MARINE BIOLOGICAL ASSOCIATION OF INDIA

MEMOIR II

THE DINOPHYCEAE OF THE INDIAN SEAS

Part 2. Family PERIDINIACEAE Schütt emend Lindemann

BY

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PREFACE TO PART II

Family PERIDINIACEAE (Schütt) emend Lindemann

In this second part of *The Dinophyceae of the Indian Seas*, species under them of the Family Peridiniaceae from the Indian Ocean region are described, comprising the genera *Diplopsalis* Bergh, *Peridiniopsis* Lemmermann, *Preperidinium* Mangin, *Diplopeltopsis* Pavillard, *Diplopsalopsis* Meunier and *Peridinium* Ehrenberg. The account deals with the original work of the author and those of earlier workers reproduced here duly acknowledged. One hundred marine species and eighteen fresh water forms from the region are dealt with ; seven insufficiently known are mentioned. A list of species exclusively (so far) recorded from other seas and oceans is given. Over 50% of known Peridiniaceae occur in the Indian Ocean waters.

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The author owns full responsibility for defective proof-reading which has necessitated an *errata* list and he hopes that this will not detract the value of the work to users.

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Family **PERIDINIACEAE** Schütt emend Lindemann, 1928

Cells spherical to longish; small horns often on the hypotheca. An apex present or absent. Girdle circular or spiralled, right-handed (dextral) or left-handed (sinistral). Theca thin in the younger stages, later becomes thick and strong; consists of variously shaped plates. Tabulation variable, malformation common. Difficult to set up valid plate patterns for members of the family. Mostly there are 6 to 7 precingulars, 5 to 6 postcingulars and two antapical plates which may be fused in *Diplosalis*. Tabulation of epitheca more variable than that of hypotheca. Surface of theca sculptured with areoles, papillae, spines, lists or pores; seldom smooth. Plasma of marine species at times coloured. Stigma present or absent; when present sometimes pale; rarely present in freshwater species. Pusules occur in marine species. Chromatophores greenish yellow or brown, present often in large numbers, at times with pyrenoids. Starch, fatty substances and rods (rhabdosomes) constitute inclusions. Nucleus round or elongated. Cells rarely form colony. Cysts formed after casting off of theca. Not much known about reproduction. Size varies from 18 to 300 μ. In fresh, brackish and marine habitats.

The plate-pattern on the cells is an important taxonomic character for diagnosis of genera and species. The plates composing the body of the cell are arranged in rows parallel to the girdle for convenience in designation. The terminology of Kofoid (1909 *a*) is widely accepted for this purpose.

On the epitheca, the plates around the apex are called the *apicals*. Anterior to and touching the girdle is a row of plates, the *precingular* series. Another group in contact with the apex, is the *apical* series. Between these two plates may be found interpolated plates called *anterior intercalaries*. The girdle also is made up of a series of plates not well known and hence usually omitted in the formulae. On the hypotheca, bordering the girdle, is a row of plates known as *postcingular* series. Another series, which touches the antapex is termed *antapical* plates. Between these and postcingulars, there may be interpolated the *posterior intercalaries*.

Kofoid (*l. c.*) uses prime signs to designate the plates which is adopted by most workers. Graham (1942) has proposed use of letters to denote them. The two are given below:—

Plates	*Kofoid*	*Graham*
Apical platelet		pl
Apical plate	1′, 2′.....4′	ap
Anterior intercalary	a	a

Precingular	1'', 2''.....7''	pr
Girdle		g
Postcingular	1''',...2'''...5'''	po
Posterior intercalary	posterior intercalary	p
Antapical	1'''', 2'''', ...	ant
Sulcal		s

e. g. The plate formula for *Peridinium* Ehrenberg would be:

Lebour: 4' 3a 7'' 5''' 2''''
Schiller: 4' 2-3a 7'' 5''' 2''''
Graham: 2-5ap; 0-8a; 6-7pr; 3-6g; 5-6s, 5-6po; Op, 2ant.

The additional details in Graham's formula is due to knowledge accrued since Schiller. As most of the workers adopt Kofoid's signs, the same is employed here to help easy reference.

Lindemann (1928) merged some of the genera of earlier authors into *Diplosalis* and Schiller (1937) merged some into *Glenodinium* and some into *Peridinium*. Investigations since 1937 tend to show that several of the genera merged by these authors can be accorded independent status (Loeblich *et al* 1966). Thus nine genera are recognized in the family Peridiniaceae distinguished by the following characteristics.

Diplopsalis Bergh, 1881

Cells lens-shaped with a left long list fairly conspicuous. Plate formula 3' 1*a* 6'' 5''' 1''''. The plate here called the anterior intercalary may be displaced apical. Apical pore present. Marine and in relict seas.

Peridiniopsis Lemmerman, 1904

Cell with plate formula: 3' 1*a* 6'' 5''' 2''''. Round conical or lenticular. Like *D plopsalis* but with two antapicals. The large anterior intercalary may, however, be displaced apical.

Diplopelta Jörgensen, 1912

Two antapicals, second small anterior intercalary plate. Formula: 3' 2*a* 6'' 5''' 2''''.

Diplopeltopsis Pavillard, 1913

Cells lens-shaped. Plate formula: 3' 2*a* 7'' 5''' 1'''' or the large intercalary apical, 7 precingulars and 1 antapical; otherwise like *Diplopelta*.

Entzia Lebour, 1922

Plate formula: 4' 1-2*a* 7'' 5''' 1''''. Apical pore present. Differs from *Peridinium* subgenus *Archaeperidinium* in having only one antapical plate and sometimes, only one anterior intercalary.

Diplopsalopsis Meunier, 1909

Cells lens-shaped. Plate formula: 3′ 2*a* 7″ 5‴ 2⁗ or 4′ 1*a* 7″ 5‴ 2⁗. Like *Diplopeltopsis* but with 2 antapicals.

Heterocapsa Stein, 1883

Cells more or less spindle-shaped. One antapical drawn out into a horn. Plate formula: 4 *ap* 2*a* 6 for 5 *pst op* 2 at (4′ 2*a* 6′ 5‴ 2⁗.)

Peridinium Ehrenberg, 1832

Shape variable, round ellipsoidal or spindle-shaped, and dorsiventrally compressed. 2-5′, 0-8*a*, 6-7″ (3-6 ? *g*), 5 (-6) ‴ *op* 2⁗.

Preperidinium Mangin, 1913

Ellipsoidal or spherical cells Tabulation: 4′ 1*a* 7″ 5‴ 1⁗ or 4′ 1*a* 5-6″ 5‴ 1⁗. One of the apical plates very much to the left.

Genus *Diplopsalis* Bergh, 1881

Bergh, 1881 *a*.
Paulsen, 1908, p. 34.
Lebour, 1925, p. 99.
Lindemann. 1928, p. 90.
= *Glenodinium* Pouchet, 1883, in part.
= *Peridinium* Ehrenberg, Paulsen, 1908, p. 41, in part.

Shape of cells globoid or, sphaerical, flattened pole to pole. Apical pore present, generally slightly marked, peg-like. Girdle equatorial, circular; there appears to exist an inclination to the right sometimes. Sulcus does not extend on to the epitheca, always accompanied by a characteristic winged list on the left margin, which can extend over the antapex. Plate formula : (3-4 *ap*; 0 - 2*a*; 6 - 7 *pr*; ? *g*; 5 postcingular; 0 *p*; 1 - 2 *at*); 3 - 4′; 0 - 2*a*; 6 - 7″; ? *g*; 5‴; 0 *p*; 1 - 2⁗.

Shell surface smooth or finely punctate; in freshwater forms also areolated. Large sack pusule (according to Schütt besides a small retort-like or round collecting pusule with zone of very small, tiny tubes in them, daughter pusules). Chromatophores apparently absent. According to Schütt, the outer marginal layer of marine forms is coloured often pink. Length between 30 to 50 μ; diameter 30 - 90 μ. Marine; one species freshwater.

Diplopsalis lenticula Bergh, 1881
(Pl. I, figs. 1–3, 5, 7-9, 16; III, fig 1, 2, 3, 8, 10)

Bergh, 1881, p. 244, figs. 60 – 62.
Stein, 1883, pl. 8, figs. 12 - 14; pl. 9, figs. 1, 2 (?).

Schütt, 1895, pl. 15, fig. 50.
Paulsen, 1908, p. 35, fig. 44.
Lebour, 1922, p. 795, figs. 1 - 5; 1925, p. 99, pl. 15, figs. 1 *a* - *e*.
Matzenauer, 1933, p. 453.
Wood, 1954, p. 222, fig. 86 *a* - *e*.
= *Glenodinium lenticula* (Bergh) Schiller, 1937, p. 103, fig. 95 *a* - *h*;
Kisselev, 1950, p. 136, fig. 217 *a* - *e*.
= *Diplopsalis sphaerica* Meunier, 1909.

Cells lens - to globular-shaped. Epitheca and hypotheca equal, former with short apical horn. Girdle circular, median. Girdle membrane supported by fine prongs. Sulcus generally reaching neighbourhood of posterior end; its left margin with conspicuous, hyaline list, which in ventral view projects like a process towards the right. Chromatophores absent. Plasma coloured pink, or lightly purple. Shell with fine or coarse pores. Propagation by two spores, often observed, which are liberated through a split in the girdle region. Plate formula 3′, 1*a*, 6″, 5‴, 1⁗. The suture lying between 2′ and 3′ is of varying length, so that the intercalary plate reaches more or less the apical opening. One can also consider this plate as apical plate. For the designation of species here it is immaterial how one considers it. Length 29-75μ; breadth 33-155μ.

Widely distributed. Eurythermal and euryhaline. Coastal waters of Europe including brackish water. Indian Ocean; Red Sea; Gulf of Aden; Arabian sea (June to October, rarely January); Malay region; Antarctic, Adelie Land.

The remarks of Lebour. (1922, p. 797) on this species may be cited here being of interest. Bergh's specimens agree with this description (of Labour) as to size, shape, colour and form and size of the left longitudinal list. The plate arrangement was not described by him. Stein (1883, pl. ix, fig. 1) figures what he describes as a young specimen of *Diplopsalis lenticula* having 3 apicals and 5 precingulars. Although he does not figure nor describe the hypotheca of this form, the epitheca shows it to be almost containing the species described above, the dorsal end plate and the division of the corresponding precingular into 2 not being shown. It is extremely easy to make such a mistake, as these 2 precingulars are very narrow and in certain positions seem blended with the dorsal plate. Pavillard (1912) having rediscovered this species, in the latter of them describes the dorsal plate but not the 2 corresponding precingulars. In a later account he reports (Pavillard 1913) the dorsal plate to be non-existent. In the Mediterranean specimens Pavillard (1916) gives 3 apicals, 5 precingulars, 5 postcingulars and 1 antapical and he regards this species as identical with Bergh's and Stein's fig. 1, pl. ix. Lebour found Mediterranean and Plymouth specimens to be

identical as regards plates and their number, the first apical being rather larger and the longitudinal list slightly more conspicuous. Specimens similar to those at Plymouth have also been found off Roscoff.

Diplopsalis saecularis Murray and Whitting, 1899
(Pl. IV, figs 2, 3, 16, 18)

Murray and Whitting, 1899, p. 325, pl. 28, fig. 5.
Ostenfeld, 1900, p. 56.
——————and Paulsen, 1904, p. 165.
Paulsen, 1908, p. 36, fig. 46.
=*Glenodinium saeculare* Murray and Whitting, Schiller, 1937, p. 107, fig. 99 *a - d*.

Cells in girdle view irregularly elliptical, in valve view circular, due to compressed nature. Girdle strongly dextral, oblique, lying approximately median. Anterior half with a large some-what crescent shaped plate and many smaller of which two are adpressed to the sides of the rhomboid plate. Plates of lower half typical. At the posterior end of the short sulcus two large spines present besides the united small ones which are present in the flagellar slit. Surface scattered with punctae.

Tropical Atlantic; Red Sea; Gulf of Aden; Arabian Sea (June to October).

Diplopsalis pilula Ostenfeld, 1908
(Pl. IV, figs. 1, 4, 5, 6, 7)

Ostenfeld, 1908, p. 169, pl. 5, figs. 31 - 37, 61 - 62.
Paulsen, 1908, p. 37, fig. 47.
=*Glenodinium pilula* (Ostenfeld) Schiller, 1937, p. 110, fig. 104 a-d;
Subrahmanyan, 1958, p. 439.
=*Peridinium pilula* (Ostenfeld) Lemmerman, 1910 *b*, p. 674, fig. 6-10.
=*Peridinium* sp. van Breeman, 1905, p. 145, fig. 13.

Cells roundish, with apical opening. Left margin of sulcus reaching antapical end, winged. Chromatophores absent. Length 20-26μ. Breadth same.

Aral sea and Zuidersee; Arabian Sea. (July to October)

Genus *Peridiniopsis* Lemmermann, 1904

Lebour, 1922, p. 798, 809. 1925, p. 100.

Cells round, conical or lenticular. Plate formula 3', 1 - 2 *a*, 6'', 5''', 2''''. Similar to *Diplopsalis* but with two antapicals. Large anterior intercalary, may, however, be a displaced apical. Marine and freshwater. Genus founded by Lemmermann for freshwater species *P. borgei*.

Peridiniopsis rotunda Lebour, 1922
(Pl. IV. figs. 9, 10, 11, 12, 14)

Lebour, 1922, p. 804, figs. 16, 20, 1925, p. 101, pl. XV, figs. 4 *a* - *e*.
= *Peridinium limnophilum* Lindemann, 1924 *c*, p. 3, pl. I, figs. 10 - 13; Schiller, 1937, p. 268., fig. 269 A *a* - *d*.
= *Diplopsalis rotunda* (Lebour) Lindemann 1928, p. 91; Wood, 1954 p. 223, fig. 88 *a* - *b* (as *D. rotundata*).
= *Glenodinium rotundum* (Lebour) Schiller, 1937, p. 107, fig. 98 *a* - *e*; Kisselev, 1950, p. 137, fig. 223 *a* - *d*.

Cells globular, apical pore on a small prominence. Girdle central, not displaced, slightly indented, provided with conspicuous lists strengthened by minute spines. Tabulation: 4′, O*a* (or 3′, 1*a*), 6″ (?), 5‴, 2⁗. First apical pentagonal and in shape like that of the section *Metaperidinium* of *Peridinium* (i.e. first apical pentagonal or hexagonal, touching the first, second and seventh precingulars sometimes also the sixth, and the second and fourth apicals), the anterior intercalary coming round to meet it on the left side. Sulcus not reaching to the centre of the hypotheca, provided with a conspicuous wing-like list on the left. Theca finely punctate. Sutures in older specimens broadly striated. Plasma pink or colourless. Pusule present. Probably saprophytic. Diameter 22-28μ.

Plymouth; Australia ; Port Hacking, N. S. W; Swan River, W. Australia, Antarctic.

Schiller (1937, p. 107) holds *Peridinium limnophilum* Lindemann as a synonym of *Glenodinium rotundum* (Lebour) Schiller; elsewhere the same is given specific status (*l. c.*, p. 268). The figures also are comparable; in the latter, the sutures show intercalary striae (older specimens ?).

Genus *Preperidinium* Mangin, 1913

Mangin, 1913, p. 230.
= *Peridiniopsis* Lemmermann, 1904; Lebour, 1922 p. 798; 1925, p. 100, in part.
= *Peridinium* Ehrenberg, 1840 *b*, in part.

Ellipsoidal or sphaerical cells; girdle equatorial. At the apical region one rhomboid plate. Of the four apical plates one very much to the left; 5 to 7 precingulars; in the antapical region one or two antapicals and five post cingulars. Plates light, coloured, and mature ones punctate. Sutures striated at first, linearly and then side ways.

Mangin (1913) created this genus to hold those species where the shape is constant and whose tabulation, at first symmetrical becomes complicated

little by little taking on the asymmetry of *Peridinium* where all the species go to form an ascendent series comparable to that given by Pavillard. Type species : *Preperidinium paulsenii* (Pavillard) Mangin, 1913, p. 230 (= *Peridinium paulsenii* Pavillard 1909, p. 280).

Loeblich and Loeblich (1963) have revalidated this genus which was treated as a synonym by Lebour (1922) under *Peridiniopsis* Lemmermann.

Preperidinium asymmetricum Mangin, 1913
(Pl. I, figs. 10, 11, 15: II, figs. 1, 2, 3, 4, 6, 8, 10, 12, 13, 14, 15; III, figs. 4, 5, 9, 11).

Mangin, 1913 p. 230.
= *Peridiniopsis asymmetricum* Mangin, 1911 *d*, p. 644, fig. 1; Lebour, 1922, p. 798, fig. 6-10; 1925, p. 101, pl. 15, fig. 3*a* - *e*; Matzenauer, 1933; p. 453, fig. 24.
= *Diplopsalis lenticula*, Stein. 1883, pl. VIII, figs. 12, 13, 14 and pl. IX, figs. 1-4; Schütt, 1895, pl. XV, fig. 50; Paulsen, 1907, p. 9, fig. 9; 1908, p. 35, fig. 44.
= *Glenodinium lenticula* f. *asymmetrica* (Mangin) Schiller, 1937, p. 104, fig. 97 *a-h*; Subrahmanyan, 1958, p. 439; Kisselev, 1950, p. 136, fig. 219 *a, b*.

Cell rather depressed, lens-shaped, large. Left longitudinal list projecting but only reaching about half way across the radius of the cell; edge smooth, not bent over the flagellar pore. Flagellar pore on the left near the hind end of the list; Right longitudinal list inconspicuous. Girdle not displaced, indented. Transverse lists not supported by spines. Cell contents pink. Large pusule apparatus present. Theca punctate. Sutures striated except in the very young forms. Epitheca with four end plates, only numbers 1, 2 and 4 reaching to the apical pore; number 3 meeting 2 and 4 behind the apex. A very small anterior intercalary on the left side between apicals 2 and 3. 6 precingulars. Hypotheca with 5 postcingulars and 2 antapicals. A small plate called by Mangin a supplementary post-equatorial, is probably, as Pavillard (1913) suggests, part of the ventral area. Reproduction by division of contents into spores (?). Diameter usually 80μ, 50 to 89μ.

North sea, Swedish and Norwegian seas, Clyde, Irish Sea; Atlantic, English Channel; Flemish and Brittany Coasts, Mediterranean, Boeton Straits, Arabian Sea (July-October) Celebes, Indian Ocean.

Genus *Diplopelta* Jörgensen, 1913

Cells round or conical or lenticular like *Diplopsalis* but with two antapicals; and with second small anterior intercalary plate.

Type species : *D bomba* Stein 1883.
No species of this genus recorded in the Indian Ocean region.

Genus *Diplopeltopsis* Pavillard, 1913

Pavillard, 1913 p. 7

Cell lens shaped. Plate formula 3′ 2*a* 7″ 5‴ 1⁗ or the large intercalary may be an apical. Like *Diplopelta* but with 7 precingulars and 1 antapical. Marine and estuarine. One species. *D. minor* (Paulsen) Pavillard.

Diplopeltopsis minor (Paulsen) Pavillard, 1913
(Pl. I, figs. 4, 6, 12, 13, 14 ; II, figs. 5, 7, 9, 11, III, fig. 6, 7)

Pavillard, 1913. p. 7.

Lebour 1922, p. 801, figs. 11-15; 1925, p. 102, pl. xv, fig. 2*a* - *e*.

Balech 1958 *a*, p. 83 pl. 2, figs. 26-31 ; 1958 *b*, p. 385; 1959, p. 20, pl. I. fig. 10.

= *Diplopsalis lenticula* f. *minor* Paulsen, 1907, p. 9; 1908, p. 36, fig. 45
= *D. minor* Paulsen, 1907, p. 9. fig. 9; Silva, 1955, p. 26, pl. iv figs. 1-4.
= *D. lenticula* f. *minor* Meunier, 1910, 1919 in part; Jörgensen, 1912.
= *D. sphaerica* Meunier, 1910.
= *Peridinium lenticulatum* Margin, 1911 *b*.
= *P. paulsenii* Mangin, 1911 *b*. p. 647.
= *P. meunieri* Pavillard, 1912.
= *P. lenticula* (= *P. minus*) Paulsen, 1912; Ostenfeld 1915, in part.
= *Glenodinium lenticula* f. *minor* (Paulsen) Pavillard, Schiller, 1937, p. 105, fig. 96 *a* - *e*. — Kisselev, 1950. p. 136, fig. 218 *a* - *e*.

Epitheca and hypotheca nearly equal. Girdle central, not displaced ; provided with lists strengthened by fine spines. Sulcus not reaching to the centre of the hypotheca, with a conspicuous but narrow wing-like list on the left. Small anterior intercalary diamond-shaped and occupying a position similar to that in *P. asymmetrica*. There is only one antapical plate. Plasma pink. Large pusule ; probably satrophytic. Theca finely punctate. Diameter 28-56 μ, usually over 40 μ.

Zuider Sea ; western Baltic, Skaggerak; Kattegat; Belt Sea, Faeröes; Brittany coast; English Channal; Barents and Kara Seas; Arabian Sea (July-October).

Genus *Diplopsalopsis* Meunier, 1909

Meunier, 1909, p. 46.

Cell lens-shaped; plate formula 3', 2 *a*, 7'', 5''', 2'''' or 4', 1 *a*, 7'' 5''', 2''''. Like *Diplopeltopsis* but with 2 antapicals. Marine, only one species known.

Diplopsalopsis orbiculare (Paulsen) Meunier, 1909

(Pl. IV, figs. 8, 13, 15, 17)

Lebour, 1922; 1925 p. 103, pl. xvi, fig. 1 *a* - *e* (as *D. orbicularis*).
Matzenauer, 1933, p. 454 (as *D. orbicularis*).
= *Peridinium orbiculare* Paulsen, 1907, p. 17; 1908, p. 12, fig. 50; Schiller, 1937 p. 141, fig. 141 *a* - *e*.
= *Diplopsalis orbiculare* (Paulsen) Paulsen, Wood, 1954, p.223, fig. 89, Silva, 1956 p. 357, pl. iii, fig. 12 - 15; pl. vii, fig. 4. (The reference to *Paulsen 1949* here is erroneous).

Cells globular to lens-shaped. Apical horn hardly apparent. Girdle median, not displaced. Lists without spines. Sulcus not reaching to antapical end, with large winged-list on the left. Apical plate with a more or less diamond - shaped first apical which touches the first and seventh precingulars and the second and fourth apicals. (Orthoperidinium type). Protoplasm pinkish. Diameter 40 - 90 μ.

