Report of the Biological Survey of Mutsu Bay_18. Protozoan Fauna of Mutsu Bay. Subclass Dinoflagellata; Tribe Gymnodinioidae

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18. Protozoan Fauna of Mutsu Bay.*
Subclass Dinoflagellata; Tribe Gymnodinioidae

By

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(With Pls. I–III and 12 text-figures).

This elusive group of the unarmored Dinoflagellata has not received from investigators of the plankton the attention merited by its wide-spread occurrence and its importance in the ecology of the sea. This omission has occurred largely because of certain technical difficulties in the collection and preservation of the plankton arising from the minute size and the delicacy of these organisms. Most species of this group are less than 50 μ in diameter, the size of the openings in No. 25 silk bolting cloth used in the finest plankton nets. Their minute size, supplemented of their own active movements enables them to escape through the silk so that their representation retained in the plankton is disproportionately small in comparison with the more passive, more angular diatoms. The rush of water through the net as usually handled also destroys the more delicate species.

The usual methods of preservation of plankton, formalin or picro-formalin, disrupt or distort these dinoflagellates or render them adherent to other organisms so that they are recongnized with difficulty, if at all, and their numbers are so reduced that their detection, even if preserved, and investigation by cytological methods is rendered doubly difficult. Fortunately their delicacy renders them so transparent in life that much cytological detail can be secured from the living organisms. Their own activities, however, put limits upon this method.

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They have mainly disappeared or are encysted in small numbers in plankton standing even for an hour in the laboratory. Further-more and perhaps the main reason for their neglect, they are so active in the normal free-swimming state as often to defy all efforts to get even an ocular micrometer reading of their length, to say nothing of a cytological analysis of the often complex systems of girdle and sulcus on which their classification so completely depends.

The investigator of this very important and morphologically most interesting group is thus forced to collect with care, to search the plankton assiduously for normal specimens, and to work rapidly when a favorable opportunity offers. All too often the most promising material disintegrates under the illumination of the microscope, before a complete analysis can be made. All attempts to study structure satisfactorily in cytologically prepared material have failed except in some of the more rigid genera such as *Gymnodinium* and *Noctiluca*.

Care must always be taken to distinguish the young stages of skeleton-forming Peridinioidea of exuviating genera such as *Peridinium*, *Pyrophacus* and *Gonyaulax*, from encysted *Gymnodinium*. The undivided skeletal wall of such exuviated individuals is usually close-fitting, even into the girdle and sulcus, and in this state they provide the species of the so-called genus *Glenodinium*. The cyste of true Gymnodinioidae, except in initial stages, does not enter the trough of the girdle, is not as close fitting throughout, and is usually more delicate and of a different optical appearance from these early stages in the development of the skeleton in the Peridinioidea. A familiarity with such exuviating genera in the normal skeletal-bearing phase, always coincident in occurrence with these *Gymnodinium*-like, plateless early stages is invaluable to the student of the Gymnodinioidae. A familiarity with their cell contents is also a safeguard against confusing them with the Gymnodinioidae.

The separation of the zoospores of the Blastodiniidae and possibly of other imperfectly known dinoflagellates, from minute species of *Gymnodinium* and related genera is a difficult task, for whose solutions a knowledge of life histories based on culture will be essential.

The species reported in this paper were observed in the plankton of Mutsu Bay during July 1 — August 20, 1930, but mainly between August 1 and 20. The best material was obtained with a net of

No. 25 silk with low filtration coefficient, in vertical hauls from 30 meters to surface, brought promptly to the laboratory. The list therefore is representative of the midsummer only, but fortunately this is the reason of maximum abundance of this tribe of dinoflagellates. The list is by no means complete as many forms observed, especially the smaller ones, 10–50 μ in length, and the more active ones, have not been determined by me, and the time has been insufficient to give an account of all of the forms seen. However, the list contains the larger species, some of the most abundant, and many species of considerable morphological interest. It is representative enough to reveal the splendid resources of the Asamushi Biological Station for the further study of the pelagic Protozoa.

LIST OF GYMNODINIOIDAE FROM MUTSU BAY.

With records from the Mediterranean, Plymouth, and La Jolla, California.

Species	Mediterranean	Plymouth	La Jolla	Mutsu Bay
1. *Protonoctiluca pelagica* FABRE DOMERGUE	+	+	+	+
2. *Amphidinium inflatum*, sp. nov.	−	−	−	+
3. *Gymnodinium abbreviatum* K. and S.	−	+	+	+
4. ,, *arcuatum*, sp. nov.	−	−	−	+
5. ,, *coeruleum* DOGIEL	+	−	+	+
6. ,, *fusus* SCHÜTT	+	−	+	+
7. ,, *gelbum*, sp. nov.	−	−	−	+
8. ,, *heterostriatum* K. and S.	−	+	+	+
9. ,, *lunula* SCHÜTT	+	+	+	+
10. ,, *ochraceum*, sp. nov.	−	−	−	+
11. ,, *simplex* LOHMANN	+	+	+	+
12. ,, *spheroideum*, sp. nov.	−	−	−	+
13. ,, *viridescens*, sp. nov.	−	−	−	+
14. *Gyrodinium ascendans*, sp. nov.	−	−	−	+
15. ,, *citrinum*, sp. nov.	−	−	−	+
16. ,, *falcatum* K. and S.	+	−	−	+
17. ,, *ferrugineum*, sp. nov.	−	−	−	+
18. ,, *flavum*, sp. nov.	−	−	−	+
19. *Cochlodinium flavum*, sp. nov.	−	−	−	+

Species	Mediterranean	Plymouth	La Jolla	Mutsu Bay
20. *Cochlodinium helicoides* LEBOUR	+	+	+	+
21. ,, *radiatum* K. and S.	−	−	+	+
22. ,, *schuettii* K. and S.	+	+	+	+
23. *Polykrikos schwartzii* BÜTSCHLI	+	+	+	+
24. *Noctilluca scintillans* MACARTENY	+	+	+	+
25. *Nematodinium atromaculatum*, sp. nov.	−	−	−	+
26. ,, *partitum* K. and S.	−	−	+	+
27. *Pouchetia hataii*, sp. nov.	−	−	−	+
28. ,, *mutsui*, sp. nov.	−	−	−	+
29. ,, *purpurata* K. and S.	−	−	+	+
30. ,, *reticulata*, sp. nov.	−	−	−	+
31. ,, *rosea* (POUCHET) K. and S.	+	−	+	+
32. *Blastodinium crassum* CHATTON	−	+	−	+
33. *Oodinium poucheti* CHATTON	−	+	−	+
	11	11	15	33

In all 33 species as shown above are listed here. Of these 14 are new. Of these 19 previously described 11 are listed by LEBOUR (1925) in the plankton at Plymouth, 11 were reported by SCHÜTT (1896) or others from the Mediterranean at Naples or elsewhere, and 15 were included in the fauna of the California Current off La Jolla by KOFOID and SWEZY (1921) in their monograph on the Gymnodinioidae.

This list is significant in indicating the cosmopolitan destribution of the Gymnodinioidae and the warm-temperate character of the plankton of Mutsu Bay. Its neritic character is also suggested by absence of *Erythropsis*, *Proterthropsis*, *Torodinium*, the abundance of *Noctiluca*, and some species of *Gymnodinium*. No species of distinctively northern habitat are included in this list, although among the Tintinnoinea identified by us in the plankton of Mutsu Bay are species of *Parafavella* and *Ptychocylis* which are specifically northern or Arctic in their origin or affiliations.

I am indebted to the Rockfeller Foundation for the opportunity, while serving as Visting Lecturer in Biology at Tôhoku Imperial Unversity, of making this investigation, to Professor SHINKISHI HATAI, founder and Director of the Asamushi Biological Station for facilities generously made available for this study, to Assistant Professor S. KOKUBO for the benefit of his extensive knowledge of the local plankton, and to Mr. YOSHINE HADA for effective assistance in finishing my sketches for reproduction as illustrations.

Subclass DINOFLAGELLATA BÜTSCHLI

Mastigophora with two differentiated flagella and permanently beaded chromatin threads in the nucleus.

Order DINIFERIDEA DELAGE and HÈROUARD emend. KOFOID and SWEZY.

Dinoflagellates with tranverse girdle and longitudinal sulcus.

Tribe *Gymnodinioidae* POCHE emend. KOFOID and SWEZY

Diniferidea with no exoskeleton of discrete plates, but often with temporary cyst of homogenous structure.

Family **Protonoctilucidae** LEBOUR

Gymnodinioidae with rudimentary girdle and sulcus, flagella anterior (or posterior ?) or ventral ; tentacle more or less developed.

Genus PROTONOCTILUCA LEBOUR

Protonoctilucidae with tentacle well developed, anterior (? or posterior) ; body elongated.

1. **Protonoctiluca pelagica** FABRE DOMERGUE

(Figs. A and B)

Pelagorhynchus marina PAVILLARD (1917), PP. 238–241, figs. 1–9.
Protodinifer tentaculatum KOFOID and SWEZY (1921) PP. 112–115, pl. 7, fig. 74, fig. R, 2.

Body elongate obovate, or slightly asymmetrically fusiform ; widest in the posterior third ; length 2.2–2.5 transdiameters ; apex asym-

metrically subconical, antapex contracted into a more or less elongated, blunt projection; girdle scarcely developed at all, located within 0.5 transdiameter of the apex; sulcus slightly developed; transverse flagellum as long as the body, usually encircling the anterior end; longitudinal flagellum often carried anteriorly; transverse flagellar pore about 0.5 transdiameter from the anterior end, longitudinal flagellar pore near base of tentacle; tentacle arising from anterior end, slender, cylindrical, about 0.5 transdiameter in length waving slowly, or bent forward suddenly, often bent at right angles; no striae, pellicle punctate.

Cell contents consisting of the antero-dorsally located, elongate ovoid dal nucleus with about 10 chromatin threads across one face; an irregularly contoured, homogeneous, yellowish blue (amyloid?) mass of variable size, in the posterior 0.5 of the body; a cluster of highly refractive oil droplets in the antapical cone; food vacuoles rarely seen; greenish rhabdosomes sometimes found anteriorly radiating from the pore of the transverse flagellum.

Dimensions: — Length, 25–54 μ (LEBOUR, (1925) gives 12–45 μ; transdiameter 13–33 μ; length of tentacle 8–16 μ.

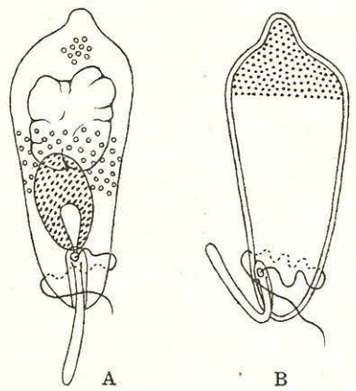


Fig. A and B. *Protonoctiluca pelagica* FABRE DOMERGUE.
A. Ventral view. B. View of left side showing surface stippling of pellicle in the anterior region only. ×800.

Occurrence: — Rather common in the surface and vertical hauls of plankton in Mutsu Bay in July, 1930.

The orientation of this problematical and curious flagellate is based on its functional orientation in locomotion. Morphologically it might be oriented with the tentacle posterior; in which case the tentacle is in a position homologous to that of *Pavillarda*, *Noctiluca*, and *Erythropsis*. The movements of the tentacle are strikingly like those of the tentacle of *Pavilardia* and *Noctiluca*. This proposed orientation is adopted in our figures only.

In my opinion the status of this genus requires further investigation. While at present there is no conclusive evidence of its relationship to *Noctiluca* the tentacle is curiously similar in the two genera in its behavior. Furthermore the very large reserve or amyloid (?) body is rather unique among dinoflagellates, and its range in dimensions is unusual among the smaller Gymnodinioidae. In Mutsu Bay its period of prevalence coincides with that of sporulation of *Noctiluca*. The possibility that it is a stage in the life cycle of *Noctiluca* representing the earliest stage in the life of that species before inflation by hydrostatic vacuoles, should be investigated by culture methods.

Family **Gymnodinioidae** KOFOID

Gymnodinioidae with girdle with 1–4 turns; sulcus spiralling with the girdle beyond 1 turn; no tentacle; no ocellus.

