UNIVERSITY OF CALIFORNIA PUBLICATIONS

ZOOLOGY

Vol. 3, No. 13, pp. 299-340, Pl. 22-33 April 13, 1907

CONTRIBUTIONS FROM THE LABORATORY
OF THE
MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO.

XVII.

DINOFLAGELLATA OF THE SAN DIEGO REGION, III. DESCRIPTIONS OF NEW SPECIES.

BY

CHARLES ATWOOD KOFOID.

The investigations of the plankton of the waters off the coast of Southern California, carried on since 1901, principally at the Marine Laboratory at San Diego, have brought to light an exceedingly rich protozoan fauna, in which the Dinoflagellates are abundant and often predominant. In addition to practically all of the species of this order known from warm temperate seas in other parts of the world, there have come to light a number of new forms which are here described. A fuller account of some of them, especially in the genus *Ceratium*, will appear in a later paper.

The present paper includes 22 new forms distributed as follows in the system:

GYMNODINIDAE.
Amphidinium sulcatum.
PERIDINIDAE.
CERATIINAE.
Heterocapsa pacifica.
Ceratium californiense.
Ceratium gallicum.

Ceratium inclinatum.
Ceratium macroceros deflexum.
Ceratium mollis.
Ceratium ostenfeldi.
Ceratium reticulatum spirale.
Ceratium schranki.
Ceratium tenuissimum.
Ceratium teres.
Gonyaulax pacifica.
Peridinium crassipes.
Peridinium minutum.
Peridinium multistriatum.
Peridinium rectum.

Oxytoxinae.

Amphidoma biconica.

Dinophysidae.

Dinophysis diegensis.
Dinophysis diegensis forma curvata.
Dinophysis ellipsoides.
Amphisolenia spinulosa.

Amphidinium sulcatum, sp. nov.

Pl. 22, figs. 1-3.

Body is compressed oval in form, broadly oval in lateral view, ellipsoidal in ventral view. The length 1.7 and the greatest dorso-ventral diameter 1.4 times the greatest transdiameter. Body widest (dorso-ventrally) about midway between the girdle and antapex.

The epitheca is low, its altitude 0.14 of the total length, highest laterally and dorsally and hollowed out toward the longitudinal furrow which passes dorsally beyond the apex.

The hypotheca is broadly rounded posteriorly and very deeply channeled ventrally by the longitudinal furrow which deepens as it passes posteriorly from the flagellar pore. Its depth at the pore is 0.25 of the dorso-ventral diameter at that level and at the antapex it reaches the main axis. The right lip of this furrow is somewhat higher than the left.

The girdle is anterior in position, and the transverse furrow is very deep, sinking obliquely posteriorly into the plasma. It narrows distally to a slender channel displaced posteriorly the width of the proximal end of the furrow. The flagellar pore lies to the left of the tongue of the epitheca extended posteriorly be-

tween the longitudinal furrow and the distal end of the transverse one (Pl. 22, fig. 2). The longitudinal furrow extends from the dorsal half of the epitheca to the antapex, and is a narrow deep channel on the epitheca but widens out on the hypotheca.

The surface is covered by a thin hyaline membrane noted by Stein ('83) but omitted in the generic diagnosis of Schütt ('96). Nucleus spheroidal, in the middle of the hypotheca, with moniliform chromatin reticulum, and two polar centrosomes (?) sunk into its substance. A pyriform vacuole lies near the flagellar pore and small angular yellowish chromatophores are scattered about the amyloid body. Plasma dense and coarsely granular.

Length, 68μ; transdiameter, 35μ; dorso-ventral, 55μ; nucleus, 15μ.

Taken in a vertical haul from 90 fathoms off San Diego in June.

This is the second pelagic species of this genus, the other being *A. aculeatum* Daday ('88) from Naples. The other species of the genus are from fresh (*A. lacustre*) or brackish (*A. operculatum*) water.

Heterocapsa pacifica, sp. nov.

Pl. 22, figs. 4, 5.

A very minute species with prominent asymmetrical spine, resembling *H. triquetra* but less elongated.

Body oval, dorso-ventrally compressed, the length, excluding spine, 1.3 times the transdiameter and 2.1 times the dorso-ventral one. Epitheca exceeds the hypotheca, its altitude 0.75 of the basal transdiameter, its sides slightly convex. Apical pore present. Hypotheca less than 0.5 of the transdiameter in height, slightly asymmetrical, the right side more convex than the left, continued posteriorly in a stout acuminate antapical spine a little to the left of the axis. Its base merges gradually into the outline of the hypotheca and its length is 0.3 of a transdiameter. There is a slight elevation on the right side suggestive of a second rudimentary antapical spine.

The girdle is postmedian; the transverse furrow is impressed, without lists and forms a descending right spiral displaced distally nearly its own width. The longitudinal furrow is faint and

continues posteriorly for half the length of the hypotheca. Thecal wall hyaline, structureless, without suture lines in individuals examined.

Nucleus relatively large, ellipsoidal with moniliform chromatin reticulum. A large spherical amyloid body is present and there are numerous ellipsoidal peripherally located chromatophores of yellowish color.

Differs from *H. triquetra* in its relatively greater transdiameter and consequently stouter form, and in the prominent antapical spine.

Length, including spine, 45μ; transdiameter, 30μ.

In surface oceanic plankton off San Diego in June.

Ceratium californiense, sp. nov.

Pl. 23, figs. 6-9.

Ceratium furca var. *baltica* (in part), Entz (:05), pp. 99-101, Taf. 1, Fig. 8.

Ceratium tripos macroceros (in part), Entz (:05), pp. 101-102, Taf 2, Figs. 13, 14.

This is a small species of delicate habit with slender antapicals curved regularly toward or even beyond the horizontal plane. Midbody resembles that of the *macroceros* group. Tips of the antapicals are closed, acute. The postmargin is wide and abruptly delimited from the bases of the antapicals. Thecal wall hyaline, porulate, but otherwise structureless.

Not in the form cycle of *C. furca balticum* (= *C. lineatum*) and *C. tripos macroceros* (= *C. macroceros*) as suggested by Entz (:05).

Rare in oceanic plankton at San Diego.

Ceratium gallicum, sp. nov.

Pl. 24, figs. 10-12.

Ceratium tripos var. *macroceros,* Gourret ('83), pp. 26-27, pl. 2, fig. 41.

Ceratium tripos var. *macroceras* (in part), Schröder (:00), p. 15, Taf. 1, Fig. 17 f.

Ceratium tripos macroceros (in part), Entz (:05), p. 100, Taf. 2, Figs. 15, 16.

Ceratium tripos macroceros (in part), Karsten (:06), Taf. 23, Fig. 29 c.

A delicate species of the *macroceros* section with deep postindentation and left antapical passing posteriorly from the midbody for a short distance before curving in the major flexure. Both antapicals are convex outwardly.

The midbody is smaller and more rotund than in *C. macroceros* narrowing abruptly into the erect submedian apical horn. The girdle is relatively high, passing some distance above the base of the right antapical. The postindentation is very deep, usually exceeding 0.5 of a transdiameter, and the postobliquity (24°) is less steep than in *C. macroceros* and is set off abruptly from the bases of the antapical horns. The major flexures are more abrupt and the distance between the shoulders is less, in absolute distance, than in *C. macroceros.* The antapicals spread distally in a relatively wide antapical angle which is greater in short-horned (54°–103°) than in long-horned (51°–78°) individuals. Both horns are convex outwardly but the right is usually less curved than the left and often shorter.

The thecal wall is delicate and hyaline and the girdle is often incomplete distally.

Length, 250–480μ; transdiameter, 50–60μ; distance between arms at girdle, 215–295μ; at tips, 300–480μ.

Common in oceanic plankton at San Diego. Eupelagic in warm temperate and tropical seas.

Ceratium inclinatum, sp. nov.

Pl. 25, figs. 16-21.

"*Ceratium tripos patentissimum* Ost.", Karsten (:06), p. 144, Taf. 21, Figs. 23, 23*a*. Symmetry reversed in his figures.

A small species of delicate habit, with narrow shoulders, slight postindentation, and spreading antapicals distally incurved, with contracted but still open tips, sometimes slightly inflated distally. The antapical angle is usually 60°–80°. Differs from *C. ostenfeldi* in its more delicate habit, smaller size, lesser antapical angle, and in the tips of the antapicals; from *C. macroceros* in the tips, narrower shoulders and more delicate habit.

Length, 240–510μ; transdiameter, 32–42μ; distance between horns at girdle, 95–150μ; at tips, 225–440μ.

Abundant at times in the oceanic plankton off San Diego.

Ceratium macroceros deflexum, subsp. nov.

Pl. 24, figs. 13-15.

This is a warm water subspecies of *C. macroceros* with moderate postindentation, but differing from the type in the marked ventral deflection of the antapicals in their proximal regions. As a result of this position, the antapicals, seen from either face, approach a course subparallel to the apical horn and the distance between them is considerably narrowed as compared with the distance in *C. macroceros*. In extreme cases the dorso-ventral distance of this ventral deflection exceeds one transdiameter. The postindentation of this subspecies is nearly equal to that in the typical *C. macroceros*.

Length, 300–420μ; transdiameter, 52–62μ; antapical angle, 0°–16°.

Occasionally taken in plankton of tropical character at San Diego.

Ceratium mollis, sp. nov.

Pl. 27, fig. 26.

Ceratium tripos flagellifera forma *angusta* (in part), Karsten (:06), Taf. 22, Fig. 33*b*.

