

The Peridinales of Plymouth Sound from the Region beyond the Breakwater.

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With Figures 1-14 in the text.

THE following list includes all the Peridinales identified in the plankton throughout the year from September, 1915, to September, 1916, from the water samples, details of which will be found in another paper in the same journal (p. 133). Also from the plankton in the tow nets in the same year and a portion of the summer 1915. As is shown in the above-mentioned paper, the summer is the time for nearly all the Peridinales, June being the maximum month. After October very few are seen in the water samples, although in the tow nettings the larger and stronger forms, such as *Ceratium* and *Peridinium*, are still present.

The new and least-known forms belong to the *Gymnodiniaceæ*, which have no cellulose sheath. Perfectly transparent and extremely thin cases, however, are often seen which may be close fitting or many times larger than the gymnodinian. *Pouchetia* and various species of *Cochlodinium* are instances of this (see Plate II, Fig. 14). The *Gymnodiniaceæ* are perhaps the most interesting of the Peridinales, as many of them obtain nourishment holozoically and often the food can be determined. Throughout June the flagellate *Phæocystis pouchetii* was excessively abundant, and this furnished food for many gymnodinians (e.g. *Gymnodinium rhomboides* and *G. triangularis*, see Plate I, Figs. 6 and 7).

Division stages in this group are often seen which in the genera *Gymnodinium* and *Spirodinium* take place usually, if not always, in the free state and not in capsules as in *Pouchetia* and others (Pouchet, 1885; Dogiel, 1906).

Although no special investigation has been made closer inshore, the examination of a few samples of water show that many of the species occur near the land, such as *Gymnodinium* and *Spirodinium* species and *Dinophysis*, besides several species of *Peridinium*.

In the following list 60 species are recorded. Of these 5 of *Gymnodinium*, 2 of *Spirodinium*, and one of *Cochlodinium* are new. Twenty-one species are, I believe, new records for British seas and 28 are new records for the Plymouth area. In addition to those recorded and described there are many which I have not been able to identify. Some of these are young forms, others collapsed before they could be properly observed, and others were distorted. Among these there are probably many new species belonging to the *Gymnodiniaceæ*.

The classification adopted is that of Paulsen (1908) in "Nordisches Plankton." Those marked * are new to Plymouth, those marked N.R. are new records for British seas.

PROROCENTRACEÆ.

Genus EXUVIELLA Cienk.

- (1) * *Exuviella compressa* (Bailey) Ostenfeld. Occasionally in water samples in the summer.

Genus PROROCENTRUM Ehrenberg.

- (2) *Prorocentrum micans* Ehrenberg. From May to October in the water samples, rarely in tow nettings. Commonest in the late summer. Its maximum early in September.

PERIDINIACEÆ.

Genus DINOPHYSIS Ehrenberg.

- (3) *Dinophysis acuta* Ehrenberg. Fairly frequent in very fine tow nettings, not so common in the water samples. May to October.
- (4) *D. acuminata* Cl. and L. Common in water samples, usually gets through the very fine net. There is a small form of this species which occurs more rarely than the type in the spring and early summer.
- (5) *D. ovum* Schütt. Occasionally in water samples.
- (6) *D. rotundatum* Cl. and L. Common in water samples.
- (7) *D. homunculus* Stein v. *tripos* Gouss. Occurred once only in tow nettings, August, 1916.

Genus GLENODINIUM (Ehrenberg) Stein.

- (8) * *Glenodinium bipes* Pauls. Common from May to September. Abundant in May and June with its maximum in early June. This species is so small that it always gets through the very fine

net. It is exceedingly active and lives many hours in a bottle of sea-water.

Genus *PROTOCERATIUM* Bergh.

- (9) * *Protoceratium reticulatum* (Cl. and L.). Occurs fairly commonly in water samples from May to September, commonest in August.

Genus *GONIAULAX* Diesing.

- (10) * *Goniaulax triacantha* Jörgensen. Rare, in water samples, May to September.
- (11) *G. polygramma* Stein. Rare, in water samples, May to September.
- (12) *G. spinifera* (Cl. and L.). This is the commonest species of *Goniaulax*. May to September.
- (13) N.R. *G. scrippsæ* Kofoid. Occasionally in the water samples, July to September.
- (14) *G. polyedra* Stein. Occasionally in water samples, May to September.