Neritic, North Sea; English Channel, Danish waters; Iceland; - Indian Ocean.

Genus *Entzia* Lebour 1922

Lebour, 1922, p. 808, 1925, p. 102.

Cell shaped like *Diplopsalis*, but with a more pointed apex. Four apical plates, the third very small. A large dorsal intercalary, which may be divided into 2. Seven precingulars. Hypotheca with 1 antapical and 5 postcingulars.

One species *E. acuta* (Apstein) Lebour 1922.
= *Diplopsalis* (*Glenodinium*) *acuta* (Apstein) Entz filius, 1906, p. 13.
= *Glenodinium acutum* Apstein, 1896, p. 152.
Not recorded in Indian Ocean Region.

Genus *Heterocapsa* Stein 1883

Stein, 1883, p. 9, 13; Lindemann, 1928, p. 88.

= *Glenodinium* Ehrenberg 1838.
= *Properidinium* Meunier, 1919.

Shape more or less spindle like, epitheca slightly larger than the hypotheca. Girdle almost equatorial, quite a little sinistral. Longitudinal furrow equally extended on both the thecae, reaching to about half from ends. Shell, rather always smooth, recalling *Glenodinium*, is, however, more compact than there. Plates always clearly visible. Plate formula (*H. triquetra*) 4', 2*a* 6'' pr 5''' *Op* 2'''' at. (In *H. pacifica* unknown). Apical opening in *H. triquetra* usually not present; rarely is it, however, one such clearly expressed; in *H. pacifica* always present. Characteristic of this genus is the short antapical *horn which is formed from the right antapical.* Chromatophores plate-shaped or reticulate, yellow, brown. In the rear a pyrenoid with amylum casing, a pusule and vacuole. Nucleus in *H. pacifica* relatively large, ellipsoidal. Stigma absent. Length 25 μ to 50 μ. Marine and brackish, rarely in freshwater, which perhaps has partly higher salt content. Often enormous quantity in coastal region, common with *Glenodinium foliaceum* Stein causing fish mortality.

Type Species: *H. triquetra* (Ehrenberg) Stein. 1883.
No species known from Indian ocean region.

Genus *Minuscula* Lebour, 1925

Lebour, 1925, p. 137.

Lebour created this genus to include the *Peridinium* described by Paulsen (1904) as *Glenodinium bipes* and by Pavillard (1905) as *Peridinium minusculum*. It is certainly not a *Glenodinium* as its theca is divided into distinct plates, and from their arrangement, as given by Pavillard (1907) and confirmed by Lebour, it is not a true *Peridinium*. The plate formula is 4' 3*a* 6'' 5''' 2'''', i.e. one precingular less than *Peridinium*. The sixth precingular is very large and occupies the position of 6 and 7 together; the first precingular is also very large and runs in between postcingulars 2 and 3 and antapical 1.

Schiller (1937) treats this genus as a synonym of *Peridinium*, but Paulsen (1949) has justified its individual status, (also refer Löblich *et al*, 1963).

Only one species known; *M. bipes* (Paulsen) Lebour 1925.
Not recorded from Indian Ocean region.

Genus *Peridinium* Ehrenberg 1832

Ehrenberg, 1832.
Paulsen, 1908, p. 37.

Lebour, 1925, p. 105.
Lindemann, 1928. p. 89.
Schiller, 1937, p. 123.
= *Vorticella* O. F. Müller, 1786.
= *Glenodinium* Ehrenberg, 1838.
= *Ceratium* Claparède et Lachmann, 1858-61.
= *Protoperidinium* Bergh, 1881 *a*.
= *Nephrodinium* Meunier. 1910.
= *Chalubinskia* Woloszynska, 1916, p. 89.
= *Properidinium* Meunier, 1919.

Cells globular, egg-shaped, ellipsoidal, double-cone shaped or elongated polyedra. The upper end mostly narrowed, with a short cylindrical or button-like knob or ending in a more or less long and varyingly developed horn; with and without apical opening. Girdle (transverse furrow) more or less median, ring-like or oblique, twisted right or left. Sulcus (longitudinal furrow) extending over epitheca rarely, and if so, only slighty; on the hypotheca varyingly long and broad, with or without winged margin. Hypotheca either rounded and without or with one to two processes with or without wings; or passing on with two more or less long, robust variously oriented plasma-filled horns. Cell wall thick or thin, is of cellulose composed of plates. The young covering (shell), thin at first, then always according to age or habitat often more or less thick. The covering is in a distinctly characteristic manner separated into plates held together by rabbat joints.

At the margin of the plates, during cell growth, bands are formed (growth striae, intercalary zone) and in such width in these particular regions of the body, that the tendency to preserve the original cell shape is obvious. Only in instances of irregular formation growth striae lead to changes in cell shape (growth forms) as against normal forms of the species.

Plate surface smooth, papillous, reticulate or striated. Pores always present, though often very small. Cells often surrounded by a thin or firm mucilage cover. With and without chromatophores, latter at times with pyrenoids. Plasma coloured or colourless. Assimilation product: some quantity of oil besides starch. Nucleus prominent. Sometimes stigma present, not typically developed. Pusules - storage and collecting, main and accessory, known in other genera are visible often with difficulty.

The lists are a prominent feature of the thecal morphology. The girdle lists are always well developed. The posterior girdle list is usually confluent with the sulcal lists. The ventral area is usually enclosed by the right,

posterior and left accessory sulcal lists. The apex is encircled by a list made up of parts of three lists attached to the apical plates. These lists extend down the ventral side of the body as far as the posterior end of the ventral apical platelet; but may also extend down the ventral and lateral sides of the body part way or entirely to the girdle. Sometimes body lists are developed along plate sutures. The transverse ridges across the girdle sometimes take the character of lists.

Antapical spines are developed in some species in the place of antapical horns. No other spines occur.

The apex of the theca has same general structure in all species. Only three of the four apical plates actually extend to the apex; the first subtended by a narrow plate, the *ventral apical platelet*. The apical ends of this and the second to fourth apical plates are joined together around the apical pore platelet which is a ring enbedded in the apex.

The plate pattern is used in the classification. A certain stability obtains in this regard within the species, particularly in the region of the first apical plate and dorsal epithecal plates; and, for *Peridinium* proper three intercalary plates. Graham (1942) has found species in the Section Oceanica with only two intercalary plates.

Of late, the ventral area or the sulcal region has assumed importance; however, the necessity for dissection and study of this complex area with several plates is to be reckoned. Kofoid (1909 *a*) and Faurè-Fremiet et Puigeaudeau (1922) have studied the ventral plates but these are considered not quite accurate (Graham, 1942). Studies of these plates by Abé (1936) for *P. ovatum* and related forms and of Balech (1958 *a*, *b*; 1959, 1962, 1964, 1967) for several species appear to be more authentic.

In this genus, certain features of the ventral area are constant; others vary from species to species. The number of plates are from five to six; some, at times absent. The constant ones are: an *anterior*, a *posterior*, a *right* and a *left sulcal plate*. They have the same relation to each other and to the flagellar pore. Their shape might vary. The anterior sulcal plate occupies the area between the ends of the girdle and joins the posterior end of the first apical; it extends to the anterior edge of the flagellar pore. The posterior has roughly the shape of U in which one limb has been rotated so that the axis lies at right angles to that of the other; the curve narrow, limbs expanded wide. The right plate is the largest of the ventral area and forms the right edge of the flageller pore and extends from anterior to the posterior sulcal plate. It bears, on its left margin, a prominent list, the right accessory sulcal list which overlies the pore and may bear processes which project into the protoplast.

This plate even in undissected specimens, is a prominent one on the ventral area. Left sulcal plate is deeply set in the sulcus, not visible without cleaning and dissecting; fairly large, forms the left side of ventral area and left edge of flagellar pore; a constant element varying little from species to species. In addition to these four principal plates, this area may have three others, not all occurring simultaneously: i. the *right accessory sulcal plate;* ii. the *posterior accessory sulcal plate;* and iii. the *right internal sulcal plate.* The right accessory sulcal plate lies against the distal end of the girdle; found only in *P. pollidum* and represents simply the anterior end of the left sulcal plate in other forms. The posterior accessory sulcal plate lies between the right and the left and the posterior sulcal plates, thus forming part of the posterior margin of the pore. It occurs in almost all species investigated, varying much in size. The right internal sulcal plate is a part of the complex internal skeleton on the inner side of the right sulcal plate, found only in *P. crassipes* and *P. depressum.*

It has not been possible for the present writer to make dissections of species in his studies.

In this connection, the following observations of Paulsen (1949, p. 22-23) are worth quoting: "……if only one could adhere to the purely schematic classification according to the tabulation, especially as suggested by Peters we should have something more tangible to work with. Actually, however, the Peridinians are too variable for classification in that manner, and the dorsal area is more variable than the ventral……In his latest work (1936 *a*) which Schiller had not seen, Abé points out that the four (- five) plates of the longitudinal furrow provide better characters for species and " Groups " than the plates on the epitheca and he brings beautiful and undoubtedly very careful drawings accompanied by detailed descriptions of a number of species. 'The ventral area', he says, (1936 *a*, p. 641) 'exhibits wide diversity in structure and is to be regarded as the most highly specialized, and functionally, morphologically and genetically important part of the skeleton', it having, 'direct relations with the motile organ'. Abé was unable to describe the structure of the ventral area of all the species which he dealt with; its analysis is very difficult because it is complex, composed as it is of tiny plates which are apt to adhere together.

"I think it is justifiable to express some doubt as to whether we have any real main criterion. For, on comparing Abé's figures (1936 *a*) of the species *Peridinium abei, P. clavus, P. thorianum* which are grouped among the Avellana, with *P. constricta,* which is placed to the Monovela (which two groups are held to be separable by the structure of ventral area), we find that there is no great difference between the ventral plates of these species; but merely that

P. constricta has a flagellar fin and its anterior plate extends a little beyond the girdle up upon the epitheca. These, of course are differences that are worth noting. but I scarcely think they are so weighty as Abé believes. Naturally it is very difficult and time-cosuming to elucidate these matters, so that unless someone with unlimited time and energy undertakes to go through the entire genus *Peridinium* for that purpose, we shall scarely ever get a new taxonomy built up on the ventral area. *For the present at any rate, we shall be compelled to adhere to the old one"*. (Emphasis present writer's)

Multiplication (1) by total division of cell while in the motile condition, division of the protoplast as well as the shell; (2) through division of protoplast alone inside the shell, whereby daughter cells give up the mother shell and each forms a new shell of its own; and (3) division of protoplast outside the shell after its escape through rupture of girdle region. Cysts are also known - one or two inside the old shell surrounded with a membrane. These cysts also are capable of division.

Sexual reproduction not recorded so far for *Peridinium*, though this has been more or less established for *Ceratium* (von Stosch, 1964, 1965). The writer (unpublished) has come across large sized naked (without shell) protoplast of *Peridinium* with flagella swimming about and the same type of protoplast later with developing skeleton, Also *Peridinium* cells with contents divided into a number of small protoplasts; these may be the male gametes and the former the female. These bodies met with appeared to be those of *P. depressum*. These may represent stages in sexual reproduction; however, this requires detailed study and confirmation.

Species of this genus play an important part in the organic productivity of waters, more so in some freshwaters than the sea. Meunier has recorded a vegetative form from snow and ice in the Karasee. Some marine species produce a cold phophorescent light.

About 200 authentic species are known in this genus. The number of species described is many more, almost 600; this is due to the tendency to create as species any form which differs in some manner from others. Ecological factors are known to cause considerable variations and, therefore, a closer study is required before importance is attached to the variations and species erected. Schiller (1937) has compared the descriptions and figures existing in literature, the species and its scope of variation as well, and after his own investigations allowed the existing species to stand or combined them with others, This has been questioned by Paulsen (1949) for a number of species. Loeblich and Loeblich (1966) after thorough evaluation have given generic status to a number of forms regarded as synonyms by Schiller and

merged by him in *Peridinium*. After considering all views; the writer has arrived at his own conclusion as regards disputed forms.

Lefévre (1928 c) has attempted a synthesis of freshwater species of *Peridinium*.

The kind of variations met with may briefly be refered to. Variations in size occur, probably depending on growth state. The sides of the body, when normally concave, can change to a straight course (*P. divergens*, *P. abei* and others). Likewise the shape of the hypotheca is variable as also the body processes.

It can considerably fluctuate thus around a median thing of value, the apical horn (*P. steinii*, *P. diabolus* and others). Same holds good for the posterior horns. In the same species the processes can occur or be absent. Also, they may occur isolated at the posterior end or both be present at the end of the longitudinal furrow sulcal lists, be longer or shorter, with or without wings. Length, shape and course of the sulcus and its winged lists are subject to large variations; same applies to the girdle. The girdle, even in the same species, is ring-like, or more or less oblique, and may have its ends more or less strongly shifted from one another. Otherwise we see almost without exception the girdle face even with the convex contour line of the girdle region, with more even nature than the furrow in contrast to the furrowed part. Generally, the variable orientation of the dorsal plate - pattern is well known, particularly with reference to the intercalary plate 2 *a*, which can be four-, five-, and six- sided. So far the investigation on the magnitude of the variation of the *Peridinium* cell has been of rich interest; their causes, however, are not known. Attempts have been made to culture them but not much has been achieved in this regard.

Not much is known about the ecology and biology of *Peridinium* spp. Some work has been initiated in this regard by the writer, but it is too early to express any views in this matter. It may be of interest to reproduce here remarks of Schiller (1937) who has reviewed the information available.

Species inhabiting lighted freshwater almost throughout have a simple, round-oval shape and develop no floating apparatus, whereas almost all armoured Peridineae inhabiting the many times denser sea water possess fully developed floating mechanisms. By comparing a freshwater species and a marine one- the marine within the former (Plate,

V, fig. 3.) Schiller concludes that the relationship between cell content and water is very intimate in the marine form.

The reduced surface development of freshwater species is related to the richness of important nutrients like phosphates and nitrates present in the water. In contrast, the large surface development of the Peridinales has a parallel relationship with the poverty of both these nutrients.

The total nitrate content of surface waters of eutrophic Mendota Lake in N. America, according to Domogalla *et al* (in Schiller 1937) amounts to 600 mg/m^3, the highest value during the year being over 900 mg/m^3. The value for summer months for this lake at which time the Dinoflagellates mainly develop amounts to between 450 - 750 mg/m^3. According to Ruttner, the phosphate content of Lake Ranoe Lamojen, Java, is 200-600 mg/m^3 up to 10 m depth. The ammonia content alone, generally amounts to 280 mg/m^3. Similarly, both these nutrients influencing production occur in rich quantities according to investigations carried out so far in all eutrophic fresh waters.

On the other hand, the maximum phosphate content of the highly fertile mixed water between Ireland and Greenland is only 20 mg/m^3 and the nitrate content 50 mg/m^3 in 0-50 m depth. In the tropicial region of the Atlantic, the phosphate content is only 2-9 mgm/m^3 and it increases towards the Antarctic up to 35 mgm/m^3, Correspondingly, in the most fertile marine region, where even the Dinoflagellates form a characteristic constituent of the population, the production falls to 2500 cells per litre. Such a small population number is often present in one ml of eutrophic freshwater In the nutrient deficient alpine lakes themselves. in winter 60,000 cells per ml are present and in summer ten times more. In the waters of the fertile ponds, throughout the year, at least a million organisms per L are found, which during spring increases many times this number. The most fertile marine regions do not seem to stand comparison. Hitherto, only in Kiel harbour water, which is mixed with nutrient rich freshwater and polluted with city effluents, a maximum of 2.7 million cells have been recorded. In the coastal waters of Alaska also, the population density reaches a similar value. It may be added here (writer) that high densities of Dinoflagellates–*Gonyaulax*, *Gymnodinium*-occur in the sea in instantces of what are known as "Red water" or "Discoloured water" phenomena.

In the protophyta, the absorption of disssolved nutrients takes place through their surface. Larger the orgaism quicker and complete is the absorption. Therefore, the inhabitants of nutrient deficient tropical waters have a large surface development. The plasma-filled processes of cells

(horns) are to be considered as physiological contrivances in the service of nutrient intake. This is a primary and important problem of every organism. If one were to draw comparison with leafy plants, poorer the soil in nutrients, greater the development of the root systems. Perhaps, it is not accidental that genera such as *Ornithocercus*, *Histoneis*, *Ceratocorys*, *Ceratium*, etc. are characteristic forms typical of warm waters, and in the genus *Peridinium* the species with the longest horns live only in the warm regions; such as *P. murrayi*, *P. grande*, *P. elegans*, *P. fatulipes* and *P. steinii*. The density of warm water in the oceanical tropical regions is not less in contrast, often far higher, than in the cold water regions, then here the salts content has a lower value. The surface enlargement of Peridineae thus increases from the nutrient rich coldwater seas towards the nutrieut-deficient warm water region. If in the cold water regions isolated individuals with long horns are met with this does not contradict the above mentioned view, as, on an average, they do not reach the length of tropical forms.

The above recapitulated remarks of Schiller are interesting. However, the writer should like to add here that they are based on the data available to Schiller then when much was not known about "so-called" poor tropical waters. It is now known that as in the arctics and temperate regions, in the tropics also there are rich and poor regions. Suffice to mention here that the specimens of species of *Peridinium* with long horns, mentioned above, and which nature is reported to be due to nutrient-deficiency by Schiller, were collected from the Arabian Sea inshore and off-shore waters; this region is one of the richest as regards nutrients owing to considerable upwelling. The question of relationship between morphology and variation of species with nutrient content of water requires further study.

Classification

The first attempt at classification was by Gran (1902) who divided the genus into sub-genera: *Protoperidinium* Bergh and *Euperidinium* Gran, the former adapted from Bergh (1881 *a*) who had described a number of species with this generic name.

Protoperidinium is characterised by solid antapical spines and right handed (dextral) girdle. *Euperidinium* is characterised by hollow antapical horns and left-handed (sinistral) girdle.

As the number of species known were very few, this classification was satisfactory. As more species were added this classification proved unsuitable; for, forms were discovered with no girdle displacement, with left handed girdle with solid antapical horns, etc. Paulsen (1908) indicated discrepancies in Gran's classification.

Broch (1910 *a*) pointed out that the plate pattern of the theca could be used for diagnosis and figured the plate pattern for each species although he grouped the species under the above two subgenera.

A comprehensive reclassification of the genus was made by Jörgensen (1912) based on the plate pattern, the number of plates that border the first apical as a primary character in the constitution of sub-genera and the pattern of the dorsal plates as a criterion for division of sub-genera into sections (Plate V and Plate VI).

Jörgensen divided the genus into two sub-genera, *Orthoperidinium* and *Metaperidininm*; in the former, the first apical touches four of the major plates of the epitheca; the second apical and first precingular on the left side, the fourth apical and seventh precingular on the right side.

In *Metoperidinium*, the first apical plate borders 5 or 6 of the principal plates of the epitheca; the second apical and the first and second precingulars on the left side, the fourth apical and the seventh, or sixth or seventh, precingular on the right side.

Orthoperidinium is divided into three sections based on the dorsal plates:

1. *Tabulata*: in which the second anterior intercalary borders the third and fourth or the fourth and fifth precingular plates.

2. *Conica*: in which the second anterior intercalary touches the third, fourth and fifth precingulars.

3. *Oceanica:* in which the second intercalary touches only the fourth precingular.

Metaperidinium: was divided into four sections.

1. *Pyriformia*: in which the second anterior intercalary plate touches two precingular plates as in sections *Tabulata* of *Orthoperidinium*.

2. *Paraperidinium:* in which second intercalary borders the third, fourth and fifth precingulars; the first apical plate is bounded by six of the major plates of the epitheca; the second apical and first and second precingulars on the left side, the fourth apical and sixth and seventh precingulars on the right side. Jörgensen did not give this group sub-generic rank because there was considerable variation in the length of the suture between the first apical and sixth precingular plates; the suture is sometimes quite short.

Humilia: in which the second intercalary touches only the fourth precingular with solid antapical horns.

Divergens: As *Humilia* but with hollow antapical horns.

Jörgensen had considered the number of plates in the theca to be constant though presenting different patterns. According to him, the genus *Peridinium* has three anterior intercalary plates; forms which had only two, included in *Peridinium* by others, were placed by Jörgensen in a new genus *Archaeperidininm.*

Further investigations revealed this to be inadequate as it could not accommodate great many variants. Paulsen (1931) revised the system of Jörgensen, proposing a system in which not only plate pattern but a combination of this as well as other characters was used. The sub-genera of Jörgensen were abolished but sections retained with revision.

Paulsen (1931) considers, as was done by Lebour (1925) *Archaeperidinium* as a sub-genus of *Peridinium*, characterised by two anterior intercalary plates.

Those with three intercalary plates were constituted into sub-genus *Veroperidinium*, equivalent to sub-genus *Peridinium* proper of Lebour.

Paulsen divided *Archaeperidinium* into two sections :

1) *Avellana:* in which the two intercalaries are equal.

2) *Excentrica:* in which the two intercalaries are very unequal.

Sub-genus *Veroperidinium* was divided into eight sections, seven corresponding to those of Jörgensen and the eight *Paradivergentia* new.

For describing the relation of dorsal plates, he uses the terms "quadra", "penta" and "hexa" to designate the number of sides on the second anterior intercalary; and, "ortho", "meta" and "para" to designate a four, five and six-sided first apical.

Pellucida: Para hexa, rarely para penta or quadra or meta hexa. Right handed. Without antapical horns. Has two or more, frequently three, antapical spines. This section corresponds to *Paraperidinium* of Jörgensen.

Humilia: Meta quadra, right handed, without horns, but often with two antapical spines.

Pyriformia: Meta, penta, rarely quadra or hexa, right handed without antapical horns, but in general has two antapical spines.

Tabulata. Ortho, penta or hexa or quadra. Left-handed or with circular girdle. Cells round, without horns or spines or with tiny spines.

Paradivergentia: Para, quadra or hexa. Right-handed or with circular girdle. With two hollow antapical horns.

Divergentia: (=*Divergens* Jörgensen) Meta, quadra, rarely penta. Girdle circular or right handed; with two hollow antapical horns.