A small species of delicate habit with all three horns greatly elongated and subparallel, rounded tips and slight postindentation. The midbody is small, rotund, with erect apical horn 6–12 transdiameters in length. The hypotheca is low, with slight postindentation, not abruptly delimited from the bases of the antapicals, often with small fin. The postobliquity is rather steep, 30°–50°. The major flexures of the antapicals are completed within 2 transdiameters of their bases. Their course beyond the flexure is approximately parallel to that of the apical at a distance from it of 1.5–2 rarely 2.5 transdiameters. They are delicate and somewhat flexible, exhibiting considerable range of curvature, sinuosities and undulations. Their tips are broadly rounded with terminal pore open or obscure. Thecal wall is hyaline and structureless.

The species differs from Schröder's ('00) *C. tripos* var. *macroceros* forma *longissima*, which is probably a valid species, *C.*

longissimum (Schröder), and from the form figured by Schütt ('93, fig. 21, Va) in its postindentation, median position of the apical on the epitheca, in its much smaller size, more sinuous horns and delicate habit. Karsten's (:06) *C. tripos flagellifera* forma *augusta* includes (his figure 33*a*) *C. inflexum* Gourret and this species (his fig. 33*b*) which differs from *C. inflexum* in its narrower shoulders, less localized major flexures, and greater postobliquity.

Length, 260–430μ; transdiameter, 35–40μ.

Rare in plankton of tropical character at San Diego.

Ceratium ostenfeldi, sp. nov.

Pl. 26, figs. 22-25.

Ceratium volans, Ostenfeld og Schmidt(:01), p. 168, fig. 21. This is not *C.* (*tripos* var.?) *volans* Cleve (:00), p. 15, pl. 7, fig. 4. Cleve's species is *C. carriense* Gourret.

Ceratium (*tripos* var.) *vultur*, Okamura and Nishikawa (:04), pp. 123-124, pl. 6, fig. 8. Also as *C.* (*tripos* var.) *vulture*.

Ceratium volans Cleve forma, Schröder (:06), p. 363, fig. 34.

A very large species of the *macroceros* group, of robust habit, long, spreading, straightish, symmetrical antapicals with open tips. Deep postindentation. Antapical angle 85°–90°. Antapicals not so spreading as in *C. carriense*, and more so than in *C. macroceros*.

Length, 530–740μ; apical horn, 390–665μ; antapicals, 435–675μ; distance between arms at girdle, 300–380μ; at tips, 675–920μ.

Eupelagic in warm temperate seas.

In material examined by me this species is distinct from both *C. carriense* Gourret and *C. macroceros* (Ehrbg).

Ceratium reticulatum spirale, subsp. nov.

Pl. 27, figs. 27, 28.

Differs from *C. reticulatum* Pouchet ('83) [= *C. hexacanthum* Gourret and *C. tripos* var. *inaequale* Gourret ('83); not *C. reticulatum* Imhof ('83)] in the fact that the left antapical is not only carried across the apical on its ventral (occasionally dorsal) side but is coiled up in a nearly flat spiral of 1–4 turns.

The center of the spiral lies just anterior to the base of the apical horn and its plane is oblique from the left dorsally to the right ventrally at an angle of about 30°–45° to the frontal plane. The diameter of the coil is 1–2 transdiameters. The spiral is quite regular, the interval between the turns being 2–3 times the diameter of the horn and increasing slightly from the center to the periphery of the coil. The surface reticulations of the midbody, postmarginal fin, form of the right horn and dimensions are similar to those of *C. reticulatum* in its longer horned forms.

In oceanic plankton of tropical character off San Diego.

Ceratium schranki, sp. nov.

Pl. 28, figs. 29*a*-31.

Ceratium (*tripos* var.) *arcuatum* (in part), Okamura and Nishikawa (:04), p. 122, pl. 6, figs. 3, 3*a*.

Ceratium tripos arcuatum (in part), Entz (:05), pp. 107, 109, Taf. 5, Figs. 31, 32, Taf. 6, Fig. 45.

Ceratium tripos lunula (in part), Karsten ('06), pp. 142-143, Taf. 20, Figs. 12*a*, 12*b*.

A large robust species related to *C. arcuatum*, having regularly curved, balanced, often subequal antapicals, and almost semicircular posterior outline.

The midbody is less rotund than in many species of the *tripos* group and the margins of the epitheca are but slightly convex or even concave. The apical horn is not so much displaced as in *C. arcuatum* and is stout and heavy and often relatively short. The distal part of the girdle is crowded close to the base of the right horn. The postmargin of the midbody is not set off from the bases of the antapicals by any indentation and its curvature is continued without marked change in its radius till the antapicals attain a direction parallel to the apical where the curvature slackens and the horns continue distally with little, if any, curvature toward the axis. The posterior border is thus a semicircle whose radius equals approximately two transdiameters. The distance between the antapicals at the level of the base of the apical is 3–3.5 transdiameters. The antapicals are stout and heavy with closed pointed tips and are often approximately equal in length. Occasionally the right horn exceeds the left in length. Often found in chain formation.

This species differs from *C. arcuatum* in its subequal antapicals, wider arc, and more contracted epitheca.

Length, 350–425μ; transdiameter, 65–95μ; distance between horns at level of base of apical, 290 to 370μ; between tips, 310 to 400μ.

Common in plankton of tropical character off San Diego.

Ceratium tenuissimum, sp. nov.

Pl. 29, figs. 32, 33.

A minute species resembling *C. carriense* but much smaller with delicate attenuate spreading antapicals.

The midbody is very small, rotund, with erect apical, 3–8 transdiameters in length. The postmargin is scarcely differentiated from bases of the antapicals and the postobliquity (15°) is not very steep. The antapicals spread laterally with slight major flexures, the right forming an angle of 50°–80° and the left of about 90° with the apical. The antapicals are straight or in many cases slightly reflexed *posteriorly* but less pronouncedly than in a form of *C. carriense* which Schröder (:06) has described as *C. hundhauseni*. All intergradations between straight and curved horns are found. I do not regard such curvature as of specific significance. It is more common in *C. tenuissimum* than in *C. carriense* as I have observed it. The antapicals are attenuate distally and the tips are open or sometimes contracted. Thecal wall hyaline, girdle often obsolete distally. The three horns are usually subequal in length.

This species is a fifth, or less, of the size of the typical forms of *C. carriense* (= *C. patentissimum* Ost. et Schm.), which it resembles in its proportions. I find no intergrading connections and regard this smaller form as a distinct species.

Length, 100–430μ; transdiameter, 35–45μ; distance between tips of antapicals, 215–850μ.

In oceanic plankton off San Diego.

I retain Karsten's (:06) name "*recurvata*" for the relatively rare forms with the tips of the antapicals recurved posteriorly. In the typical species the antapicals are not thus recurved. These recurved forms do not belong, as Karsten indicates, to "*Ceratium tripos volans*" but to the species here described.

Ceratium teres, sp. nov.

Pl. 29, figs. 34-36.

A minute species related to *C. eugrammum* (Ehrbg. '59 and '73) but of more delicate habit. It differs from *C. eugrammum* in its fusiform midbody. The lateral margins of the epitheca are convex and the hypotheca is contracted distally. The antapicals are short, the right diverging 25° to 30°. The postmargin is relatively wide and the postobliquity is not so steep as in *C. eugrammum*. The thecal wall is hyaline and structureless, and is very delicate on the horns, and comparatively thick on the midbody. Pores very faintly marked, suture lines rarely evident.

Length, 160–210μ; transdiameter, 33–37μ.

Rare in oceanic plankton off San Diego.

Gonyaulax pacifica, sp. nov.

Pl. 30, figs. 37-39.

An elongated species with a single asymmetrical antapical horn and suture lines marked by parallel longitudinal striae.

Body broadly fusiform, rounded posteriorly and somewhat flattened on the ventral face. Total length nearly twice transverse diameter at girdle. Compressed laterally, ratio of transverse and dorso-ventral diameters, 1 to 1.2. Epitheca a cone whose lateral faces are slightly concave and whose altitude is about equal to the diameter of the spreading base. Hypotheca dome-shaped, abruptly rounded posteriorly and flattened and excavated on ventral face, flaring at the girdle. Its altitude about three-fifths of its transdiameter at girdle. The hypotheca is prolonged at the left of the median line in a stout acute antapical spine about one-seventh of the diameter at the girdle in length.

Girdle located about five-ninths of the total length from the apex, its plane perpendicular to the axis. Transverse furrow narrow, its width a little more than one-twentieth of the transdiameter, forming a descending right spiral with displacement nearly twice its width and most of its curvature near the distal end, deeply impressed, with sharply angled overhanging margins formed by the flaring bases of the epitheca and hypotheca. Flagellar foramina located at the displaced ends of the transverse furrow. The longitudinal furrow was obscured in the specimen.

but it appears to extend from a collared apical pore to a broadly expanded posterior end near the antapex, and to be somewhat narrower on the epitheca than on the hypotheca.

Thecal plates as follows: 6 apical, of which 5 are wedge-shaped and one, the furrow plate, almost linear; 6 precingular; 6 postcingular, and 1 longitudinal ventral furrow plate; 1 antapical with postero-dorsal exposure; and the ribbon-like girdle plate. Surface marked by a few scattered longitudinal striae and scattered pores. Transverse furrow ribbed at regular intervals. Suture lines often marked by 2–5 approximated parallel striae between some of which cross striae appear in places.

Only the skeleton thus far observed.

Length, 142μ; transverse diameter at girdle, 92μ; altitude of epitheca, 92μ; of hypotheca, 78μ; width of girdle, 5.5.

Singly in oceanic plankton off San Diego in summer.

Peridinium crassipes, sp. nov.

Pl. 31, figs. 46, 47.

A medium-sized species related to *P. depressum*, with oblique girdle and short, stout antapicals.

The body is low and stout, its length being 1.1 transdiameters. It is slightly dorso-ventrally flattened, the greatest dorso-ventral diameter being 0.9 of the transdiameter. It is excavated ventrally and has a reniform girdle section.