Genus *AMYLAX* Meunier.

- (15) N.R. *Amylax lata* Meunier. Occurred a few times singly. Slightly smaller than the type.

Genus *DIPLOPSALIS* Bergh.

- (16) *Diplopsalis lenticula* Bergh. Fairly common in very fine tow nettings and in water samples. May to September.
- (17) N.R. *D. pillula* Ostf. This minute species is abundant in June in the water samples, very often with *Glenodinium bipes*.

Genus *PERIDINIUM* Ehrenberg.

Sub-genus *PROTOPERIDIUM* Bergh.

- (18) *Peridinium orbiculare* Paulsen. Occurs rarely in the water samples.
- (19) * *P. cerasus* Paulsen. This little species is one of the commonest and easily recognised. Occurs fairly frequently but never in large quantities in the water samples.
- (20) * *P. roseum* Paulsen. Very like the last species but larger and flatter. Occurs rarely in the water samples.

- (21) *P. ovatum* (Pouchet). Common in late summer but rare in May and June. Specimens with broad and conspicuously striated interspaces between the plates are as common as the typical forms and are probably older, as Mangin (1913) has already noted. More common in tow nettings than in water samples.
- (22) *P. pedunculatum* Schütt. Very rare, in water samples only.
- (23) *P. pallidum* Ostf. This and the following species are both common, the present species being larger is commoner in the tow nettings.
- (24) *P. pellucidum* (Bergh). Common in water samples.

Sub-genus EUPERIDINIUM Gran.

- (25) *P. oceanicum* Vanh. Rare in tow nettings.
- (26) *P. divergens* Ehrl. Abundant in the tow nettings, especially in August and early September. Following Meunier (1910) I have reunited the *P. depressum* of the "Nordisches Plankton" with this species.
- (27) *P. crassipes* Kofoid. Not very common in the tow nettings in August and September.
- (28) *P. conicum* (Gran). This species and *P. divergens* are almost the only peridinians to be found in winter: although not abundant *P. conicum* is found throughout the year both in tow nettings and water samples. Commonest in early spring.
- (29) N.R. *P. Thorianum* Paulsen. Rare in water samples in June. Meunier (1910) gives good figures of this species, which resemble the Plymouth form more than do Paulsen's. The present specimens have small knobs conspicuously ornamenting the skeleton which are very characteristic.

Genus PYROPHACUS.

- (30) N.R. *Pyrophacus horologicum* Stein. Occurred very rarely in tow nettings in August.

Genus OXYTOXUM Stein.

- (31) N.R. *Oxytoxum Milneri* Murr. and Whitt. I have referred to this species, a very small Oxytoxum about half the size of the type but agreeing with it in form. Only one specimen was found in August in the water samples.

Genus CERATIUM Schrank.

- (32) N.R. *Ceratium platycorne* V. Duda. Rare, occurred singly two or three times in the tow nettings.
- (33) *C. bucephalum* (Cleve). Occurred sparingly in tow nettings in early summer, more frequently in the late summer months.
- (34) *C. tripos* (O. F. Müll.). Occasionally in water samples and tow nettings. A variety which approaches the form *lineata* (Ehrb.) and which I have referred to this variety occurs more frequently (Fig. 1). This has a short and straight apical horn, the hind horn nearly straight and the right horn about one-third as long as the left. The usual markings are longitudinal striations from the apex to the girdle, sometimes also with reticulations.



FIG. 1.—*Ceratium tripos* (O. F. Müll.) f. *lineata* (Ehrb.). $\times 466$.

Although apparently nearest to the form *lineata*, the apical horn is very much shorter—less than half the length from its apex to the girdle.

- (35) * *C. arcticum* (Ehrb.). Very rare, in tow nettings, 1915.
- (36) *C. macroceras* (Ehrb.) Cleve. Rare in tow nettings.
- (37) *C. furca* (Ehrb.). Occasionally, in tow nettings and water samples in summer.
- (38) *C. fusus* (Ehrb.). The commonest *Ceratium* here. Occurs both in tow nettings and water samples and is often the only peridinian present in the winter. Maximum in October.