Amphidinium CLAPARÈDE and LACHMANN

Gymnodinioidae with girdle anteriorly located, never posterior to 0.3 total length, often higher dorsally than ventrally; sulcus straight, without apical loop, often deeply impressed with large lateral flaps; epicone relatively quite small.

2. **Amphidinium inflatum,** sp. nov.
(Pl. I, fig. 4)

A large species (for *Amphidinium*); body broadly ellipsoidal, sack-like, flattened ventrally; cross section slightly flattened ventrally; its length 1.52 transdiameters; epicone 0.3 total length ventrally, 0.15 dorsally, dome-shaped, apex flattened; hypocone sack-shaped, subcylindrical in its anterior 0.5, flattened hemispherical antapically, depressed in the mid-ventral region; girdle located in anterior 0.3 of body, horizontal dorsally, broadly V-shaped ventrally, trough deeply incised, with sharp overhanging margins; sulcus extending nearly to the apex on the epicone where it is very narrow, widening below the girdle, where it is also straight, but terminating 0.16 total length above the aboral end; anterior flagellar pore at junction of proximal end of girdle with the sulcus, posterior flagellar pore about the mid-

dle of the postangular sulcus; no striae; pellicle double-contoured, distinct.

Cell contents consisting of the large, ellipsoidal, transversly placed, centrally located nucleus with about 12 transverse, beaded chromatin lines; minute oil globules clustered in the perinuclear cytoplasm; elliptical, plate-like, canary yellow chromatophores in the distal ends of radiating cytoplasmic strands which pass to the subpellicular cytoplasm; a small spheroidal, bluish green amyloid body near the nucleus; large hydrostatic fluid-filled vacuoles surrounding the central cytoplasmic mass; general color tone yellowish gray.

Dimensions: — Length, 47 μ; transdiameter at girdle 30 μ.

Occurrence: — Two individuals observed in the surface plankton of Mutsu Bay, August, 17–18, 1930, in surface temperatures of 25°–25.2°.

Amphidinium inflatum belongs in the non-compressed subgenus *Amphidinium* because of its subcircular cross section. It differs from all other species in the fact that the sulcus does not reach the antapex and from all except *A. fastigium* in the degree of development of hydrostatic vacuoles.

Both specimens observed were very active continuously circling with occasional motor reactions and change of course.

Genus GYMNODINIUM (STEIN) emend. KOFOID and SWEZY

Gymnodinioidae with body without torsion; girdle with not over 1 turn, its displacement not over 0.2 total length; no nematocysts, ocellus, or tentacle.

3. Gymnodinium abbreviatum KOFOID and SWEZY
(Fig. C)

A large species; body elongated ovoidal, with expanded cingular region, its length 1.9–2.0 transdiameters; epicone about 0.33 length of the hypocone, subconical (about 80°), flaring basally, lateral outlines concave, apex broadly rounded; hypocone flaring a little at the girdle, subcylindrical in its anterior 0.5, subconical (about 50°) below with asymmetrically rounded antapex, with the longer extension at the left of the sulcus; girdle a spiral of one turn ascending 20° above the

horizontal in its proximal 0.25, descending 20° in the aboral 0.5 turn, and increasing to 40° in the distal 0.25, displaced 0.4 transdiameter, trough deeply incised with prominent margins; sulcus narrow, straight, extending from apex to antapex where it widens locally; anterior flagellar pore in the proximal end of the girdle, posterior flagellar pore in the sulcus at its junction with the distal end of the girdle, surface distinctly striate with broken lines, about 23 across the ventral face; pellicle thickened and covered with minute bosses.

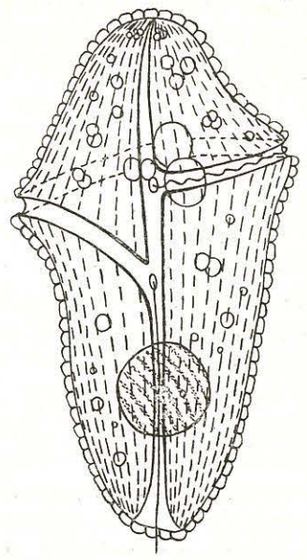


Fig. C. *Gymnodinium abbreviatum* KOFOID and SWEZY. Ventral view. ×800.

Cell contents consisting of the spherical, or broadly ellipsoidal nucleus in the center of the hypocone, with distinct, but fine, moniliform chromatin threads; club-shaped pusules at the pores; spherical oil globules of varying sizes in the periphery; yellowish, or greenish food masses, or food reserves; pinkish vacuoles in the hypocone; cytoplasm very clear, color tone hydrangea pink.

Dimensions: — Length 97–115 μ; transdiameter 50–75 μ.

Occurrence: — Common in plankton of Mutsu Bay, July 1–30, in surface temperature of 16°–25.2°. Not seen in August. This is the commonest species of the Gymnodinioidae in the plankton of Mutsu Bay, with the exception of numerous minute species of uncertain status.

4. Gymnodinium arcuatum, sp. nov.
(Pl. I, fig. 9)

Body stout subellipsoidal in ventral view, with deeply arcuate antapical end; elongate ovoidal in lateral view, its length 1.38 transdiameters and the dorso-ventral diameter 0.88 of the transverse in

the girdle; girdle median in location, its distal end deflected posteriorly for about two girdle widths at an angle of 45°; girdle plane horizontal; body slightly constricted at the girdle whose furrow is narrow and acute in cross section; epicone dome-shaped, its length about 0.88 its greatest transdiameter which is 0.33 of its length above the girdle, its greatest dorso-ventral diameter almost equalling the transverse; apex broadly rounded; hypocone in ventral view subequal to the epicone but deeply indented by a broadly arculate postmargin, about 0.5 transdiameter between the subequal bounding lobes whose apices are equally broadly rounded, its dorso-ventral diameter not exceeding that in the girdle and 0.88 that of the epicone; girdle horizontal, no overlap or displacement; sulcus narrow, invading the epicone for 0.2 its length, flaring in its distal 0.5 to nearly 0.5 the arcuate postmargin; transverse flagellar pore at proximal end of girdle; longitudinal flagellar pore about 0.3 of the distance from girdle to postmargin below the girdle; longitudinal flagellum very long, nearly twice that of the body; numerous longitudinal pellicular striae faintly marked by granular structures.

Cell contents consisting of a spherical nucleus, located at the right of the axis at the level of the girdle; pusule a short, canal near the nucleus; two spherical food vacuoles with light and dark brown contents adjacent to the nucleus; numerous small, spherical highly refractive oil droplets mainly in the epicone; color pale lemon yellow.

Dimensions: — Length, 69 μ; transdiameter 50 μ; dorso-ventral 44 μ; length of longitudinal flagellum 200 μ; diameter of nucleus, 26 μ.

Occurrence: — Rather commen in the plankton of Mutsu Bay, July–August, 1930, at temperatures of 18°–23°.

5. Gynodinium coeruleum DOGIEL

(Pl. I, fig. 5)

A large species, body elongated, subconical, its length nearly 2 transdiameters; cross section subcircular, flattened on ventral face; epicone and hypocone subequal; epicone subconical (about 45°) with slightly convex ends and rounded asymmetrical apex; hypocone proximally conical (30°), distally contracting to a subhemispherical form

with concave postmargin at the end of the sulcus, its sides slightly convex; girdle narrow, a descending left spiral of one turn with a displacement of about 0.25 transdiameter, trough deep with sharply defined, double contoured margins, overhang of 0.5 girdle width; sulcus extending from apex to antapex, nearly straight, with a slight sigmoid curve in the intercingular region, very narrow on the epicone, widening on the hypocone especially in its distal half; anterior flagellar pore in the proximal end of the girdle, posterior flagellar pore almost at the distal end of the sulcus; pellicular striae very prominent, 12–14 across the ventral surface from side to side.

Cell contents consisting of an indistinct spheroidal nucleus near the center of the body with faint nuclear membrane; a pyriform amyloid (?) body in the base of the epicone, a cluster of highly refractive, spherical oil droplets in the apical region; a linear pusule connecting the two pores; rows of minute ellipsoidal chromatophores of a cornflower blue color along the longitudinal striae; plasma very clear, of pale Prussian blue color.

Dimensions: — Length, 120 μ; transdiameter, 60 μ.

Occurrence: — One specimen taken in surface plankton in Mutsu Bay, August 16, 1930 in a surface temperature of 26.8°. Drawn from an active individual.

Gymnodinium coeruleum belongs to the striate subgenus *Lineadinium*, and is nearest to *G. costatum* KOFOID and SWEZY in its proportions and shape but differs from it in its blue instead of pink color, in its more contracted epicone, and in a slightly more slender form.

One specimen from Mutsu Bay differs in some particulars from specimens described by DOGIEL. It has fewer striae, the sulcus extends to the apex, and the body is more elongated. It seems probable that the differences are due more to the contracted state of the individuals drawn by him than to specific characters.

Our specimen remained active in a small slender dish for at least three hours moving continuously in characteristic anti-clockwise circles interrupted by frequent motor reactions.

6. Gymnodinium fusus Schütt
(Figs. D and E)

A large species; body asymmetrically fusiform; its length 2.06–2.50 transdiameters; epicone and hypocone subequal; epicone campanulate, flaring at the base, convex above, contracted in the distal 0.4 to a stout cylindrical horn contracting apically to a rounded tip; hypocone less flaring basally, convex subconical (35°), with an oblique (30° below the horizontal) postmargin, sloping from right to left, with a blunt horn 1–2 girdle diameters in length extending near the end of the sulcus on the right side; girdle a descending left spiral of one turn displaced distally about 2 girdle widths with an overhang, its trough deeply incised with acute margins; sulcus extending upon the epicone for 0.7 its length, with a slight sigmoid curve on the hypocone, flaring distally; no striae; cyst inflated ellipsoidal.

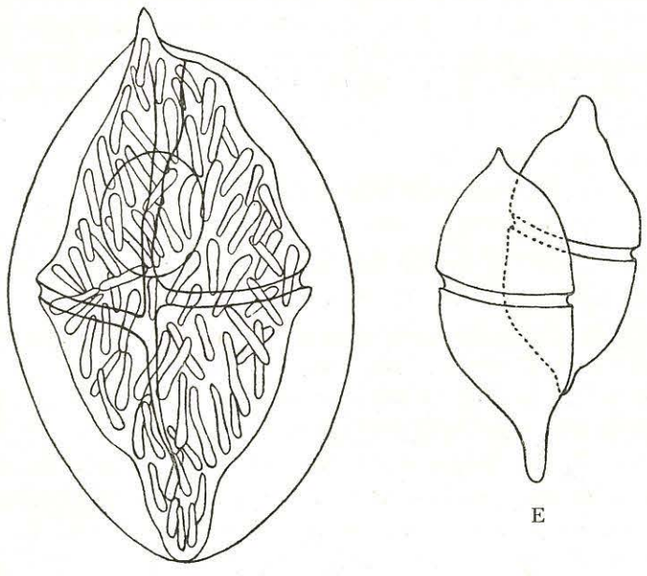


Fig. D and E. *Gymnodinium fusus* Schütt.
D. Ventral view, after Schütt (1895, pl. 24, fig. 79 (1)). ×800.
E. Two conjoined individuals in reversed polar relations, probably recent 50 schizonts. Original, Asamushi, 1930.

Cell contents consisting of a spherical nucleus located in the hypocone, with very fine moniliform chromatin lines, about 20 across one face; numerous elongated, ellipsoidal, or comma-shaped, lemon yellow chromatophores scattered throughout the cytoplasm, numerous spherical oil droplets of varying sizes in the periphery; and several subellipsoidal amyloid bodies near the nucleus; cytoplasm dense; general color tone dark lemon yellow.

Dimensions: — Length, 55–63 μ, transdiameter, 27–30 μ. Schütt's figure, length 100 μ, transdiameter, 45 μ.

Occurrence: — In the plankton of Mutsu Bay from 30–0 meters August 9, 1930, in a surface temperature of 22.8°. Two conjoined individuals, connected ventrally with poles in reversed relation remained in this condition from 10 a. m. to 4 p. m., but clearly moribund. They may be sister schizonts still connected, but with one reversing its antero-posterior relations. This seems more probable than conjugation, since sexual reproduction is still problematical in this group of Protozoa, and this reversed position is not suggestive of conjugation. The nucleus of each was in a dumb-bell shape suggesting an advanced stage of mitosis.