The main axis is deflected antero-dorsally from a perpendicular to the plane of the girdle at an angle of 15°. The ventral face of both epitheca and hypotheca is somewhat concave, but the dorsal convex. There is no apical horn and the antapicals are short and stout, the greatest depression of the postmargin being about 0.15–0.2 of the transdiameter. This species is characterized primarily by the form of the end of the antapicals. Instead of terminating distally in a single conical projection, each ends in a blunt semitruncated projection with two or three principal points, one of which is homologous with the tip of the antapical and the other two represent respectively dorsal and ventral angles of the wide (dorso-ventrally) postmargin which forms in a dorso-posterior view a sort of an arch with wider posterior and narrow anterior opening. The median ventral points are formed by posterior extensions of the lists of the longitudinal furrow.

The transverse furrow is impressed, with ribbed membranous lists. It has strong proximal arch and little distal displacement.

Thecal wall with three mid-dorsal epithecal plates, sutures with broad bands of intercalary striae, surface areolated, with nodal pores. Plasma reddish.

Length, 80–90μ; transdiameter, 67–80μ.

Common in neritic plankton in summer off San Diego.

Peridinium minutum, sp. nov.

Pl. 31, figs. 42-45.

A minute species of globular form with a low apical horn and no antapical extension. Two dorsal intercalary plates instead of three.

The body is spherical, without ventral flattening or excavation. The epitheca slightly exceeds the hypotheca and ends in an abruptly differentiated stout apical horn whose diameter is 0.7 and height 0.5 of the width of the transverse furrow. The hypotheca plus the girdle is about equal to the epitheca. It has no antapical horns or spines. The girdle is horizontal and not displaced. The lists of the transverse furrow are low hyaline fins. The longitudinal furrow expands posteriorly and is bordered by membranous lists with two distal ribs and one in the highest part of the left list. Thecal wall hyaline, porulate, without reticulations (in individuals thus far examined). Sutures marked by well defined lines and short intercalary striae.

Differs from *P. globulus* in the presence of the short apical, the non-displaced girdle and its smaller size.

Length, 23–43μ; transdiameter, 23–47μ.

Abundant in May in San Pedro Harbor, California.

Peridinium multistriatum, sp. nov.

Pl. 30, figs. 40, 41.

A medium-sized species without apical or antapical horns, characterized by thick walls with exceedingly wide striated intercalary bands.

The body is rotund, subpentagonal in face view. Its length and transdiameter are about equal but exceed the dorso-ventral diameter. The epitheca is slightly contracted to a low eminence containing the slit-like apical pore and flares as it approaches the

salient girdle. It is but little larger than the hypotheca, which has no antapical horns but only small acute points near the ventral side of the antapical plates. There are no spines or fins as in *P. steini* Jörg. The girdle is narrow and deeply impressed and the transverse furrow forms an ascending right spiral with a distal displacement equal to its width. The longitudinal furrow is short and shallow, reaching only half way to the postmargin.

There are three dorsal intercalary plates. The suture lines are marked by exceedingly wide bands of intercalary striae. The reticulated surface of the plates is correspondingly reduced. A median row of thickenings on the striae marks the suture lines. The plates are punctate with numerous minute pores. Plasma dense, chromatophores brownish.

Length, 88μ; transdiameter, 88μ.

Rare in oceanic plankton off San Diego in June and July.

Peridinium rectum, sp. nov.

Pl. 32, figs. 48, 49.

A small species related to *P. pedunculatum* Schütt, but having a sharply differentiated, straight antapical horn of uniform calibre.

The body is ellipsoidal or less ovoidal than in *P. pedunculatum* and passes abruptly into a short straight apical horn, 0.1–0.2 of the transdiameter in length. The horn often flares a little at the aperture but is not swollen as in *P. pedunculatum.* The girdle is slightly postmedian, the transverse furrow is not impressed, has thin hyaline lists and its distal end is displaced anteriorly from 0.3 to 0.9 of its width. The two antapical spines are finned, subequal, 0.3–0.5 of a transdiameter in length. Thecal wall hyaline, structureless. Plasma rosy.

Length, excluding horn and spines, 52μ; transdiameter, 43μ.

Common in midsummer in oceanic plankton off San Diego.

Amphidoma biconica, sp. nov.

Pl. 32, figs. 50-52.

A medium sized biconical species with wide girdle.

Body biconical, ends acuminate, epitheca and hypotheca approximately equal, ratio of their lengths 10:11. Epitheca a low cone with its sides straight or slightly concave, equaling in length

the diameter of the base and somewhat recessed and concave on ventral face. Hypotheca of similar proportions but slightly larger, with straight or slightly convex sides, also concave on the right ventral face. Transverse furrow wide, about one-tenth of the length in width, forming a descending right spiral with a displacement of 1.2 times its width, deeply excavated, with low heavy lists. Longitudinal furrow small, short and shallow, to the left of the concave ventral face. Plates of the generic pattern, antapicals very short, apicals long, sutures marked by rugose ridges along the middle of the faint intercalary striae. Shell with secondary longitudinal striae and intervening reticulations forming irregular polygons. Transverse furrow traversed by the longitudinal sutures and striae.

Plasma dense, translucent (in fixed material), nucleus mid-ventral, reniform, chromatophores large, ellipsoidal, yellowish with brown center. About 15–20 disc-shaped and ellipsoidal perforate skeletal (?) inclusions in plasma mainly in the epitheca, the single ones resembling the elements in the epithecal skeleton of *Amphilothus elegans* as figured by Schütt ('95, Taf. 27, Fig. 102) but without their arrangement in a definite pattern. I have seen similar inclusions but larger and less regular in the endoplasm of a large holotrichous ciliate of the plankton in which this species is found but am unable to determine from the scanty data at hand, whether they are indigenous or adventitious with food in the ciliate. Indeed this latter possibility is not entirely excluded in the case of *Amphidoma*, for as Schilling ('91) has shown, there is a possibility that holozoic nutrition may occur in some *Dinoflagellata*. These structures do not resemble any known *Coccolithophoridae* and I know of no organisms in the plankton having normally such skeletal structures.

This species differs from *A. nucula* Stein, the only other well established species in the genus in its reversed proportions of epitheca and hypotheca, wider girdle, longer apical and shorter antapical plates, in its rugose suture lines, surface structure and skeletal (?) inclusions.

Dimensions: length, 71μ; diameter at girdle lists, 41μ.

Taken in vertical haul from 70 fathoms, 7 miles off Pt. Loma in July.

Dinophysis diegensis, sp. nov.

Pl. 33, figs. 57-61.

D. homunculus (in part), Stein ('83), Taf. 21, Fig. 8. "Ein junges Individuum."

A small species with elongated, laterally compressed body, pointed antapex, but lacking the dorsal elevation found on *D. homunculus.*

The body is stouter than in *D. homunculus,* its length, excluding lists, being 2.5 times its dorso-ventral diameter. It is much compressed laterally, its transdiameter being less than 0.5 of the dorso-ventral diameter.

The epitheca is exceedingly low, being less than 0.5 of the width of the transverse furrow in height and almost without convexity. The hypotheca has its dorsal and ventral margins almost parallel as far as the level of the posterior rib of the ventral fin. There is a little convexity in the dorsal outline and a slight local swelling in some individuals at the flagellar pore on the ventral margin. From approximately at the level of the posterior rib the posterior third of the hypotheca is contracted to a bluntly rounded point. Both margins are concave, the dorsal more so than the ventral. The antapex is rarely curved ventrally as in forma *curvata* (Pl. 33, fig. 58).

The collar lists are lower and less oblique than in Stein's ('83) figure, being relatively heavy low ridges. The height of the anterior one about equals the width of the furrow and is higher ventrally than dorsally. The posterior one is about half this height and more flaring. The plane of the girdle is oblique to the main axis postero-ventrally at an angle of 25°. The anterior collar is closed ventrally across the suture between the valves by a thin lamella.

The longitudinal fin arises from the rib on the proximal angle of the posterior collar and continues posteriorly for about 0.6–0.7 of the length of the body. The suture spine lies posterior to the middle of the fin and a more or less prominent posterior spine arises beyond the end of the longitudinal furrow. The fin in some individuals continues beyond this spine and is shortly confluent with the ventral margin. The fin crosses from the left to the

right valve at the suture spine. The pore and longitudinal furrow lie upon the right valve. Flagellar pore more posteriorly located than usual in *Dinophysis*, being near the base of the suture spine.

The thecal wall is delicate and hyaline with numerous fine pores, 12–20 across the valve. The suture is marked by a prominent line.

The plasma is hyaline, and contains a posteriorly located nucleus, and scattered irregular yellowish chromatophores.

In the many individuals of this species which I have seen, no evidence appears that this is a "young" individual of *D. homunculus*, as Stein ('83) states. It appears to be a perfectly distinct species of small size, different form and habitus. It varies in the outline of the antapical region, the protuberance of the flagellar pore and the distinctness of the pores on the valves.

Length, 55–110μ; dorso-ventral diameter, excluding fin, 23–44μ.

Rare in neritic plankton in the summer off Southern California. Taken off San Diego and La Jolla, and in San Pedro Harbor.

Dinophysis ellipsoides, sp. nov.

Pl. 33, fig. 56.

A small hyaline species with ellipsoidal, laterally compressed body and low collars.

Body symmetrically ellipsoidal, its length 1.6–1.7 times the greatest dorso-ventral diameter. Transdiameter about 0.3–0.4 of the dorso-ventral diameter. Epitheca very low, scarcely convex. Hypotheca broadly and symmetrically rounded at the antapex, equally convex dorsally and ventrally except in the region anterior to the flagellar pore which is slightly concave. Girdle nearly perpendicular to the main axis. Collar lists low and flaring, the posterior lower than the anterior, and diminishing in elevation toward the distal end. Anterior collar faintly ribbed. Longitudinal fin with three ribs, one at the anterior angle, a middle suture spine and a recurved posterior one. The fin is abruptly decurrent behind the posterior spine.