GYMNODINIACEÆ.

By far the greater portion of the Peridinales of this area belong to this group and are missed almost entirely by the tow nets, only a few of the larger forms being retained by them.

Genus AMPHIDINIUM Cl. and L.

- (39) N.R. *Amphidinium crassum* Lohmann. I have referred to this species, a form between *A. crassum* and *A. longum* of Lohmann, but which is slightly larger than either of these (Fig. 2). The shape of the body is not so pointed posteriorly as in *A. longum* but not so broadly rounded as in *A. crassum*, the greatest breadth being in about the centre of the body. The nucleus is posterior as in both forms, and a coloured body, greenish, is situated just in front of the nucleus and behind the transverse groove, with small refractive bodies scattered round it. This is perhaps the remains of ingested food material. A thin transparent covering can sometimes be seen detaching itself from the body. Length



FIG. 2.—*Amphidinium crassum* Lohmann. $\times 466$. N=nucleus.

of body 0.030 mm. The only record so far of this species is by Lohmann from Kiel.

Genus GYMNODINIUM Stein.

- (40) N.R. *Gymnodinium teredo* Pouchet. Fairly common in July and August in the water samples in 1915, less common in 1916. This is the only gymnodinian found here in the winter months, but then only rarely. It turns up singly nearly all the year round. Many abnormalities and deformities occur and a variety of shapes is seen.
- (41) N.R. *G. pseudonoctiluca* Pouchet (Fig. 3). To this species I refer one which agrees well with one condition of the above species, but which I never saw with the long contractile tentacle described by Pouchet (1885). It only occurred twice, the first time in medium tow nettings in July, 1915, and the second time in the water samples in June, 1916. It is rather smaller than the type (length 0.10 mm.). The ventral surface on each side of the longitudinal groove is pulled out into a flap, the left flap slightly longer than the right. The bright yellow chromatophores radiate from the centre. The longitudinal groove is more marked than in Pouchet's figures. The nucleus is in the centre of the body.

- (42) *G. viridis* n. sp. (Fig. 4). Closely related to the last species is one also found only singly and which is less than half the size. In shape it is much like *G. pseudonociluca* with a cap-like anterior

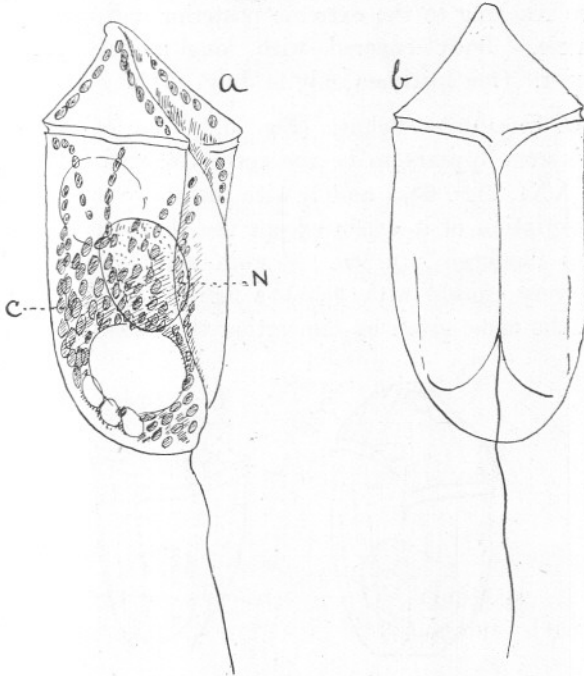


FIG. 3.—*Gymnodinium pseudonociluca* Pouchet. $\times 466$.
a side view, b ventral view. N=nucleus. C=chromatophores.

