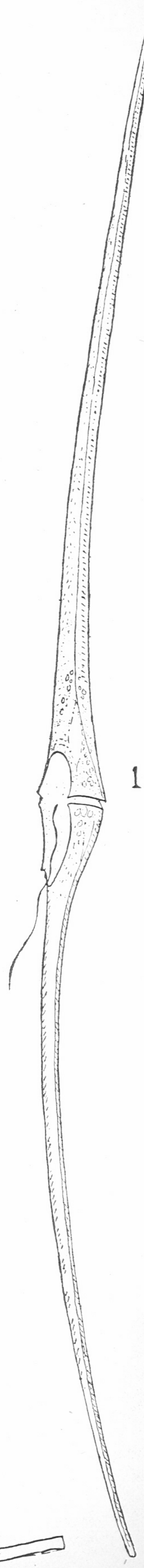


1

PLATE XXXII

Ceratium tripos (O. F. Müller).
var. *Baltica* Schütt.

60μ broad, 210μ long, Plymouth Sound. (*a*) ventral view. (*b*) and (*c*) showing plates (lesser magnification).

PLATE XXXII

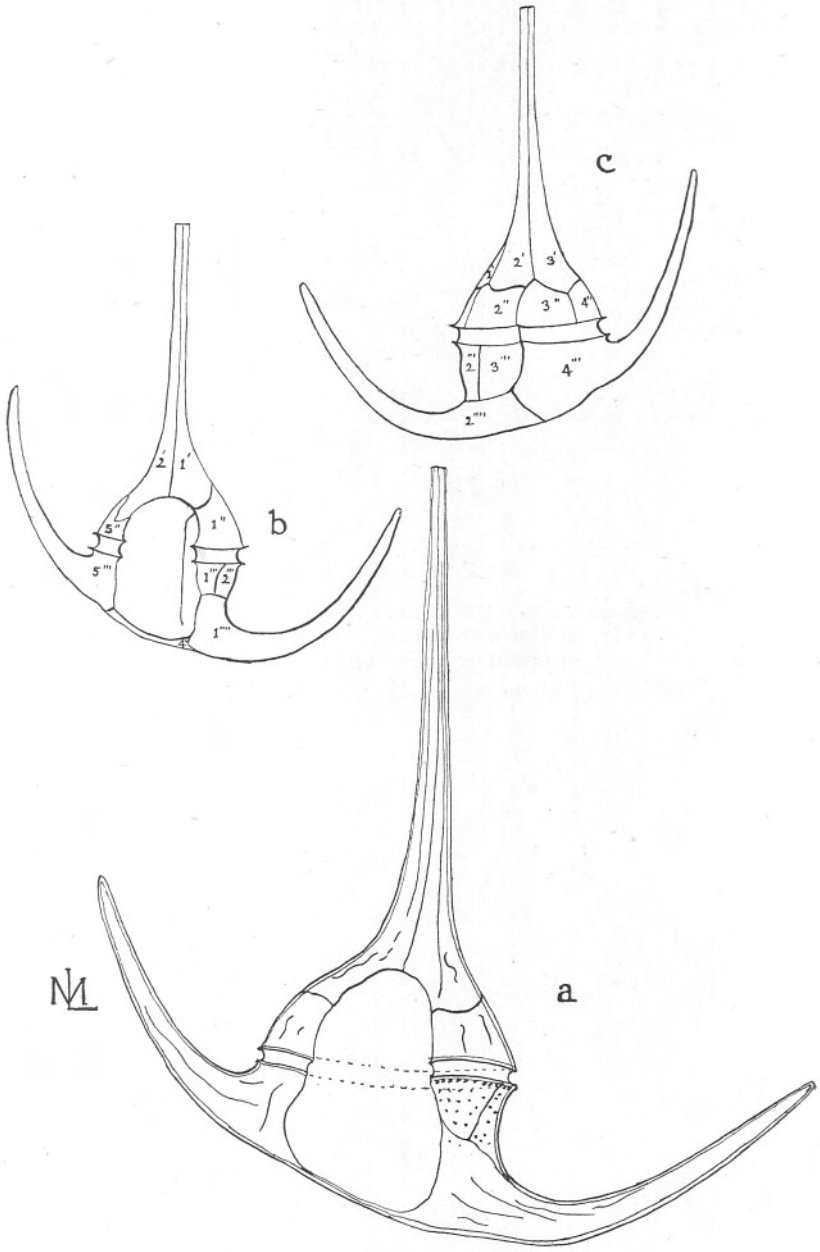


PLATE XXXIII

Ceratium tripos (O. F. Müller).
var. *Atlantica* Ostenfeld.
forma *neglecta* (Ostenfeld)
270μ long, Plymouth Sound. Ventral view.