Oceanica: Ortho, quadra, rarely penta or hexa (or even para). Left-handed. Girdle oblique relative to the longitudinal axis of the body. Epitheca narrows into an apical horn; two hollow antapical horns.

Conica: Ortho, hexa, more rarely penta or quadra. Girdle circular or left-handed. Body square or rhomboid in ventral view, without apical horn but usually with two hollow antapical horns.

In a latter account, published posthumously Paulsen (1949) gives up the classification into sub-genera and confines himself to Sections; he has revised these in the light of knowledge accrued. This has been adopted by the writer also. They are:

Section *Tabulata* Jörgensen: Rounded cells without horns and without or with small antapical spines. Girdle left-handed (or circular). No apical furrow or groove including the apical pore. Tabulation: ortho, penta, quadra or hexa; three, rarely, two, intercalaries. Under this heading come all freshwater species and some marine species.

Section *Avellana* Paulsen: Rounded cells without horns and without or with small antapical spines. Girdle left-handed. A dorso-ventral furrow or groove including the apical pore. Tabulation: Ortho, two intercalaries.

Section *Monovela* Abé: Rounded cells without horns and spines, but with a conspicuous flagellar fin as the sole extension of the thecal surface. Girdle circular. The anterior plate of the ventral area indents the epitheca deeply. Tabulation: Ortho; mostly two, but sometimes three intercalaries; symmetric or more or less asymmetric.

Section *Excentrica* Paulsen: Depressed or globular cells without spines; girdle circular or left-handed. Tabulation: ortho; two intercalaries, one of them much bigger than the other.

Section *Humilia - piriformia* Paulsen: Formerly two sections: Humilia Jörgensen and Piriformia Jörgensen on the ground that former is quadra and

latter penta. It has been shown by Barrows (1918) and Lebour (1925) that species under these may be sometimes quadra and sometimes penta. Therefore, united into one by Paulsen.

Cells without hollow antapical horns. The shape of the cells is depressed i.e., flattened from above downwards, globular or pear-shaped; girdle right-handed; often, not always, with two antapical spines. Tabulation: always meta, dorsally penta, quadra or hexa. Depending on shape mostly, this large section has been divided into a number of groups by Paulsen (*refer text*).

Section *Pellucida* Jörgensen Cells without hollow antapical horns, Cell mostly ovoid and pointed or acuminate at the top, but rarely with an "affixed" apical horn. Girdle right-handed, two antapical spines, often a third on the left side as a continuation of the left edge of the longitudinal furrow. Tabulation: Para, usually hexa, rarely quadra or penta. Exceptions: a *P. pellucidum* of Matzenauer (1933, fig. 42) which is meta; a *P. macrospinum* of Mangin which is ortho; and so also Meunier who depicts some orthos. Three groups recognized under this section.

Section *Conica* Jörgensen: Species mostly with hollow antapical horns, cell ventrally seen quadrangular or nearly so, hence no apical horn; girdle left-handed or circular. Tabulation: ortho, mostly hexa, but penta and quadra also occur. Two groups recognized.

Section *Oceanica* Jörgensen: Hollow antapical horns. Epitheca with concave sides, tapering into a long or short apical horn. Girdle left-handed, forming an oblique angle with the longitudinal axis. Tabulation: ortho, mostly quadra, but also penta and hexa occur. For convenience number of groups recognized.

Section *Divergentia* Jörgensen (incl. *Paradivergentia* Paulsen): Cells with hollow antapical horns; there is often a deep indentation between them. The epitheca usually conical and only faintly tapering to an insignificant apical horn or not at all. Tabulation: meta, hexa or quadra. One group is Para and was ascribed to Section *Paradivergentia* Paulsen. This is now united with *Divergentia* for two reasons: i. several authors (Meunier, 1910; Barrows, 1918; Lindemann, (1924, have described and illustrated specimens of "*P. divergens*" with para tabulation. Peters (1928 p. 113) says of this that no such irregular variation in the ventral tabulation is known elsewhere and that, for *P. divergens*, it is probably a matter of a different species. ii. *Paradivergentia* has a right-handed girdle. In addition, there are some meta species that are right-handed like para species. The direction of the girdle seems to be constant, like ventral tabulation; based on these characters, if separate sections are to be set up,

according to Paulsen, three sections would be required instead of the original *Divergentia*. As all species otherwise as regards general structure are closely related, Paulsen recognizes three groups only.

Section *Tabulata* Jörgensen 1912

Rounded cells with horns and without or with small antapical spines. Girdle left handed (sinistral) or circular. No apical furrow or groove including the apical pore. Tabulation: ortho, penta, quadra, or hexa; three, rarely two intercalaries. Under this section come all fresh water species and some of the marine species. (*Fresh water species* are given in Annexure. I.)

Marine species :
Perdinium adense Matzenauer
P. bulla Meunier
P. globosum Dangeard
P. hyalinum Meunier
P. trochoideum (Stein) Lemmermann.

Peridinium adense Matzenauer 1933
(Pl. VII, fig. 1)

Matzenauer, 1933, p. 465, Fig. 47.
Schiller, 1937. p. 133, Fig. 124.

Anterior and posterior of cells rounded, asymmetrical. Girdle (transverse furrow) strongly twisted leftwards, displaced by a width equal to that of furrow; furrow hollowed out. Sulcus (longitudinal furrow) widened out below. Surface smooth. L = 42μ; B = 38μ;

Indian Ocean; Gulf of Aden.

Peridinium bulla Meunier 1910
(Pl. VII, figs. 2-6)

Meunier, 1909, p. 43, Pl. I, Figs. 32-34.
Lebour, 1925, p. 122, Fig. 36*c*.
Schiller, 1937, p. 134, Fig. 125 *a-c*.
Kisselev, 1950, p. 154, Fig. 237 *a-c*.
Subrahmanyan, 1958, p. 439.

Cells almost globular about 32μ diameter. Girdle almost circular, their ends displaced about half furrow width. Sulcus short, rounded. No spines present. Theca finely reticulated.

Barents Sea; Arabian Sea.

Peridinium globosum P. Dangeard 1927
(Pl. VII, figs. 7 - 10.)

Dangeard, 1927 *c*, p. 355, Fig. 20, *e*, *f*.
Schiller, 1937, p. 135, Fig. 128 *a* - *d*.

Globular cells, occurring rarely, fast swimming. Seen only in living state by writer. According to Schiller the plates arrangement is strikingly deviating from that characteristic for the genus (refer figures) and he stresses the need for further investigation. Unfortunately, the present author could not get the specimens he saw in preserved samples for detailed study. About this species Paulsen (1949, p. 14) states "*P. globosum* Dangeard may possibly be an abnormal *P. sphaeroides*; of its accessory plates, 3 *a* is the largest, 2 *a* is very small, which might perhaps explain why the girdle has become circular. But it is Ortho and has no "apical button". The sides of the sulcus converge below and the girdle has very narrow lists". He also stresses the need for further investigation.

According to Dangeard (1927 *c*, p. 555) who established this species, he encountered this only once; a species perfectly spherical with no "apical button" and whose tabulation is very unique. The ventral side presents an *Orthoperidinium* aspect while towards the dorsal side the anterior intercalary plate is extremely reduced confined solely to two preequatorial plates. By its shape and cut, this *Peridinium* resembles somewhat *P. sphaeroides* but the ventral sulcus terminates in a point oblique to the right side, not bordered by any wing; the remaining part of tabulation is all different. This interesting species is, therefore, placed in the section Tabulata, but just at presents scarcely finds any affinity with the other species of the group.

Gaarder, (1954, p. 25 fig. 28) considers *P. globosum* a *Goniaulax* and has named it *Goniaulax paulseni*. However, the figures in Schiller, 1937, 128 *a* - *d*, and specimens met with here are in agreement and differ from those of Gaarder. The present writer is inclined to consider this a *Peridinium* species.

African Coast of Atlantic; Arabian Sea.

Peridinium hyalinum Meunier 1910
(Pl. VII, figs. 11 - 15)

Meunier, 1910, p. 43, pl. 2, Figs. 37 - 39.
Schiller, 1937, p. 136, Fig. 130 *a* - *c*.
Kisselev, 1950, p. 156, Fig. 241 *a* - *c*.
Subrahmanyan, 1958, p. 439,

Epitheca conical with a small knob at apical end, hypotheca almost hemispherical in outline in dorsal and ventral view. Cell slightly compressed dorso-ventrally. Girdle circular, excavated, no displacement of ends. Sulcus wide, winged, does not reach antapical end.

Indian Ocean; Arctics.

Peridinium trochoideum (Stein) Lemmermann 1910
(Pl. VIII, figs. 1 - 7)

Lemmermann, 1910*a*, p. 336; 1910*b* p. 673, Figs. 14 - 17.
Lebour, 1925, p. 113, pl. 19, Fig. 3 *a* - *d*.
Schiller, 1929 p. 401, fig. 14 *a*, - *h*; 1937, p. 137, fig. 134 *a* -*g*,
Kisselev, 1950, p. 157, fig. 244, *a* - *d*.
Gaarder, 1954, p. 50.
= *faeröense* Paulsen, 1905, p. 5, fig. 5; 1908, p. 64, fig. 85;
Lebour, 1925. p. 113, pl. 19, fig. 2 *a* - *d*.

= *Glenodinium trochoideum* Stein, 1883. pl. 3, figs. 27-29; Klebs, 1884, fig. 4-5; - Schütt, 1895, pl. 25, fig. 87 - Ostenfeld, 1908, p. 163, pl. 5, figs. 44-49; Paulsen, 1908, p. 24; Subrahmanyan, 1958, p. 439.

= *Glenodinium acuminatum* (Ehrenberg) Jörgensen, 1899, p. 32.

Cells elongated - to round-pear shaped, 16-36μ broad. Girdle almost round, median or somewhat sub-median. Sulcus reaching almost upto ant-apex. Chromatophores yellowish-brown, disc shaped. Resting cells round with firm membrane.

Neritic, European Coasts, Coast of England; brackish water of Aral Sea; Arabian Sea.

General Remarks

Lebour (1925) found the plates arrangement of *P. trochiodeum* and *P. faeröense* identical; the former is slender and the latter roundish with short apical horn. Such differences occur often in other species also. These two are therefore, to be considered same species with transition forms. Mediterranean forms are still slender. Probably these differences are states Schiller, due do growth factors such as nutrients, temperature etc.

Section *Avellana* Paulsen 1949

Rounded cells without horns and without or with small antapical spines Girdle left-handed. A dorso-ventral furrow or groove includes apical pore. Tabulation: Ortho, two intercalaries.

1. Cells much longer than broad :

   P. ventricum Abé
   P. abei (Abé) Paulsen

2. Cells almost globular, over 50μ in diameter :

   P. thorianum Meunier

3. Cells almost globular, smaller :

   P. avellana Meunier
   P. colombense Matzenauer
   P. nux Schiller

Peridinium abei (Abé) Paulsen, 1931
(Pl. IX, figs. 1 - 8)

Paulsen, 1931, p. 73.
Schiller, 1937, p. 138, fig. 136 *a* - *h*.
Kisselev, 1950, p. 157 fig. 250 *a* - *f*.

= *P. biconicum* Abé, 1927, p. 416, fig. 34; Matzenauer, 1933, p. 454, fig. 26 *a* - *c*. (*non* P. Dangeard, 1927 *c*)
= *P. biconium f. elongata* Matzenauer, 1933, p. 454, fig. 26 *d*.

Girdle strongly sinistral with deep sulcus which at the terminal of the antapical cone is cut out and two usually unequal apices result, of which the right one is generally longer. Surface lightly punctate. L=70-100μ ; D=47 - 85μ.

f. elongata of Matzenauer differs in that the epitheca and hypotheca are somewhat tapering with concave sides. Schiller recorded from the eutropical waters of Sumatra a form without concave sides. Evidently this type of difference has no significance.

(The name *P. biconicum* has been used by P. Dangeard (1927 *c*, p. 347) for a species of *Peridinium* under section *Conica*)

Mutsu Bay (Japan) ; Indian Ocean ; USSR waters. The Indian Ocean form is often larger.

Peridinium ventricum Abé, 1927
(Pl. VIII, figs. 8 - 12)

Abé, 1927, p. 418, fig. 35.
Schiller, 1937, p. 143, fig. 114 *a* - *e*.
Kisselev, 1950, p. 210, fig. 354 *a* - *c*.
Wood, 1954, p. 229, fig. 93 *a* - *b*.

Peculiar species; cell biconical. Epitheca shorter and broader, with straight sides. Hypotheca narrower, however longer, antapically by the longitudinal furrow emarginate. Girdle without wing, strongly sinistral, end displaced about a furrow width. Apical pore slit-like. L = 51-54μ; B = 42-47μ. Characters resemble more a fresh water species.

Japan; Indian Ocean, Indonesian waters.

Peridinium thorianum Paulsen, 1905
(Pl. X, figs. 1 - 5)

Paulsen, 1905, p. 3, fig. 1; 1908, p. 62, fig. 81; 1930, p. 56.
Meunier, 1909, p. 40, pl. 1 *bis*, figs. 20-23; pl. 2, figs. 5, 6.
Lebour, 1925, p. 108, pl. 17, figs. 2 *a* - *d*.
Dangeard, 1927, *c*, p. 347, fig. 13 *c* - *d*.
Schiller, 1937, p. 142, fig. 143 *a* - *f*.
Silva, 1955, p. 28, pl. IV, fig. 5, 6.
Subrahmanyan, 1958, p. 439.
= *Protoperidinium thorianum* Meunier, 1919, p. 57. pl. 18, figs. 42-46.
= *Peridinium* (*Archaeperidnium*) *thorianum* Lebour, 1922, p. 809.

Cells in ventral view with typical rhomboidal outline and convex to almost straight sides. Cross-section round. Girdle striated, excavated, its ends displaced about a furrow width. Sulcus straight, slightly broad with lightly developed lists; at the end generally without tiny spines. The species is easily distinguished by the presence of papillae developed on plate surface. Colour pale yellow. Diameter 56-70μ. Somewhat depressed and more compressed.

Warm water form. Barents Sea; Iceland; English Channel; Flemish Coast; African Coast; Atlantic and Indian Oceans; Arabian Sea.

Peridinium avellana (Meunier) Lebour, 1925
(Pl. IX, figs. 9-13)

Lebour, 1925, p. 108, pl. 17, figs. 1*a* - 1 *f*.
Schiller, 1937, p. 139, fig. 137 *a* - *e*.
= *Properidinium avellana* Meunier, 1919, p. 56, pl. XVIII, figs. 37-41.

Cell somewhat nut shaped, irregular. No apical horn. Girdle conspicuously sinistral, excavated, striated, with narrow lists not supported by spines. Sulcus reaching nearly to the middle of the hypotheca, expanding posteriorly, without conspicuous lists. Broad intercalary striae sometimes present. Theca thickly covered with pores and striae. First apical not reaching to the apex, the fourth apical coming over ventrally like a hood. Colour greenish yellow or colourless. Diameter of cell 30-42μ.

Plymouth Sound and outside; Flemish Coast, littoral and brackish; Antarctic; Indian Ocean.

Peridinium colombense Matzenauer, 1933
(Pl. X, figs. 6 - 8)

Matzenauer, 1933, p. 455, fig. 27 *a, c.*
Schiller, 1937, p. 140, fig. 138 *a - c.*

Epitheca convex conical, narrowed towards the apical horn. Hypotheca rounded with two short processes. Girdle dextral, excavated. Sulcus much broadened towards posterior. Dorsal precingulars very large. L = 28μ; B = 23μ. St. = 2μ.

Colombo Harbour; west coast of India.

Peridinium nux Schiller, 1937
(Pl. VIII, figs. 13 - 15)

Schiller, 1937, p. 140, fig. 139 *a - c.*
Kisselev, 1950, p. 216, fig. 364 *a - c.*
= *P. levanderi* Abé, 1927, p. 413, fig. 32.
non P. levanderi Lemmermann, 1900.

Similar to *P. achromaticum* in cell shape and differs only in that there are two intercalary plates. Cells rhombic, dorsiventrally somewhat flattened. Girdle circular, excavated. Sulcus more or less of uniform width, margin without wings, reaches antapical end. No antapical spines. L=37μ; B=34μ.

Pacific and Indian Oceans.

Section *Monovela* Abé, 1927

Rounded cells without horns and spines, but with a conspicuous flagellar fin as the sole extension of the thecal surface. Girdle circular. The anterior plate of the ventral area indents the epitheca deeply. Tabulation: Ortho; mostly two, but sometimes three intercalaries; symmetrical or more or less asymmetrical.

P. minutum Kofoid.

Peridinium minutum Kofoid, 1907
(Pl. X, figs. 9–13, Pl. XI, figs. 1-2)

Kofoid, 1907 *b*, p. 310, pl. 31 figs. 42-45.
Schiller, 1937, p. 141, fig. 140 *a-e.*

Kisselev, 1950 p. 158, fig 239 *a,b*.
Silva, 1955, p. 29, pl. 4, fig. 7,8.
Subrahmanyan, 1958, p. 439.
Balech, 1964, p. 120, pl. 1, figs. 1-10.
Taylor, 1966, p. 462.
= *P. monospinum* Paulsen, 1907, p. 12, fig. 11; 1908, p. 42, fig. 49; Lebour, 1925, p. 107, pl. 16, fig. 3,; Dangeard, 1927 *c*, p. 347, fig. 13.
= *Properidinium aspinum* Meunier, 1919, p. 55, pl. 18, fig. 33-36.
= *Archaeperidinium monospinum* Jörgensen, 1912., Pavillard, 1913.

Cells globular, with a conspicuous, but low, apical horn. Girdle not displaced; provided with narrow lists, spines absent. Sulcus reaching nearly to the centre of the hypotheca and expanding posteriorly, provided on both sides with lists, the left wing-like and conspicuous with a spine at its broadest part; two other small spines sometimes present below. Broad intercalary striae sometimes present. Theca with fine pores far apart. Colourless. Reproduction by spore formation, a single spore liberated by the theca separating at girdle. L = 40-56μ.

Pacific; Atlantic; North Sea, near Plymouth; USSR waters; Indian Ocean, Arabian sea.

Section *Excentrica* Paulsen, 1949

Depressed or globular cells without spines. Girdle circular or left-handed. Tabulation: ortho; two intercalaries, one of them much bigger than the other, with ventrally displaced apical horn.

P. excentricum Paulsen

Peridinium excentricum Paulsen 1907
(Pl. XI, figs. 3 - 11)

Paulsen, 1907, p. 14, fig. 17; 1908, p. 51, fig. 64.
Pavillard, 1916 *a*, p. 30, fig. 4.
Meunier, 1919, p. 35, pl. 17, figs. 1 - 7.
Lebour, 1925, p. 108, pl. 18, fig. 1 *a - d*.
Matzenauer, 1933, p. 454.
Schiller, 1937, p. 144. fig. 145 *a - g*.
Kisselev, 1950, p. 160, figs. 254 *a - c*; 261, *a - c*.
Subrahmanyan, 1958, p. 439.
= *P. perrieri* Fauré - Fremiet, 1908, p. 228, fig. 14, pl. 16, fig. 16.
= *Archaeperidinium excentricum* Lebour, 1922, p. 809.

Cells compressed in the vertical axis and twisted obliquely, hence left side of hypotheca larger than the right side and longer than the left. Apex quite excentric, vertically shifted. Anterior intercalaries very dissimilar, the

first small, the second very large and reaching beyond the centre of the dorsal surface. Girdle circular excavated, with winged lists. Left side of sulcus wall with wing. Lower end demarcated by the sulcus, left side with process which according to Meunier, is dentate. Plasma pink in colour. Length 36 - 60μ, diameter 45 - 75μ. The Arabian sea specimens have larger dimensions.

Northern seas, Skaggerak, English Channel, Flemish Coast, Brittany Coast; Mediterranean; Indian Ocean, Arabian Sea; USSR waters.

Section *Humili - Piriformia* Paulsen, 1949

Species without hollow antapical horns. The cell depressed *i.e.* flattened from above downwards; globular or pear-shaped; girdle right - handed. Often but not always with two antapical spines. Tabulation: always meta, dorsally penta, quadra or hexa.

A number of species in this section has been treated by Schiller (1937) as synonyms of *P. globulus* Stein or as a variety or forma of this species: *P. cerasus* Paulsen, *P. ovatum* (Pouch.) Schütt, *P. patens* Dangeard, *P. quarnercnse* (Schröder) Broch, *P. simulum* Paulsen, *P. sphaeroides* Dangeard and *P. subpyriforme* Dangeard. Paulsen (1949) disagrees with Schiller and considers these forms entitled to specific status. Balech (1959) also disagrees with Schiller in this regard. On similar grounds the writer feels, many of the other species would also lose their specific status. The forms designated by the different authors under the above names are certainly distinguishable, from one another. The writer, therefore, agrees with Paulsen and they are given specific status.

1. Globular species without antapical spines, apical horn hardly apparent or very short and " affixed ":

   P. globulus Stein
   P. sphaeroides Dangeard

2. Cells flattened from above downwards, with antapical spines :

   P. applanatum Mangin
   P. monocanthum Broch
   P. obovatum Wood
   P. ovatum (Pouch.) Schütt
   P. simulum Paulsen

3. Cells globular or pear-shaped with two antapical spines :

(a) Globular cells whose apical horn is plainly "affixed":

P. gibbosum Matzenauer
P. patens Dangeard
P quarnerense (Schröder) Broch
P. subpyriforme Dangeard

(b) Cells pear-shaped with semiglobular hypotheca and more or less cuneate epitheca:

P. ampulliforme Wood
P. breve Paulsen
P. brevipes Paulsen
P. cerasus Paulsen
P. latispinum Mangin
P. pyriforme Paulsen
P. roseum Paulsen
P. sinaicum Matzenauer
P. stenii Jörgensen
P. mediterraneum (Kofoid) Balech

(c) Somewhat depressed cells, hypotheca ending in two broad rudimentary hollow horns each bearing a spine:

P. granii Ostenfeld
P. mite Pavillard

(d) Cells pear-shaped with distinct ("affixed") long apical horn:

P. tenuissimum Kofoid.

Peridinium globulus Stein, 1883
(Pl. XII, figs. 1, 2, 5, 6, 7, 9, 11 - 13)

Stein, 1883, pl. a, figs. 5, 6, 7.
Cleve, 1901, p. 16; 1903, p. 346.
Paulsen, 1908, p. 42, fig. 51.
Broch, 1910, p. 182, fig. 2.
Meunier, 1910, p. 36, pl. 2, fig. 20, 21.
Lebour, 1925, p. 129, fig. 40.
Dangeard, 1927 *b*, p. 11, fig. 8
Paulsen, 1930, p. 59, fig. 31.
Matzenauer, 1933, p. 474, fig. 63.
Schiller, 1937, p. 182, fig. 185, *a - r*.
Kisselev, 1960, p. 180, fig. 298 *a - c*.
Gaarder, 1954, p. 42.
Wood, 1954, p. 236, fig. 110.