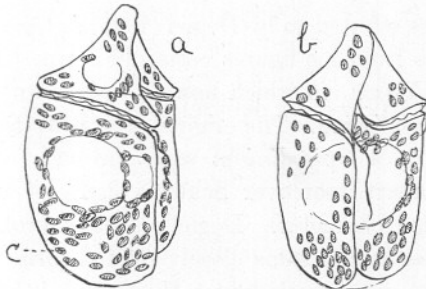


FIG. 4.—*Gymnodinium viridis* n. sp. $\times 466$.
a side view, b ventral view. C=chromatophores.

end; the longitudinal groove, however, reaches back slightly over the dorsal surface posteriorly so that the hind end is divided. The chromatophores are of a greenish yellow colour, not bright yellow as in *P. pseudonociluca*. Length 0.06 mm. Occurred once in June.

- (43) *G. achromaticum* n. sp. (Fig. 5). Related to *G. viridis* but without chromatophores. Perfectly colourless and transparent, transverse groove conspicuously left-handed, longitudinal groove reaching to the extreme posterior end. Apex somewhat excentric. Body covered with longitudinal striæ. Nucleus posterior. One specimen only in July, 1915.
- (44) N.R. *G. rhomboides* Schütt (Fig. 6). One of the commonest in this area appears to be the species figured by Schütt (1895, Plate XXI, Figs. 63, 1 and 2) with the above name. Apparently no description of it exists except the short diagnosis in "Nordisches Plankton" (p. 99). Certain aspects of my specimens agree very closely with Schütt's figures, and I have therefore taken the name given by him rather than create a new one.

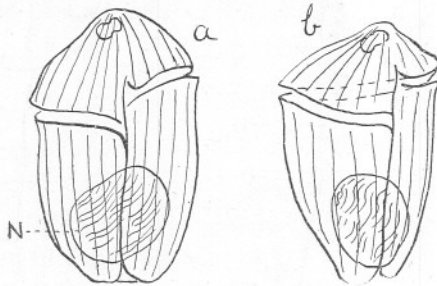


FIG. 5.—*Gymnodinium achromaticum* n. sp. $\times 466$.
a ventral view, b side view. N=nucleus.

The species referred to by Dogiel (1906) as *Gymnodinium spirale* v. *obtusum* is from his figures certainly a true *Gymnodinium* and not a *Spirodinium*, to which now *G. spirale* and all its varieties have been transferred. The original figures by Bergh of *G. spirale* show it to be a *Spirodinium* with the ends of the transverse groove far apart, moreover Schütt's figure of v. *obtusum* shows also the same character. Dogiel's species probably belongs to *G. rhomboides* or else some closely related form. His specimens, however, are very much larger than mine. His figures of the stages in division show it in another form which is also common with us and which I have found in division and very similar to Dogiel's figures. Schütt's figure 63, 1 is also of this type, and apparently this is the form before and during division. These two forms I have therefore placed together as *Gymnodinium rhomboides*. The body is elongated, oval or rhomboidal, the transverse groove is only slightly displaced and left-handed,

the longitudinal groove is inconspicuous. The whole surface is covered with longitudinal striæ, those on the anterior portion being further apart than those posteriorly. Remains of food in

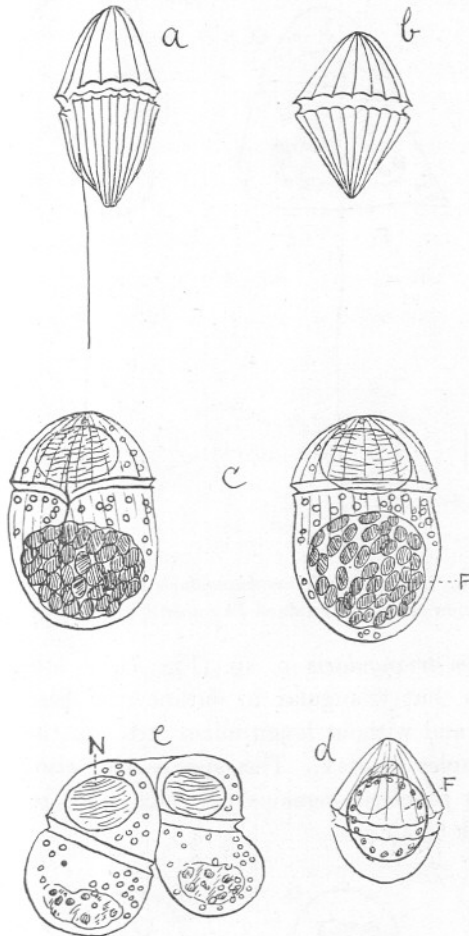


FIG. 6.—*Gymnodinium rhomboides* Schütt. $\times 466$

a side view, *b* dorsal view, *c* ventral and dorsal views of older forms containing food masses of *Phæocystis*, *d* young form containing a *Thalassiosira*, *e* division. N=nucleus. F=food.