7. Gymnodinium gelbum, sp. nov.
(Pl. I, Fig. 1)

A small species; body broadly and slightly asymmetrically elliptical in ventral outline, its length 0.71–0.80 transdiameters; broadly elliptical in cross section; epicone and hypocone subequal; epicone subhemispherical, flattened ventrally, with right shoulder steeper than left; hypocone subhemispherical with concave postmargin, its flat side a trifle longer than the right; girdle median, a descending left spiral of one turn, distally displaced 1.8 its width, trough lightly impressed (in cyst) with indistinct margins (normal?); sulcus not indenting epicone, straight, widening posteriorly; anterior flagellar pore in proximal end of the girdle, posterior flagellar pore near distal end of sulcus; striae not evident; cyst wall closely applied.

Cell contents consisting of an indistinct spherical nucleus located in the epicone; numerous scattered oil droplets; several homogenous greenish amyloid bodies; numerous small, elongated, lemon yellow,

peripherally located chromatophores; a small pusule directed anteriorly from the posterior flagellar pore; plasma dense; general color tone, deep lemon yellow.

Dimensions: — Length, 48–50 μ; transdiameter, 40 μ; dorso-ventral diameter, 30–32 μ.

Occurrence: — Two specimens, both encysted, in surface plankton from Mutsu Bay, August 16, 1930 in a surface temperature of 24.6°.

Gymnodinium gelbum seems to belong to the subgenus *Gymnodinium* without striae. It was difficult to be certain that faint striae were not present. It is nearest in shape to *G. contractum* KOFOID and SWEZY, but differs from that species in proportionately larger hypocone, in its greater displacement of girdle, and in its yellow, instead of reddish color.

8. Gymnodinium heterostriatum KOFOID and SWEZY

(Fig. F)

A medium-sized species; body subsymmetrically ellipsoidal with slight equatorial expansion; its length about 1.5 transdiameters; epicone and hypocone subequal; epicone with hemispherical apex, becoming convex conical (35°) basally; left side more convex than right; hypocone similar to epicone but less contracted distally and right side more convex than left; girdle a somewhat, low, descending left spiral of one turn, with distal displacement of 1 girdle width and very slight overlap, its trough not deeply impressed, with ridged margins; sulcus narrow, slightly curved to the right in the epicone where it nearly reaches the apex, turning sharply between the overlapping end of the girdle, and terminating at 0.2 the length of the hypocone above the antapex; anterior flagellar pore in the narrowed proximal end of the girdle, posterior flagellar pore midway on the

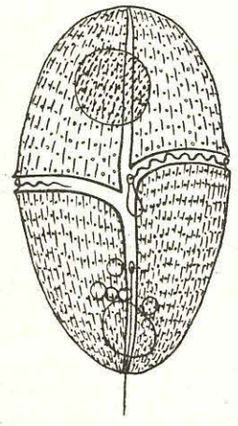


Fig. F. *Gymnodinium heterostriatum* KOFOID and SWEZY. Ventral view. After KOFOID and SWEZY (1921, Fig. Y, 7). ×800.

hypocone; about 18 striae on the epicone on the ventral face and nearly twice as many on the hypocone; cyst hyaline, thin-walled, applied.

Cell contents consisting of the subspheroidal nucleus in the epicone; a sack-like pusule from the anterior flagellar pore; no chromatophores; minute, periphally located, spherical oil droplets; a dense layer of short rodlets in the periphery; food vacuoles containing other Gymnodinioidae, often greatly distending the body; cytoplasm clear, general color tone pinkish cinnamon.

Dimensions: — Length, 66–85 μ; transdiameter, 48–72 μ.

Occurrence: — A number seen in plankton of Mutsu Bay, July 1–30, in surface temperatures of 16°–25.2°.

This is one of the most cannibalistic species of the genus *Gymnodinium* and accordingly varies in size, somewhat in proportions, and in color, as a result of the amount and nature of its recent feeding.

9. Gymnodinium lunula SCHÜTT

(Figs. G. to Q.)

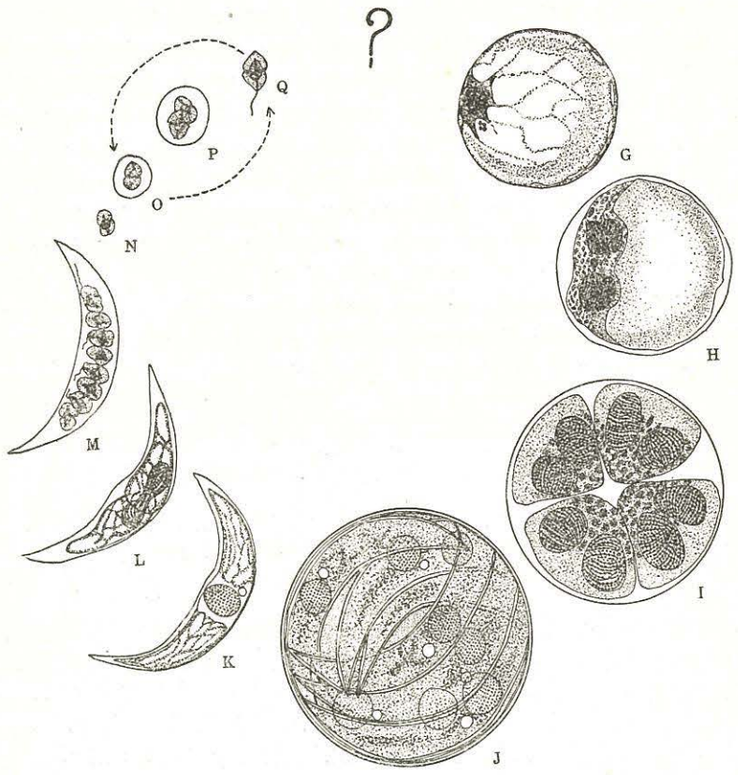
This species exists in the plankton in three forms; a small Gymnodinioid free stage, a large spherical cyst, and a lunate cyst, formed in the succession named except that the connection between the first and second stages is not established.

Free-swimming stage with subequal epicone and hypocone; its length 1.3 transdiameters; cross section subcircular; apex ovoidal, antapex hemispherical with slightly concave postmargin; girdle median, a descending left spiral, displaced distally nearly its own width, rather narrow and deeply impressed with angular margins; sulcus indenting the epicone for 0.35 its length, straight, widening antapically; flagellar pores both anterior near the ends of the girdle; no striae; color tone, greenish yellow.

Cell contents consisting of the ellipsoidal, obliquely placed nucleus in the epicone; a cluster of oil droplets near the apex; small linear, or sinuous, pale yellow chromatophores; length, 22 μ, transdiameter 17 μ.

Spherical cyst neatly spherical with firm, well-developed entire cyst wall; its contents consisting of a thin protoplasmic layer on the

inner face of the cyst, locally thickened about the laterally located nucleus which is ellipsoidal with typical moniliform chromatin threads; numerous linear, or sinuous chromatophores; numerous oil droplets;



Figs. G. and Q. Life cycle of *Gymnodinium lunula* SCHÜTT. After KOFOID and SWEZY (1921, p. 64, fig. I (1–11) from DOGIEL, 1906, pl. I). Pyrocystis stage, G.–M. *Gymnodinium* stage, N.–Q. G. Large globular form. Resting spore? H. Formation of first cleavage nuclei. Protoplasmic body shrinking away from cyst wall. Primary cyst stage. I. Second cleavage with fourth division of nuclei completed. J. Formation of cresent-shaped spores. Secondary cysts. K. Single spore released from the cyst. L. Begining of division of the spore. M. Completion of spore divisions with the formation of eight *Gymnodinium* individuals. N. *G. lunula* escaped from cyst. O. Formation of tertiary cyst. P. Division of encysted individuals. Q. Individual escaped from cyst. Encystment may take place, repeating O–Q many times before the next stage is begun. The change from Q to G is unknown. ×220.

a huge central vacuole filling most of the cyst; no pusules noted; diameter, 80–155 μ. This stage undergoes cell division passing through the 2–4–8–16 cell stages in rapid succession, the last elongating with the cyst into a stout form of the lunate stage.

Lunate stage also encysted with a rigid, thick, entire wall, when fully formed, the outer convex contour forms nearly a perfect arc of 180°, the innner concave, being somewhat flattened, and sometimes having a local bulge at the center; tips blunt; length, 80–155 μ.

Cell contents as in the spherical cyst, except that the chromatophores are elongated and anastomosing beyond the central mass, the oil droplets numerous and widely scattered; the hydrostatic vacuole in two parts filling the plasma sack of the two horns; a girdle-like constriction is sometimes formed about the equator as division approaches. This stage by three successive divisions forms 8 small *Gymnodinium* stages which escape as the free stage.

Occurrence: — Rather common in the spherical and lunate stages in the plankton of Mutsu Bay in July–August, 1930, at surface temperatures of 16°–26°.

10. **Gymnodinium ochraceum,** sp. nov.

(Pl. I, fig. 6)

A medium-sized species; body broadly ovoidal, considerably flattened dorso-ventrally, its length 1.2 transdiameters; dorso-ventral diameter 0.82 transverse diameter; epicone and hypocone subequal; epicone in ventral view subconical (70°) basally, rounding broadly at the apex, with convex sides; hypocone subhemispherical with a shallow concavity in the sulcul region of the postmargin; girdle a descending left spiral with a distal displacement of one girdle width, without overhang, trough very shallow without distinct margins (in cyst); sulcus not seen to extend upon the epicone, straight, flaring distally; no striae; cyst wall loosely applied but not distended.

Cell contents obscured by depth of color and crowded chromatophores especially in the hypocone, consisting of a small, centrally located, indistinct, spheroidal nucleus whose structure was obscured; a large, subovoidal, yellowish amyloid body in the center of the hypocone; numerous small oil droplets; a large number of ellipsoidal

and disk shaped, ochraceous chromatophores in the periphery and heaped about the nucleus and amyloid body; plasma (in epicone) remarkably transparent; general color tone dark ochraceous.

Dimensions: — Length, 65 μ; transdiameter, 55 μ; dorso-ventral diameter 45 μ.

Occurrence: — One specimen taken in the surface plankton of Mutsu Bay, August 16, 1930 in a surface temperature of 26.8°.

This species is a member of the subgenus *Gymnodinium*, without striae. It is nearest *G. flavum* but differs from that species in larger size (65 μ as against 26–35 μ), and is ochraceous instead of strontium yellow in color and the girdle is not so far anterior.

11. Gymnodinium simplex LOHMANN
(Pl. I, fig. 8)

A minute species of simplest structure; body broadly ellipsoidal, length about 1.5 transdiameters; cross section broadly ellipsoidal both apices subhemispherical; girdle equatorial, horizontal, not displaced; trough shallow, without angled margins; sulcus not deepened, not extending on the epicone; no striae; flagella not seen.

Cell contents consisting of relatively large, centrally located nucleus with clearly defined chromatin granules; large, flattened, dark yellow chromatophores in the periphery, or grouped posteriorly, four to many in number, when numerous, small and subcircular.

Dimensions: — Length, 10–20 μ; transdiameter 6–13 μ.

Occurrence: — In alimentary canal of *Mytilus dunkeri*, *Pecten yessoensis* and in that of trochophore larvae in the plankton from Mutsu Bay, July–August, 1930, also free in the plankton, especially in August, at surface temperatures of 22.4°–26°.

12. Gymnodinium sphaeroideum, sp. nov.
(Pl. I, fig. 7)

A small species; body asymmetrically spheroidal; epicone and hypocone equal, each a hemisphere; epicone with a slightly flattened apex; hypocone with left side a trifle more distended distally than the right side; girdle median, of 1 turn, without displacement, trough shallow, with indistinct margins (in cyst); sulcus extended on the

epicone to the flattened apex, narrowing distally and broader in the postcingular region, extending a little beyond the antapex; anterior flagellar pore in the proximal end of the girdle, posterior flagellar pore about 1.5 girdle widths from the apex (in vertical distance); no striae; cyst wall delicate, closely applied.