Subrahmanyan, 1958, p. 439.
non Murray and Whitting, 1899, pl. 30, fig. 2.
= *P. sphaericum* Murray and Whitting, 1899, p. 328, pl. 30, fig. 1.

Cells varying from round to lens-shaped form, *i.e.*, more or less compressed vertically, 50-75μ in diameter or 42-75μ long, 42 - 110μ broad. Apical horn knob-like. Girdle more or less markedly dextral, generally making more than a revolution and right end strongly overhanging; not excavated. Sulcus arched, rounded below, not reaching to the posterior end, its border with or without slender wings. Dorsal plate design variable, qudrate, hexa, symmetrical or asymmetrical. Contents colourless or reddish. Plate 1′ seen at times, very small. 1″ always very small, as against the large plate 7″; 3′ variable in size.

In the warmer waters, frequent. Red Sea, Gulf of Aden, Malay waters, Bay of Bangal, Arabian Sea, Indian Ocean; Port Fairy to Fremantle Harbour.

Peridinium sphaeroides Dangeard, 1927
(Pl. XII, figs. 4, 8, 10)

Dangeard 1927 *a*, p. 5, fig. 3, A. B. C. D; 1927 *c*, p. 371, fig. 39 *a*; 1932 *a*, p. 348, fig. 11.
Matzenauer, 1933, p. 474, fig. 62 *a*, *b*.

Cells ordinarily almost spherical, but rather frequently, a little more high than broad. Tabulation: *Paraperidinium* with some special characters *a* et *g* (plate *a* very small) the presence of a common suture between plates 2 and 8, the extreme reduction of apical plate 3. The girdle dextral slightly overhanging not excavated, its border wing projects very little; the sulcal pocesses two marginal fins which terminate as spines in the shape of wings in-curved. Length 80 to 90μ, diameter 72-88μ.

Tropical Atlantic, Indian Ocean, Colombo.

This species found common in a certain number of catches from the tropical region. It is probable that it has been confused in certain instances with *P. globulus* Stein which is always present in the plankton of the warm regions of the world. However, it is very different from *P. globulus* in its tabulation which is of *Paraperidinium* and not a *Peridinium* of the section *Humilia*. On the other hand, these authors agree for identifying with *P. globulus*, the absence of spines and fins bordering the longitudinal furrow whereas *P. sphaeroides* possesses two wing-shaped extensions in-curved from side of antapical.

Finally one character is wholly special, that is, the presence of an apical plate 3 extremely small and disposed asymmetrically. In *P. globulus* the apical plate 3 is of median shape and symmetrical.

Dangeard thinks that the equivalent of that species have been provided by *P. sphaericum* Murr. *et* Wh. described by Murray and Whitting among their new species from the Atlantic in 1899. The authors, unfortunately, not having given for that *Peridinium* a description sufficient for characterisation, it is preferred to create a new epithet which will have the merit of at least supplying a well defined organism a name. (Dangeard)

Peridinium applanatum Mangin, 1915
(Pl. XVIII, fig. 4)

Mangin, 1915 p. 79, fig. 58; 1922, p. 78.
Balech, 1958 *b*, p. 391, pl. II, fig. 52.

This species belongs to the group of *P. steinii* and is very much flattened in the apical and antapical regions. The transverse diameter is about 50μ, double that of longitudinal diameter, excluding the spines and the neck. The latter very long, about 12 to 15μ, and inserted abruptly on the apical region; the two antapical spines, scarcely winged, are about 15μ.

This species is localized in the cold regions of the Antarctic between 52° 8′ S and 68° S, very rarely at 40° S.

Peridinium monocanthum Broch, 1910
(Pl. XV, figs. 13-16)

Broch, 1910 *a*, p. 50, fig. 25.
Lebour, 1925, p. 133, fig. 41 *e*.
Schiller, 1937, p. 201, fig. 196 *a-d*.
Kisselev, 1950, p. 186, fig. 311 *a-f*.
Taylor, 1966, p. 264.
= *P. complanatum* Meunier, 1910, p. 29, pl. 1, figs. 29, 30.

Cells depressed, cake shaped, with one conspicuous antapical spine on the right outside the list of sulcus. Epitheca with sigmoid sides and suddenly adnate apical horn. Hypotheca bread-loaf like. Girdle dextral, ends slightly displaced, running almost around, with smooth winged lists. Length 40μ, breadth 64μ.

Spitzbergen; Indian Ocean.

Peridinium obovatum Wood, 1954
(Pl. XVI, fig. 1, Pl. XVIII, figs. 1–3, 7, 10 *a-d*, and 14)

Wood, 1954, p. 242. fig. 159.
Balech, 1962, p. 33, pl. II, figs. 57-60; Balech and El-Sayed, 1965, p. 120, Pl. II, fig. 25-26.

A small species with a very low cake-shaped body; depressed; girdle slightly dextral, lists moderate. Sulcus narrow, near girdle very wide, circular on antapical surface, lists narrow. Apical horn long, slender, characteristic. Antapical horns not distinct but two long hair-like spines present. Tabulation: meta, quadra or hexa. H = 15 μ; B = 55 μ. Apical horn = 20 μ; antapical spines = 20μ.

Antarctic, Indian Ocean.

For this species (with a querry) Balech (1962, p. 33) gives the following description: small species; tabulation meta quadra; body very flattened anterio-posteriorly, with apical neck subconical, very long and with abrupt inplantation. From the ventral view, the body has the anterior and posterior margin almost straight and parallel, in the lateral view, its greatest height is displaced ventrally to which plane neck and spines are shifted. Antapical spines very long, without fins, very divergent. Girdle high, dextral, end displaced 3/4-1 width of girdle, with moderately developed fins sustained by ribs. Light-coloured protoplasm. Plate 1′ rather wide; 2 *a* small; 1″ very small; 7″ much longer; C_1 & C_3 narrow, the same as the transitional which is scimitar shaped. The sulcals were not well studied; however, they seem to be similar to those of *P applanatum*. Measurements: length (left sulcal) 35-38μ of which 14-17·5μ belongs to the neck; total length 50-53.5μ; transdiameter 41.5-44μ; interval between spines 16-22μ at the base and 30-39μ; at the extremities, usually between, 35 and 36μ. Maximum width of a specimen of 41.5μ transdiameter is 33μ.

The remarks of Balech (1962) are worth nothing here: The great similarity between this species and *P. applanatum* is evident. The original drawing of the latter showed a specimen somewhat shorter than those Balech observed. Later, Balech found specimens from Land Adélie with height more than those he recorded from the Argentinian Sector.

In 1954 Wood described a species that is even more flattened than the one figured by Mangin, with longer spines and neck; actually, it is perhaps closer to Mangin's figure than Balech's. According to Balech, *P. applanatum* is clearly ascendent. *P. obovatum* is rarely so (Mangin is silent on this).

The specimens Balech presents are much wider than the *P. applanatum* of the same region and much more flattened. In lateral view, the neck is much more ventral. The relative length/transdiameter brings them close to *P. obovatum;* however, if Wood's figure is correct, they differ because of the closely ascendant girdle, for 1'' being lower and above all for the flattening, and for the middle part of the epitheca being rectified in such a way that the contour is more similar to rectangle with rounded ends, while in *P. applanatum* as well as in *P. obovatum*, according to Wood, the body is clearly lenticular-elliptic. A more detailed study of the tabulation, especially the sulcal perhaps, will give the key-note on the validity of *P. obovatum* and the possible variability of *P. applanatum*. The sulcal plates are very similar between them. It may be mentioned here that Gaarder (1954) has described under the name of *P. bulbosum* another species from cold waters, Arctic not Antarctic (from the Terranova banks) that is closely similar to *applanatum - obovatum*. Its measurements are very approximate, but the neck is shorter and emerges only gradually, not abruptly, and the spines are much more close together.

Peridinium ovatum (Pouchet) Schütt, 1895
(Pl. XIII, figs. 1 - 12; Pl. XVII, figs. 3, 5, 6, 8 and 10).

Schütt, 1895, pl. 16, fig. 49.
Paulsen, 1904, p. 23, fig. 8; 1908, p. 44, fig. 54; 1930, p. 61.
Broch, 1910 *a*, p. 40, fig. 9, 1 - 4; fig. 10, 1 - 3.
Pavillard, 1916 *a*, p. 34.
Meunier, 1910, pl. 1, figs. 27, 28; 1919, p. 26, figs. 10, 16.
Forty, 1922, p. 94, fig. 88.
Lebour, 1925, p. 126, pl. 26, fig. 1.
Dangeard, 1926 *c*, p. 324, fig. 13 f, g?; 1927 *c*, p. 3, figs. 3, 4.
Peters, 1928, p, 40, fig. 10.
Matzenauer, 1933, p. 476, fig. 65.
Wood, 1954, p. 236, fig. 112 a - d.
= *P. lenticulatum* Fauré - Fremiet, 1908, p. 217, fig. 4; pl. 15, fig. 5.
= *Protoperidinium ovatum* Pouchet, 1883, p. 35, pl. 18, 19. fig 13; Meunier, 1919, *l. c.*
= *P. globulus* var. *ovatum* (Pouchet) Schiller, 1937, p, 186, fig. 187 *a - i*; Kisselev, 1950, p. 182, fig. 299 *a, b*; Gaarder, 1954, p. 42. - Subrahmanyan, 1958, p. 439.
= *P. ovatum* (Pouchet) Schütt var. *inarmata* Matzenauer, 1933, p. 476, fig. 65 *a - c*.
= *P. aff. ovatum* (Pouchet) Schütt, 1895; Balech, 1959, p. 22, pl. I, figs. 20 - 24.

Cells lens - shaped. Apical horn short as in *P. globulus*. Girdle rarely circular; mostly clearly dextral, often making more than a revolution and displaced around more than a girdle width; flat or hollow; margin broadly winged. Both antapical processes with or without wings, more or less long, placed at the end of margin of sulcus or placed isolated. Dorsal plate design symmetrical or asymmetrical. Length 56 - 62μ; breadth 57 - 84μ. Neritical forms often smaller.

Interoceanic; occurs abundantly in European coasts, Antarctic, Indian Ocean, Arabian Sea, Bay of Bengal.

According to Balech (1959) this is an ill - described species differently defined and described by different authors. This species is in need of a good description.

Peridinium simulum Paulsen, 1931

(Pl. XII fig. 3; Pl. XVIII, figs. 5, 6, 8, 9, 11, 12, 15 and 16)

Paulsen, 1931, p. 58, fig. 30, A, B.
Balech, 1959, p. 21, pl. I, fig. 11 and 19.

Almost lenticular, fairly large, with small neck, without antapical, or spines, with flattened posterior pole; tabulation meta quadra. Girdle ascendant, displaced twice width of girdle and ends projecting beyond. It is further characterised by its dark brown colour with strong irregular granulations or vermiculations. Precingular usually low. Intercalary and apical plates well developed. 1′ very asymmetrical. Cingulars with the same sculpture as the rest of the epitheca; fins well developed with rod - like reinforcements many of which do not reach the body.

Sulcus sinuous, S - shaped, *S. a.* long, sinuous with well marked angle in the middle, somewhat widened posteriorly and with a small vertical branch. *S. i.* very wide, half moonshaped, widened posteriorly; anterior apophyses only slightly developed but clear; strong reinforcement in the concave border; a wide hyaline border in the remaining portion and without posterior spine; inside the hyaline border a punctated - alveolated sculpture. Posterior sulcal flat; very simple, usually surrounded by a wide hyaline sutural border; the plate itself is sculptured like the preceding one.

Dimensions : length 59 - 65μ; width 74 - 85μ.

A species usually found in seas, tropical and sub-tropical Atlantic; Mediterranean etc. Indian Ocean (?).

Its shape, the characters of the girdle, the dark colour and the well marked sculpture differentiate it easily. Between the slide and cover slip, the form is easily deformed and tends to stick to the glass.

Peridinium gibbosum Matzenauer, 1933
(Pl. XVI, figs. 2, 3)

Matzenauer, 1933, p. 461, fig. 41 *a*, *b*.
Schiller, 1937, p. 182, fig. 184 *c*, *d*.

Somewhat related to *P. steinii*, shows undulated compressed contour in otherwise rounded body, Girdle dextral, one girdle - width displaced. Sulcus wings from antapical two small precesses; L = 60μ; B = 57μ; St = 3μ.

Indian Ocean, 11° 30'N and 63° 03' E.

Peridinium patens Dangeard, 1927
(Pl. XV, figs. 3, 4).

Dangeard, 1927 *c*, p. 372, fig. 40.

= *P. globulus* var. *quarnerense* (Schröder) Schiller, 1937. p. 184, fig. 186 *q*. *r*. In part.

This species is close to *P. spheroidea* Abé; it differs from it in the antapical spines being somewhat more short and absence of the wings besides markings in the border of sulcus; at the apex of epitheca a slightly projecting button is present; cell globular, ovoid. Length 60μ; width 56μ.

Atlantic, Indian Ocean?

Peridinium quarnerense (Schröder) Broch, 1910.
(Pl. XIII, figs. 10, 11; Pl. XIV, figs. 1, 2, 3, 5, 8, 9, 12;
Pl. XV, figs. 1, 2, 5, 6, 8, 10 - 12)

Broch, 1910 b, fig. 3.
Dangeard 1927 *b*, p. 14, fig. 9.
Matzenauer, 1933, p. 476, fig. 64.
= *P. globulus* var. Stein, 1883, pl. 9, fig. 8.
= *P. globulus* var. *quarnerense* Br. Schröder, 1900, p. 18.- Schiller, 1937, p. 184, fig. 186, in part—Kisselev, 1950, p. 182, fig. 300 *a* - *c*. - Gaarder 1954, p. 43, fig. 52. - Subrahmanyan, 1958, p. 437.
= *P. spitzbergense* Broch, 1913 *a*, p. 49 fig. 24 (?)
= *P. globulus* Meunier, 1919, pl. 16, figs. 24 - 26.
= *P. quarnerense* Schröder, Wood, 1954, p. 236, fig. 111 *a*, *b*.

Cells round to somewhat compressed vertically. Apical horn when present "affixed", button - like. Antapical horns two, spine - like, long without wings, usually continuous with the sulcal lists or at times isolated.

The species is very variable.

In the warmer waters. Red Sea, Gulf of Aden, Indian Ocean, Arabian Sea, Malay Region, Bay of Bengal; Australian Waters; Mediterranean.

Peridinium subpyriforme Dangeard, 1927
(Pl. XIV, figs. 7, 11; Pl. XV, fig. 7)

Dangeard, 1927 *c*, p. 358, fig. 21 *d*, *e*.

This species is somewhat close to *P. mite* Pavillard which it resembles in having two antapical spines which are solid. Cells oval or eliptical with a button - like apical. The ventral furrow is particularly narrow. Of the two solid antapical spines, one, the left, is from the prolongation of the wing of the furrow; the other, right one, inserted isolated, a little retracted; at the right a small accessory spine is inserted obliquely and in the prolongation of the right border of ventral wing. Length 50 to 55μ.

Atlantic. Indian Ocean ?.

Peridinium ampulliforme Wood, 1954
(Pl. XXIV, figs. 7 and 8)

Wood, 1954, p. 242, figs. 160 *a*, *b*.

A small flask - shaped species. Epitheca narrowly conical, with tapering apical horn and concave sides, convex near girdle. Girdle slightly depressed, with lists, slightly dextral. Hypotheca evenly rounded; sulcus flaring widely, right and left lists equally developed, concurrent with 2 long, slender, divergent spines. Tabulation: meta, quadra. Length 40μ; width at girdle 25μ.

Estuarine, Port Hacking, N. S. W.; Swan River, W. A.

Peridinium breve Paulsen, 1907
(Pl. XVI, figs. 4 - 15)

Paulsen, 1907, p. 13; 1908, p. 46 fig. 56; 1911, p. 309, fig. 7.
Broch, 1910 *a*, p. 47, fig. 21.
Fauré - Fremiet, 1922, p. 433, fig. 4.
Lebour, 1925, p. 132, fig. 41 *c*.
Dangeard, 1927 *c*, p. 366, figs. 33.
Schiller, 1937, p. 198, fig. 194 *a* - *f*.

Kisselev, 1950, p. 184, fig. 305 *a* - *e*
Gaarder, 1954, p. 38.
Silva, 1955, p. 29, pl. IV, fig. 9, 10.
= *P. steinii f. brevis* Paulsen, 1905
= *P. sphaeroideum* Mangin, 1922, p. 81, fig. 24, II.
= *P. styliferum* Schiller, 1929, p. 404, fig. 19 *a* - *c*.
= *P. pedunculatum* Schütt, Schiller, 1929, p. 409, fig. 21.

Cell of short ovoid shape, thick-walled sides, somewhat rounded. Apical horn short. Epitheca conical. Hypotheca semi-circular, slightly flattened posteriorly. Girdle dextral, slightly excavated, with lists supported by spines. Sulcus broad, with inconspicuous lists. Theca sculpture: reticulations. Intercalary area clear, striated. L = 30 - 75μ. Breadth often greater than length. Variable species.

In the warm and cold regions of the Atlantic and its neighbouring seas (Mediterranean); Antarctic, S. W. Indian Ocean; USSR waters.

Peridinium brevipes Paulsen, 1908
(Pl. XX, figs. 1 - 12; Pl. XXI, ffg. 1.)

Paulsen, 1908, p. 108, fig. 151; 1911 *b*, p. 313, fig. 13.
Meunier, 1910, p. 44, pl. 2, fig. 35; pl. 14, fig. 44.
Broch, 1910 *a*, p. 48, fig. 22.
Lebour, 1925, p. 131. pl. 27, fig. 2 *a* - *d*.
Woloszynska, 1929, p. 264, pl. 14, figs. 7 - 11.
Schiller, 1937, p. 200, fig. 195 *a* - *m*.
Kisselev, 1950, p. 186, fig. 310 *a* - *e*.
Wood, 1954, p. 241, fig. 122.
Gaarder, 1954, p. 38.
= *P. varicans* Paulsen, 1911, p. 312, fig. 12; Lebour, 1925, p. 132; Woloszynska, 1921, p. 264, pl. 14, fig. 12 - 13.
= *P. incurvum* Lindemann, 1924 *c*, (?) p. 2. pl. I, figs. 7 - 9.

Cells somewhat rhombic in outline, with rounded sides and a conical apex. Girdle right-handed, excavated, with narrow lists. Sulcus broadened towards posterior, ending in two small spines, which, according to Paulsen, may be absent. Plasma colourless. Second anterior intercalary almost square and very small. Length 18 - 45μ. Plymouth specimens (Lebour 1925) always smaller than others.

Neritic; Iceland; Spitzbergen; English Channel; N. S. Wales; Antarctic; African coasts; USSR waters.

Peridinium cerasus Paulsen, 1907
(Pl. XIII, figs. 12; Pl. XIV, figs. 4, 6, 10; Pl. XV, figs. 9)

Paulsen, 1907, p. 12, fig. 12; 1908. p. 43, fig. 52; 1930, p. 58.
Pavillard, 1916 *a*, p. 34, fig. 7.
Lebour, 1925, p. 130, pl. 27, fig. 1 *a* - *e*.
Dangeard, 1927, *c*, p. 358, figs. 24.
Peters, 1928, p. 45, fig. 12.
Wood, 1954, p. 112, fig. 113, *a*, *b*.
= *P. globulus* var. *quarnerense* (Schröder) Schiller, 1937, p. 184, fig. 186 *u* - *x*, p. p.

Cells almost globular. Apical horn sometimes long, sometimes short, but conspicuous. Girdle dextral, not excavated, with narrow lists supported by spines. Sulcus narrow. Two fine antapical spines, in individual cells variable. The left wing of sulcus is always somewhat stronger than the very slender right one. Membrane surface is always robustly punctate or pitted. Plasma colourless; cells transparent. The tabulation in this species is very constant. Particularly characteristic seems to be the small pre-equatorial plate 1″ in contrast to the relatively strong plate 7″ Intercalary striae often present. Dimensions; length 54 - 66μ; transdiameter with girdle, 30 - 58μ.

How much are *P. cerasus* and *P. quarnerense* related, various investigations must show (*cf.* Lebour, 1925, Broch, 1910 Pavillard, 1916 *a*). Besides, the *P. globulus* figured by Meunier (1919) does not belong to *P. cerasus* (in contrast to Lebour, 1925) for, this species is, as evident from Meunier's figures a representative of the subgenus *Orthoperidinium*.

North Sea, Iceland, Greenland, Mediterranean, Flemish and Brittany coast, English Channel, west coast of India.

Peridinium latispinum Mangin, 1922
(Pl. XXI, figs. 2 - 8)

Mangin, 1922, p. 81, fig. 24 *I*.
Schiller, 1937, p. 193, fig. 190 A, *a* - *d*.
= *P. sylvanae* Dangeard 1927 *a*, fig. 1 A - C; 1927 *c*, p. 357, fig. 22 *a*, *b*.
= *P. africanoides* Dangeard, 1927 *c*, p. 357, fig. 22 *c*.

Cells globose to spherical. Epitheca surmounted by a straight cylindrical apical tube. Girdle slightly dextral, displaced about half a girdle width. Sulcus narrow, edges winged, terminating in two antapical winged spines, right

one of average shape, left one slightly curved than the other. Theca surface smooth, very finely punctate. Length 70 - 90μ ; B = 50 - 60μ ;

Species related to *P. stenii* and *P. pyriforme*.

In warm waters of Atlantic; Antarctic; Arabian Sea, Bay of Bengal.

Peridinium mediterraneum (Kofoid) Balech, 1964.
(Pl. XXIII, fig. 14; Pl. XXIV, figs. 1 - 6; XXV, figs. 1-10)

Balech, 1964, p. 184, pl. II, figs. 26 - 55.

= *P. stenii* sub. sp. *mediterraneum* Kofoid, 1909 *a*, p. 40, pl. II, figs. 1 - 11.