a ball is often seen in the hind portion of the body. Nucleus anterior. The body colourless with no chromatophores. Its food consists very often of *Phæocystis pouchetii* when that flagellate is abundant, at other times of diatoms; remains of *Thalassiosira* and *Coscinodiscus* were also found inside the body. Division takes place in the free state as described and figured by Dogiel.

This is perhaps the commonest gymnodinian and occurs close to the shore as well as beyond the Breakwater. Length of body 0.040 mm. to 0.050 mm

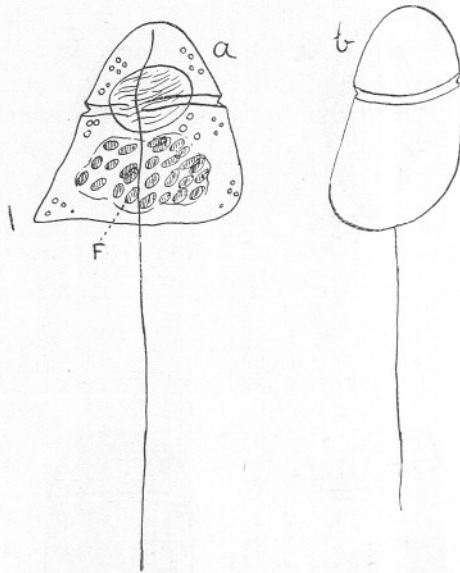


FIG. 7.—*Gymnodinium triangularis* n. sp. $\times 466$,
a ventral view showing contained *Phaeocystis*, b side view. F=food.

- (45) *Gymnodinium triangularis* n. sp. (Fig. 7). Closely related to *G. rhomboides*, but triangular in outline (the base of the triangle posterior) and without longitudinal striæ on the body. Rare in water samples in May. This species had also been feeding on *Phaeocystis pouchetii*, remains of which were recognisable inside it. Length 0.045 mm.

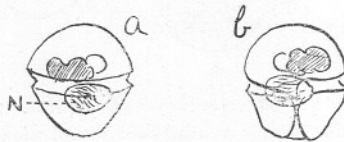


FIG. 8.—*Gymnodinium minor* n. sp. $\times 466$.
a dorsal view, b ventral view. N=nucleus.

- (46) *Gymnodinium minor* n. sp. (Fig. 8). This little species is transparent and destitute of any sculpture. It is nearly spherical but with the posterior end slightly narrower than the anterior. Transverse groove left-handed and only slightly displaced, longitudinal groove reaching to the posterior end. Nucleus nearly

central; green masses, probably food material, at the anterior end. Length 0.028 mm. Occasionally in water samples May to July.

- (47) *Gymnodinium filum* n. sp. (Fig. 9). Body long and narrow, tapering to a thread-like point posteriorly. Anterior end conical. Transverse groove almost straight, longitudinal groove reaching about three-quarters of the way to the posterior end. Nucleus behind the centre. A dark brown mass (probably food remains) in front of and at the side of the nucleus. One specimen was found with no coloured body. Body clear and colourless with no striæ. Length 0.065 mm. Rare in water samples July, 1915. Very fragile and easily collapses.

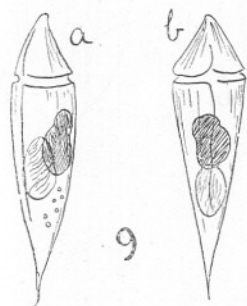


FIG. 9.—*Gymnodinium filum* n. sp. $\times 466$
a side view, b ventral view.

Genus SPIRODINIUM Schütt.