Thecal wall very thick but exceedingly hyaline. Sagittal suture scarcely marked, pores minute, about 20 across the valve. A

large, laterally compressed, posteriorly located nucleus and a few irregular pale chromatophores in the hyaline plasma.

Differs from *D. acuta, D. sacculus* and *D. rotundata* in its symmetrically ellipsoidal body and very hyaline aspect.

Length, excluding collar, 43μ; dorso-ventral diameter excluding fin, 25μ.

Rare in neritic plankton off San Diego in midsummer.

Amphisolenia spinulosa, sp. nov.

Pl. 32, figs. 53-55.

A large species related to *A. palmata* Stein but without terminal expansion of the antapical horn and with no lateral spinule.

The body is elongated, its total length about 40 times the greatest dorso-ventral diameter of the midbody. Neck and head, midbody and antapical horn forming respectively 0.1, 0.3, and 0.6 of the total length. The head is depressed, with convex upper and under surface, and impressed furrow. It is oblique (30°) to the main axis. The neck is of nearly uniform calibre, and is channeled ventrally as it approaches the flagellar pore. The midbody is elongated, fusiform, tapering gradually into the long apical horn. This is of a nearly uniform calibre and is deflected distally to the right and ventrally in a curve in its terminal third. It is not expanded distally as in *A. palmata* but bears a similar group of three, short, equal, divergent, terminal spinules. There is no lateral spinule as in *A. palmata.* Chromatophores subspherical, or irregular.

Length, 740–800μ; greatest dorso-ventral diameter, 18–20μ; diameter of antapical horn, 3–5μ.

Taken in oceanic plankton off San Diego in June and October.

Zoological Laboratory, University of California,

March 31, 1907.

LITERATURE CITED.

Cleve, P. T.

:00. Notes on some Atlantic Plankton Organisms. Kongl. Svenska Vet.-Akad. Handl., Bd. 34, No. 1, 22 pp., 8 pls.

Daday, E. von

'88. Systematische Uebersicht der Dinoflagellaten des Golfes von Neapel.. Term. Fuset, Budapest, Bd. 9, pp. 98-109, Taf. 3.

Ehrenberg, C. G.

'59. Ueber des Leuchten und über neue mikroskopische Leuchtthiere des Mittelmeeres. Monatsber. Akad. Wiss., Berl., 1859, pp. 727-738, 791-793.

'73. Die das Funkeln und Aufblitzen des Mittelmeeres bewirkenden unsichtbar kleinen Lebensformen. Festschr. z. Feier 100 jahr. Bestehens Ges. naturf. Freunde Berlin, 4 pp., 1 Taf.

Gourret, P.

'83. Sur les Peridiniens du Golfe de Marseille. Ann. Mus. d'Hist. Nat. Marseille, T. 1, Mem. 8, 114 pp., 4 pls.

Imhof, O. E.

'83. Studien zur Kenntnis der pelagischen Fauna der Schweizerseen. Zool. Anz., Bd. 6, pp. 466-471, 2 figs.

Karsten, G.

:06. Das Phytoplankton des Atlantischen Oceans nach den Material der deutschen Tiefsee-Expedition 1898-1899. Wiss. Ergebn. deutsch. Tiefsee-Exp. Valdivia, Bd. 2, II Teil, pp. 137-219, Taf. 20-34.

Okamura, K. and Nishikawa, T.

:04. A list of the species of *Ceratium* in Japan. Annot. Zool. Japon., Vol. 5, pp. 121-131, pl. 6.

Ostenfeld, C. H. og Schmidt, J.

:01. Plankton fra det Rode Hav og Adenbugten. Vedensk. Meddel. Nat. For. Kbhvn., 1901, pp. 141-182, 30 figs.

Pouchet, G.

'83. Contribution a l'histoire des Cilioflagellés. Journ. Anat. Physiol., Paris, T. 19, pp. 399-455, pls. 18-21, figs. A-L.

Schilling, A. J.

'91. Untersuchungen über thierische Lebensweise einiger Peridineen. Ber. deutsch. Bot. Ges., Bd. 9, pp. 199-208, Taf. 10.

Schroeder, B.

:00. Das Phytoplankton des Golfes von Neapel nebst vergleichenden Ausblicken auf das des Atlantischen Oceans. Mitth. Zool. Sta. Neapel, Bd. 14, pp. 1-38, Taf. 1.

:06. Beiträge zur Kenntnis des Phytoplanktons warmer Meere. Vierteljahrschr. naturf. Ges., Zurich, Jahrg. 51, pp. 319-377, 46 figs.

Schütt, F.

'93. Das Pflanzenleben den Hochsee. 76 pp., 35 Textabb., 1 Karte, Kiel und Leipzig.

'95. Die Peridineen der Plankton-Expedition. Ergebn. Plank.-Exp., Bd. 4, Ma, I Theil., 170 pp., 27 Taf.

'96. Peridiniales. Engler und Prantl's Nat. Pflanzenfamilien, I Teil, Abth. b, pp. 1-30, 43 figs.

Stein, F.

'83. Der Organismus der Infusionsthiere nach eigenen Forschungen in systematischer Reihenfolge bearbeitet. III Abth., II Halfte., Die Naturgeschichte der Arthrodelen Flagellaten, 30 pp., 25 Taf.

EXPLANATION OF PLATES.

PLATE XXII.

Fig. 1. Lateral view of *Amphidinium sulcatum*, sp. nov. × 850.

Fig. 2. Ventral view of same. × 850.

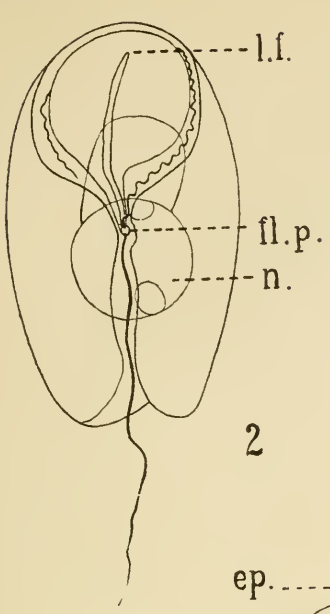
Fig. 3. Dorsal view of same. × 850.

Fig. 4. Ventral view of *Heterocapsa pacifica*, sp. nov. × 1370.

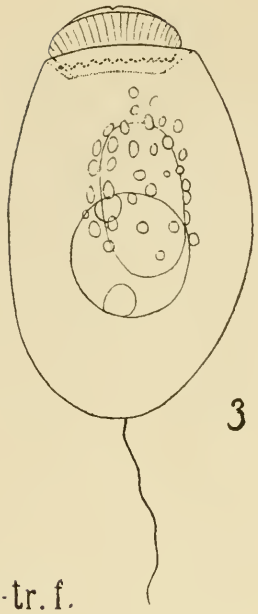
Fig. 5. Dorsal view of same with cell contents. × 1370.

ABBREVIATIONS.

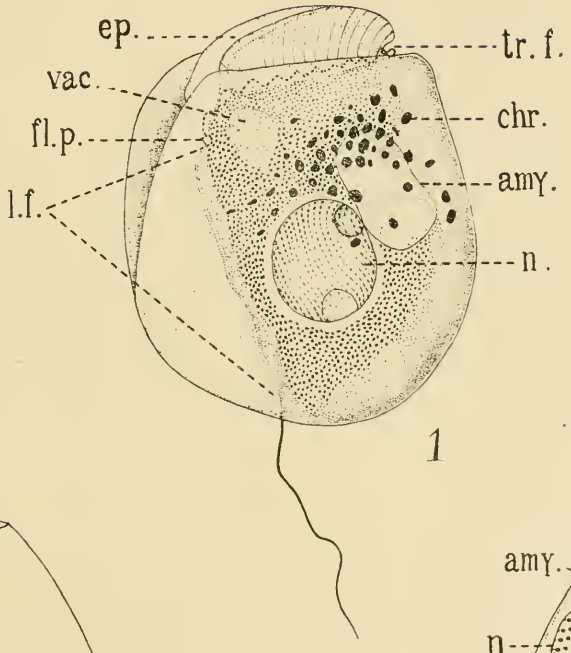
amy.—amyloid body.
chr.—chromatophore.
cp.—epitheca.
fl.p.—flagellar pore.
l.f.—longitudinal furrow.
n.—nucleus.
tr.f.—transverse furrow.
vac.—vacuole.



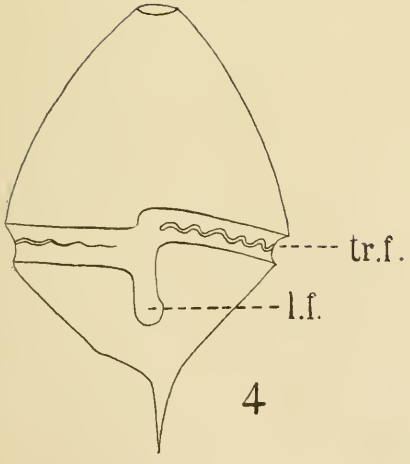
2



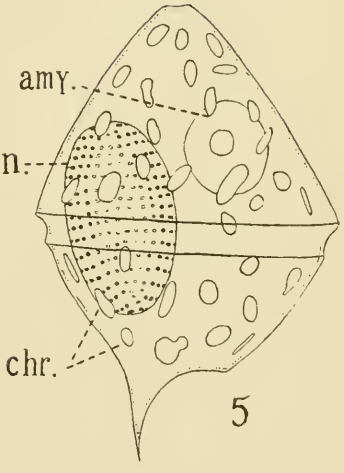
3



1



4



5

PLATE XXIII.

Fig. 6. Ventral view of *Ceratium californiense*, sp. nov. × 155.

Fig. 7. The same of another individual. × 155.

Fig. 8. Ventral view of individual with abnormally long horns showing distal zone of recent growth in apical horn and proximal zones in the antapicals at points marked by asterisk. × 450.