PLATE XXXIII

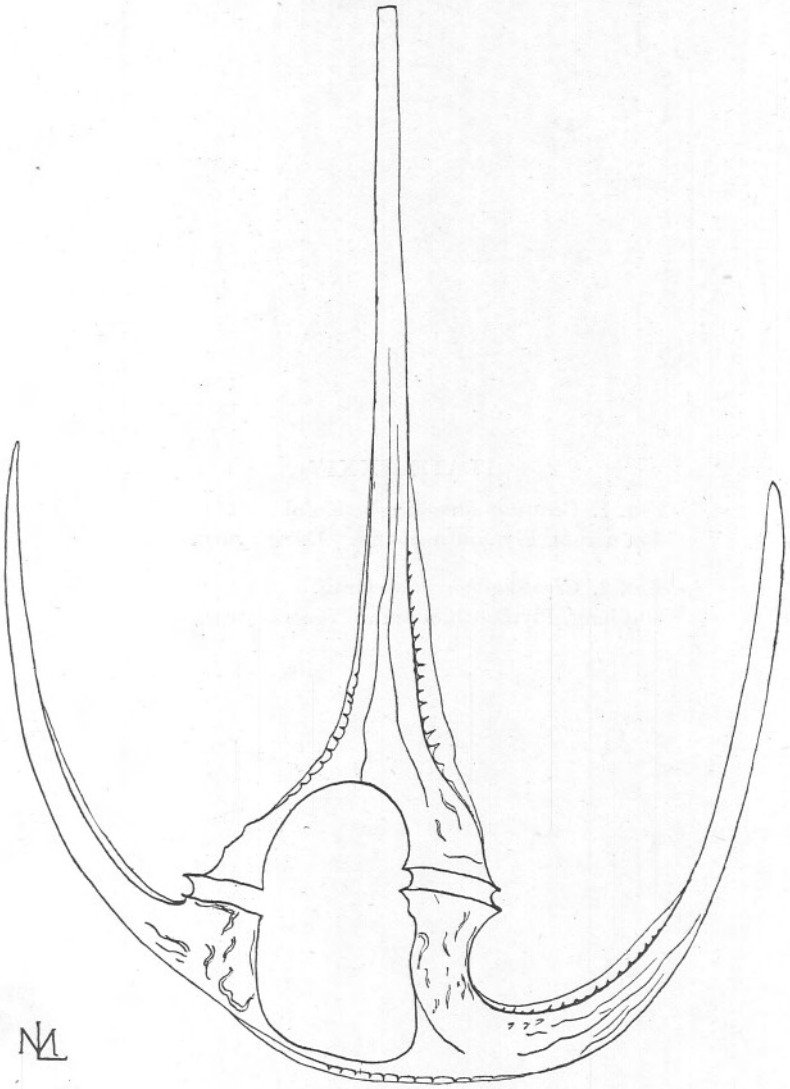
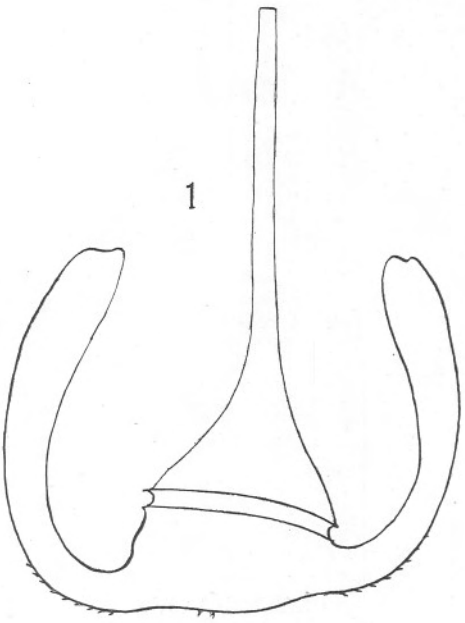


PLATE XXXIV

FIG. 1. *Ceratium lamellicorne* Kofoid.
45μ across, Plymouth Sound. Dorsal view.

FIG. 2. *Ceratium horridum* Gran.
60μ long, Plymouth Sound. Ventral view.