- (48) N.R. *Spirodinium fissum* (Levander) Lemmermann. Occurs occasionally in August and September in water samples. Conspicuous from its yellow colour and peculiar dorso-ventral flattening. Division in the free state was noticed in September.
- (49) N.R. *Spirodinium spirale* (Bergh) (Fig. 10). This species is exceedingly common in the water samples in many varieties. The typical form which agrees with Pouchet's description and figure (1885, p. 67, Plate IV, Fig. 30) is usually much smaller than his specimens and generally colourless, although bright yellow examples are sometimes seen, such as Pouchet himself observed occasionally. The yellow examples are always blunter at the apex than the type which is pronouncedly acuminate. My specimens, including the yellow forms, measure generally 0.04 mm. to 0.06 mm., whereas Pouchet (1883-85) gives 0.10 mm. as the typical size. The longitudinal striations are characteristic,

and green remains of food are sometimes to be found inside the body, also small roundish masses of fat.

The variety *acutum* Schütt (Plate XXI, Fig. 66) is also found, which seems to be close to the typical form and more nearly the size of Bergh's (1882) and Pouchet's specimens. Length of this variety 0.14 mm. One specimen which occurred in August, 1915, was coloured a beautiful carmine, the colour running along

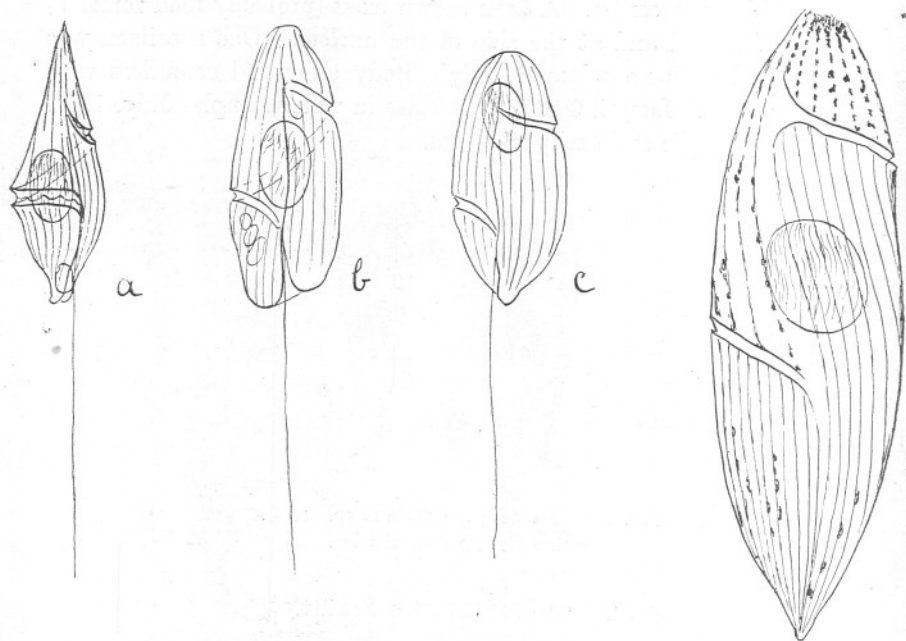


FIG. 10.—*Spirodinium spirale* (Bergh). $\times 466$.
a typical form, b and c v. *obtusum* Schütt, d v. *acutum* Schütt.

the lines of the striæ in droplets. Other specimens are quite colourless.

The variety *obtusum* Schütt is also common but of small size. Length 0.06 mm. usually. Characterised by its blunt apex.

- (50) *Spirodinium concentricum* n. sp. (Fig. 11). This species is characterised by the sculpture of concentric striæ on the body, the longitudinal striæ being arranged concentrically round a certain point at the side or on the dorsal surface. Body colourless. Grooves and shape of the body very much like the variety *obtusum* of the preceding species. A large and a small form exist, the larger form being several times the size of the smaller. Both rare, only in the summer of 1915.

(51) N.R. *Spirodinium crassum* (Pouchet) (Fig. 12). I have referred to this species a somewhat rare form which is definitely smaller than the type, length 0.075 mm. (type 0.12–0.2 mm.