Fig. 9. Dorsal view of same. × 450.

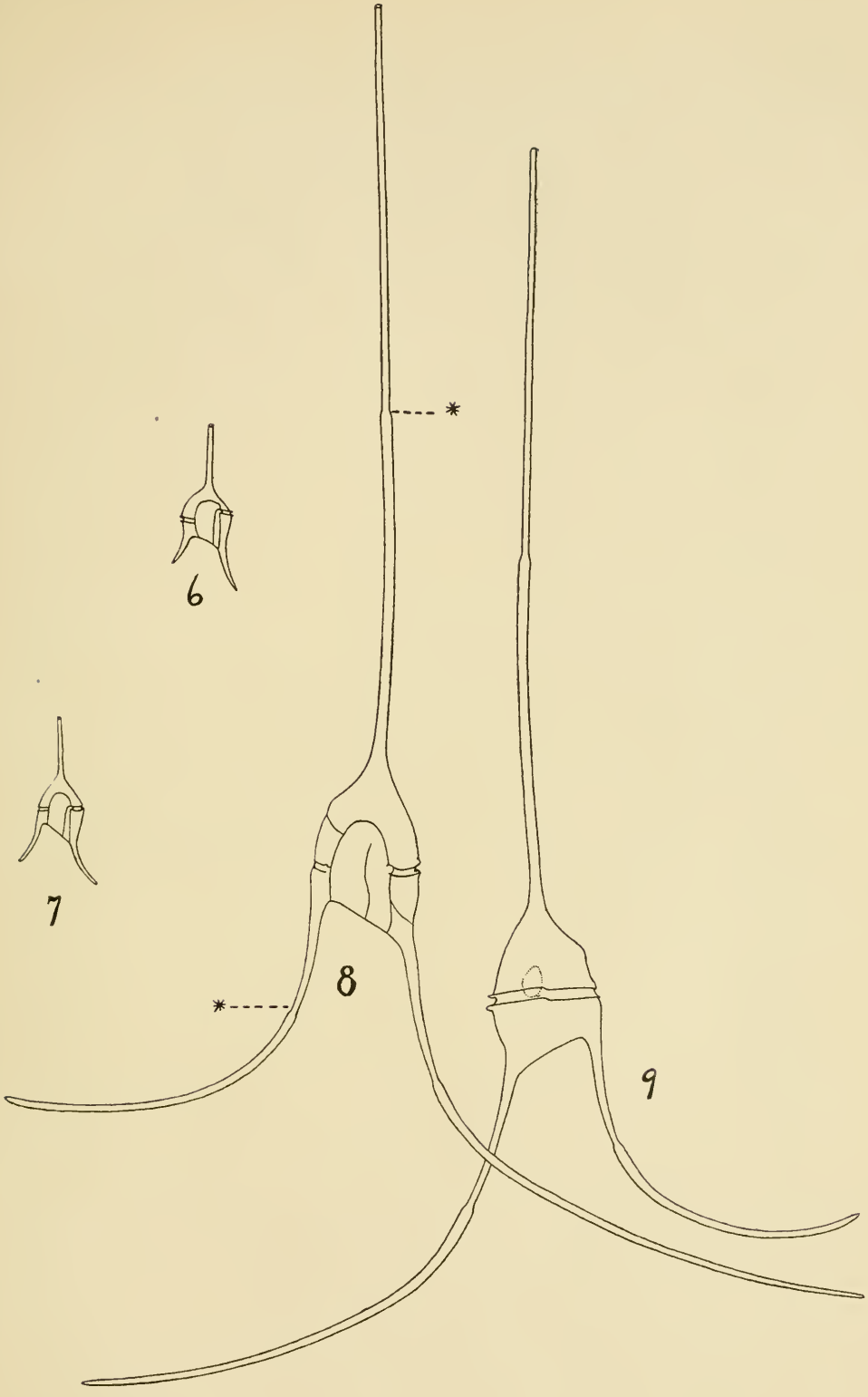

6
7
8
9

PLATE XXIV.

Fig. 10. Ventral view of *Ceratium gallicum*, sp. nov. × 313.
Fig. 11. Dorsal view of same. × 313.
Fig. 12. Cell contents of same. × 313.
Fig. 13. Ventral view of *Ceratium macroceros deflexum*, subsp. nov. × 100.
Fig. 14. Lateral view of same. × 100.
Fig. 15. Dorsal view of same. × 100.

ABBREVIATIONS.

chr.—chromatophores.
n.—nucleus.
vac.—vacuole.

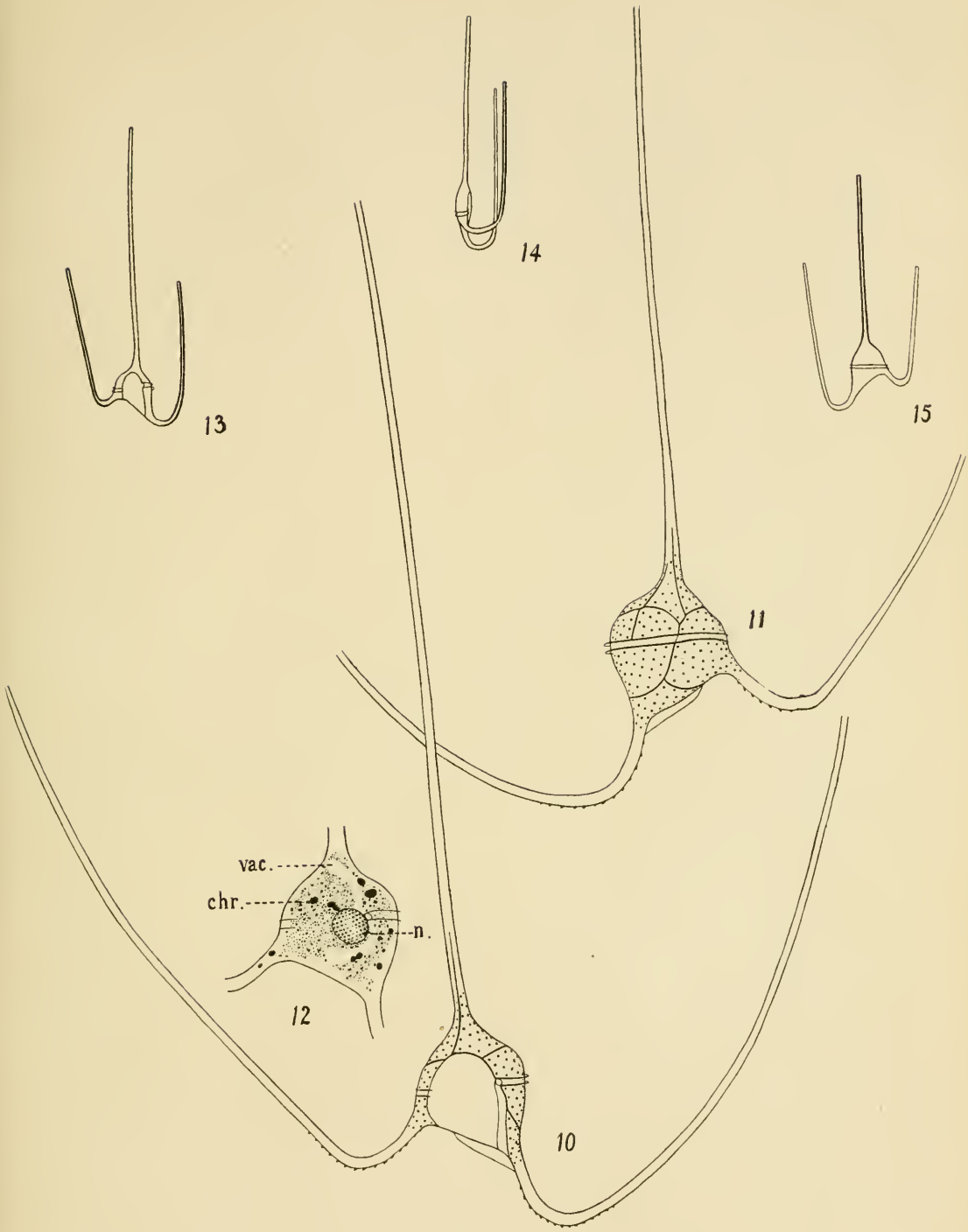
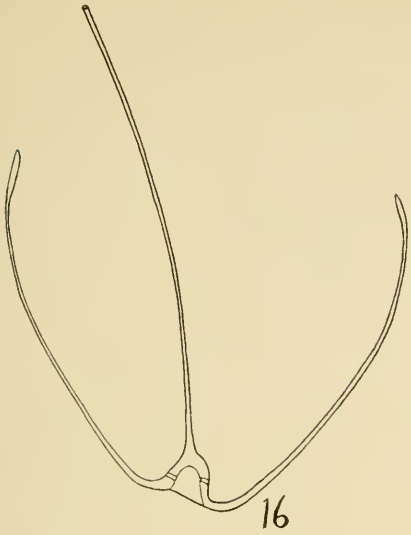
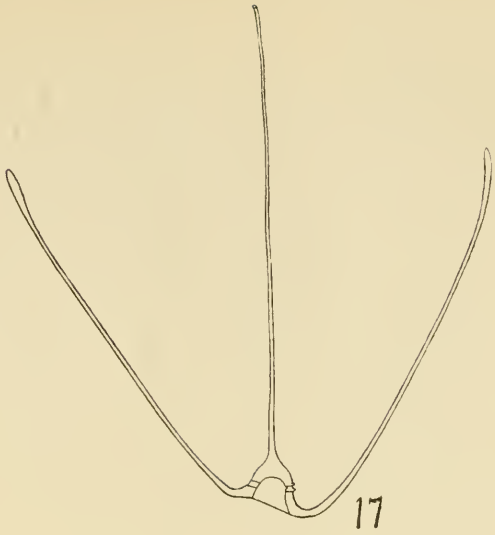
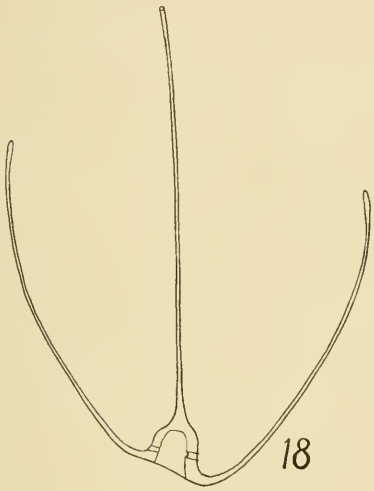