Cell contents consisting of a transversely elongated, broadly dumb-bell-shaped, median nucleus extending almost the entire width of the body with concentric lines of coarse chromatin beads at the left and at right angles at the opposite end; a central spheroidal mass of highly refractive spherules (fat?); two large greenish yellow amyloid bodies in the hypocone; a few minute oil droplets in the periphery; a thick layer of crowded, ellipsoidal, canary yellow chromatophores in the periphery; radiating strands between this layer and the central mass.

Dimensions: — Length, 37–54 μ; diameters, 37–54 μ.

Occurrence: — Three specimens taken in plankton at 3 meters, August 18, 1930, off Futagojima, in Mutsu Bay in a surface temperature of 26.8°.

Gymnodinium spheroideum belongs in the non-striate subgenus *Gymnodinium* and is similar in shape to *G. ovulum* but differs from that species in the presence of chromatophores, holophytic nutrition and larger size, 37 μ as against 28 μ. Somewhat similar forms were rather frequently seen during July–August. There seems to be no connection of this species with any exuviating, Peridinoid species in occurrence or appearance.

13. Gymnodinium viridescens, sp. nov.
(Pl. I, fig. 2)

Body very broadly ellipsoidal, bifurcated antapically, its length 1.16 transdiameters; cross section broadly ellipsoidal, the dorso-ventral diameter about 0.8 the transverse; ventral face flattened, sulcus deeply impressed; girdle horizontal, not displaced, located about 0.4 of the total length from the apex, its trough angular, not very deeply impressed; sulcus slightly indenting the spicone, very deeply impressed; postmargin deeply notched, the right and left horns subequal, the depression between the two extending upon the dorsal face; no striae;

pellicle distinct and heavy (but no sign of plates or skeleton).

Cell contents very dense, obscuring the structure; nucleus small, spheroidal, mainly in the epicone, with very faint moniliform chromatin threads; two large, irregularly ovoidal, nearly homogeneous, highly refractive amyloid bodies near the nucleus; a layer of small, spheroidal oil droplets in the periphery and several irregular, large, bright green chromatophores in either horn; color tone, pale greenish; no pusules seen.

Dimensions: — Length, 30 μ; transdiameter 25 μ; dorso-ventral diameter, 20 μ.

Occurrence: — One specimen taken in a vertical haul from 30 meters in Mutsu Bay, in a surface temperature of 23.6° on August 11, 1930.

This species belongs in the subgenus *Pachydinium* because of its thick pellicle. It is significant that the only other bifurcated species in the genus, *G. bifurcatum*, also belongs in the same subgenus with our species. The layer of subpellicular droplets is also more or less developed in other species of *Pachydinium*. It is the smallest species in that subgenus. It stands apart from all other species in the character of its bifurcation.

That it is not a stage in the development of *Peridinium* is apparent by the character of the pellicle, the absence of any evidence of an apical pore, and the fact that no green species of *Peridinium* occurred in Mutsu Bay during the months of July and August.

Genus GYRODINIUM KOFOID and SWEZY

Gymnodinioidae with girdle a descending left spiral of more than 0.2 total length; no nematocysts, ocellus, or tentacle.

14. **Gyrodinium ascendans**, sp. nov.

(Pl. II, fig. 11)

Body ellipsoidal, circular in cross section, its length 1.62 transdiameters; apex and antapex subequal, the latter slightly more flattened; girdle oblique, 40° above the horizontal plane, its proximal end ascending sharply in the first 90° of the circumference, turning rather abruptly at the left margin obliquely posteriorly across the dorsal face and continuing in the distal 90° at an angle of about 15° below the horizontal plane; trough rather deeply impressed; sulcus extending from near the apex to the antapex, curving above the girdle slightly to the right side, widening towards the postmargin; anterior flagellar pore at the proximal end of the girdle below the middle of the body, posterior flagellar pore almost at the postmargin; no striae.

Cell contents consisting of the relatively large, elongated ellipsoidal nucleus with rather coarsely beaded chromatin threads, about 20 across one face, scattered, linear, lemon yellow chromatophores beneath the pellicle clustered in the antapical region; a few slender linear rhabdosomes in the antapical region; a few greenish homogeneous oil droplets seen; general color pale yellow.

Dimensions: — Length, 60 μ; transdiameter, 37 μ; length of cyst, 65 μ.

Occurrence: — One specimen taken in a vertical haul from 30 meters in Mutsu Bay, on August 11, 1930 in a surface temperature of 23.6°.

This species belongs in the subgenus *Laevigella* since it lacks surface striae. It differs from all species in that subgenus, however, in having the proximal end of the girdle ascending steeply in its proximal 90°. In this peculiarity it resembles *G. pingue* SCHÜTT belonging to the striate subgenus *Gyrodinium*. However, it differs from *G. pingue* in a greater prolongation of the steep ascent, in less obliquity of the distal quadrant of the girdle, in a more posterior position of both flagellar pores and in a greater anterior extension of the sulcus.

During the first minutes of observation our specimen shed its rather closely applied cyst wall, the process being entirely completed within less than one minute. Excystement began with the rounding up of the cell and loss of furrows followed by protrusion of a narrowed posterior process, an active protoplasmic movement, followed by a more gradual extrusion of the rest of the cell through the rent in the wall, and a final shrinkage of the cyst in a wrinkled cap about the apex. Immediately a second, closely applied cyst wall was formed about the escaped cell which did not resume the normal form with girdle and sulcus.

15. **Gyrodinium citrinum,** sp. nov.
(Pl. II, fig. 10)

Body elongated ovoidal, somewhat contracted anteriorly to a broadly rounded point and wider posteriorly; its length about two transdiameters and its dorso-ventral diameter greatest in the hypocone at the level of the distal end of the girdle, equalling the transdiameter throughout; epicone equals the hypocone in length, flattened ventrally, more convex dorsally, and contracts more abruptly in its anterior third; in ventral view the apical region forms a cone of about 95° with slightly convex sides and rounded apex; hypocone hemispherical in its distal half in ventral view, but contracting to a blunt point in lateral view in a cone of about 90°, becoming more convex towards the girdle and slightly flatter on the ventral than on the dorsal face; girdle forming a descending left spiral with a distal displacement of 0.33 total length and an overhang of 0.2 transdiameter, steepest in its proximal and distal parts; furrow very deeply impressed and the anterior lip overhanging somewhat; sulcus extending over the posterior two-thirds of the total length; its anterior end continued above the girdle onto the epicone for a girdle width; the intercingular portion forming nearly 0.5 its length, and deflected to the left in the middle part in a sigmoid curve; below the distal end of the girdle widening asymmetrically to the right; pellicle distinctly visible though not so much thickened as in the subgenus *Pachydinium* of *Gymnodinium.*

Cell contents consisting of the spherical, centrally located nucleus with faint, moniliform chromatin threads; a small number of greenish, longitudinally placed, linear rhabdosomes; apical and antapical masses of dark orange color; a few irregular, yellowish chromatophores beneath the pellicle; and numerous, spherical, peripherally located oil globules of greenish blue color; general color tone of the organism lemon yellow.

Dimensions: — Length, 54 μ: transdiameter, 27 μ; diameter of nucleus, 14 μ.

One specimen was taken in the surface plankton, July 11, 1930 in Mutsu Bay, off the Biological Station in a surface temperature of 18.4°.

This species is near *Gymnodinium flavescens* but differs from it in slightly greater size, less overhang of girdle, greater steepness of proximal part of the girdle, rather more tapering epicone, and greater rotundity of the hypocone which results in a greater contrast between these two regions of the body.

16. **Gyrodinium falcatum** Kofoid and Swezy
(Pl. II, fig. 14)

Gymnodinium fusus Schütt, 1896, partion, pl. 25, fig. 81 (1–3), his pl. 24, fig. 79 (1–3) is *Gymnodinium fusus.*

A large species of fusiform shape; body elongated, tapering subequally at the ends, arched ventrally; its length (in free stage) 3–4 transdiameters, in the cyst, 2 transdiameters; dorso-ventral diameter at girdle only slightly less than the transdiameter; epicone and hypocone subequal; epicone subconical with convex sides basally changing from 45° to 70° distally, constricted within a transdiameter of the girdle into an apical horn, bulging distally, with a truncate apex; in the free phase this horn is strongly curved sinistro-ventrally, nearly a transdiameter in length and is swollen slightly near the apex, in the cyst it is shorter and stouter, about 0.5 transdiameter in length, with more lateral bulge; hypocone basally similar to the epicone, with a terminal horn of cylindrical shape, about a transdiameter in length, curved sinistro-ventrally, with contracted, pointed tip; girdle a descending left spiral of one turn, displaced distally about 0.5 transdiameter with no overhang, trough deep, rounded, margins rounded; sulcus slightly sigmoid, 1.0–1.3 transdiameters in length, invading the epicone for 0.3 transdiameter and terminating on the hypocone in about the same distance below the distal end of the girdle; anterior flagellar pore in the proximal end of the girdle, posterior flagellar pore in the distal end of the sulcus; no striae; cyst wall shaped to the configuration of the body but elongated at the ends.

Cell contents consisting of a dense peripheral layer of elongated ellipsoidal to short rod-shaped, deep ochraceous chromatophores which obscure the nucleus; numerous large spheroidal oil globules; general color tone dark ochre to light brown.

Dimensions: — Length, (between apices, not along curvature) 63–90 μ; transdiameter, 24–32 μ; Schütt's 1895, pl. 24, fig. 79, is 100 μ long.

Occurrence: — One individual taken in the plankton of Mutsu Bay from 30–0 meters on August 16, 1930 in a surface temperature of 25.3°.

We have referred this specimen to *Gyrodinium falcatum* because of its chromatophores and girdle. It is much more elongated than the encysted, and presumably contracted specimen figured by SCHÜTT (1895, pl. 25, fig. 81 (2)).

17. **Gyrodinium ferrugineum,** sp. nov.
(Pl. I, fig. 3)

A small species; body asymmetrically ovoidal; its length 1.23 transdiameters; cross section subcircular; epicone slightly less than the hypocone; epicone subhemispherical with a minute apical elevation, left shoulder more elevated than the right; hypocone asymmetrical, subconical, (40°) right side convex distally, left flattened, antapical end slightly flattened with trace of a sulcus embayment on the postmargin; girdle a descending left spiral of one turn, displaced distally a little more than 0.5 transdiameter, descending rather uniformly at about 20° below the horizontal, trough very deeply impressed with sharp overhanging margins; sulcus extended in a slender straight channel on the epicone almost to the apex, with a sigmoid curve in its intercingular course, widening below its junction with the distal end of the girdle; anterior flagellar pore in the proximal end of the girdle, posterior flagellar pore 1.5 girdle widths from the postmargin; no striae.

Cell contents consisting of the relatively large ellipsoidal nucleus, detected with difficulty, 0.6 by 0.4 transdiameter, with its long axis deflected dextro-sinistrally; an elongated, ellipsoidal pusule deflected to the left from the posterior flagellar pore; numerous minute oil droplets distributed along both sides of the distal end of the girdle and about the posterior part of the sulcus; two large irregular, subellipsoidal, greenish yellow amyloid bodies in the left part of the hypocone; numerous rusty brown, elliptical, plate-like chromatophores crowded in the epicone; general color tone in the epicone marked rusty brown, in the hypocone greenish gray.

Dimensions: — Length, 32 μ; transdiameter, 26 μ.

Occurrence: — One specimen taken in the plankton collected at 3 meters below the surface in Mutsu Bay, August 17, 1930, in a surface temperature of 25.8°.

Gyrodinium ferrugineum belongs to the subgenus *Laevigella* lacking striations. It is nearest to *G. melo*, resembling that species in proportions, but has less torsion in the intercingular sulcus, no overhang of the ends of the girdle and a postmarginal embayment. It also differs in color, being ferruginous instead of green. The sharp limitation of chromatophores to the epicone is unusual, and the color rather exceptional in the genus.

18. **Gyrodinium flavum,** sp. nov.
(Pl. II, fig. 12)

A small species of asymmetrical biconical shape; its length 2.13 transdiameters; epicone distinctly wider than hypocone, asymmetrically convex conical (60° in lateral view) with the angular apex tilted ventrally, the dorsal face more convex than the almost straight ventral face; hypocone subconical (32°) with broadly rounded antapex; girdle a descending left spiral, displaced posteriorly 0.45 total length, making 1.25 turns, descending 20° in the first 0.5 turn, and 30° in the remaining 0.75, trough very deeply impressed with overhanging margins; sulcus narrow, not invading the epicone, with torsion 0.25 turn, its distal end below the distal end of the girdle straight; anterior flagellar pore in sulcus opposite the proximal end of the girdle, posterior flagellar pore in the distal end of the sulcus; surface coarsely striate throughout, some lines more distinct than others.