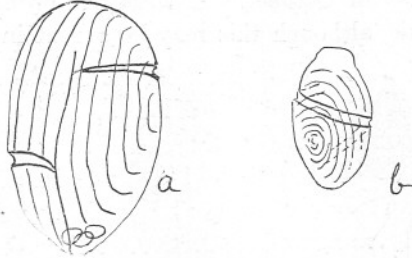


FIG. 11.—*Spirodinium concentricum* n. sp. $\times 466$.
a large form, b small form.

Pouchet). In shape and contour of the furrows it corresponds and has a diffuse colouring of brownish red beginning at the apex and following the transverse furrow. Faint longitudinal striæ

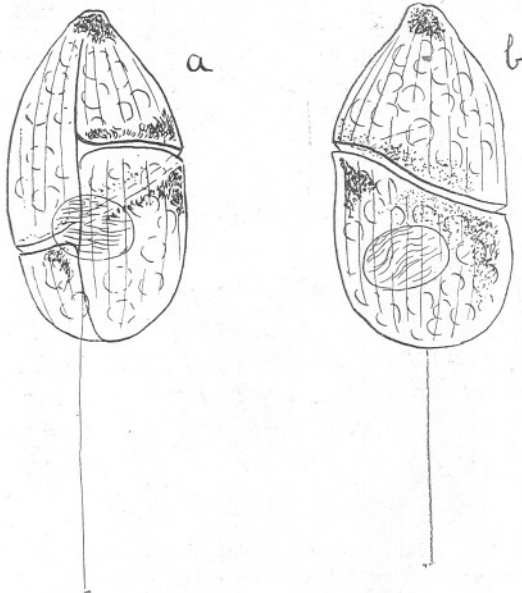


FIG. 12.—*Spirodinium crassum* (Pouchet). $\times 466$.
a ventral view, b dorsal view.

are present; transverse furrow with its ends widely separated, longitudinal furrow weakly developed. Nucleus posterior. Interior of body full of large granules. Occurs occasionally in June.

- (52) *Spirodinium glaucum* n. sp. (Fig. 13). This is a very common species, perhaps the commonest *Spirodinium* in this area. It begins in May, having its maximum in May and June and persists till October. A large yellow body posteriorly is characteristic, although this may be absent in young forms and

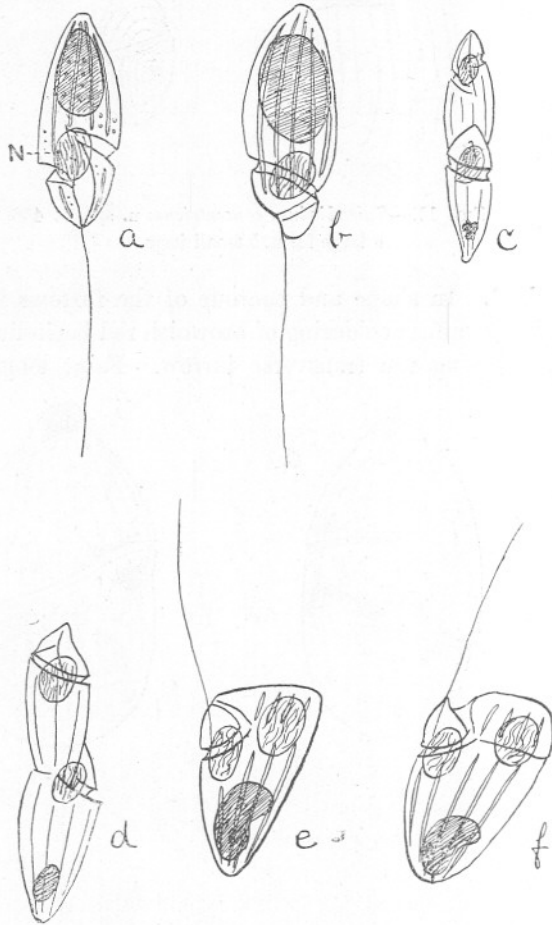


FIG. 13.—*Spirodinium glaucum* n. sp. $\times 466$.
a ventral view, b dorsal view, c-f division stages. N=nucleus.