14
13
15
11
vac.
chr.
n.
12
10

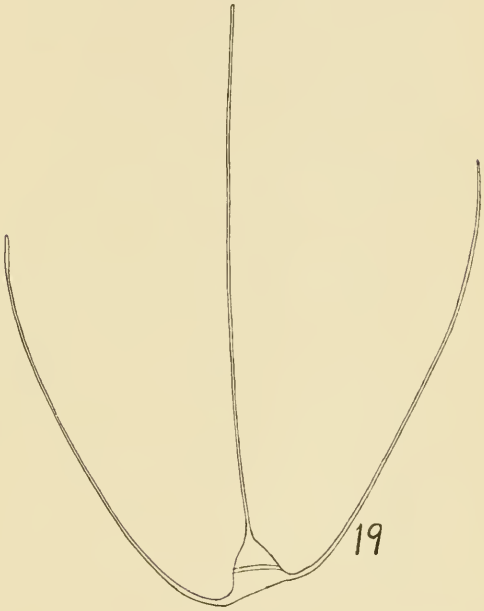
PLATE XXV.

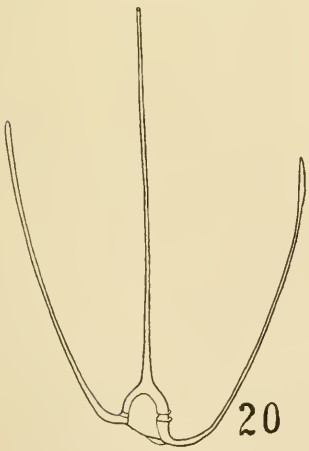
Figs. 16-18, 20. Ventral views of *Ceratium inclinatum*, sp. nov. × 155.
Figs. 19, 21. Dorsal views of same. × 155.


16


17


18


19


20

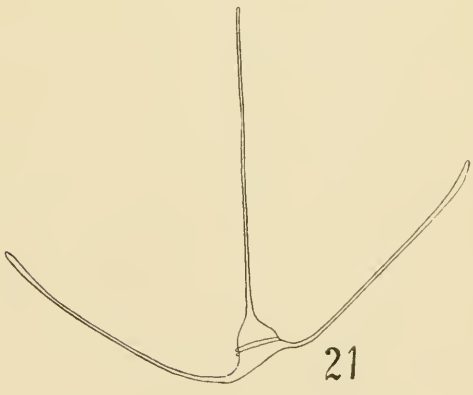

21

PLATE XXVI.

Fig. 22. Ventral view of *Ceratium ostenfeldi*, sp. nov. × 313.

Fig. 23. Dorsal view of same. × 313.

Fig. 24. Ventral view of individual with wide antapical angle. × 100.

Fig. 25. Dorsal view of a second individual. × 100.

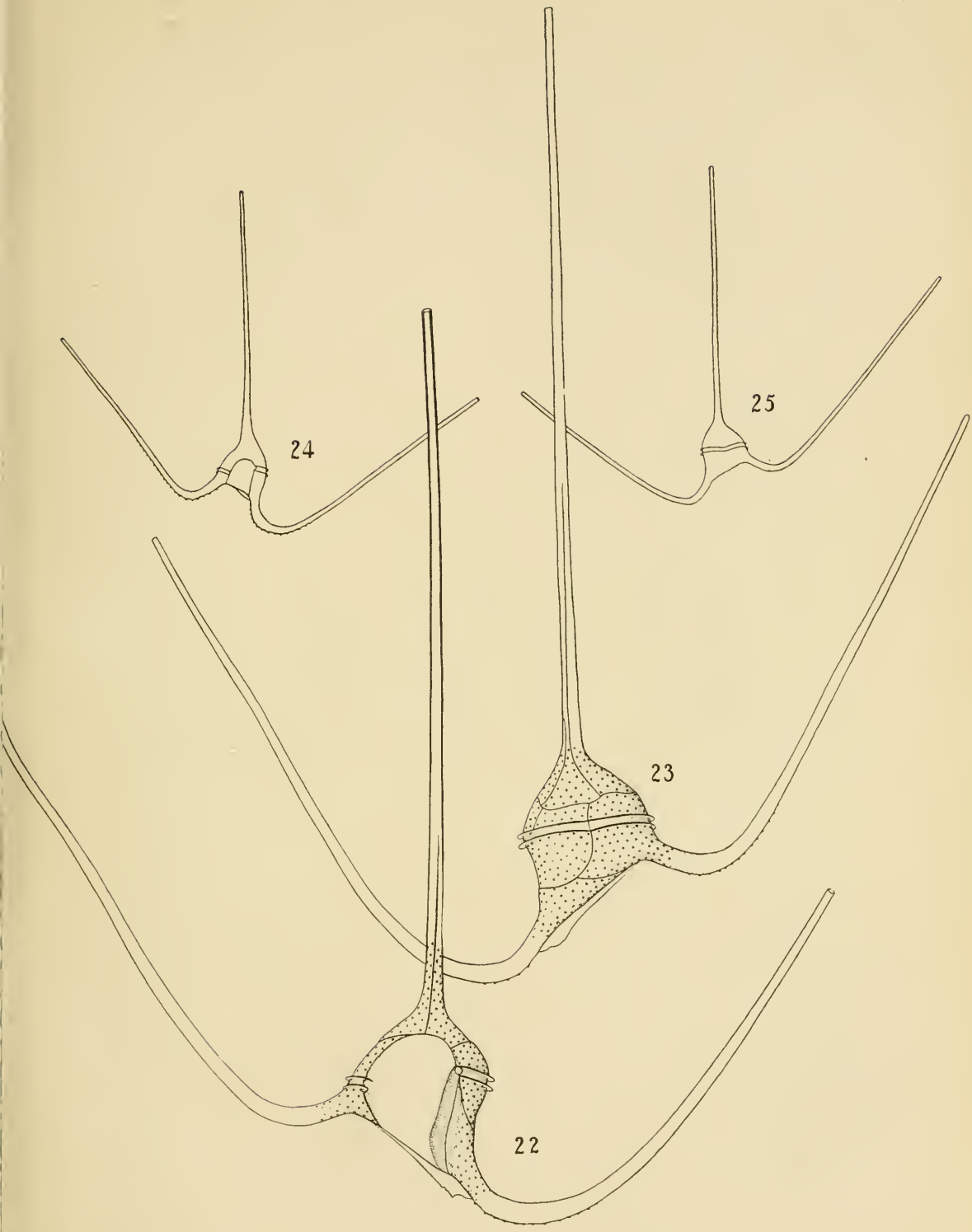

24
25
23
22

PLATE XXVII.

Fig. 27. Dorsal view of *Ceratium reticulatum spirale*, subsp. nov. × 313.

Fig. 28. Dorsal view of another individual with a more completely coiled antapical. × 135.

Fig. 29. Dorsal view of *Ceratium mollis*, sp. nov. × 280.