= *P. longicollum* Pavillard, 1916, pl. 2, fig. 3; Dangeard, 1927 *c*, p. 358, fig. 23, *a*, *b*, *c*.

P. stenii var. *mediterraneum*. (Kofoid) Scchiller, 1937, p. 198, fig. 193 *a*, *c*, *f*; Subrahmanyan, 1958, p. 439.

Balech (1964) gives a detailed description which is adopted here.

Very large species, pear-shaped to spherical, slightly compressed dorso-ventrally; epitheca conical, apical horn long, sub conical, truncated, almost cylindrical most of its length with or without swelling at apex. Two long antapical spines, only slightly divergent with conspicuous wings. Meta, penta. 1' rather narrow; right lateral angle at about the same height as the superior left or slightly lower; margin to 2'' more or less straight, very long; margin to 7'' concave, sometimes slightly convex posteriorly; anterior laterals slightly irregular, the left one being more concave; apical truncation short and slightly oblique backwards and to the left. Extreme precingular plates very differen form one another since 1'' is a curved line triangle and much smaller than 7'' that is trapezoidal.

Median intercalary plate *a* penta, fair size.

Apical grove narrow, median length, in side view seen limited by at small lateral fin, very narrow and thin.

Post cingular plates very tall; 1''' and 5''' trapezoidal but with posterior margin only slightly inclined; the 1'' plate is narrower; 3''' somewhat asymmetrical, with shorter margin to 1''''. General sutures single or more often wide and striated.

General sculpturing: small thin alveoles that enclose others, small and poroid. Often the large alveoles are found undeveloped and only the small ones are seen that under dry objectives they appear like punctations, more or less well marked.

Girdle, convex, dextral, ends displaced about once its own width, limited by narrow fins, with not very dense reinforcements, between which are interpolated some incomplete ones that do not touch the internal margin. C_1 is half or less the length of C_3. Plate *t* very narrow, somewhat curved, with almost parallel sides.

Antapical spines thick and long almost alike, the left one often more irregular; strongly winged with irregular edged fins, frequently clearly denticulated. Usually one or more internal edges can be seen on the left fin and one on clear external angle of the right one. A false spine seen at the right corresponding to the fin of the *S. d.* right sulcal.

Sulcus only slightly excavated, rather narrow, widened posteriorly, with right margin very ill-defined in intact specimens.

Anterior sulcal very long and narrow with anterior segment or neck well defined by a posterior right angle that is much in the front in respect to the left one; sides of the neck are straight and parallel in front of their right base. Body on the right side slightly concave; left one with a protruding angle and rounded half way up. Posterior apophysis short, turned to the right, implanted at right angle or slightly acute angle on the body through a short peduncle. Some pores are visible on the body.

Left sulcal J-shaped with internal side concave, slightly reinforced, with anterior and posterior angles stretched into spines (the anterior one thicker and somewhat curved). Anterior margin very oblique, somewhat sinuous. Anterior left angle extended in a long triangular appendix. Left margin clearly made by two segments joined by an angle of about 150°; the anterior segment is one and a half times longer; it is more or less straight; the posterior one is shaped like an italics *S*. Internal or right margin corresponds to the posterior branch of the J that makes a medium protruding angle. This plate has fine pores irregularly distributed.

Right sulcal has narrow long body, small neck curved and ill-defined, concave towards the right. Right side of the body may be broken down into two concave segments, the anterior one being the longer. The left margin is also divided into two unequal convex segments. In the posterior angle of the body there is a robust tooth protruding outwards. Well developed fin, with wide internal margin divided into two convexities; the posterior one, somewhat shorter, is wider; posterior margin of the fin well defined, short. Body with scattered pores, strong especially near to the external margin, and sometimes also small alveoli. Fin sometimes has fine punctations.

Posterior sulcal flat, rather small, with right branch having a posterior margin, concave and an anterior one irregular with a spine near to the external angle; the other branch is more regular and widened distally.

S. p. a. triangular, small.

Dimensions: L = 60 - 95μ; total L = 99 - 119μ; apical horn, = 18 - 25μ; diameter = 45 - 62μ (usually not larger than 58μ); if compressed, depth to about 7μ less; distance between spines 14 - 16μ at base and 27 - 29·5μ at the extremes.

Protoplast shrunk in preserved specimens; brownish yellow. Nucleus prominent, placed near equator of the cell or somewhat to the front, wide, spherical or ellipsoidal.

Warm water form; Atlantic, Mediterranean; Pacific, Californian coast; Arabian Sea.

Peridinium pyriforme Paulsen, 1907
(Pl. XXII, figs. 1 - 15)

Paulsen, 1907, p. 13, fig. 15; 1908, p. 46, fig. 57; 1911, p. 310, fig. 8.
non Meunier, 1910, pl. 1, fig. 14 - 18; pl. 2, figs. 18, 19.
Lebour, 1925, p, 126, fig. 38.
? Schiller, 1929, p. 405, fig. 20.
Schiller, 1937, p. 194, fig. 191 *a - n*.
Kisselev, 1950, p. 183, fig. 303 *a, b*; 309 *a, b*.
Gaarder, 1954, p. 49.
Wood, 1954. p. 239, fig. 118.
= *P. steinii* f. *pyriformis* Paulsen, 1905, p. 4, fig. *d, e*.
= *P. castaneiforme* Mangin, 1922, p. 79, fig. 20, II.
= *P. steinii* var. *africanum* Dangeard, 1927 *a*, p. 3, fig. 1 *D–F*.
= *P. oviforme* Dangeard, 1927 *a*, p. 3, fig. 2 *A–C*;? 1927 *c*, p. 356, fig. 21 *b, c*; Schiller, 1929, p. 403, fig. 17; Paulsen 1 30, p. 62, fig. 34; Matzenauer, 1933, p. 461.
= *P. sylvanae* Dangeard, 1927 *a*, p. 2, fig. 1, ABC; 1927 *c*, p. 357, figs. 22 *a, b*.
= ? *P. rectum* Kofoid, 1907 *b*, p. 311, pl. 32, figs. 48, 49.
= *P. rectiforme* Schiller, 1929, p. 402, fig. 15.

Cells slender, broadly pear-shaped to elliptical; hypotheca semicircular to broadly flattened; epitheca conical to half-egg shaped, with straight or convex sides. Ventral side of epitheca steeper than dorsal. Girdle broad,

concave or not, lying sub-median; slightly dextral. Sulcus runs straight, its margins, particularly right more or less winged and ending in two long or short more or less broadly winged processes. The wing is set generally dorsally, however, a little forward. Shell at times very thick. Dorsal plates arrangement asymmetrical or symmetrical. The intercalary plate 2*a* appears to be often displaced to the left, so that the suture between 2 *a*/ 3 *a* comes to be over and below plates 4'' and 3'. L = 42-70μ; B about always around 10μ lessser than L.

In cold as well as warm waters. N. Atlantic, S. E. Australia, Indian Ocean.

Schiller remarks: The investigations of Peters and others have elucidated the species. Now it appears justified that a number of species have to be examined afresh with regard to their identity. The shape and particularly the plates arrangement as well as validity of *P. sylvanae* appears doubtful; for Dangeard (1927 *c*, p. 356) reckons the elongated elliptical cell form to his *P. oviforme*. He must have had transition forms before him, otherwise, his identification is not understandable. Besides, the most insignificant difference sufficed for him for erection of a new species.

Peters (1928) gives more details about this species: Peters observed this species in the Antarctic. The one described by Meunier as "*piriforme* " does not belong here; according to the ventral plate-pattern it belongs to the subgenus *Orthoperidinium*.

The length of *P. pyriforme* from the Weddel sea varies between 63 and 83 μ; the width 53 and 74 μ. The length (with the spines) exceeds in some individuals the breadth (with the wings of the girdle) usually by about 10μ. Paulsen gives the length as 42–70μ, probably without spines.

Shape of cell is elongated egg-like, in ventral view the anterior half has approximately straight sides, whereas the posterior half has more or less semi-circular outline. In the equilibrium position in the preparations, the cells usually present a rounded contour. The sulcus is rather broad and is enclosed by narrow right and a broad left wing which becomes projected at the body end into two robust processes. The anterior cell half projects usually into a scarcely distinguishable apical horn. The membrane is thin in young cells, in the large old forms very thick-walled. Surface of shell is delicately reticulate. The ventral tabulation shows it to be of *Metaperidinium*. The suture 4'/7'' is almost always very small, so that often the false impression is created as of the plates 1', 7'', 4' and 6'' projecting into a point together. If this

point is compared in more individuals, the *Metaperidinium* pattern emerges. The tabulation of the dorsal side is characterised by an intercalary plate 2*a* widely displaced left. This plate lies so widely displaced to left, that suture 2*a*/3*a* comes to lie midway over and under plates 4'' and 3', so that one believes first that one has a precursor of the genus *Archaeperidinium* Jörgensen with only two intercalary plates. The plate pattern, to some extent recalls the sketchy figures of Paulsen. In all cases the tabulation in the region of the rhomboid plate is same and also the oblique orientation of the intercalary ptate 2*a* prominent, The symmetrical arrangement of the dorsal plate pattern has not hitherto been observed in *P. pyriforme*.

The intercalary striae are narrow in small individuals, in the larger ones broader. Specimens with simple sutures have not been observed. These must thus be still smaller than the smallest observed cells with narrow intercalary striae so that it is well possible that the youngest individuals with simple sutures are only 12μ long, as indicated by Paulsen. With increase in the breadth of the intercalary striae, the sulcus adjoins the anterior half in a grasping manner. The progressive growth extension of the ventral intercalary zone makes clear the dorsals and antapicals.

Peridinium roseum Paulsen, 1904
(Pl. XXI, figs. 9 - 13)

Paulsen, 1904, p. 23, fig. 9; 1949 p. 53, fig. 19, A - E.
Meunier, 1910 pl. 2. figs. 10, 11.
Jörgensen, 1912, p. 7.
Lebour, 1925, p. 130, fig. 41 *a*.
Pavillard, 1931, pl. 2, fig. 10 A, 10 B.
Kisselev, 1950. p. 271, fig. 491.
? Wood, 1954, p. 237, fig. 114, *a. b.*

Cells in ventral view rounded or somewhat rhombic, tapering gradually above to a short apical horn. Girdle right handed. Sulcus broadening below, the left margin bearing a small wing which is not connected with the spines. Two spines without conspicuous wings are situated a short way from the end of the longitudinal furrow. Apical view somewhat kidney shaped. Theca smooth. Plasma pink. Length 50-58μ without spine.

Paulsen has not given a diagnosis. He refers to Pavillard (1931) according to which plates arrangement is meta, quadra, (a single specimen penta), hence this belongs to Section *Humile-Piriformia*.

Indian Ocean, Australian waters, Norwegian coast, Sweden, Iceland, Skaggerak, Greenland.

Peridinium sinaicum Matzenauer, 1933
(Pl. XXIV, figs. 9-10)

Matzenauer, 1933, p. 459, fig. 37 *a, b.*
Schiller, 1937, p. 272, fig. 279 *a, b.*
Subrahmanyan, 1958, p. 439.

Cells small, rounded. Epitheca somewhat conical with clearly demarcated apical horn. Girdle not or slightly dextral to one half-furrow width. Sulcal wing connected with the process, right process free, separated away from the sulcus. This character is a proof for the close relationship of the species with *P. steinii*. L=28-31μ.

Indian Ocean, Arabian Sea, Red Sea.

Peridinium steinii Jörgensen, 1899
(Pl. XXIII, figs. 1 - 13)

Jörgensen, 1899, p. 38.
Paulsen, 1907, p. 13, fig. 14 *a, b* (*non* 1905); 1908, p. 47, fig. 58 *a, b.*
Kofoid, 1909 *a*, p. 25.
Broch, 1910 *b*, p. 185, fig. 4.
? Meunier, 1909, pl. I, 32, fig. 19-21; pl. I, *bis*, figs, 24, 25.
Dangeard, 1927 *c*, p. 356, fig. 21 *f.*
Lebour, 1925, p. 125, pl. 25. fig. 4.
Peters, 1930, p. 74, fig. 41, C, D.
Matzenauer, 1933, p. 459.
Schiller, 1937, p. 196, fig. 192 *a-h.*
Kisselev, 1950, p. 184 *a-g.*
Wood, 1954, p. 240, fig. 120 *a.*
Taylor, 1966, p. 462.
=*P. michaelis* Stein, 1883, pl. 9, figs. 9-14; Schütt, 1895, pl. 14, fig. 46 *non* Vanhöffen, 1897, pl. 5, fig. 3.
=*P. pellucidum* Ramsay-Wright, 1907 pl. 1, fig. 17; *non* Bergh.
=*P. steinii* subsp. *paulseni* Kofoid, 1909 *a*, p. 40.
=*P. micrapium* Meunier, 1919, pl. 16, figs. 37-40.
=*Protoperidinium pellucidum* var. B. Pouchet, 1883, p. 431, pl. 18, 19, figs. 10, 11.
= ? *P. africanoides* Dangeard, 1927 *c*, p. 357, fig. 22 *c.*

Cells rounded or pyriform; epitheca produced into a more or less long apical horn, hypotheca almost semicircular. Girdle slightly dextral, generally broadly winged, excavated; sulcus to begin with narrow, towards posterior somewhat widened, its left margin with broad fin stretched up to the left pro-

cess. Two strong processes surrounded by more or less broad serrated (according to Lindemann tripartite) fins, Length without process 39-88μ; B = 22 - 40μ. Plasma generally reddish. Very variable. Close to *P. pyriforme*.

Kofoid (1909 *a*) has made a very detailed study of this species.

All European seas; Atlantic; Eastern Australia; Pacific Ocean; Indian Ocean, Zanzibar, Red Sea to Malaya, Bay of Bengal, Arabian Sea.

Peridinium granii Ostenfeld, 1906
(Pl. XXVI, figs 1—17)

Ostenfeld, 1909, p. 15.
Paulsen, 1907, p. 16, fig. 18; 1908, p. 52, fig. 66 (non *a*).
Meunier, 1910, p. 33, pl. 1, figs. 35-37; pl. 1*b*, figs. 35-36; 1919, p. 24, pl. 16, figs. 1-9, figs. 17, 20.
Lindemann, 1924 *f*, p. 226, figs. 54, 55.
Lebour, 1925, p. 124, pl. 25, fig. 2.
Peters, 1928, p. 47, flg. 13.
Woloszynska, 1928, p. 263-64, pl. I3, fig. 4.
Matzenauer, 1933, p. 469.
Schiller, 1937, p. 189, 188 *a-r*.
Kisselev, 1950, p. 182, fig. 301 *a-c*.
Wood, 1954, p. 238, fig. 116 *a-c*.
Gaarder, 1954, p. 54.
Silva, 1955, p. 30, pl. IV, figs. 11, 12.
Subrahmanyan, 1958, p. 439.
= *P.* sp.Gran, 1902, p. 188, fig. 13.
= *P. pellucidum* var. Pouchet, 1883, p. 443, pls. 18-19, fig. 8.
= *P. finlandicum* Paulsen, 1907, p. 15, fig. 19; 1908, p. 51, fig. 65; Woloszynska, 1928, p. 263, pl. 13, figs. 4-12.
= *P. divergens* Levander, 1894, p. 51, pl. 2, fig. 22; *non* Ehrenberg.
= *P. divergens* var. *levanderi* Lemmermann, 1900.
= *P. calosum* Jörgensen, 1912.
= *P. tenuicorne* Mangin, 1913, p. 230, fig. 13.
= *P. concavum* Mangin, 1922, p. 79, fig. 21, II.
= ? *P. pseudogranii* Peters, 1930, p. 73, fig. 39, F. G.
= *P. gracile* Gran and Braarud, 1935, p. 382, fig. 59.
non P. gracile Lindemann, 1924; *non P. gracile* Meunier, 1910.

Cell broad. Epitheca with concave or concavo-convex sides. Girdle right-handed, slightly excavated with lists supported by fine spines. Wings very broad. Hypotheca ending in two broad hollow horns, each bearing a

spine where the sulcus ends; the latter is broad with lists. Theca finely reticulated /areolated. Length = breadth = 40 – 99 μ.

In cold and warm water of all seas; brackish water of East Sea and Belgian coast; Arabian Sea, Bay of Bengal, Indian Ocean.

Schiller's remarks on this species are of interest. The cell-shape of this species is very variable and difficult to contain in a diagnosis. The girdle here, as it is in other species, is flat in individuals with rounded form, and hollow in such with keel - shaped transverse region.

Many authors have commented on the variable structure of the posterior horns. Paulsen speaks of two hollow elevations each of which has a wing-less process. His old as well as recent figures show them up to the form with horns developed. Meunier's figures also prove the strong variations. Here, as with Paulsen, the processes are sometimes large and sharply demarcated, sometimes they are represented so small, that they are scarcely evident, and the posterior horns appear as pointedly running horns (Peters, 1928). Lebour represents these body parts characteristically. The specimens of Peters from the Antarctic possess strongly developed processes. In a few cells, he could also recognise a fine plama run into the base of the horn-like processes. They approximate thereby the type of posterior horns. It must, therefore, be adjudged in this species, relatively, the type of formation of the posterior processes to have large variations capacity, as they may be seen developed as spines or horns and as transitions between these. The dorsal 2 *a* plate has not only been observed symmetrical but on the right and left, asymmetrically also.

Peridinium mite Pavillard, 1916
(Pl. XXVII, figs. 1-11)

Pavillard, 1916, p, 36, fig. 9.
Lebour, 1925, p. 125, pl. 25, fig. 3.
Dangeard, 1927 *c*, p. 357, fig. 22 *d*.
Paulsen, 1930, p. 61, fig. 33.
Matzenauer, 1933, p. 459, fig. 35.
Wood, 1954, p. 238, fig. 117.
Silva, 1955, p. 53, pl. IV, fig. 13.
= *Peridinium granii* f. *mite* (Pavillard) Schiller, 1937, p. 192, fig. 188 *s - z*.

Cells with rounded sides, with elongated apical horn and two, long, slender antapical spines placed apart. Girdle slightly dextral, not excavated, with narrow lists supported by spines Intercalary striae absent or very narrow. Length = 45 - 55μ.

Atlantic (warm water) up to England; Mediterranean; Indian Ocean.

Peridinium tenuissimum Kofoid, 1907
(Pl. XXIV, figs. 11 - 13)

Kofoid, 1907 *a*, p. 176, pl. 5, fig. 34.
Dangeard, 1927 *c*, p. 369, fig. 36.
Matzenauer, 1933, p. 478, fig. 68.
Schiller, 1937, p. 215, fig. 211 *a -c*.
Taylor, 1966. p 462.
= ? *Peridinium steinii* var *elongata* Karsten, 1907, p. 415, pl. 50, fig. 12 *a-c*.

Body in ventral view shaped like a round bottomed conical flask, compressed dorso-ventrally. Long diverging posterior horns winged. Length without processes 45 – 50μ; diameter 25 – 28μ.

The species somewhat resembles *P. diabolus* and *P. steinii*.
Warm water form. Indian Ocean.

Section *Pellucida* Jörgensen

Species without hollow antapical horns. Cells mostly ovoid, pointed or acuminate at the top, rarely with an "affixed" apical horn. Girdle right handed, two antapical spines, often a third on the left side as a continuation of the left edge of the sulcus. Tabulation: para, usually hexa, rarely quadra or penta.

Pear-shaped cells:

P. curvipes Ostenfeld
P. subcurvipes Lebour
P. diabolus Cleve
P. longipes Karsten
P. okamurai Abé
P. pallidum Ostenfeld
P. pedunculatum Schütt
P. pellucidum (Bergh) Schütt
P. tristylum Stein

Globular or ovoid cells:

P. heteracanthum Dangeard
P. nipponicum Abé
P. obesum Matzenauer
P. ovum Schiller
P. inclinatum Balech
P. variegatum Peters

Peridinium curvipes Otenfeld, 1906
(Pl. XXVIII, figs. 6, 9, 13, 15, 16)

Ostenfeld, 1906, p. 15, fig. 128.
Paulsen, 1908, p. 45, fig. 55; 1911, p. 308, fig. 76.
Pavillard, 1916 *a*, p. 34, fig. 8.
Forti, 1922, p. 96, fig. 92.
Lebour, 1925, p. 135, pl. 29, fig. 1 *a–c*.
Dangeard, 1927 *c*, p. 370, fig. 38 *b*.
Woloszynska, 1929, p. 265, pl. 13, fig. 1–3.
Schiller, 1937 p. 201, fig. 197 *a-p*.
Kisselev, 1950, p. 187, fig. 312 *a-e*, 318 *a-g*.
Wood, 1954, p. 242, fig. 124.
Gaarder, 1954, p. 40.
Silva, 1955. p. 34, pl. IV, fig. 14, 15.

Roundish-oval, length same as breadth or somewhat less. Apical horn short. Girdle broadly winged, dextral. Left sulcal border with broad wing which runs curved towards antapex. On the right side winged border narrower, ending in a process. Rhomboid plate more or less asymmetrical. The ventral plate formula very variable, ortho, meta, para ; 2*a* four–or six-sided. Here there appears to be a deviation in the ventral plate order which exceeds that known for long in *P. divergens*, where Barrow (1918) and others saw meta alternating with para. Length 44-52μ ; breadth 44-46μ.

Greenland to the tropics of the Atlantic; Mediterranean, East Sea; Indian Ocean (Antarctic); USSR waters.

Peridinium sub-curvipes Lebour, 1923
(Pl. XXVIII, figs. 1, 3, 4, 5, 10, 11, 12, 14)

Lebour, 1923, p. 267, fig. 4; 1925, p. 133, pl. XXVII, fig. 3-*a*, *c*.
Dangeard, 1927 *c*, p. 367, fig. 33 *d*.
Balech, 1959, p. 23, pl. II, fig. 36-37.
= *P. curvipes* Broch, 1910 *a*, p. 42-43.