Cell contents consisting of an indistinct nucleus, centrally located, spherical, with faint chromatin lines; a small pusule posteriorly directed from the anterior flagellar pore and a larger one postero-dorsally directed from the posterior flagellar pore; a small cluster of black pigment granules in the postcingular angle and several others near the distal end of the girdle; no chromatophores; no rhabdosomes; numerous minute oil droplets; plasma very clear; general color tone grayish dark yellow.

Dimensions: — Length, 68 μ; transdiameter, 32 μ.

Occurrence: — A single very active specimen taken in surface

plankton in Mutsu Bay, August 15, 1930, in surface temperature of 22.6°.

Gyrodinium flavum belongs in the striate subgenus *Gyrodinium* and differs from all other species in proportions. Its wider epicone and asymmetrical apex are unlike these regions in other species. It is nearest to *G. truncus* KOFOID and SWEZY but differs from that species in more slender proportions, greater torsion of sulcus, less pointed antapex, and the presence of black pigment.

Genus COCHLODINIUM SCHÜTT

Gymnodinioidae with body with torsion of 1.5–4.0 turns; sulcus often with an apical loop; no nematocysts, ocellus, or tentacle; usually holozoic, usually highly colored.

19. **Cochlodinium flavum,** sp. nov.

(Pl. II, fig. 13)

A small species with an asymmetrical, deeply constricted ellipsoidal body 1.9 transdiameters in length; apex flattened dome-shaped, antapex subhemispherical; dorso-ventral diameter about equal to the transverse; girdle a descending left spiral of 1.75 turns, horizontal in the proximal 0.5 turn, descending at 45° in the next 0.5 turn, and again horizontal in the next 0.5 turn, and at about 20° below the horizontal in the distal 0.25 turn, rather deeply constricting the body, with a deep trough with overhanging precingular margin; sulcus making 1 full turn in a steep descending left spiral, with a short apical loop of 0.25 turn reaching the apex and a longitudinal course to the postmargin behind the junction with the distal end of the girdle, rather deeply constricting the body in its intercingular region; anterior flagellar pore at the proximal end of the girdle, posterior flagellar pore midway between the junction of the distal end of the girdle and sulcus and the postmargin; no striae.

Cell contents consisting of a large, broadly ellipsoidal nucleus in a postmedian location, with beaded chromatin network; a slender pusule joining the two flagellar pores; several large, spheroidal oil globules; a peripheral layer of stout, radially arranged rhabdosomes; a crescentic reddish body somewhat like a simple ocellus near the

postmargin; numerous discoidal, yellow chromatophores, peripherally located; general color tone lemon yellow. Our specimen was enclosed in a detached cyst wall within which a second cyst was beginning to from and detach itself.

Dimensions: — Length, 32 μ; transdiameter, 20 μ.

Occurrence: — One specimen was taken in the surface plankton in Mutsu Bay, August 12, 1930 in a surface temperature of 25.4°. Also in vertical plankton from 30–0 meters, August 13. This specimen had a red granule of spherical form in the epicone.

Cochlodinium flavum belongs to the subgenus *Glyphodinium* and is near to *G. convolutum* but differs from it in smaller size, yellow instead of greenish color, and in having a longer, more deeply constricted body.

20. **Cochlodinium helicoides** LEBOUR

(Fig. R)

Cochlodinium helix SCHÜTT, *partim*, 1895, pl. 24, fig. 77 (5) (wrongly cited by LEBOUR, 1625, p. 62, as "pl. 22".

Cochlodinium helix, KOFOID and SWEZY, 1921, *partim*, pl. 9, fig. 92, text-fig. HH8; text (pp. 370–371) includes SCHÜTT, 1895, pl. 24, figs. 77 (1–5) in *C. helix*.

A small species; body asymmetrically ovoidal, with marked antapical asymmetry, but not deeply constricted, its length 1.5 transdiameter; apex convex subconical (about 80°), antapex bilobed, the lobe protuberant; epicone somewhat greater than the hypocone; girdle a descending left spiral of 1.5 turns, rising 10° in its proximal 0.25 turn descending nearly 45° in the dorsal 0.5 turn and about 10° with increasing steepness distally in the next (ventral) 0.5 turn, increasing in the last 0.25 turn, trough moderately impressed; sulcus with an apical loop of 0.5 turn reaching the apex, its proximal part quite oblique (20°), the intercingular section 45° with a total of 1 complete turn; pores at junction of girdle and sulcus; no striae.

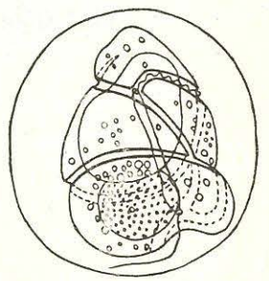


Fig. R. *Cochlodinium helicoides* LEBOUR (1925), Ventral view, after KOFOID and SWEZY (1921, fig. HH8). ×800.

Cell contents consisting of ellipsoidal, or spheroidal nucleus centrally located, with distinct chromatin threads; thickly strewn, elliptical, light orange, peripherally located chromatophores; pusules from both pores; cytoplasm moderately clear, color tone dark yellow.

Dimensions: — Length, 36–54 μ; transdiameter 24–36 μ; cyst up to 80 μ.

Occurrence: — Several individuals in the plankton of Mutsu Bay from 3 meters off Futagojima, August 18, 1930 in a surface temperature of 25.4°.

21. **Cochlodinium radiatum** KOFOID and SWEZY
(Fig. S)

A medium sized species; body rotund ellipsoidal, its length 1.28 transdiameters; epicone considerably greater than hypocone; apex subhemispheroidal; antapex hemispheroidal, but slightly modified by girdle and sulcus, the upper part of the hypocone bulging slightly; girdle a descending left spiral of 2 turns, subhorizontal in the first 0.75 turn, then at 35°–30° for 0.5 turn, steepening out distally to 45° except near its end (20°), trough narrow, rather deeply impressed with distinct margins; sulcus extending on the epicone only half way to the apex, with torsion of 1 complete turn, quite narrow and constricting the body somewhat, oblique in the postcingular section; anterior flagellar pore opposite the proximal end of the girdle and posterior flagellar pore opposite its distal end; no striae; cyst not seen.

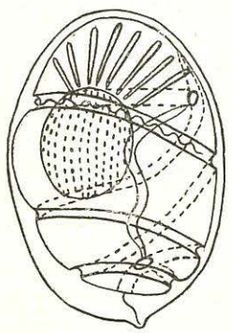


Fig. S. *Cochlodinium radiatum* KOFOID and SWEZY. View of right side. Original, Asamushi, 1930. ×800.

Cell contents consisting of the elongated ellipsoidal nucleus located in the right central region, with fine moniliform chromatin threads; a slender pusule connecting the two pores; no oil droplets; a group of radiating elongated, tapering, greenish rhabdosomes, in the epicone; diffuse reddish violet tone throughout, contracting to splashes of aster purple pigment rather uniformly distributed beneath the pellicle; cytoplasm transparent, general color tone grayish blue, when the diffused pigment concentrates.

Dimensions: — Length, 68–78 μ; transdiameter, 52–60 μ.

Occurrence: — One specimen taken in the surface plankton of Mutsu Bay, August 8, 1930, in a surface temperature of 24.5°.

Our specimen differed from that figured by KOFOID and SWEZY (1921, pl. 6, fig. 67) in that the color was diffused instead of aggregated in peripheral splashes. The latter condition indicates approaching cytolysis.

22. **Cochlodinium schuettii** KOFOID and SWEZY
(Fig. T)

Cochlodinium helix SCHÜTT, *partim*, 1895, pl. 24, fig. 77 (6); his pl. 24 figs. 77 (1–4) are *C. helix* (SCHÜTT) KOFOID and SWEZY, *partim*, figs. 77 (5) being *C. helicoides* LEBOUR (1925, pl. 9, fig. 2).

Cochlodinium schuettii KOFOID and SWEZY, 1921, pl. 1, fig. 8, text-fig. HH2.

A medium sized species; body asymmetrically ovoidal, its length 1.5 transdiameters; apex hemispheroidal, antapex asymmetrical, the morphological right side being the longer; girdle a descending right spiral of 1.5 turns, displaced distally about 0.5 total length; trough rather deeply incised, with overhanging precingular margin; sulcus indenting the epicone only (?) 0.5 the distance between girdle and apex and only slightly curved, with a torsion of 0.5 turn and no extension on the opposite face; no striae.

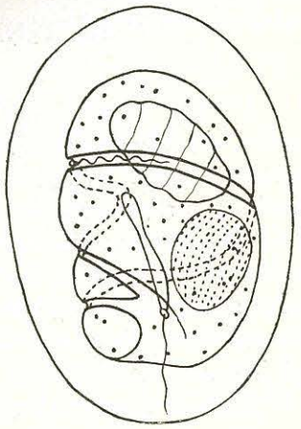


Fig. T. *Cochlodinium schuettii* KOFOID and SWEZY. Dorsal view, after KOFOID and SWEZY (1921, pl. 1 fig. 8). ×800.

Cell contents consisting of the elongated, somewhat twisted, subcentrally located nucleus with about 15 faint, moniliform, longitudinal chromatin threads; peripheral, elongated, slender, lemon yellow chromatophores; peripheral layer of spherical oil droplets; spherical amyloid (?) body; cytoplasm dense, general color

tone lemon yellow.

Dimensions: — Length, 73 μ; transdiameter 50 μ; length of cyst, 105 μ.

Occurrence: — Several individuals seen in the plankton of Mutsu Bay, August 18, off Futagojima from 3 meters in a surface temperature of 25.4°.

Differs from *C. helix* in less antapical asymmetry, less constriction and absence of the aboral lobe. It is larger than *C. helicoides* (52–54 μ) as against 36–45 μ, has less antapical asymmetry, and the twisted sulcus crowds upon the girdle less quickly.

Family **Polykrikidae** KOFOID and SWEZY

Gymnodinioidae with permanent colonial organization with zooids in linear series, but with common sulcus.

Genus POLYKRIKOS BÜTSCHLI

Number of zooids 2–4–8–16, number of nuclei usually numbering 1 to 2, rarely 1 to 4 zooids; holozoic.

23. **Polykrikos schwartzi** BÜTSCHLI
(Fig. U)

A large species, usually multicellular with 2–4–8, or rarely 16 nuclei, representing as many cells in chain formation, the neuromotor system (flagella and girdle, often one generation in advance of the nuclei); a slight constriction between adjacent cells; length (2 cells) –4.5 (8 cells) transdiameters; cross section subcircular; girdle horizontal, not displaced, no overhang, in a median location on each cell; sulcus slightly sigmoid, nearly ventral, enlarged at junction with the girdle, continuous from cell to cell; flagellar pores in sulcus near girdle; no striae.

Cell contents consisting of spherical nuclei, with distinct, spiral, moniliform chromatin threads about 20 across one face; small scattered oil globules; nematocysts 10–20 μ in length scattered through the cytoplasm; food bodies consisting of dinoflagellates, small ova of Metazoa and even small metazoan larvae often distend the body; cytoplasm hyaline; general color tone greenish grey to a delicate rose.

Dimensions: — Length, 100–140 μ; transdiameter 65 μ.

Occurrence: — A few individuals seen in the plankton of Mutsu Bay, July 22–30, in surface temperatures of 19°–26.4°.

A cosmopolitan species in warm temperate, neritic seas.

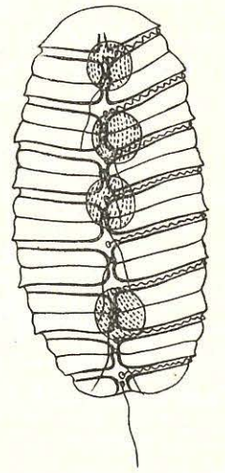


Fig. U. *Polykrikos schwartzi* BÜTSCHLI. Ventral view after KOFOID and SWEZY (1921, fig. F, 4). ×400.