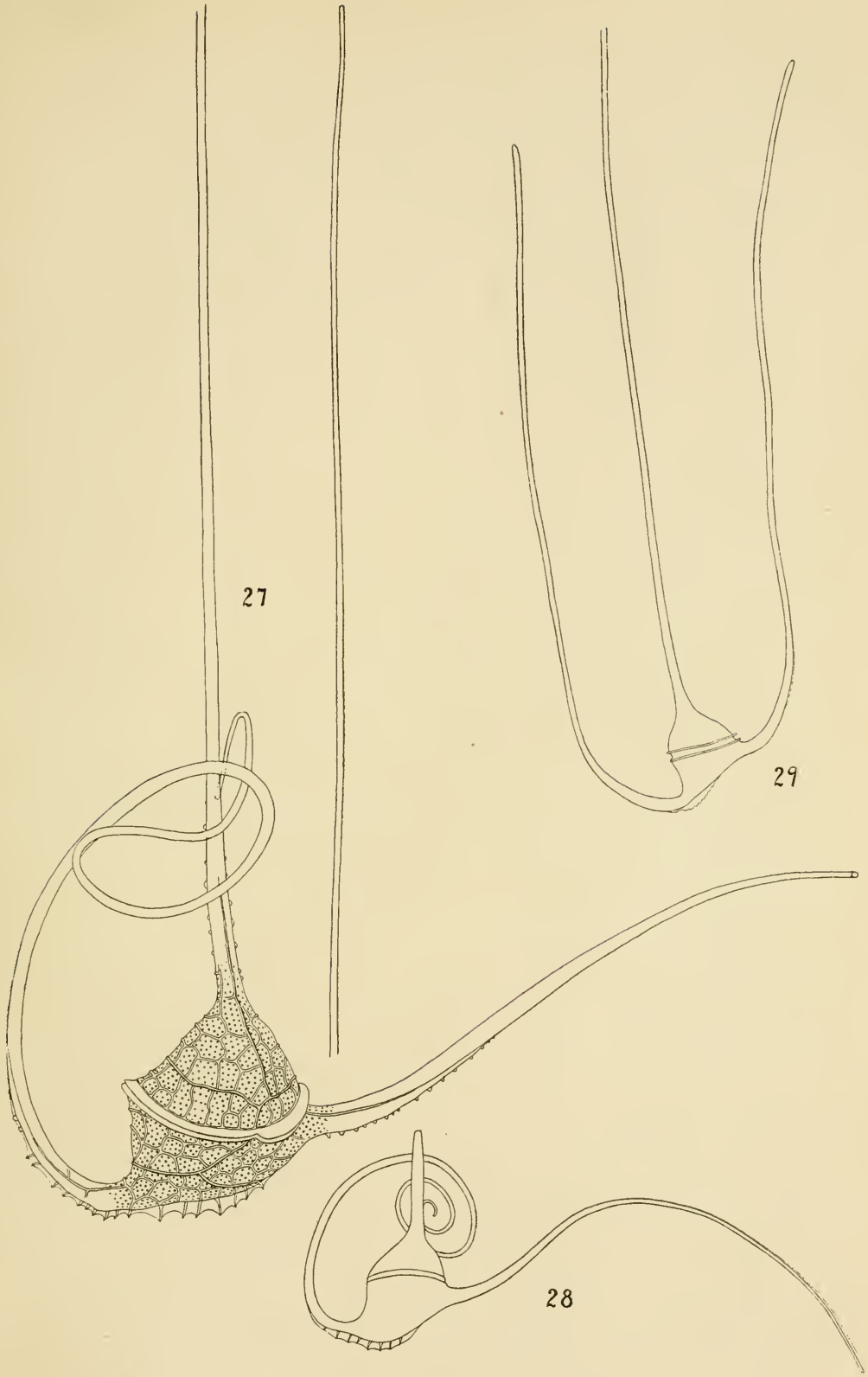

27
29
28

PLATE XXVIII.

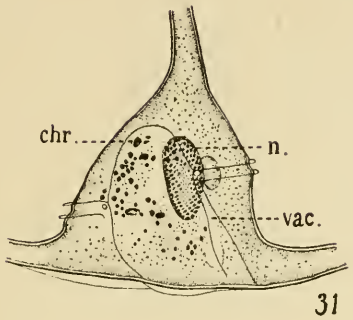
Fig. 29*a*. Ventral view of *Ceratium schranki*, sp. nov. × 387.

Fig. 30. Dorsal view of same. × 387.

Fig. 31. Cell contents of same. × 387.

ABBREVIATIONS.

chr.—chromatophores.
n.—nucleus.
vac.—vacuole.



31

PLATE XXIX.

Fig. 32. Ventral view of *Ceratium tenuissimum*, sp. nov. × 286.
Fig. 33. Dorsal view of same. × 286.
Fig. 34. Ventral view of *Ceratium teres*, sp. nov. × 400.
Fig. 35. Dorsal view of same. × 400.
Fig. 36. Cell contents of same. × 400.

ABBREVIATIONS.

chr.—chromatophores.
n.—nucleus.
vac.—vacuole.

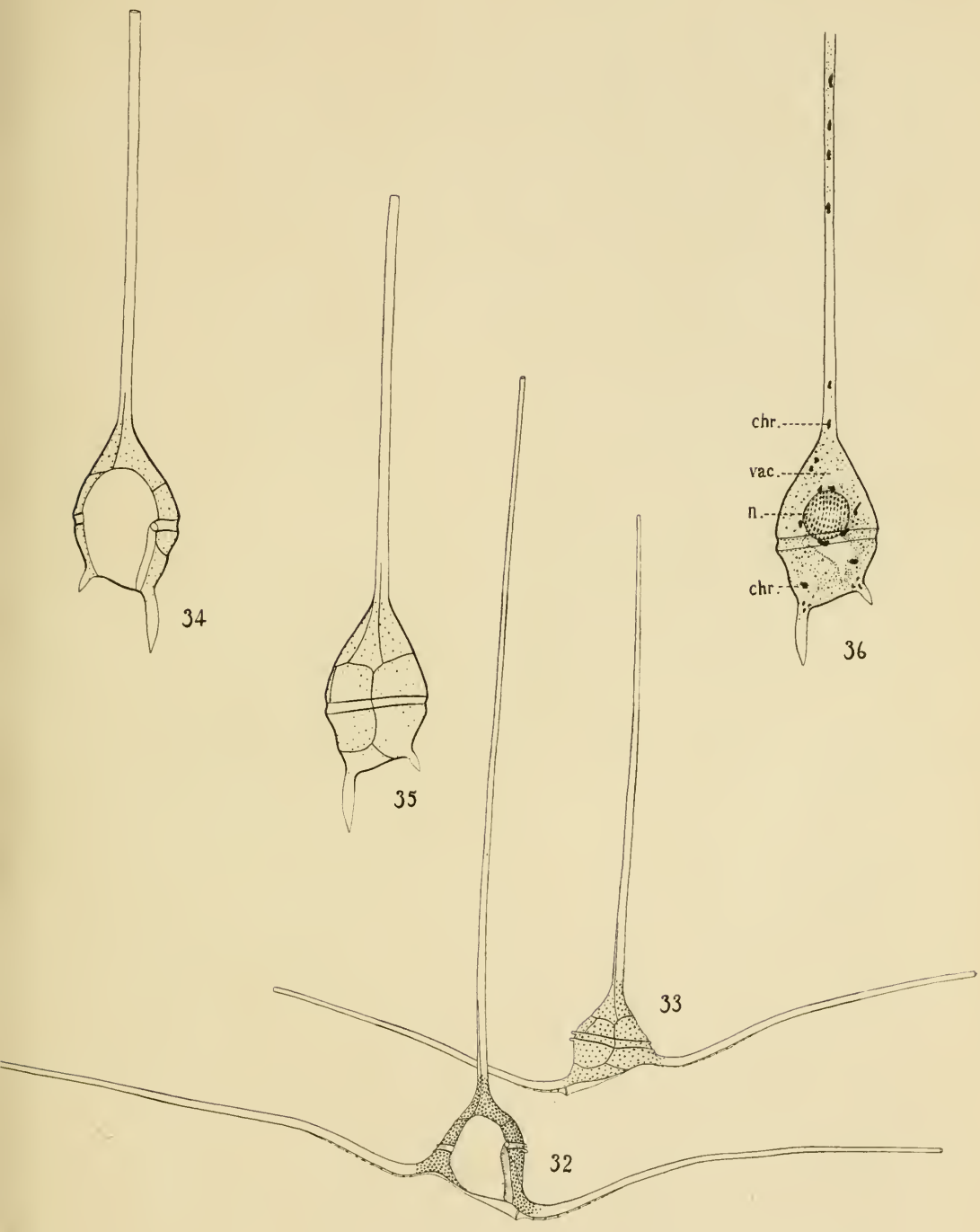
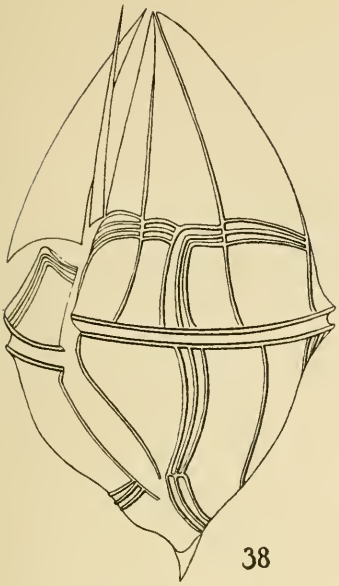

34
35
chr.
vac.
n.
chr.
36
33
32

PLATE XXX.

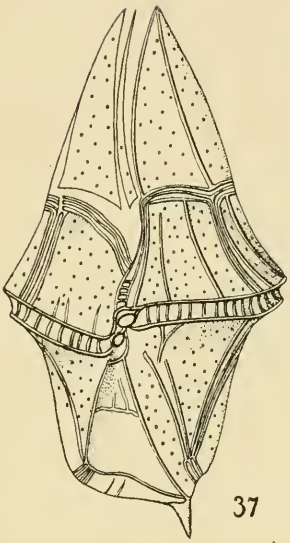
Fig. 37. Ventral view of *Gonyaulax pacifica*, sp. nov. × 533.
Fig. 38. Left face of same. × 533.
Fig. 39. Dorsal view of same. × 533.
Fig. 40. Dorsal view of *Peridinium multistriatum*, sp. nov. × 666.
Fig. 41. Ventral view of same. × 666.

ABBREVIATIONS.

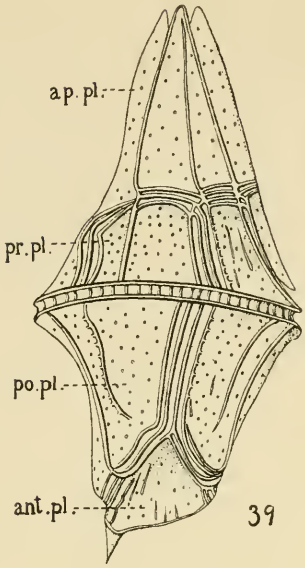
ant.pl.—antapical plate.
ap.pl.—apical plate.
pr.pl.—precingular plate.
po.pl.—postcingular plate.



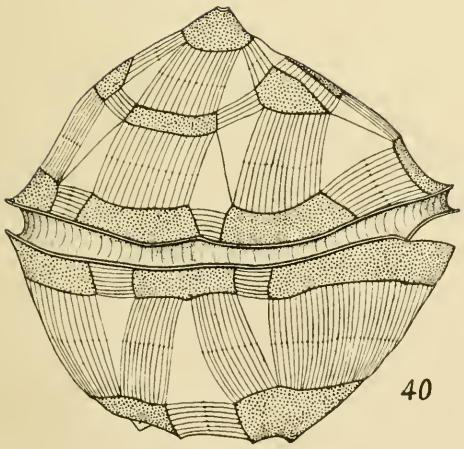
38



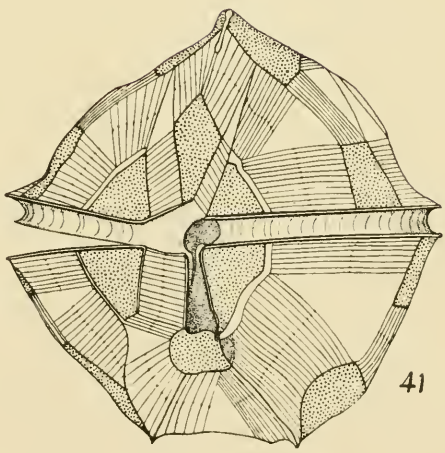
37



39



40



41

PLATE XXXI.