possibly is only food remains, although it is always the same colour and in the same place. These yellow bodies are also sometimes absent in divisional stages. The body is elongated with a long anterior and short posterior portion, with a few wide apart longitudinal striæ. Transverse furrow with the ends wide apart; longitudinal furrow short and with the appearance of a

three-cornered bite having been taken out of the posterior end. This species is rather like *G. teredo*, with the exception of the chromatophores which are numerous in the latter species. Cell colourless except for the yellow mass. Nucleus in the region of the transverse furrow. Divisional stages are often seen in the free state, one individual pushing part of its body backward so that a chain of two is formed very much like the figure given by Pouchet of the division of *S. spirale* (loc. cit.). Earlier stages in division show that the longitudinal flagellum persists as is described by Dogiel in his *Gymnodinium spirale* v. *obtusum*. A growth then takes place at the side of the whole body, so that the cell is very much swollen transversely; then division takes place, beginning at the posterior end as a groove and half the cell is pushed backwards so that the chain of two individuals is formed, one attached to the side of the posterior end of its fellow by its extreme anterior end. After division the individuals are small and may



FIG. 14.—*Cochlodinium pulchellum* n. sp. $\times 466$.

or may not contain yellow bodies. In one case the yellow body appeared to be dividing at the same time as the cell, which perhaps shows it to be a chromatophore.

Genus COCHLODINIUM Schütt.

- (53) N.R. *Cochlodinium helix* (Pouchet). Occurs occasionally in the water samples in August, sometimes free, sometimes enclosed in a spacious perfectly transparent covering.
- (54) N.R. *Cochlodinium pellucidum* Lohmann. Rare. In the water samples in July and August.
- (55) *Cochlodinium pulchellum* n. sp. (Fig. 14). This species was found once only in the water samples from 7 fathoms, August, 1915. It is perfectly colourless and contained in a roomy trans-

parent case in which it rotates freely on its longitudinal axis. It is fusiform in shape, and pointed in much the same way at both ends. The transverse furrow makes three complete turns and is deeply grooved. The longitudinal furrow is inconspicuous, making over one turn round the body. Nucleus nearly central. Length of body 0.05 mm., length of case 0.65 mm. This species is very similar to *Pouchetia fusus* Schütt, but without the conspicuous lens and stigma of that form.

Genus POUCHETIA Schütt.

- (56) N.R. *Pouchetia armata* Dogiel (1906). This species, with its characteristic stinging capsules, is common in the water samples, especially in May and June. It is sometimes contained in a case, sometimes, and more usually, free. Division into two within the case was seen. So far this species has only been recorded for the Mediterranean.
- (57) N.R. *Pouchetia parva* Lohmann. This is fairly frequent in summer, especially in June. The case fits very close to the body, much closer than in *P. armata*. Division in the case is often seen. This species is very like Pouchet's figure (1885) of *P. polyphemus* v. *nigra*, the pigment, however, in his species is red and this is always black.
- (58) N.R. *Pouchetia fusus* Schütt (1895). Occurs rarely in September. Conspicuous from its elongated body and large lens with dark red pigment. In one case the pigment mass was breaking up into small red spots. The specimens seen were always free.

Genus POLYKRIKOS Bütschli.

- (59) N.R. *Polykrikos Schwarzii* Bütschli. Occurs occasionally in tow nettings and water samples from May throughout the summer.

PYROCYSTEÆ Apstein.

Genus PYROCYSTIS Murray.

- (60) *Pyrocystis lunula* Schütt. Occurs occasionally in tow nettings in August and September in various stages of division in the semilunar cases.

Incertae sedis.

- (61) N.R. *Oxyrrhis marina* (Duj.). The position of *Oxyrrhis* is still a vexed question, and although Senn (1910) regards it as a true peridinium, the view is not universally accepted (see Klebs, 1912). In my opinion it is more of a peridinium than a true flagellate, the division

stages of *Gymnodinium* and *Spirodinium* being closely related to those of *Oxyrrhis*. *Oxyrrhis marina* occurs sparingly in the water samples, but is to be found in great abundance in cultures in the laboratory in which it thrives with the greatest ease. In cultures of *Nitzschia closterium* especially it flourishes in enormous numbers, the body being full of this diatom on which it feeds.

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