Cells small, pear-shaped compressed to be somewhat lens-or cake-shaped. There is a distinct, small, well shaped apical horn. Girdle dextral, displaced half-width or so, not excavated, with well developed fins held by ribs. Sulcus wide especially at its posterior half, bordered at its left side by a fin at the back and that in profile may seem a spine, slightly developed. On the right side there is a real spine, of medium size, somewhat curved, without fins. The anterior position of sulcus extends slightly into the epitheca. Tabulation : 1′ rather narrow, with a wide contact with 2″

Apical groove relatively long. 1'' much smaller than 7'' and 4'' large, very tall. 1''' and 5''' very asymmetrical as the first one is much small and shaped like a pistol. Sculpture spaced strong punctations. Protoplasm pinkish, nucleus large, ellipsoidal separated at the equator. Pusules present. Plates generally with strong spaced punctation : Dimensions : length 47μ, total 59.5μ; neck 3μ; diameter 44-45μ.

Schiller has placed this species as a synonym of *P. curvipes* Ostenfeld. Studies of Lebour and Balech indicate that this form can be considered a species by itself.

Indian Ocean (?)

Peridinium diabolus Cleve, 1900
(Pl. XXIX, figs. 3 - 10)

Cleve, 1900 *a*, p. 16, pl. 7, figs. 19, 20.
Pavillard, 1909, p. 279; 1916, p. 38, fig. 10.
Lebour, 1925, p. 135, pl. 29, fig. 2 *a-c*.
Dangeard, 1927 *c*, p. 368, fig. 35 *a*.
Paulsen, 1930, p. 57, fig. 29.
Matzenauer, 1933, p. 478, fig. 67.
Schiller, 1937, p. 204, fig. 198 *a-h*.
Kisselev, 1950, p. 187, fig. 319 *a, c*.
Gaarder, 1954, p. 41.
Wood, 1954, p. 243, fig. 125.
Taylor, 1966, p. 461 (as *P. diabolum* Cleve).
=*P. formosum* Pavillard, 1909, p. 279, fig. 2B; 1916, p. 39; Dangeard, 1927 *c*, p. 368, fig. 35 *c*; Lebour, 1925, p. 136.
=*P. macrospinum* Mangin, 1912; Lebour, 1925, p. 136, fig. 42 *b*; Fauré-Fremiet, *et* Puigandeau, 1922, p. 438, fig. 6.
=*P. longispinum* Mangin, 1930, p. 376, fig. 1.
=*P. pellucidum* Carrisso, 1911, pl. 2, fig. 10, 11. (*fide*, Paulsen, 1930, p. 57).
=(?) *P. longicollum* Pavillard, 1915, p. 122; 1916 *a*, p. 35, pl. 2, fig. 3; Dangeard, 1927 *c*, p. 357, fig. 23.

Body rounded, slightly compressed dorsiventrally. Apical horn of medium length, conical Both antapical processes winged, slightly spreading; their length approximately equal to half cell width. Body of warm water form often strongly concave wedge shaped; apical horn long and thin; the processes strongly spreading and longer than half cell-width. Chromatophores yellow. Total length 85-180μ; breadth 35-75μ.

A characteristic species. - *P. formosum* Pavillard and *P. macrospinum* Mangin are identical with body form of *P. diabolus*. Mangin found the type to be *Ortho*, confirmed by Fauré-Fremiet (1922); but, this is not reconcilable with the dextral girdle and processes. If it be not an error of the two authors, then we have here a remarkable form as has been recorded by other authors, for other species (Peters, 1928, pp. 112, 113).

P. longicollum Pavillard (1915, p. 122; Dangeard 1927 *c*, p. 357, fig. 23) agrees slightly morphologically with the above species; has, however, type *Para*.

In the warm waters of the Atlantic and Indian Oceans probably also in the Pacific Ocean; Mediterranean; English and Belgian coasts; USSR waters.

Peridinium longipes Karsten, 1907
(Pl. XXIX, figs. 1, 2; Pl. XXX, figs. 1 - 10)

Karsten, 1907, p. 418, pl. III, fig. 6 *a*, *b*. (as *P. (divergens) longipes*)
Matzenauer, 1933, p. 477, fig. 66.
Balech, 1964, p. 189, pl. III, figs. 48 - 55.

Balech (1964) gives a detailed description and that is followed here.

Very elegant species with a very long neck and large symmetrical antapical spines, somewhat curved; divergent, and with well developed fins. Well marked dorso-ventral flattenning. Tabulation: Para hexa; girdle ascendant, displaced more or less one girdle width.

Apical horn conical, truncated, with slight median dilatation and variable apical dilation. Low epitheca, except for neck. Hypotheca shaped more or less like a trapeze, with lateral margins gently convex and posterior slightly concave. These three margins have about the same length.

The epi-and hypo-theca form a rather abrupt angle when they meet. Altogether the body is closely pentagonal with a hypotheca higher than the epitheca.

Plate 1′ has a short hexagonal body rather wide with boundary with 6″ somewhat shorter than that with 2″; those that articualate with 1″ and 7″ are regularly concave. Inferior vertex truncated (small), superior elongated into a very long branch, approximately twice the length of the rest of the plate. Apical sulcus relatively short (6 - 8μ).

Extreme precingular plates, 1″ and 7″ sub-equal. The second intercalary, 2 *a*, hexagonal and very wide.

In the hypotheca 1''' and 5''' have approximately the same shape and height; however, the first one is narrower and has a wide sulcal fin. 3''' is very large, symmetrical.

Girdle very narrow, convex, with well developed fins having dense ribs. Extreme angular plates, especially *c*, very narrow.

The sulcus long, shallow, penetrates only slightly into the epitheca and widens positively and from the left margin a fin protrudes appearing like a third spine.

Transitional plate very long and narrow. Anterior sulcal long, very narrow, with an irregular body, strongly punctate, with not very well developed neck and medium sized posterior apophysis that makes an angle of about 90° with short posterior branch almost non-existent and poorly limited; right margin reinforced but without denticulations; posterior angle without a spine or only vaguely formed; anterior margin very oblique and interrupted by the end of a membrane or fold originated from the left margin; strong irregular punctations; a denser group of 6 - 7 pores in the anterior third.

Right sulcal with right border with two concavities united by the middle make a well marked angle; neck short. Anterior half of the left side convex; posterior half rather irregular with well developed fin with left border with slightly accenuated labulation at the beginning of the posterior third; posterior border of the fin 2 - 3 times longer than the anterior, rather low neck and with free angle turned backwards.

Posterior sulcal V - shaped, with a long arm to the right with strengthened concave border from which a strong spine with small fin is borne next to the union point with the median point. The left branch is characterized by a hyaline fin very broad and with dentations. This fin is the one that goes beyond the left antapical region as if it were a third spine. Besides it, one can see, but less clearly, the posterior part of the fin of the right sulcal.

All the plates are punctate. Plate 1' has punctation irregular in shape and size. Those of the other general plates, with the immersion lens, it can be seen that the pores are Y or star shaped.

Dimensions: length (without spines 81 - 104μ (neck 32-48μ) total 115 - 160μ ; transdiameter 47 - 62μ ; width 38 - 41.5μ ; interval between spines at their base 24 - 29μ ; at their ends 51 - 62μ.

In the material studied, specimens differ only slightly in their aspect, but a lot in their details and proportions, both absolute and relative measure-

ments. The absolute measurements are given above. As far as the relative are concerned, the development of the neck and of the spines is very variable in relation to the total length. Also, their divergence in specimens is variable in relation to the transverse diameter, its curvature and angles. The relation between length of the theca (without spines) and transverse diameter is more constant. In justification of upholding Karsten's *P. longipes* Balech (*l c.*) remarks:

This species has had a variable fate. According to Schiller and others, it is synonymous with *P. diabolus*. This is not acceptable for several reasons. In the first place, Cleve gave for his species two completely different drawings. The first one could have the priority, but bears no relation with the species described although the second one is very different; there are no doubts that Karsten's sp. must be accepted. With this conviction Balech (1959) describes under the name *P. longipes* some very similar specimens collected by Argentinian Oceanographic cruises " Merluza ". Later Balech (1962) could notice some remarkable differences and thus the argentinian specimens became a separate sp. (*P. acanthophorum*). This *P. acanthophorum* is similar to the *P. diabolus* of some authors (Pavillard, Dangeard) and differs from Karsten's species in the different body shape, being more ellipsoidal, absence of flattening, the number of well marked angles, shorter and more gradual neck, shorter spines more or less straight, and less divergent and, also in the details of the sulcal plates specially the right sulcal.

Rampi (1951) has depicted, without describing it, a *P. longipes* that evidently does not belong to that species; it is much smaller than Karsten's sp. and above all has a very different shape. In fact it might well be a very large specimen of another species of the same group: *P. tennuissimum*, much longer and narrower without the marked angularity at the level of the cingulam that is characteristic of *P. longipes*.

According to Karsten, his species would have the following measurements. Length 68μ; transverse diameter 44μ. If this is correct, then Balech's drawings on the same scale would measure: length 90μ, total 132μ, neck 40μ, interval between the spines 24 to 62μ, measurements that agree, all of them closely with those of the Californian specimens that were also studied by Balech. The great width of the girdle membrane that reaches up to 8μ and the well marked ribs need to be emphasized.

In the warm waters of Atlantic and Indian Oceans.

Peridinium okamurai Abé, 1927
(Pl. XXVII, figs. 12—14)

Abé, 1927, p. 402, fig. 20.
Schiller, 1937, p. 201, fig. 204 *a-c*.
Kisselev, 1950, p. 213, fig. 363 *a-c*.
Wood, 1963*a*, p, 328.

Cells elongated pear-shaped. 56—75μ long, 31-53μ broad, 34-40μ deep. Figures show all characteristics.

Mutzu-Bay, Japan; Indian Ocean.

Peridinium pallidum Ostenfeld, 1899
(Pl. XXXI, figs. 1-8; pl. XXXII, figs. 1-5)

Ostenfeld, 1899, p. 60; 1900, p. 38; 1903, p. 581, figs. 130-131.
Cleve, 1900*a*, p. 17, pl. 7, figs 21-22; 1900 *f*, p. 267.
Paulsen, 1907, p. 14; 1908, p. 48, fig. 60; 1911 *b*, p. 311, fig. 9.
Broch, 1910 *a*, p.45, fig. 17.
Meunier, 1909, p. 29, pl. 1, figs. 5-9; 1919, p. 20, pl. 15, figs. 24-29.
Pavillard, 1916 *a*, p. 38.
Forti, 1922, p. 100, fig. 98.
Lebour, 1925, p. 134, pl. 28, fig. 1 *a*, *d*.
Dangeard, 1927 *c*, p. 367, fig. 34.
Peters, 1928. p. 31, fig. 7.
Schiller, 1937, p. 209, fig. 206 *a-m*.
Kisselev, 1950, p. 188, 314 *a-e*.
Gaarder, 1954, p. 47.
Silva, 1955, p. 35, pl. iv, figs. 16-18.
Wood, 1962 *b*, p. 127.
= *P. pseudopallidum* Peters, 1930, p. 73, fig. 39 E.

Cells more or less broadly pear-shaped, contours almost straight or curved, dorso-ventrally flattened, 62-96μ long, 40-72μ broad. Apical horn more or less clearly demarcated. Girdle slightly dextral, with broad winged list, flat or excavated, inclined to the longitudinal axis up to 21°. Sulcal margin terminates, left in two, right in one long broadly winged process. According to Peters, Antarctic forms are without winged processes. Chromatophores, many yellowish. 2 *a* quadra or hexa.

The typical characteristic forms can scarcely be in confusion with another species. Meunier (1909, 1919) had certain of these before him. But, here as in other species the reproduction of tabulation is unreliable.

Neritic and oceanic. Atlantic coast of Europe and Africa; Mediterranean; Arctic and Antarctic Oceans, Indian Ocean.

Peridinium pedunculatum Schütt, 1895
(Pl. XXXII, figs. 6 - 11)

Schütt, 1895, pl. 14, fig. 47.
Jörgensen, 1899, p. 3a; 1905, p. 110, pl. 8, fig. 29.
Paulsen, 1908, p. 48, fig. 59.
non Schiller, 1925, p. 405, fig. 21.
Matzenauer 1933, p. 459, figs. 36.
Schiller, 1937, p. 211, fig. 208 *a-e*.
Kisselev, 1950, p. 188, fig. 315 *a, b*.
Gaarder, p. 48, fig. 139 (?).
Subrahmanyan, 1958, p. 439.
Taylor, 1962, p. 462.

In dorsal view epitheca broadly conical with long cylindrical apical horn. Hypotheca broadly conical; outline shows a shallow sinus on each side and also at lower end. In side view also epitheca is conical; hypotheca somewhat rounded, then evenly narrowed posteriorly into a rounded lower end. Girdle in side view, at right angles to longitudinal axis dextral, left end displaced towards lower side by about one girdle width; excavated, winged with radial lists. Two posterior spines with broad wings, that of ventral one broader and extending laterally covering base; contents yellowish. Length=51μ; B=47μ.

Warm water form, Atlantic; Mediterranean; Pacific and Indian Oceans; Arabian Sea, Bay of Bengal.

Peridinium pellucidum (Bergh) Schütt, 1895
(Pl. XXXIII, figs. 1-11; pl. XXXIV, figs. 1-12 pl. XXXV, figs. 1-11)

Schütt, 1895, pl. 14, fig. 45.
Ostenfeld, 1899, p. 60; 1903, p. 581, fig. 129.
Jörgensen, 1905, p. 110.
Paulsen, 1907, p. 14; 1908, p. 49, fig. 61; 1911, p. 311, fig. 10; 1930, p. 56.
Fauré-Fremiet, 1908, p. 220, fig. 6.
Broch, 1910 *a*, p. 44, fig. 15; 1910 *b*, p. 188, fig. 6.
Pavillard, 1916, p. 38.
Forti, 1922, p. 98, fig. 97.
Lebour, 1925, p. 134, pl. 28, fig. 2 *a-d*.
Dangeard, 1926 *c*, p. 325, fig. 13 *C-F*; 1927 *c*, p. 370, fig. 38 *D*.

Woloszynska, 1929, p. 265, pl. 14, figs. 1-4.
Schiller, 1937, p. 212, fig. 209.
Kisselev, 1950, p. 190, fig. 316 *a-c*.
Wood, 1954, p. 245, fig. 131 *a, b*.
Gaarder, 1954, p. 48.
Balech, 1964, p. 191, pl. III, figs. 56-66.
= *Protoperidinium pellucidum* Bergh, 1881, p. 227, figs. 46-43 - *non* Pouchet, 1883, pp. 33, 34, pls. 18, 19, figs. 8-12, 16-19-*nec* Vanhöffen, 1897, pl. 5, fig. 6.
= *P. cavispinum* Mangin, 1922, p. 79, fig. 20, III.
= *P. huberi* Schiller, 1929, p. 408, fig. 25 *a-e*.
= ? *P. pedunculatum* Schütt, Schiller, 1929, p. 405, fig. 21.
= *P. meunieri* Peters, 1930, p. 73, fig. 3 *a, D*.

Balech (*l. c*) has given a detailed description which has been followed here. His figures are also reproduced (pl. XXXV. figs. 1-11).

Small species, pyriform group, neck short emerging at middle gradually without antapical horns, but with two well developed spines, diverging, with narrow fin and a very prominent false spine on the left side, projecting from the fin of the posterior sulcus. Sulcus somewhat dilated, slightly excavated, no real socket, although in the antapical region a slight flattening or concavity. Dorsoventral flattening little pronounced.

Tabulation para hexa; girdle dextral, ends displaced almost a girdle width, left side girdle extremity frequently rather curved. Girdle fin amply reinforced by strong and dense ribs. In general, a light membrane which is raised from the anterior wing to the posterior is seen thus closing the girdle.

Plate 1′ hexagonal, somewhat asymmetrical, with side towards 2″ largest than that corresponding to 6″; 7″ slightly more taller and much more wider than 1″. The intercalaries 1*a* and 3*a* very much narrow; 2*a* in contrast amply large, hexagonal with border towards 3″ and 5″ rather short.

Postcingulars relatively taller, especially 3‴, that it is somewhat asymmetrical. 1‴ and 5‴ trapezoidal; the first is more taller and narrow and holds a wing of the cingulam rather amply directed backwards. Of the antapicals the 1⁗ is the more striking.

The two extreme cingulars are more narrow, especially C_1; their sides are more longer than broad. The transitional is in the form of a scymitar, rather large, narrow, somewhat widening backwards, the posterior border markedly oblique.

S, a. long, prominently narrow, its median constriction and posterior branch markedly abruptly curved

S. i. in the shape of J rather striking with its two anterior angles especially the left one, projecting. very much spinelike: anterior border very much oblique and relatively spread out from the left; internal border concave usually slightly reinforced Posterial slightly spread out without spine; posterior angle externally rounded. Plate not visibly sculptured, except for, exceptionally, some pores in the posterior region.

Sulcus right handed from body rather widely backwards, generally pentagon - shaped extending somewhat irregularly with short neck and not well delimited. Fin narrow beginning from anterior level from the middle of plate with two very striking flaps and some markings, slightly somewhat ahead of its median part and the other posterior extremity; some irregular pores about the right border.

S. m. rather large and somewhat reinforced. *S. pa.* tiny, triangular situated united at the right border with the posterior branch of the *S. i.*

S. p. with right branch striking and narrow with socket and hook at its base; right branch with strong oblique apophyses and large fin with denticulations on its free border.

On the plate *1'* are seen some polygonal markings and tiny, moreover irregular punctae; in the other only dispersed punctae, more numerous and robust along the sutures enveloping all precingulars.

Dimensions : Length - 30 - 68μ; transdiameter 36 - 70 μ; length of neck 4 - 5 μ approx. Distance between spines at base 8 - 11 μ, 13 - 24 μ at extremities. The thickness, measured in some specimens is about 7 μ less than the transdiameter.

Protoplasm clear sometimes coloured red or yellow, nucleus more or less broadly ellipsoidal, somewhat elongated depending on transverse axis, of large size.

This is a very much discussed species and that in need of revision. On account of its relative tiny size and for want of clarity in the original description to its tabulation, has led its name given to a large number of species with some resemblance (in actuality rather remote) with original description. In other words, the name of *P. pellucidum* has been applied

conveniently to a large number of individuals wherever studied irrespective of locations. It seems essential so often to establish an acceptable criterion and basis in a serious study which deviates from the detailed descriptions of types which harmonize with original drawings. Evidently, this does not occur with those short descriptions of those names by Paulsen, Lebour, Woloszynska, Schiller, Matzenauer, Wang, Halim, Rampi and others and rather not even with *P. cavispinum* Mangin and *P. meunieri* Peters, which Schiller considers as synonyms of the species in question.

The first description of the species is by Bergh which is lodged in another genus. *Protoperidinium*. Unfortunately, even its importance has not been referred to by the majority of authors even though the language of original description refers to that of Schütt, who passes it of to *Peridinium*.

Almost all these false *P. pellucidum* have more height, neck much less developed, the spines more striking and little divergent, with tabulation that varies depending on their authors, meta or para, quadra or hexa, with girdle excavated or not.

As in other instances the description and figures of Schütt give a diversity of criterion. In Balech's view those figures correspond to more than one species. Taking into consideration some representives of these primarily (45.4 μ, 45.5 μ) not only for priority but for other reasons between them, that of 45.4 μ is the best figure of the species oriented well in ventral view. Moreover, it serves, as the basis for some other authors and that which Schiller selects for his revision of Dinoflagellates. There are those who note that Schütt, indeed with neither drawing or tabulation has created a section within the genus (Section *Pellucida*), *Paraperidinium*. One encounters then a *Peridinium* "Para" whose outline and diamensions agree with the said figure of Schütt selected as typical of *P. pellucidum*.

The dimensions calculated above for the mentioned figures are: Length 42 μ, total 51 μ and transdiameter 35,5 - 36 μ which agrees as already seen, with the samples from La Jolla (California) which being *Para* served for these studies. It being "*Para*" therefore no change of conception of the section *Pellucida* of the genus was needed. Balech has no doubt in fact that the specimen encountered by him earlier is true *P. pellucidum* according to Schütt. It remains to be seen in turn those examples of Schütt agreeing with all those admitted implicitly with those of Bergh.

Broch (1910, p. 44) distinguishes three forms: f. *spinosa*, f. *intermedia*, and f. *membranata* (fig. 4, pl. XXXIV) and, Fauré - Fremiet (1903, p. 220, 221,

recognises two varieties: *crassum* and *acutum*. The bases for distinctions are not sound; var. *acutum* might deserve consideration if better known.

Species belongs to type *para*; Broch (?), Matzenauer and Schiller have seen also type *meta*. According to Matzenauer (1933, p. 461) the systematic position of this species is not clear. He has found the species *meta*, so also has Abé (1927, p. 401). The species has a wide range of distribution and is variable and needs detailed investigation, fact stressed by Balech (1964) also.

In cold as well as warm waters of all oceans; also brackish; Red Sea, Gulf of Aden, Indian Ocean Boeton Straits.

Peridinium tristylum Stein, 1883
(Pl. XXXVI, fig. 1 - 4)

Stein, 1883, pl. 9, fig. 15 - 17.
Entz, G. Jr. 1905, p. 11.
Broch, 1910 *b*, p. 187, fig. 5.
Schröder, 1911, p. 40.
Forti, 1922, p. 98.
Pavillard, 1931, p. 60.
Dangeard, 1927 *c*, p. 368, figs. 34 - 35.
Schiller, 1937, p. 216, fig. 212 *a* - *d*.
Silva, 1955, p. 35, pl. V, figs. 1 - 3.
Taylor, 1966, p. 462.
= *P. tristylum* var. *ovata* Schröder, 1900, p. 18, pl. I, fig. 13.

Cells longitudinally stretched - pear shaped, slightly flattened dorsiventrally. Girdle region protruding. Posterior end flat, with three winged processes. Girdle dextral, its ends displaced almost a furrow width. Sulcus margin with broad wings which run to the processes, two on left side and one on the right, all broadly winged. Such wings are also present on the body all along several plates margins. Plates reticulately sculptured.

In the figures 1 and 2, pl. XXXVI, after Stein, reproduced here, at the antapical end two spines are found on the right side, contrary to the diagnosis, *i. e.* two on the left side as seen in figures 3 and 4, after Broch and Pavillard. Compared with similar occurrences in other species, Stein's specimens are unique, and requires re-examination.

Warm water form. Mediterranean; Gulf of Aden, Red Sea, Indian Ocean; Freemantle Harbour.

Peridinium heteracanthum Dangeard, 1927
(Pl. XIX, figs. 8 - 10; XXIX, fig. 11; XXXVI, figs. 5 - 6)

Dangeard, 1927 *a*, p. 7, fig. 4; 1927 *c*, p. 371, fig. 38 *a*; 1931 *a*, p. 348.
Matzenauer, 1933, p. 480, fig. 72.
Schiller, 1937, p. 206, fig. 199 *a*, *b*.
Taylor, 1966, p 461.