PLATE XXXIV



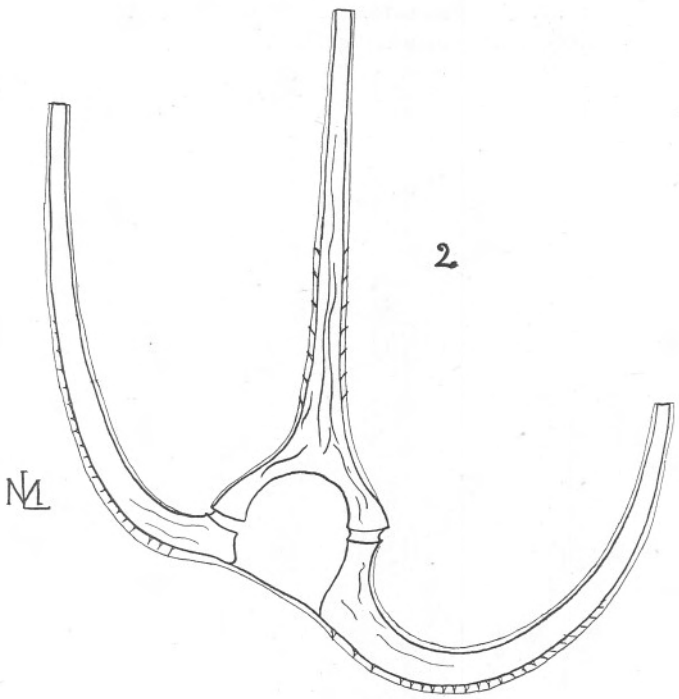
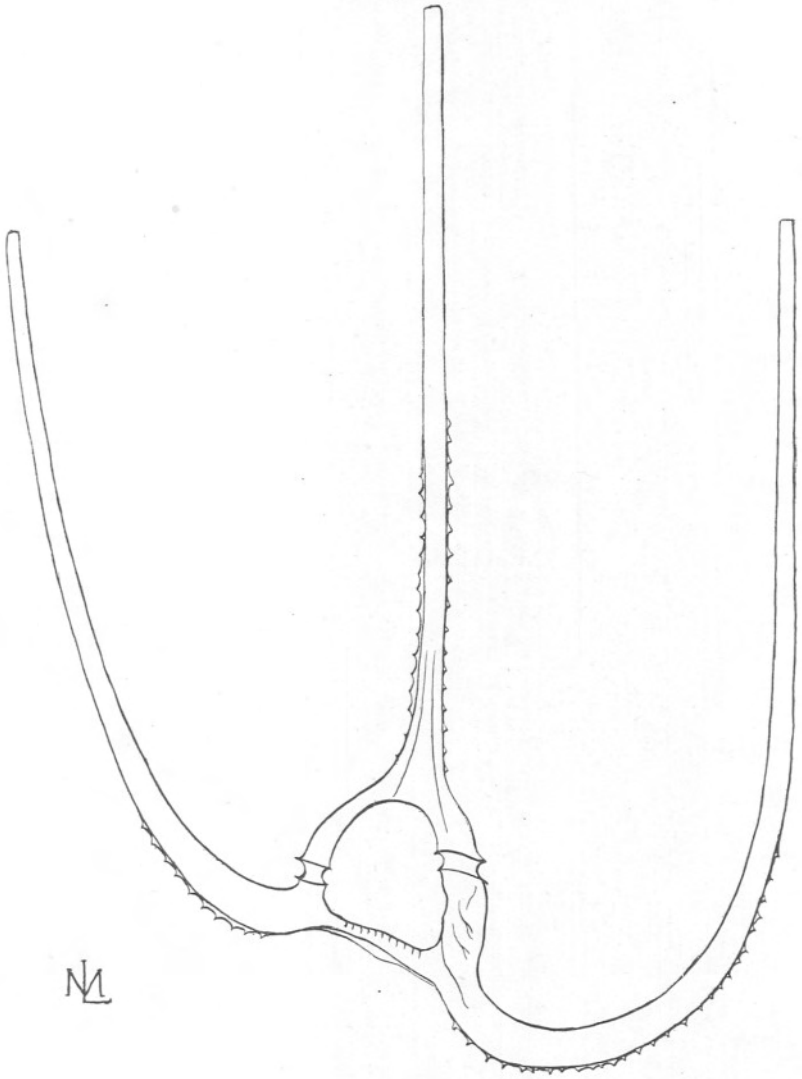


PLATE XXXV

FIG. 1. *Ceratium macroceros* (Ehrenberg).
45μ broad, Plymouth Sound. Ventral view.

PLATE XXXV



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Numerals in ordinary type refer to the description of terms, species, or text figures.