Family **Noctilucidae** SAVILLE KENT

Gymnodinioidae with tentacle at the posterior end of the sulcus; no ocellus; no nematocysts.

Genus NOCTILUCA SURIRAY

Girdle degenerated except for a small remnant of the proximal end, obliterating the separation of the epicone and hypocone, save in the zoospores; hydrostatic vacuoles greatly developed; no transverse flagellum; nutrition holozoic.

24. **Noctiluca scintillans** (MACARTNEY) EHRBG.
(Figs. V–BB)

A very large species; body inflated with hydrostatic vacuoles, broadly reniform to subspheroidal and furrowed ventrally; girdle reduced to a proximal remnant, faintly outlined in the surface structure for less than 0.2 circumference; sulcus forming in the postcingular region the reëntrant cytostome, extended anteriorly in a rigid, straight structure which in small and in collapsed individuals forms a straight axis in the antero-ventral region; transverse flagellum reduced to the mobile tooth at the left of the sulcus near the proximal end of the girdle; longitudinal flagellum arising in the sulcus just below the tooth; prehensile tentacle moving characteristically as in *Pavillardia* and *Etythropsis*, located at posterior end of sulcus; no striae; pellicle firm.

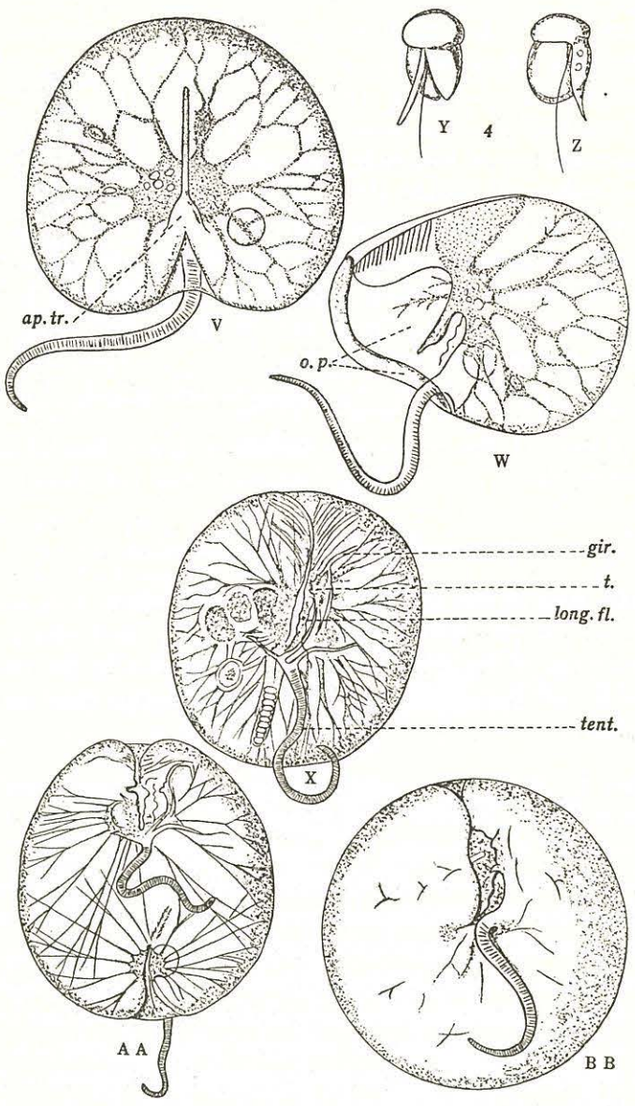


Fig. V–BB. *Noctiluca scintillans* (MACARTNEY). From KOFOID and SWEZY 1921, p. 408, fig. KK (1-6).
V. Dorsal view showing apical trough. After ALLMAN (1872, pl. 18, fig. 1). ×125. W. Lateral view from the left side showing the deep oral pouch. Modified after ALLMAN (1827, pl. 18, fig. 2). ×100. X. Posteroventral view showing sulcus. girdle, undulating membrane or tooth, flagellum and tentacle. The anterior lip is at or near the upper margin of the figure. Modified slightly after ROBIN (1878, pl. 36, fig. 4). ×80. Y and Z. Zoospores. After CIENKOWSKY (1873, pl. 6, figs. 38, 42). × 400. AA. *Noctiluca* in chain at mitosis showing girdle in the anterior schizont. After ROBIN (1878, pl. 41, fig. 24). ×100. BB. Midventral view showing sulcus, rudimentary girdle, transverse flagellum or tooth, longitudinal flagellum and tentacle. Modified after WEBB (1855, pl. 6, fig. 7). Magnification not given. Abbreviations: *ant. l.*, anterior lip; *ap. tr.*, apical trough; *g.*, girdle; *l. fl.*, longitudinal flagellum; *o. p.*, oral pouch; *t.*, tooth or transverse flagellum; *tent.*. tentacle.

Cell contents consisting of a central protoplasmic mass surrounding the nucleus with delicate strands passing to the thin peripheral plasma layer; huge hydrostatic vacuoles inflating the body; numerous spherical, luminescent oil droplets in the central mass, radial strands, and periphery; food masses containing diatoms, ova or larvae of Metazoa, or even entire Copepoda which distort the large body; no chromatophores: small zoospores formed on surface of adult, with longitudinal flagellum, tentacle, and partial girdle.

Dimensions: — Diameter of adult 200–1200 μ; rarely 2000 μ.

Occurrence: — Maximum abundance in Mutsu Bay in May–June (fide Dr. KOKUBO), diminshing rapidly in July, practically absent in August; during periods of greatest abundance forming local shoals by wind action so dense as to discolor the water. Taken occasionally throughout the year in Mutsu Bay.

Family **Pouchetiidae** KOFOID and SWEZY

Gymnodinioidae with ocellus on left side of intercingular sulcus; usually with 1.5 or more turns of girdle, and torsion in the precingular, and postcingular sections of the sulcus; posterior border of sulcus often mobile, but no permanent tentacle; holozoic; usually brightly colored.

Genus NEMATODINIUM KOFOID and SWEZY

Pouchetiidae with nematocysts.

25. **Nematodinium atromaculatum,** sp. nov.

(Pl. II, fig. 15)

Body subellipsoidal, its length 1.7 transdiameters; dorso-ventral diameter 0.7 of the transverse; epicone subhemispherical anteriorly, hypocone more pointed in the antapical region; ventral face flattened and deeply furrowed by sulcus; girdle a descending left spiral of about 1.25 turns, displaced posteriorly at its distal end for nearly a transdiameter, its trough deeply impressed with some overhang of its anterior edge; sulcus extending anteriorly above the girdle for at least one girdle width, deeply impressed in a groove in the flattened

ventral face, with a torsion of about 0.25 turn; anterior flagellar pore in the proximal end of the girdle, posterior flagellar pore below the distal end in the sulcus; no pellicular striae.

Cell contents consisting of the large, anteriorly located, flattened broadly ellipsoidal nucleus with very clear, moniliform chromatin threads, about 15 across one face; four fully developed, elongated cylinndrical nematocysts radiating from the right ventral face of the nucleus near the anterior flagellar pore (and centrosome?) and two smaller partially developed ones in our specimen; ocellus located below the proximal end of the girdle, consisting of a four segmented line of homogeneous, greenish gray lens bodies, pointed antero-dextrally, and two small, sooty black pigment granules adjacent to its base, no red core seen; several small, much reduced food bodies; pusules not seen; pigment granules of sooty black color very uniformly spaced over the whole body beneath the pellicle, about 14 across the apex from girdle to girdle and 10 along the precingular margin in lateral view, granules slightly larger and more numerous in epicone than in hypocone; no chromatophores; cytoplasm very transparent, with a slight olivaceous tint.

Dimensions: — Based on contracted individual; length, 80 μ; transdiameter 48 μ; dorso-ventral diameter 35 μ.

Occurrence: — Description taken from a specimen in a surface plankton collected at 8 p. m. August 11, 1930 in Mutsu Bay in a surface temperature of 22°. Individuals, presumably of this species repeatedly seen in the week of July 23–30 in plankton from Mutsu Bay.

Nematodinium atromaculatum differs from all other species in its pigmentation. Its ocellus has less pigment than any other species except *N. torpedo*, and its girdle has less torsion than elsewhere in the genus. It is about the same size as *N. armatum* but its ocellus is much less developed, lacking the concentric lens and red core of that species.

Nematodinium atromaculatum is an exceedingly active species, ceaselessly moving so that it is wholly impossible to get a camera drawing. The specimen on which the description is based was observed for about 30 minutes under the cover glass. It did not once cease for more than a few seconds at a time the characteristic rotation,

circling locomotion, interrupted by repeated motor reactions during this period. At the close it suddenly stopped, abruptly contracted, ruptured at the anterior flagellar pore and deliquesced in a few seconds except for a disorganized mass of protoplasm containing the pigment granules and the nematocysts. These did not discharge but slowly disintegrated. The two large pigment granules grew progressively lighter in color internally but remained black on their periphery.

26. **Nematodinium partitum** Kofoid and Swezy
(Fig. CC)

A medium sized species; body elongate ovoidal; deeply constricted; length 1.7 transdiameter; epicone and hypocone subequal; apical region asymmetrically hemispherical, prolonged and flattened on the left face; antapical region truncated with a projecting, low dome-shaped lobe at the left below the last turn of the sulcus; intercingular area bulging laterally; girdle with 1.25 turns of a descending left spiral, horizontal in its proximal 0.5, descending at 45° in the next 0.5 and slackening to 20° near its distal end, constricting the body, with deeply incised trough with sharp margins, its posterior displacement a little more than 0.5 total length; sulcus with an apical loop of 0.5 turn not reaching the apex by 1.5 girdle widths joining the girdle at 0.3 total length from apex, intercingular region nearly 0.5 total length, with a torsion of nearly 0.5 turn, its junction with the distal end of the girdle on the dorsal side at 0.2 total length from antapex; no striae.

Cell contents consisting of an anteriorly located pyriform or ovoidal nucleus with faint, spiral chromatin

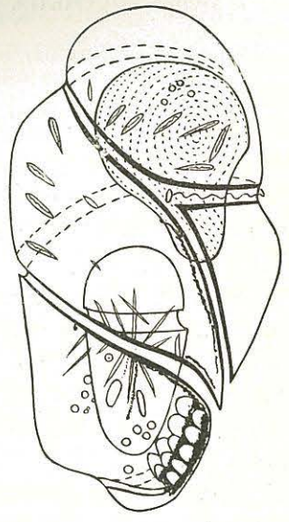


Fig. CC. *Nematodinium partitum* Kofoid and Swezy. Ventral view, after Kofoid and Swezy (1921, fig. MM). ×800.

threads; numerous (15) scattered nematocysts distributed mainly in the anterior half of the body, directed antero-dorsally, the longest 0.16 transdiameter in the girdle in length; scattered oil droplets mainly near the two apices; a cluster of radiating rhabdosomes in the posterior region; a large food vacuole opposite the intercingular sulcus containing a partially digested *Gymodinium;* an ocellus of the diffuse type at the left of the distal part of the sulcus, elongated dorso-ventrally, consisting of a distributed lens of 15–20 hyaline spheroidal bodies, in 2–3 rows, of greenish yellow color, embedded in a diffuse melanosome from which slender strands extend along the margins of the sulcus and the girdle; pusules not seen; general color tone pale rose; usually seen in a delicate closely enveloping cyst.

Dimensions: — Length, 91 μ; transdiameter, 52 μ.

Occurrence: — Recorded frequently in the plankton of Mutsu Bay, July 23–30 1930, in surface temperatures of 19°–26.4°. Reported by KOFOID and SWEZY (1921) from the California Current off La Jolla.

Genus POUCHETIA SCHÜTT emend. KOFOID and SWEZY

Pouchetiidae with no nematocysts.

27. **Pouchetia hataii,** sp. nov.
(Pl. III, fig. 16)

A small species with an ellipsoidal body, 1.3–1.7 transdiameters in length; circular in cross section; apex and antapex broadly rounded; girdle a descending left spiral of 1.25–1.40 turns, descending slightly in the proximal 0.25 turn, steeply (45°) in the next 0.5 turn, about 20° below horizontal in the next 0.5 turn, beyond which it shortly joins the sulcus, rather deeply impressed with precingular overhang, but the body not deeply constricted by it, displaced distally 0.5 length of the body; sulcus with an oblique apical loop and a total torsion of 0.5 turn, crowded against the girdle posteriorly by the large ocellus; no striae.