This species is closely related to *P. spheroides* Dangeard; like this it is a *Paraperidinium* of globular shape, almost spherical; distinguished readily by the presence of a well developed wing on the left side, which extends through a right spine and sharply directed almost horizontally. At the right, the wing bordering the sulcus is sometimes less marked and terminates in a slightly extended spine. An apical horn (tube) present, very straight, at the summit of the epitheca. Girdle flat, bordered by slightly marked wing. It is disposed in a plane without presenting any appreciable deflection. Tabulation is that of a typical *Paraperidinium* with apical plate 3 of average shape; the pre-equatorial plate *a* and *g* are very unequal. The membrane is smooth and glossy, devoid of punctations. Length 65 to 70μ. (rarely of 45μ).

Tropical Atlantic, Indian Ocean.

Peridinium inclinatum Balech, 1964
(Pl. XXXVII, figs. 2-10; pl. XXXVIII, figs. 5-11)

Balech, 1964, p. 187, pl. III, figs. 41-47.
= *P. sphaericum* Okamura, 1912, p. 14, pl. 4, figs. 71-72.
= *P. sphaeroidea* Abé, 1927, p. 397, fig. 17; Matzenauer, 1933, p. 479, fig. 71 *a*
= ? *P. globulus* Stein var. Karsten, 1907, p. 416, pl. 50, fig. 15, *a*, *b*.
= *P. sphaeroidea* Abé var. *gracilis* Matzenauer, 1933, p. 480, fig. 71 *b*, *c*.
non *P. sphaericum* Murray et Whitting 1889.
non *P. sphaeroides* Dangeard, 1927 *c*.

Ellipsoidal body, wider or globose with a very small abrupt neck slightly ventral; sulcus very narrow and shallow slightly excavated and with no depression at its antapical end; this end is distinguished to the right and left by two long spines with fins, widely divergent. The left spine is sometimes shorter, may have a short pseudospine. There is no dorso-ventral flattening and the cingulam is very inclined in relation to anterio-posterior axis.

Para hexa. Girdle ascendant one and a half times, with cingulam membranes well developed but without radial ribs or reinforcement.

Epitheca globose, clearly low dorsally due to the great inclination of the cingulam. Plate 1′ hexagonal, lateral margins long, straight, others concave. Apex prolonged into a short neck. Apical groove very short. The two lateral apicals, 2′ and 4′ are rhomboidal and almost equal ; 3′ pentagonal and very wide.

Plate 7″ wider than 1″, both small and triangular with curved sides; 4″ low.

Intercalaries well developed ; 2*a* hexa, wide and low.

Cingulars extreme, C_1 and C_3 extremes narrow.

Post cingulars very high. The extremes of this series, 1‴ and 5‴ rather narrow, the first with a wide fin as wide as $\frac{2}{3}$ of the body of the plate. 3‴ high, somewhat asymmetrical.

Transitional plate, *t*, curvilinear triangle, narrow and long.

S. a long, with a more or less straight body, neck poorly marked and short but complex posterior apophysis. *S. i.* J shaped with very short triangular posterior branch, with internal or right angle acute. Anterior margin oblique and concave altered by a light membrane; anterio-external angle or left angle extended into a very tall spur, more or less straight; the anterio-internal is prolonged into a spine, more or less, horizontal and curved. Internal margin concave, a little irregular and with a thin reinforcement, not dentate. Along the opposite-margin (external margin), at a distance from it, a line of strong punctations noticed to which at times others placed irregularly may be added.

S. d. narrow, with short well marked neck. External or right border with a protruding angle well visible at the level of the beginning of the posterior third. Short fin ($\frac{1}{4}$ length of plate), very narrow, with free border concave. Very dense punctations all along the right border of the plate.

S.m. rather very large, hyaline with irregular margin. *S. p.* with short right branch, rectangular with a notch near where it joins with the branch, that is much longer and has a very-wide fin with ventral border regularly convex.

Sculpture of plates; punctations or irregular pores, more denser towards the margins.

Length 54.5 - 62.5μ, total : 74-80μ. Diameter 54-57.5μ. Separation of the spines 8-11μ at the base, 27-29μ at tips.

The protoplast is lightly-coloured; nucleus widely ellipsoidal or ovoid with longer axis placed transversely, situated approximately at the equator of the cell.

The species can be mistaken with others only with difficulty, however, Schiller (1937) includes it doubtfully (?*P. sphaericum* Okamura) in the synonymy of *P. ovum*, which is circular, with parallel spines with no fins, sulcus perpendicular to the antero-posterior axis. He also includes in this species *P. ellipsoides* Dangeard with a wider shape and short and finned spines. On the other hand, Dangeard erected this name for *P. rectum* Kofoid according to Pavillard and for *P. sphaericum* Okamura. However, it is clearly different from *P. sphaericum*.

Balech (*l. c.*) states that the name *P. sphaericum* cannot be maintained because it has already been used by Murray & Whitting (1889). Abé erected the name *P. sphaeroidea* in 1927; a few months earlier *P. sphaeroides* Dangeard had been published. They are, therefore, homonyms. Further, *sphaeroidea* is grammatically incorrect. Hence Balech has renamed *P. sphaericum* of Okamura as *P. inclinatum*; this name refers to the inclination of the sulcus in relation to the longitudinal axis as well as to the spines between them.

Antarctic; Japanese waters; Indian Ocean.

Peridinium nipponicum Abé, 1927
(Pl. XXXVI, figs. 7 - 13; Pl. XXXVII, fig. 1)

Abé, 1927, p. 396, pl. 16.
Matzenauer, 1933, p. 480, fig. 73 *a, b*.
Schiller, 1937, p. 207, fig. 202 *a - f*
Kisselev, 1950, p. 213, fig. 369 *a - d*.
Taylor, 1962, p, 462.

Body ellipsoidal, epitheca slightly conical, towards the clear apical knob somewhat tapering. Girdle dextral, ends displaced up to a furrow width; this displacement not seen in Abé's figures. It appears that displacement of the girdle ends occur sometimes (*P. pyriforme* Paulsen, *P. oviforme* Dangeard, and *P. heteracanthum*). Two slender antapical processes, left smaller bent towards sulcal wing, which gives the impression of a highly placed third process. From *P. ovum* Schiller and *P. rectum* (Kofoid) Pavillard, this species differs first in the longer process (over two girdle widths); however, principally further by the somewhat conical shape, in the ratio of L : B = 1.27 : 1, and also in the dorsal plate combination. L = 40-μ. B = 33-36μ.

Japan, Mutzu Bay; Indian Ocean; USSR waters.

Peridinium obesum Matzenauer, 1933
(Pl. XXXVII, figs. 11 & 12)

Matzenauer, 1933, p. 481, fig. 74 *a*, *b*.
Schiller, 1937, p. 207, fig. 203 *a*, *b*.

Belongs to section *Pellucida*. Species not sufficiently known. Resembles *P. heteracanthum* Dangeard.

Indian Ocean.

Peridinium ovum Schiller, 1911
(Pl. XXXVIII, figs, 1-4; 12-15)

Schiller, 1911, figs. 1, A - D; 1937, p. 208, fig. 205 *a* - *h*.
Wood, 1954, p. 244, fig. 128 *a*, *b*.
= *P. ellipsoideum* Dangeard, 1927 *a*, fig. 6, A. D.
= *P. ellipsoides* Dangeard, 1927 *c*, p. 372, fig. 39 *b* - *d*.
= ? *P. rectum* (Kofoid) Pavillard, 1916, p. 39, fig. 11.
= ? *P. rectum* Kofoid, 1907 *b*, p. 311, pl. 32, fig. 48, 49.
non *P. ellipsoideum* Mangin 1912.

Cells oval to spherical with small affixed apical horn. Girdle circular, not depressed, with narrow lists supported by spines, ends not displaced. Sulcus wide with lists.

Tabulation meta, hexa. Left intercalary plate Y has common suture with apical plate 3. There is a very long common suture between plate 1 and *g*; the apical plate 3 is very small and plate 5 extremely developed. The two antapical spines are straight and almost parallel between them; the right is largely winged therefore by the prolongation to its level of the border from the sulcus; that wing is found twisted like a screw and that inflexion gives the appearance in certain positions of the *Peridinium* to a supplementary spine being adjacent to the left spine. There exists, moreover, something else, a genuine small spine at left slightly visible. Theca lightly punctate. Length. 45 - 50μ.

Mediterranean, warmer regions of Atlantic and Pacific; east coast of Australia; Arabian Sea off west cost of India, Bay of Bengal.

Peridinium variegatum Peters, 1928
(Pl. XXXIX, figs 1-13; XL, figs. 1 - 8)

Peters, 1928, p. 35, fig. 9.
Schiller, 1937, p. 216, fig. *a* - *h*.
Wood, 1954, p. 246, fig. 134 *a* - *b*.
Balech, 1957 *a*, p. 93, pl. VII, figs. 161 - 173.

Cells round to egg-shaped, medium sized, very variable as the name indicates. Length varies between 50 - 85μ, and breadth 50 - 90 μ. Length always more than width, rarely same, majority of cells 70μ broad. What concerns the shape of this species is the hypotheca which is always hemispherical whereas the apical half rather pointed, is thus conical. The side contours of the epitheca remain, however, always convex. A small scarcely set out apical horn is always present. Girdle strongly dextral, ends displaced a girdle width. The wings of same are generally high, rarely low. The sulcus widened towards the antapical pole and is enclosed by two wings of which the left is usually strongly developed. The wings of the sulcus are each capped by a process at their posterior end of which the left is customarily stronger and larger than the right. Peters had supposed at first that the different formations of the sulcal wings and processes in *P. variegatum* to be stable, especially as one finds similar characters given important significance in other species, and it was assumed the same was of constant occurrence. In *P. variegatum*, he could, however, by extensive study of this condition on large number of individuals establish that the shape and size of sulcal wings vary considerably. In some individuals the right wing projects prominently backwards than the left one which generally is considerably higher and robust. Between these both extreme formations occurs all transitions and so also *e. g.*, cells in which both wings appear to be of same length. To sum up, one can say that the girdle wings in height and sulcal wings in shape and size are strongly variable, so that particular formations of them are of at least poor specific characters for *P. variegatum*.

The chromatophores of this species, which preserve well, are small, longish oval to rod-like plates distributed regularly below the membrane. The colour of the chromatophore, whose shape itself, according to Schütt, in preserved material different was not possible to determine. The membrane surface is usually robustly punctate,

As in many other *Peridinium* species, so also in *P. variegatum* the plate arrangement is the most reliable character of the species. The delimitation of the rhomboid plate shows that this species is a representative of the subgenus *Paraperidinium;* for plates 1′ and 2″ and 1′ and 6″ always ram one another with larger margin. The suture 1′ / 2″ is almost always larger that the suture 1′ / 6″ which varies in its length; however, does not become shorter than that shown in figure. The considerable fluctuation of the suture 1′ / 6″ in the length is characteristic for the subgenus *Paraperidinium* and has already been emphasized by Jörgensen (1912). On the dorsal side, the plate pattern shows forms almost always inclined to left, in which the intercalary plate 2*a* is displaced to left and the pre-equatorial plate touches 3″. This asymmetrical

dorsal plate formation is hitherto only observed in *P. variegatum*, outside of that falsely represented under the name *P. granii*, figured *Peridinium* sp. by Meunier (1919), pl. XVI, figs. 17-20). Peters, has, therefore, given the corresponding section of that subgenus the name *variegata*. Detailed investigations of asymmetrical variation of dorsal plate pattern showed a few belonging to symmetrical plate arrangement which shows that *P. variegatum*. belongs really to section *Areolata* where it is to be classified. Out of 30 specimens examined in detail only a few had symmetrical tabulation.

The varying magnitude of the suture 1''''/3''' noticeable on the antapical side may be larger or smaller. The length of this suture corresponds to the surface area of plates 1'''' and 2''''. The limited length of suture 1''''/3''', one finds designated as a species character for other species

In *P. variegatum* the length of suture 1''''/3''' varies and hence the size of the antapical end plate 1'''' and 2'''' so strongly, that this quality can have in systematic view, only unclassified significance.

Growth forms are met with in plenty in *P. variegatum* in young individuals with simple sutures upto quite old ones with broad intercalary zones. Striking are particularly the extraordinarily broad intercalary striae on the ventral side, as a result, principally, it follows that the ventral sutures are fewer in number than the dorsal and therefore, must stretch strongly in growth than the dorsals, if the original shape of the cells are to be retained. The suture of the longitudinal furrow also can take part in growth width wise.

That moreover the size difference of cells are not only to be traced back to a varyingly strong growth of armour, it is proper that younger specimens have simple sutures; the larger are considerably grown older with broad intercalary striae whence results the size of cells, *i.e.*, the structure of the compact armour must be already extraordinarily different. Theca coarcely punctate.

Finally one can follow in *P. variegatum* how with advancing size growth a thickening of the membrane goes hand in hand. Young individuals possess a proportionately thin armour; samples of middle age: median thickened shell; and finally old cells with quite broad intercalary striae have a protective armour so thick as that not observed in any other *Peridinium* sp.

Antarctic, Weddel Sea; Indian Ocean.

Section *Conica* Jörgensen

Species mostly with hollow antapical horns, cell ventrally quandrangular or nearly so, hence no apical horn; girdle left-handed or circular. Tabulation: Ortho, mostly hexa, but penta and quadra also occur.

With hollow antapical horns :

P. conicoides Paulsen
P. conicum Gran
P. conicum f. *guardafuiana* Matzenauer
P. heteroconicum Matzenauer
P. humile Schiller
P. leonis Pavillard
P. leonis f. *matzenaueri* Schiller
P. marielebourae Paulsen
P. matzenaueri Gaarder
P. pentagonum Gran
P. pentagonum var. *latissimum* (Kofoid) Schiller

Cells without hollow antapical horns :

P. achromaticum Levander
P. biconicum Dangeard
P. subinerme Paulsen
P. turbinatum Mangin

Peridinium conicoides Paulsen, 1905
(Pl. XLI figs. 1 - 8)

Paulsen, 1905, p. 3, fig. 2; 1907, p. 18; 1908, p. 58, fig. 75.
Lebour, 1925, p. 112, pl. 20, fig. 2 *a - d*.
Schiller, 1937, p. 231, fig. 228 *a - d*.
Kisselev, 1950, p. 195, fig. 325 *a - e*.
Wood, 1954, p. 250, fig. 145.
Subrahmanyan, 1958, p. 439.
= *P.* sp. Fauré-Fremiet, 1908, p. 215, fig. 2.

Cell in ventral view somewhat rhombic, with slightly convex sides. Girdle almost circular, excavated, with fine lists. Hypotheca ends in two short hollow horns. Longitudinal furrow broadening posteriorly, on the left making a twist just below the girdle, sometimes with two small spines near it. Outline of cell from above and below almost circular. Cell contents pale yellow. Diameter of cell 45 - 60μ.

Arctic, neritic species; Atlantic; Antarctic; east and west coast of Australia; west and east coast of India; Bay of Bengal; USSR waters.

Peridinium conicum (Gran) Ostenfeld *et* Schmidt, 1901
(Pl. XLII, figs. 1 - 9; pl. XLIV fig. 1)

Ostenfeld *et* Schmidt, 1901, p. 174.
Gran, 1902. pp. 185, 189, fig. 14.

Lebour, 1925, p. 111, pl. 19, fig. 1.
Paulsen, 1908, p. 58, fig. 74; 1930, p. 69.
Pavillard, 1916, p. 31.
Meunier, 1919, p. 38, pl. 17, fig. 17.
Dangeard, 1927 *c*, *p*. 348, fig. 14 *e*.
Abé, 1927, p. 406, figs. 24, 25.
Schiller, 1937, p. 233, fig. 229 *a* - *j*.
Kisselev, 1950, p. 195, fig. 326 *a*, *b*, 332 *a* - *e*.
Wood, 1954, p. 250.
Gaarder, 1954, p. 39.
Subrahmanyan, 1958, p, 439.
non Meunier, 1910, pl. 1, fig. 38 - 40 (= *P. leonis*).
non Meunier, 1919, p. 38, figs. 8 - 16, 18 - 22.
= *P. acutangulum* (Lemm.) Jörgensen, 1912.
= *P. conicum* var. *bilobata* (Meunier) Schiller, 1929, p. 399, fig. 11.
= *P. conicum* f. *ceylonica* Matzenauer, 1933, p. 455. fig. 28 *c*.

Cell nearly symmetrical, flattened dorso-ventrally. Epitheca triangular in ventral view, with straight or slightly convex sides. Hypotheca and epitheca sub-equal. Hypotheca with two hollow horns filled with plasma, without spines. Girdle almost circular, slightly sinistral, excavated, supported by narrow lists. Intercalary striae often broad, especially on the sutures between the second and third apicals and the second and sixth precingulars; these form two conspicuous ridges characteristic of this species as in *P. leonis* Pavillard. Sulcus reaching to beyond the centre of the hypotheca with inconspicous lists. Theca sculpture finely reticulate. Colour pinkish to colourless, probably saprophytic. Diameter of cell 70-80μ. The sutures between the plates 1', 2' and 1'', 2'' and their anologues on the right side run straight.

In cold and warm waters; Red sea, Gulf of Aden, Arabian Sea, Indian Ocean, Australian waters; N. W. of Spain; USSR waters.

Peridinium conicum f. *guardafuiana* Matzenauer, 1933
(Pl. XLIV figs. 2 - 9)

Matzenauer, 1933, p. 455, fig. 28 *a*, *b*.
Schiller, 1937, p. 234, fig. 231 *a* - *d*.
Subrahmanyan, 1958, p. 439.

Distinguished from the species by the elongated (larger) hypotheca; longer right posterior horn; presence of a small membrane spanned between the horns.

Indian Ocean; Adriatic.

Peridinium heteroconicum Matzenauer, 1933
(Pl. XLVII, figs. 1 - 3)

Matzenauer, 1933, p. 459, fig. 34 *a* - *c*.
Schiller, 1937, p. 235, figs. 234 *a* – *c*.

Epitheca cone-like, appears sunk on cone-like hypotheca. Girdle hollow; sulcus broad and deep. Surface finely reticulate. L = 35μ; B = 45μ. Peculiar species.

Indian Ocean.

Peridinium humile Schiller, 1937
(Pl. XLVII, fig. 10)

Schiller, 1937, p. 235, fig. 235.
Subrahmanyan, 1958, p. 439.
= *P. decipiens* Jörgensen, 1899 ? Matzenauer, 1933, p. 458.

Cells broader than high, 50μ long 75μ broad, 65μ deep. Epitheca flatly conical; hypotheca lower, deeply indented by sulcus. Both posterior horns short, their end pointed.

Somewhat similar to *P. pentagonum*, however, distinguished by the closely placed antapical points.

No figure in Matzenauer as quoted by Schiller (1937).

Indian Ocean.

Peridinium leonis Pavillard, 1916
(Pl. XLIII fig. 1 - 13; pl. XLIV, fig. 10 - 14)

Pavillard, 1916 *a*, p. 32, fig. 6.
Forti, 1922, p. 89, fig. 80.
Lebour, 1925, p. 112, pl. 21, fig. 1 *a* - *d*.
Dangeard, 1927 *c*, p. 349, fig. 14 *b* - *c*.
Schiller, 1929, p. 401, fig. 13; 1937, p. 236, figs. 236 *a* - *m*.
Matzenauer, 1933, p. 456, fig. 29 *a*.
Kisselev, 1950. p. 196, figs. 333 *a* - *b*, 334, *a* - *e*.
Gaarder, 1954, p. 46.
Subrahmanyan, 1958, p. 439.
= *P. saltans* Pavillard, 1915.
= ? *P. typus* Fauré-Fremiet, 1908, p. 222, fig. 8; pl. 15, fig. 7.
= *P. conicum* Meunier, 1919, pl. 17, figs. 8 - 13, 18, 19.
= *P. pentagonum* Dangeard, 1926, p. 320, fig. 9.
= ? *P. striatum* Böhm, 1931, p, 192, fig. 7. *non* Ostenfeld *et* Schmidt 1901.

Cells in ventral view rhombic, 65-95μ long, 75-80μ broad, side contours slightly or decidedly concave. Epitheca three edged tapering to a point; hypotheca set out into two blunt wedge-shaped horns, between which lies a deep notch and which ends in two short, more or less, robust spines. Girdle more or less slightly sinistral and according to Pavillard perpendicular to the long axis. This is not so with the figures of Meunier (1919), Dangeard and Paulsen (1930), which Paulsen denotes as belonging to this species. Apical opening double and long, laterally from which are two small spine like bulges at the corner junction of plates (3'); they serve to support a low tender winged membrane which extends dorsally all along the plates 6'' and 4', and 2' and 2'' and contacts the reverse pore. This membrane coincides approximately with the sagittal plane. The line below the named plates runs here zig-zag in *P. conicum* and *P. pentagonum;* on the other hand straight - a good distinguishing character. Plates with reticulate meshes, striated rough to spiniferous, rarely ribbed.

The wing - membrane is specified by Paulsen not, however, by Pavillard and Lebour. He also shows the left side contour of epitheca convex and the left girdle half steeply mounting. This variability is thus significant and peculiar to this species.

Warm water form, coastal and high seas; Atlantic; Mediterranean; Indian Ocean, Arabian Sea, Bay of Bengal.

Peridinium leonis f. *matzenaueri* (Matz.) Schiller, 1937
(Pl. XLIII, fig. 10; pl. XLIV, figs. 15 - 19; pl. XLV, figs. 1, 2, 12, 13; pl. XLVI, fig. 1)

Schiller, 1937, p. 239, fig. 238 *a, b.*
= *P. leonis* Pavillard in Matzenauer, 1933, p. 456, fig. 29 *b, c.*
= *P. divergens obtusum* Karsten, 1906, p. 149, pl. 23, fig. 12. — Schiller, 1937, p. 240, fig. 241 *a, b.* - Gaarder, 1954, p. 47, - Subrahmanyan, 1958, p. 439. *non* Schiller, 1929, fig. 12.

Differs from the species in having epitheca rounded, plates sculptured with undulating ribbs. Relationship to type is easily judged by some transitional forms.

Indian Ocean; Atlantic.