Fig. 42. Dorsal view of *Peridinium minutum*, sp. nov. × 1120.

Fig. 43. Ventral view of same. × 1120.

Fig. 44. Lateral view of same. × 1120.

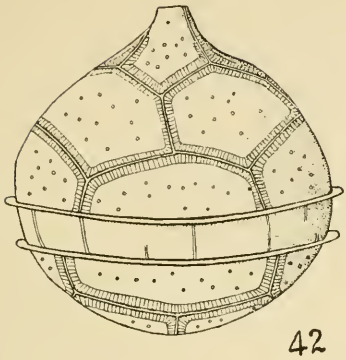
Fig. 45. Diagrammatic outline of epithecal plates of same. × 1120.

Fig. 46. Ventral view of *Peridinium crassipes*, sp. nov. × 736.

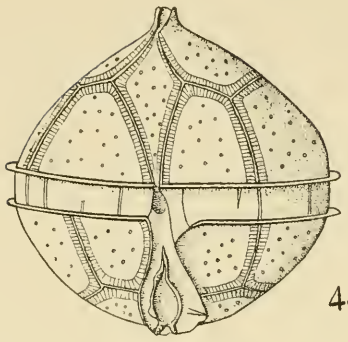
Fig. 47. Postero-dorsal view of same. × 736.

ABBREVIATIONS.

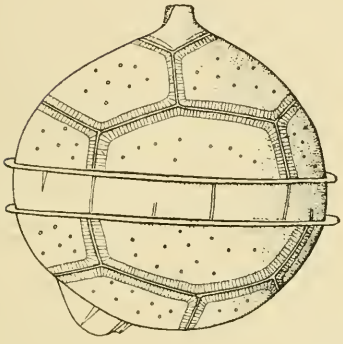
ap.pl.—apical plate.
int.pl.—intercalary plates.
pr.pl.—precingular plates.



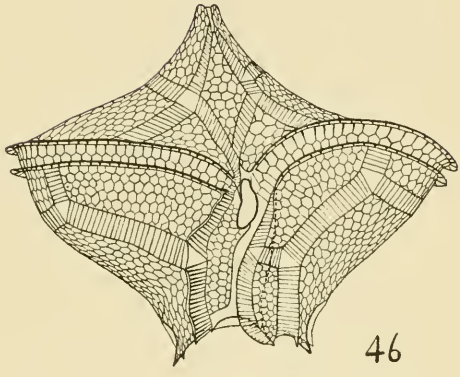
42



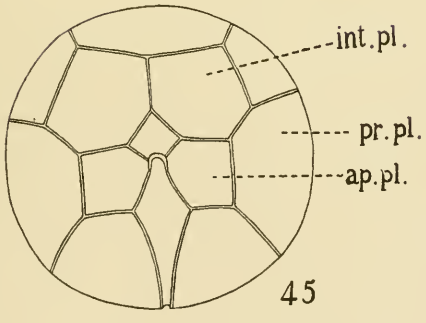
43



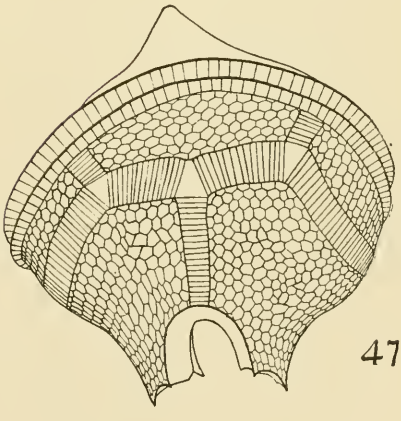
44



46



45



47

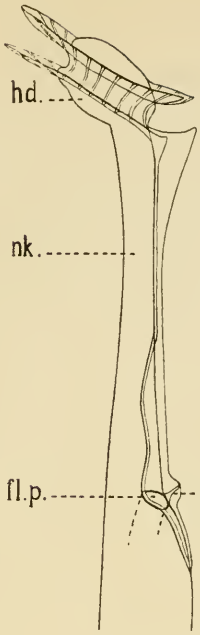
PLATE XXXII.

Fig. 48. Ventral view of *Peridinium rectum*, sp. nov. × 500.
Fig. 49. Dorsal view of another individual of the same. × 500.
Fig. 50. Ventral view of *Amphidoma biconica*, sp. nov. × 750.
Fig. 51. Cell contents of same. × 750.
Fig. 52. Skeletal inclusions of same. × 1650.
Fig. 53. View of right side of *Amphisolenia spinulosa*, sp. nov. × 168.
Fig. 54. Same, view of anterior end. × 1095.
Fig. 55. Optical section of antapical region of same. × 1095.

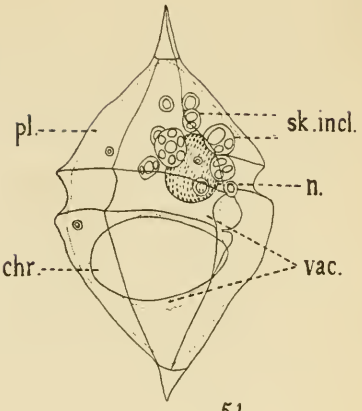
ABBREVIATIONS.

chr.—chromatophores.
fl.p.—flagellar pore.
hd.—head.
n.—nucleus.
nk.—neck.
pl.—plasma.
s.sp.—suture spine.
vac.—vacuole.

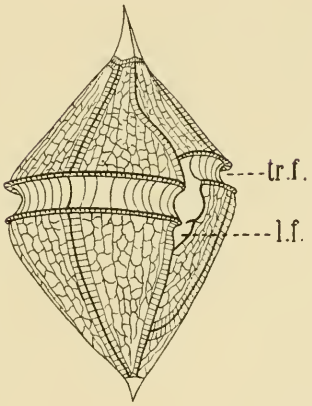
53



54

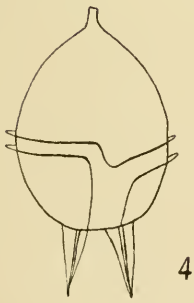


51



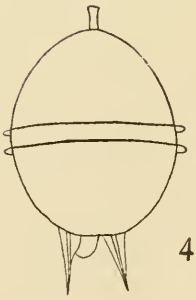
50

55



48

52



49

PLATE XXXIII.

Fig. 56. View of right face of *Dinophysis ellipsoides*, sp. nov. × 1020.

Fig. 57. View of right face of *Dinophysis diegensis*, sp. nov. × 638.

Fig. 58. View of right face of *Dinophysis diegensis*, sp. nov. forma *curvata*, f. nov. × 1028.

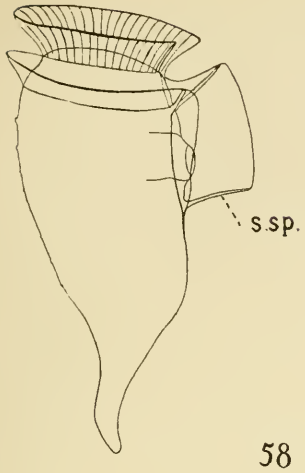
Fig. 59. Dorsal view of *Dinophysis diegensis*, sp. nov. × 638.

Fig. 60. Ventral view of same. × 638.

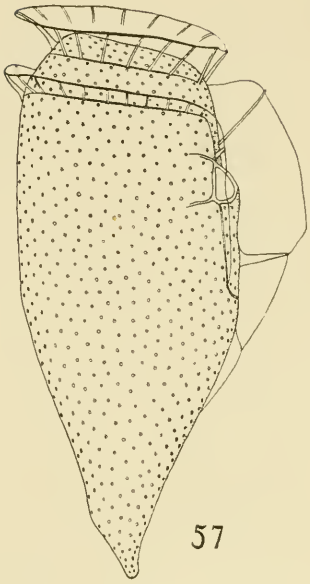
Fig. 61. View of right face of same showing different form of antapex. × 505.

ABBREVIATIONS.

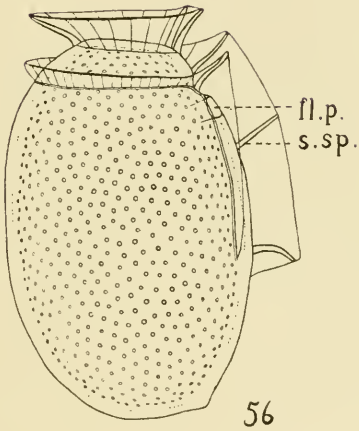
fl.p.—flagellar pore.
l.f.—longitudinal furrow.
s.sp.—suture spine.



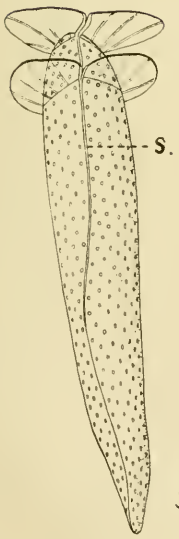
58



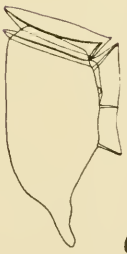
57



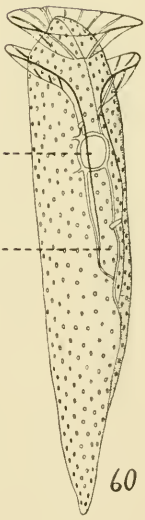
56



59



61



60