Cell contents consisting of the ellipsoidal nucleus with very distinct chromatin threads; food balls; a well developed ocellus with a condensed, dark brown pigment mass enclosing a large red sensory core in front of which is a slender pillar-like lens body of several segments,

faintly divided, located at the left of the intercingular sulcus; general color tone clear rose.

Dimensions: — Length, 70 μ; transdiameter, 45 μ; length of cyst, 102 μ.

Occurrence: — One specimen in vertical plankton from 30–0 meters in Mutsu Bay, August 13, 1930 in surface temperature of 23.8°.

Distinguished from *P. rosea* by its larger size, 70 μ instead of 44–58 μ; dark instead of red pigment mass, and non-truncated antapical end. The torsion and structure of the ocellus are, however, those of *P. rosea.*

28. **Pouchetia mutsui,** sp. nov.
(Pl. III, fig. 21)

Body ellipsoidal, its length 2 transdiameters; cross section nearly circular, apical end somewhat narrower than the antapical; girdle making 1.2 descending left turn, displaced distally 0.8 transdiameter in the antapical direction, its anterior margin slightly overhanging, and its trough rather deeply impressed; sulcus much elongated anterior to the flagellar pore, reaching almost to the apex, making 1.5 turns anterior to its junction with the girdle, and continuing the spiral direction for only about 0.2 turn between the anterior and posterior flagellar pores, a total of 1.7 turns in its entire course; anterior flagellar pore 0.4 total length from the anterior end, posterior pore a little more than a girdle width above the postmargin; no surface striae.

Cell contents consisting of a very large, anterior located, broadly ellipsoidal nucleus with about 25 moniniform subparallel chromatin threads across one face; no nematocysts; an ellipsoidal, yellowish brown food body near the center; a highly developed ocellus located in the angle below the proximal end of the girdle adjacent to the sulcus, consisting of a carbon black, flattened hemispherical pigment mass with two short amoeboid processes extending on to the base of the cylindrical, elongated, hyaline, homogenous lens body, partially constricted into the linear segments and a terminal button; no trace of red core visible through the black pigment; rufous pigment granules and threadlets in the peripheral cytoplasm rather uniformly distributed over the entire surface with a tendency to larger sizes near

the anterior edge of the girdle; no pusule present in the encysted specimen observed; no flagella were present in the cyst; color tone light red.

Dimensions: — Length, 88 μ; transdiameter, 50 μ; largest diameter of nucleus, 33 μ; width of pigment mass, 33 μ; length of cyst, 126 μ.

A single specimen was taken in a vertical haul from 30–0 meters in Mutsu Bay August 11, 1930, in a surface temperature of 23.6°.

29. **Pouchetia purpurata** KOFOID and SWEZY
(Pl. III, fig. 20)

A medium sized species; body ellipsoidal to elongated ellipsoidal, or ovoidal, its length 1.40–1.75 transdiameters; epicone slightly greater than hypocone; apex hemispherical, antapex similar or asymmetrically distended to the right of the distal end of the sulcus, according to the point of view; girdle a descending left spiral of 1.4 turns, with a distal displacement of 0.5–0.6 total length, trough not deeply impressed, with arching precingular margin; sulcus extending from apex to antapex, with a total torsion of 1.2–1.4 turns, of which nearly one turn may be in the apical loop, probably changing with contraction; no striae.

Cell contents consisting of the centrally, or anteriorly located, ellipsoidal nucleus with distinct chromatin threads; radiating rhabdosomes of greenish color in the antapical region; minute oil droplets in the periphery, food balls of varying sizes and contents; an ocellus somewhat of the diffuse type, with a brownish black melanosome from which amoeboid, granular strands pass out especially along the edges of the sulcus and girdle, located at the left of the distal end of the sulcus, with a lens body of greenish, hyaline color, segmented in 3–5 sections, distally breaking up into spherules and sometimes with an imperfect enclosing sheath of the same substance as an added lamella; sensory core not seen; additional pigment granules are found along the pre- and postcingular margins; no chromatophores; cytoplasm clear, color dahlia purple, aggregating in a peripheral net of granular threads as disintegration approaches.

Dimensions: — Length, 80–88 μ; transdiameter, 52–57 μ.

Occurrence: — One specimen taken in the plankton from 3 meters off Futagojima, August 18, 1930, in a surface temperature of 26.8°.

This specimen was enclosed in a somewhat distended hyaline cyst. During first two hours of observation the pigment became more aggregated, the body rounded up somewhat, and the lens body underwent some amoeboid deformation and a slight deflection and by the end of four hours entirely disappeared. Toward the end of the period a second cyst wall was detached from the pellicle and began to distend and the first one burst and shriveled up.

Pouchetia mutsui is one of the most highly specialized species of the subgenus *Pouchetiella* in the torsion of the anterior end of the sulcus and in the integration of the ocellus. It is most like *P. atra* KOFOID and SWEZY in structure of the girdle and sulcus, but is larger (88 μ as compared to 64 μ), has more rotundity, the ocellus is much farther anterior and its pigment mass is much larger. Its reddish pigment also differentiates it from the bluish-green *P. atra*.

30. **Pouchetia reticulata,** sp. nov.
(Pl. III, figs. 18 and 19)

A small species with ellipsoidal body, rather deeply constricted; length 1.7 transdiameters; apex and antapex broadly rounded; girdle a descending left spiral of 1.25 turns, displaced distally 0.75 transdiameter, ascending in the proximal 0.25 turn about 45°, descending in the next full turn about 25°, its trough deeply impressed with well developed margins; sulcus from apex to antapex, with long apical loop of 0.5 turn with an intercingular torsion of about 0.25 turn and continuing to the antapex or the left lateral margin; anterior flagellar pore at the anterior end of the intercingular sulcus, about 0.35 total length from the apex, posterior flagellar pore below the distal end of the girdle; no striae; cyst wall closely applied, hyaline.

Cell contents consisting of an elongated, reniform, centrally located nucleus with many distinct chromatin granules arranged locally in spiral series; a cluster of linear rhabdosomes in the antapical region; a large yellow ochre food body below the distal end of the girdle; a group of small oil droplets in the apical region; and an ocellus of the non-integrated type of remarkable structure consisting of a very black pigment net work over the left posterior region from the proximal

end of the girdle to the antapex located in the periphery under the pellicle, slowly amoeboid, forming a heavy net work of irregular and changing mesh with outlying lines on the edge of sulcus and girdle; below this net of pigment a row of four highly refractive lens bodies lying parallel, subspheroidal, homogeneous, roughly parallel to the course of the lower part of the sulcus; a linear group of canary yellow chromatophores posterior to the lens bodies; a large amyloid body posterioly located no striae.

Dimensions: — Length, 65 μ; transdiameter, 40 μ; length of cyst, 70 μ.

Occurrence: — One specimen taken in a vertical plankton from 30–0 meters on August 13, 1930 in Mutsu Bay in a surface temperature of 23.8°. Another seen in the last week of July in plankton from Mutsu Bay.

As this organism became moribund the pigment lost its characteristic pattern and ran together in droplets of varying sizes, revealing a few rose-colored droplets. The lens bodies deliquesced quickly.

Pouchetia reticulata belongs to the subgenus *Pouchetia* with non-integrated ocellus. It differs from all species in the genus in the remarkable pigment network of exceptionally large size.

31. **Pouchetia rosea** (BOUCHET) KOFOID and SWEZY
(Pl. III, fig. 17)

A small species; body ellipsoidal (in cyst); its length 1.3 transdiameters; epicone greater than hypocone; apex and antapex hemispherical; girdle a descending left spiral of 1.5 turns, displaced distally nearly 1 transdiameter, descending uniformly at about 20° below the horizontal, its trough scarcely impressed (in cyst), with indistinct margins; sulcus with antapical precingular loop of nearly one turn crossing the apex and a torsion of nearly 0.5 turn and a short (?) postcingular course; anterior flagellar pore in the proximal end of the girdle, posterior flagellar pore near the antapex; no striae; cyst wall hyaline, closely applied.

Cell contents consisting of the much elongated, ellipsoidal, subvertical nucleus with distinct, beaded chromatin threads running spirally lengthwise; a relatively huge ocellus located at the right of the distal

part of the intercingular sulcus, consisting of a dense, hemispheroidal brick red pigment mass containing a central, flattened spheroidal carmine red sensory core, and a lens body of hemispheroidal shape, greenish blue color, with two partially developed lamellae added on one side; axis of the ocellus directed anteriorly, cytoplasm clear bluish gray with no trace of pigment except for two small black granules along the sulcus and girdle; three amyloid bodies near the center, numerous minute posteriorly located oil globules; no food vacuoles.

Dimensions: — Length, 44 μ; transdiameter, 33 μ; diameter of melanosome, 15 μ.

Occurrence: — One specimen found in surface plankton of Mutsu Bay, August 18, 1930, in a surface temperature of 25°.

Our description and figure are taken from an encysted and rounded-up individual.

Family **Blastodiniidae** KOFOID and SWEZY

Gymnodinioidae with parasitic aflagellate phase, and typical *Gymnodinium*-like, free zoospores with girdle, sulcus, and two typical flagella.

Genus BLASTODINIUM CHATTON (1920)

Parasitic in the alimentary canal of Copepoda, enclosed in cyst wall with external spinules.

32. **Blastodinium spinulosum** CHATTON

Parasitic phase curved, elongated, blunt anteriorly, tapering posteriorly to a point; enclosed in a cyst with a row of spinules in a descending left spiral of about 4 turns; chromatophores yellowish brown, in a peripheral network; zooids *Gymnodinium*-like, body ovoidal, its length 1.2 transdiameters, girdle median, chromatophores ellipitical, plate-like. Parasitic in *Paracalanus parvus*.

Dimensions: — Length of parasitic phase, up to 210 μ; zooid, lengh, 7 μ.

Occurrence: — A species provisionally identified as *B. crassum* was very abundant in the plankton of Mutsu Bay in *Paracalanus* during August, from minute to large intestinal stages.

Genus OODINIUM CHATTON

Ectoparasitic on marine Invertebrata, including Copelata, *Salpa*, Annelida, and Siphonophora, forming stalked, pyriform, or spheroidal unicellular structures, with root-like extensions into the cytoplasm; detaching and forming minute *Gymnodinium*-like zoospores by repeated divisions.

33. Oodinium poucheti LEMMERMANN

Brownish unicellular stages tentatively referred to this species, with very dense plasma within which the central nuclear area could be indistinctly located, occurred attached to the tail of *Oikopleura dioica* (?) during July, 1930, in the plankton of Mutsu Bay. Occasionally these stages were found free in the plankton in early stages of nuclear division.

Dimensions: — Length of attached stage, up about 75 μ.

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EXPLANATION OF PLATES.

PLATE I.

Amphidinium, Gymnodinium and *Gyrodinium;* ventral views.
All figures made from life by camera lucida. ×800.

Fig. 1. *Gymnodinium gelbum*, sp. nov.
Fig. 2. *Gymnodinium viridescens*, sp. nov.
Fig. 3. *Gyrodinium ferrugineum*, sp. nov.
Fig. 4. *Amphidinium inflatum*, sp. nov.
Fig. 5. *Gymnodinium coeruleum* DOGIEL.

Fig. 6. *Gymnodinium ochraceum*, sp. nov.
Fig. 7. *Gymnodinium sphaeroidium*, sp. nov.
Fig. 8. *Gymnodinium simplex* LOHMANN.
Fig. 9. *Gymnodinium arcuatum*, sp. nov.

PLATE II.

Gyrodinium, Cochlodinium and *Nematodinium;* ventral views.
All figures made from life by camera lucida. ×800.

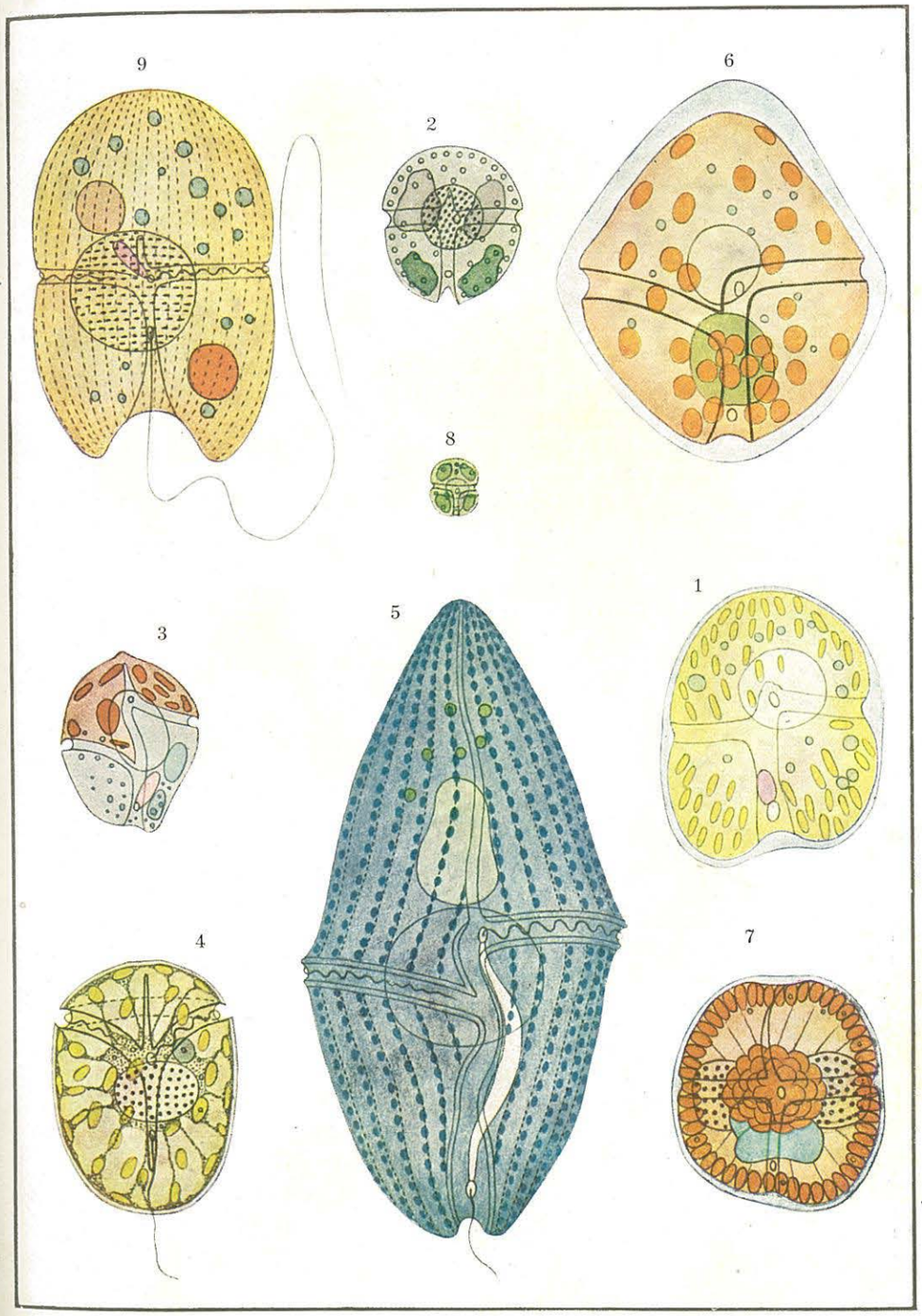
Fig. 10. *Gyrodinium citrinum*, sp. nov.
Fig. 11. *Gyrodinium ascendans*, sp. nov.
Fig. 12. *Gyrodinium flavum*, sp. nov.
Fig. 13. *Cochlodinium flavum*, sp. nov. View of right side.
Fig. 14. *Gyrodinium falcatum* KOFOID and SWEZY.
Fig. 15. *Nematodinium atromaculatum*, sp. nov.

PLATE III.

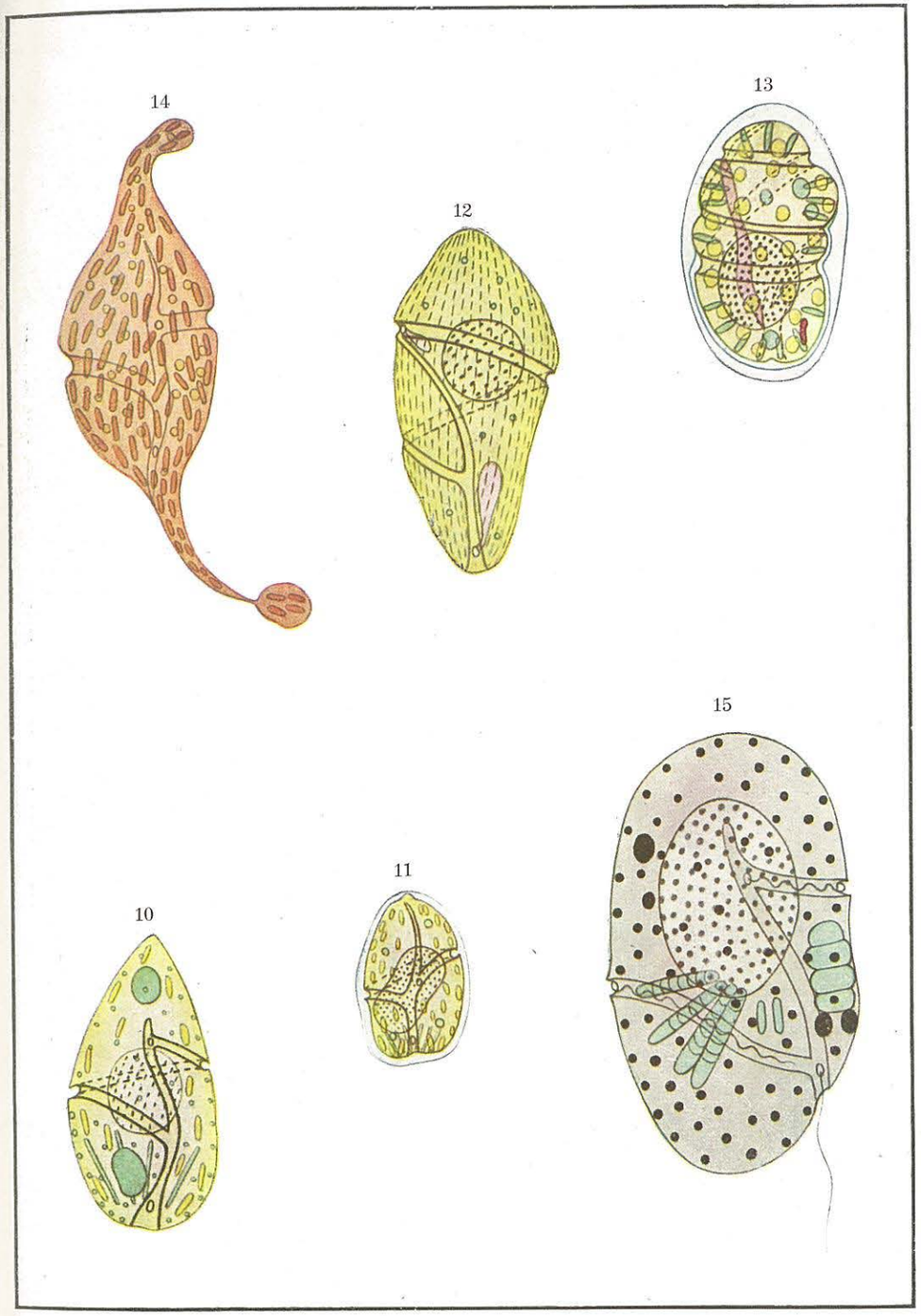
Pouchetia.

All figures made from life by camera lucida. ×800.

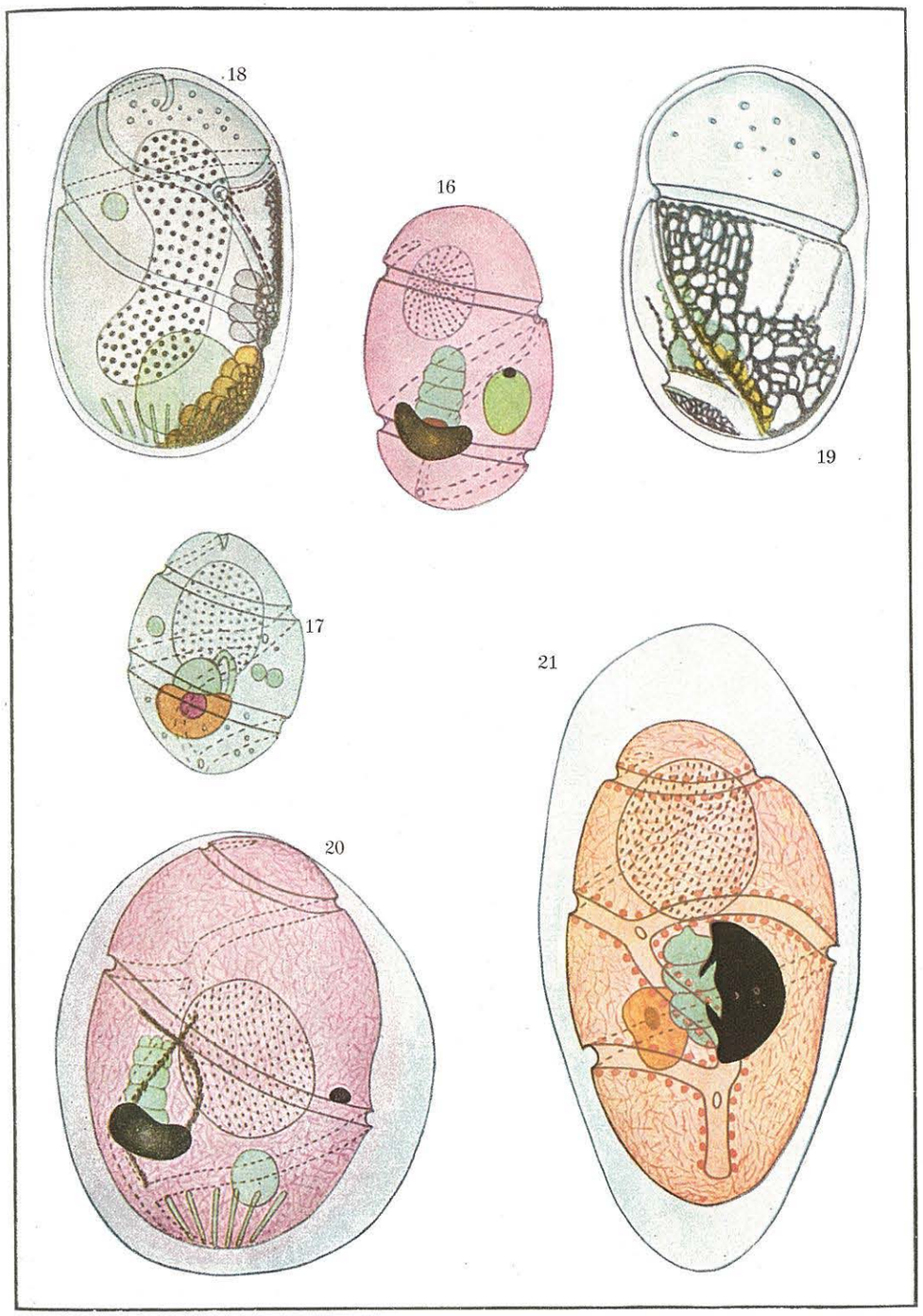
Fig. 16. *Pouchetia hataii*, sp. nov.; dorsal view.
Fig. 17. *Pouchetia rosea* (POUCHET) KOFOID and SWEZY; dorsal view.
Fig. 18. *Pouchetia reticulata*, sp. nov. Right ventral view.
Fig. 19. *Pouchetia reticulata*, sp. nov.; view of left side.
Fig. 20. *Pouchetia purpurata* KOFOID and SWEZY; dorsal view.
Fig. 21. *Pouchetia mutsui*, sp. nov.; ventral view.



C. A. KOFOID: Gymnodinioidae of Mutsu Bay.



C. A. Kofoid: Gymnodinioidae of Mutsu Bay.



C. A. Kofoid: Gymnodinioidae of Mutsu Bay.