Peridinium marielebourae Paulsen, 1930.
(Pl. XLV, figs. 3 - 11; pl. XLVI, figs. 2 - 12)

Paulsen, 1930, p. 239, fig. 40.
Schiller, 1937. p. 239, fig. 239 *a-i.*

Kisselev, 1950, p. 198, fig. 336 *a-d.*
Taylor, 1966, p. 461.

= *P. obtusum* Lebour, 1925, p. 121, pl. 24, fig. 2, - Fauré - Fremiet, 1908 p. 223, fig. 9, pl. 15, fig. 8.

non P. divergens obtusum Karsten, 1906, p, 149, pl. 23, fig. 12. - Schiller, 1929, p. 400, fig. 12 *a-d.*

Cells similar to *P. leonis;* however, smaller and more flattened dorso-ventrally. Girdle circular or slightly sinistral excavated with or without winged lists supported by spines. Sulcus reaches well into posterior end. Hypotheca with two hollow horns each having terminal spines. Theca spiny or according to Fauré-Fremiet striated. Plate 2*a* four edged (six edged ? Fauré - Fremiet). Plasma pinkish. Probably saprophytic. L = 50—55/μ.

Atlantic coast of Europe; Mediterranean; Indian Ocean; USSR waters.

Peridinium matzenaueri (Matzenauer) Gaarder, 1954
(Pl. XLI, figs. 9 - 11)

Gaarder, 1954, p. 45, fig. 60 *a-c.*
= *P. conicum* f. *concava* Matzenauer, 1933, p. 455, fig. 28*d*; Schiller, 1937, p. 234, fig. 232.

Epitheca and hypotheca slightly concave, between the posterior horns a deep indentation present so that the delimitation of plates 7''''-2'''' disappears. Posterior horns on the inside convex, carrying a small outwardly directed process. Cells smaller than *P. conicum.* L = 58μ, D = 55μ. Length of indentation = 15μ.

Several characters of this *Peridinium* described as a *forma* by earlier authors (Matzenauer, Schiller (*l. c)* are very distinct and the writer agrees with Gaarder (*l.c*) in raising it to a species. "The side lines of both the epitheca and hypotheca are distinctly concave; and, while the girdle of all other *formae* of *P. conicum* is circular or slightly left handed, that of the present form is slightly right handed. The greatest deviations, however, lie in the shape of the antapical horns. Matzenauer points out the convex contour of their inside and their being furnished with 'einen auswärts gerichteten kleinen

Stachel' (*l.c.*).* In ventral view as in Matzenauer's fig. 28*d* and in the present fig. 60*a*[1]; (Gaarder (*l.c.*,) this description seems to be correct. The side view, however, (fig. 60 *c*)[3] and the antapical view (fig. 60*b*)[2] reveal the real nature of these short spines. They represent the profiles of narrow lists, supported by spines, running along the rim of the antapical excavation and slightly bending outwards" (Gaarder, *l.c.*).

Indian Ocean; Adriatic; N. Atlantic.

Peridinium pentagonum Gran, 1902
(Pl. XLVII, fig. 4-9; pl. XLVIII, figs. 1-3)

Gran, 1902, pp. 185, 190, fig. 15.
Paulsen, 1908, p. 59, fig. 76; 1930, p. 71.
Meunier, 1919, p. 34, pl. 16, figs. 46-50.
Lebour, 1925, p. 112, pl. 20, fig. 1 *a-e*.
Conrad, 1926, p. 96, pl. 2, fig. 41 - 42.
Dangeard, 1927 *c*, p. 349, fig. 14 *a*.
Abé, 1927, p. 409, fig. 28.
Pavillard, 1931, p. 54, pl. 2, fig. 4.
Matzenauer, 1933, p. 457.
Schiller, 1937, p. 241, fig. 242.
Kisselev, 1950, p. 198, fig. 337 *a* - *e*.
Wood, 1951, p. 253, fig. 150 *a*.
Gaarder, 1954, p. 48.
Subrahmanyan, 1958, p. 439.
= ? *P. divergens* var. *sinuosa* Lemmermann 1899, p. 368.
= *P. sinuosum* Lemmermann 1905, p. 32.
= ? *P. divergens pentagonum* Karsten, 1906, pl. 23, fig. 11 *a* . *b*.

Cells asymmetrical, five-edged, right side smaller than the left, slightly compressed dorso-ventrally, 75 - 100μ broad and long. Girdle median, running left regularly or somewhat irregularly ventrally, their ends slightly displaced beset with conspicuously broad lists. Sulcus short rounded towards posterior, often on the right side with a pointed notch, normally not reaching upto the lower end. Posterior horns more or less developed, generally with two solid processes, between them a shallow notch with almost straight or somewhat irregular contour, or with deeper notch with almost cresent shaped outline. Dorsoventrally moderately compressed with yellowish brown chromatophores.

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* "an out wardly directed small spine"

1. Pl. XLI, fig. 10.
2. Pl. XLI, fig. 9.
3. Pl. XLI, fig. 11.

In cold as well as warm waters of all seas. Indian Ocean, Arabian Sea, Bay of Bengal; Boeton Straits; N Australlia, Victoria.

Peridinium pentagonum var. *latissimum* (Kofoid) Schiller, 1937
(Pl. XLVIII, figs. 4 - 11; pl. XLIX, figs. 1 - 10)

Schiller, 1937, p. 242, fig. 243 *a - j*.
Wood, 1954, p. 253, fig. 150 *b, c*.
= *P. latissimum* Kofoid, 1907 *a*, p. 175, pl. 5, fig. 31, 32. — Pavillard, 1931, pl. 2, fig. 5. — Matzenauer, 1933, p. 450, fig. 30.
= *P. pentagonum* var. *depressum* Abé, 1927, p. 409, fig. 29.

Dorso-ventrally strongly compressed and middle deeply furrowed, dorsal side arched. Asymmetry also seen in that, whole of the right half is more or less larger. L = 69 — 110 μ; B = 79 — 125 μ; Depth, 35 μ.

Matzenauer has studied well the forms coming under this in the Indian Ocean. It follows that Kofoid's species *P. latissimum* at best is to be considered as a variety of *P. pentagonum*.

Abè's account is later to Kofoid's.

In the Pacific and Indian Oceans; coast of Japan; western Australia.

Peridinium achromaticum Levander, 1902
(Pl. L, figs. 1 - 7; pl. LI, fig 1; pl. LII, figs. 7, 9 - 16)

Levander, 1902, p. 49, figs. 1, 2.
Lemmermann, 1905, p. 27; 1910, p. 666, figs. 11 - 13.
Schilling, 1913, p. 43, fig. 50.
Lebour, 1925, p. 114. pl. 22, fig. 1 *a - g*.
Abé, 1927, p. 412; fig. 31.
Woloszynska, 1929, p. 261, pl. 12, figs. 5 - 9.
Matzenauer, 1933, p. 457 (name only).
Schiller, 1937, p. 229, fig. 225 *a . h*.
Kisselev, 1950, p. 195, fig. 330 *a - e*.
Balech, 1963, p. 112, figs. 1 - 10.

Cells small, contour more or less pentagonal, with clear posterior socket. Ortho, hexa. Girdle very prominent, circular and very slightly descendent, with cingular membrane slightly or not at all developed. Without neck or apical horn; and antapical spines small.

Epi - and hypo - theca approximately the same length. Epitheca conical and sideways somewhat sinuous, making convex angle with outside, very

clearly of medium height. Outline of apical pore prominent, but frequently asymmetrical. Apical canal of medium height, well visible. Plate 1′ with lateral angle lofty, so that an inferior (low) triangle results, the height almost double that of (superior) above; it at first remains well truncate with concave truncation, at sight somewhat asymmetrical; first plate, moreover, solely is slightly asymmetrical in respect of median sagittal plane, a little more prominent than the right side. Plates 1″ and 7″ subequal, tall. Plates 2′, 3′ and 4′, especially 2′ and 4′ rather large. Intercalaries relatively narrow, same as 4″.

Hypotheca, in frontal view, sideways almost convex or sinuous, with antapical contour sunk like low neckline more abruptly to the left, and two spines which are to be seen only in correct frontal position, the right moreover, is a little more robust. Postcingular 1‴ shaped like a truncated holster; 5‴ more broad, trapezoidal. Plate 3‴ clearly asymmetrical, relatively cut in a transverse sense. 2‴ and 3‴ much more extended.

Cingulam rather broad, very much deep, with edges slightly prominent, without real fins; C_1 very short; C_5 short, more or less narrow and high.

Sulcus narrow; well expanded backwards; forming a socket, very short, but extended into the epitheca.

S. a. — Anterior border broadly truncate; right margin divided into two parts by a strong angle; the anterior a little more short, its twin subdivided into another two least pronounced; the posterior, markedly oblique and slightly convex. The posterior border, short and slightly concave, is reinforced, but apophysis without shape, or perpendicular branch. Left border concave, almost sinuous.

S i. — rather large, shaped like J, without margin really reinforced; its anterior is inclined, a little sinuous, and terminates inwards in a spine scarcely noticeable; the internal border or dorsal is regularly concave. The posterior internally is much short, without spine; the external shows an angle very slightly marked, which significantly is equal to the beginning of the *S. p.* a beginning of posterior apophysis. Neither pores nor punctations observed.

S. d. — simple, body broad, almost plane with neck very well developed, the borders internal and external regular and smoothly concave, much more the internal; internal border of body with iusufficient reinforcement but well visible still in a clean sample; posterior very oblique, almost concave; right or external rectum, a part slightly denticulate.

S. p. — shaped like a horse shoe, with right branch more large and covering all, much more wider than left; the union of both and posterior

margin tokens more clearly for a marked circle. Between *S. p.* and the border internal-posterior of *S. i.* there is a small platelet, narrow, almost curved.

Sculpture of plates of epi-and hypo-theca exhibits a form of granules irregular in shape and distribution, which frequently show a tendency for fusion and consequent formation of short irregular vermiculations that recall rather those of *P. obtusum.*

In the preserved samples, the protoplast lacks (Balech says) chloroplasts, but shows a peculiar refringence. Nucleus generally large and elongated transversely to the height of the cingulam.

Dimension: L = 33.5 — 40 μ (without spines); spines = 1.5 — 2μ. Height of posterior socket 4.5 — 6μ; transverse diameter 26.5 — 32 μ, generally 28-29/μ. Separation between spines 11–12 μ. The species is slightly flattened dorso-ventrally; in a specimen of tr. d. 31.5 μ, the thickness is about 29 μ.

As in other species of fresh and salt-waters, one encounters here also variations of importance in the tabulation. The large majority responds to the enunciation of the ventral plates, as much the epitheca as the hypotheca, staying constant, not so the dorsals. Here evidently a speciemen quadra and some hardly hexa, but, more important than this here is encountering an individual with only two intercalaries (because of it referred to a distinct subgenus). In another theca total fusion of 2*a* and 3′ was observed, with large alteration in the shape of other two intercalaries (Pl. LII, fig. 16). The asymmetry of the hypothecal plate 3‴ rather varies.

According to Levander's figures, only two anterior intercalaries separated by the fourth precingular are seen. Ostenfeld also found specimens with two intercalaries only. Schilling (1913) indicates a third dorsal plate- intercalary with a querry. In the Plymouth specimens (Lebour, 1925) this third intercalary is clearly present.

In brackish, fresh and sea water; North sea; East Sea; Aral Sea; Pacific and Indian Oceans; USSR waters.

Peridinium biconicum Dangeard, 1927
(Pl. XLIX, figs. 11 - 15)

Dangeard, 1927 *a*, p. 11, fig. 7; 1927 *c*, p. 349, fig. 15.
Paulsen, 1930, p. 72, fig. 44.
Matzenauer, 1933, p. 458, fig. 33.
non Abé, 1927, p. 416, fig. 34.

Schiller, 1937, p. 230, fig. 227 *a* - *c*.
= *P. biconicum* f. *elegans* Böhm, 1931, p. 194, fig. 14.
non *P. biconicum* Abé, 1927.

This species is easily identified by its shape. The hypotheca is in the shape of a cone and it terminates in a point towards the bottom in the same manner as epitheca in reverse; the body is, therefore, divided into two symmetrical parts in the equatorial plane. The ventral depression is not perceptible except on the anterior part of the hypotheca. No other marine *Peridinium* sp. presents a parallel arrangement.

Tabulation is that of a *Orthoperidinium* having a median dorsal plate *a* confined to a sole pre-equatorial plate (group *Oceanica*). Girdle circular and excavated, with a slight notch to the ventral side, but it is not displaced in height; the sulcus is rather broad and short, rounded at its base, devoid of wings and spines. Membrane furnished with rounded punctations and little projections. Length 60μ.

Tropical Atlantic; Indian Ocean.

Peridinium subinerme Paulsen, 1904
(Pl. L, figs. 8 - 14; pl. LI, figs. 2 - 15; LII, figs. 1 - 5, 6, 8)

Paulsen, 1904, p. 24, figs. 10; 1907, p. 18, figs. 26-27; 1908, p. 60, fig. 78; 1930, p. 71, fig. 42.
Broch, 1910, fig. 28.
Meunier, 1910, p. 40, pl. 2, figs. 43, 44; 1919, p. 43, pl. 17, figs. 36 - 40.
Lebour. 1925, p, 114, pl. 22, fig 2.
Dangeard, 1926 *c*, p. 320, fig. 8 E; 1927 *c*, p. 349, fig. 14 *d*.
Peters, 1928, p. 52, fig. 15.
Schiller, 1929, p, 402, fig. 16; 1937, p. 243, fig. 244 *a* - *o*.
Kisselev, 1950, p. 200, fig. 338 *a*, *b*; fig. 342 *a* - *g*.
Wood, 1954, p. 254, fig. 151.
Silva, 1955, p. 36, pl. V, figs. 4, 6.
Subrahmanyan, 1958, p. 449.
= ? *P. punctulatum* Lindemann, 1924 *g*, p. 232, figs. 91 - 95.
= ? *P. multistriatum* Kofoid, 1907 *b*, p. 310, pl. 30, figs. 40, 41.
= *P. subinerme* f. *asymmetrica* Matzenauer, p. 458, figs. 31.
= *Peridinium subinerme* Paulsen var. *punctulatum* (Paulsen) Schiller, 1937, p. 245, fig. 245 *a*, *b*.
= *P. punctulatum* Paulsen, 1907, p. 19, fig. 28; 1908, p. 61, fig. 79; 1930, p. 72, fig. 43. - Mangin, 1911, pl. 8, figs. 6, 7. - Carisso, 1911, pl. 3, fig. 22. - Pavillard, 1916, p. 32; 1931, p. 58.

Meunier, 1919, p. 42, pl. 17, fig. 32–35 - Lebour, 1925, p. 123, fig. 37- Dangeard, 1927 *c*, p. 354, fig. 20 *e, f* - Matzenauer, 1933, p. 458.
= *P. punctulatum* f. *asymmetrica* Matzenauer, 1933, p. 458, fig. 32.
= *P. multipunctatum* Fauré-Fremiet, 1903, pl. 16, fig. 14.

Cells bilaterally symmetrical, in girde aspect square. The hypotheca is always at least same size as the epitheca. The shell of the older individuals is frequently uneven and angular. The lower part of the sulcus lies in a depression which can be more or less deep and broad. In some cells it stands out, very strongly as in *P. inaequale* (Pl. LII, figs. 1.2,3,5).The emarginate lower part of the cell body can / *or* / not / have processes (Peters, 1928, fig. 15 *a - c*; 15 *f* and *d*; here Pl. L1, figs. 2-9; 11-15).

The size of *P. subinerme* varies. The length between 60 and 103 μ. The length - breadth ratio is proportionately stable. Mostly the breadth is about same as length, rarely is it greater (at least 90 % of length). Within this range one can distinguish slender and broader cells. The greatest frequency of size variation lies somewhat between 80 - 90μ breadth. In the literature, the size of *P. subinerme* is stated to be 40 - 72 μ. If one were to judge by the figures of Broch (1910) the individuals observed must be about 85 μ. The surpassing size of Antarctic specimens is perhaps principally because they are older individuals, whereas earlier authors perhaps have seen younger specimens as is evident from the lesser width of the intercalary zones in their figures.

The surface of the membrane is sometimes coarse and punctate, sometimes rather smooth. A prominent striation of the surface was always only apparent and becomes brought about by nothing further than the extraordinarily broad intercalary striae.

The plate arrangement of *P. subinerme* shows on the ventral side *Orthoperidinium* type (Pl. L1, fig. 7) and on the dorsal that of Section *Conica* (Pl. L1, fig. 14). The asymmetrical variations form of dorsal tabulation as it has hitherto been given for *P.punctulatum* is not found in the Antarctic material. With the appearance of intercalary striae in this species at different places, the original shape of certain plates becomes changed. Thus disappears, *e.g.* very soon, the limitation of plates 1''/2'' and 7''/ 4' on the ventral side as well as the border 2 *a*/3'' and 2*a*/5'' on the dorsal side, so that a false impression is created as a meeting together of four sutures at the mentioned place, what, as is known, should not occur in *Peridinium* species (Barrows). The form changes of the plates through the disappearance of former small sutures permits it to be traced back that strongly cross-striated false striae are formed and become partly pushed under the plates, through which the cross striation then appears throughout. Just as in *P. variegatum* so also in *P. subinerme* the length of the

suture 3 '''' / 1 '''' fluctuates and thereby also the size of the antapical end plates 1 '''' and 2 ''''.

Intercalary striae become well developed in most individuals. Only a few quite small individuals possess simple sutures. In the middle of the intercalary striae appear frequently three, rarely two punctate lines, which run parallel to the plate margin. It is probably the line of overlapping false striae. Contrary to Peters' observations on Antarctic material Broch (1910) has on the northern forms, seen only narrow intercalary striae between plates 1'/2' and 1'/4', between the remaining apical end plates, however, none at all which he advances as a characteristic mark for the species, what according to Peters' opinion, however, occurs only in young or slightly grown forms investigated by him. Besides, in *P. subinerme* also the suture of the sulcus participates in the growth and one can observe frequently growth striae on the suture of the girdle on the ventral side. The formation of the broad intercalary zone between the antapical end plates 1'''' / 2 '''' is striking, which adds to the widening of the posterior end (*cf.* Peters 1928, p. 98, fig. 29*f*).

Still broader intercalary striae than that are represented as in fig. 15*d* (Peters 1928), have not been observed in *P. subinerme*. Whether such forms have reached the zenith of their possible growth, is questionable. Perhaps *P. multistriatum* Kofoid (Kofoid. 1907, pl. XXX, fig. 40 and 41), represents a still further grown sample of *P. subinerme*. This species agrees radically in all respects with *P. subinerme*. The proportionately short sulcus which according to Kofoid's figure is only somewhat half as long as the lower cell half, one could perhaps advance as a distinguishing character; but when one considers the figure 15*f* (Peters, 1928), that in *P. subinerme* the intercalary striae bounding the longitudinal furrow below becomes so broad, as they are in the case of the figure of Kofoid for *P. multistriatum*, then the sulcus compared with the size of the hypotheca is considerably shortened Also the weaker development of the intercalary striae 1'/7'' and 1'/1'' in *P. multistriatum* permits only of a subordinate significance. All in all, Peters holds it probable, that the forms of *P. multistriatum* Kofoid, represent quite old individuals of *P. subinerme*.

Remarks

The species *P. subinerme* and *P. punctulatum* have been created by Paulsen as two closely related forms, which are distinguished by small significant characters, which as is known now considerably vary. Jörgensen (1912) doubted the validity of both species.

Both species *P. subinerme* and *P. punctulatum* are closely related and belong probably to the same species for which Peters chose the name *P. subinerme* since this species appears to represent the best developed form.

Also Lindemann (1924) cast doubts on the correctness of these two species: "The relationships are not quite clear." He mentions a form from the Bosphorus explicitely under the name *P. punctulatum*, because the same has a punctate membrane surface, which peculiarity has given the name *P. punctulatum* Paulsen to it.

Meunier (1919) considers both species again separate and emphasizes for *P. punctulatum* that on the asymmetrical arrangement of the dorsal tabulation (it is a question of leftward oblique variations form) this species is differentiated from *P. subinerme* which exhibits always the symmetrical dorsal tabulation.

Lebour (1925) supports the statements of Meunier and separate[8] explicitely under same grounds the two species, though she inconsequentially, in another species (e.g. *P. ovatum*) unites both variations forms, (the symmetrical and the asymmetrical) into one species.

As against Meunier and Lebour, Peters holds it not justified to specifically separate the two species, based on symmetrical and asymmetrical forms which are already known now to exist in ten other species. However, the distinguishing characters given by Paulsen for *P. subinerme*, which have already been doubted by Jörgensen and Lindemann, are according to Peters' observations on Antarctic material not present in reality; hence, the two species known as *P. subinerme* and *P. punctulatum* were combined by Peters and designated with *P. subinerme*, earlier name.

Schiller states that the punctation of the membrane and the small processes at the end of the sulcus margin are naturally accessory formations, not even suitable for differentiation of *forma*, and are of no systematic significance. In spite of this he considers *P. punctulatum* Paulsen as a variety of *P. subinerme* Paulsen. The present author agrees with Peters.

Boreal or Arctic form; south Greenland, Iceland; Barents and Kara seas; Skaggerak, North Sea; English Channel; Antarctic Convergence, Weddel sea; Indian Ocean, Arabian Sea, Bay of Bengal.

Peridinium turbinatum Mangin, 1922
(Pl. LIII, figs. 1-7)

Mangin, 1922, p. 81, fig. 20.
Wood, 1954, p. 254, fig. 153.
Schiller, 1937, p. 247, fig. 246.
Balech 1958 *a*, p. 91, pl. 6, fig. 141 - 150; 1958 *b*, 389, pl. II, figs. 45 - 51; 1959, p. 20

= *P. inaequale* Peters, 1928, p. 59, fig. 16.
non *P. inaequale* Fauré-Fremiet, 1908, p. 229, fig. 15.

This species is rather frequent in the plankton of Terre Adelie. This is a species rather large, very broad, epitheca conical. Ortho, slightly hexa (also positively very slightly penta) circular or slightly descending, girdle strongly excavated, without horns, with small antapical projections, having the shape of small spines. In apical view one perceives a double contour of the girdle. The dorsal tabulation of the epitheca recalls to mind, a small cell of *P. conicum*. 3′ rather high; 1″ and 7″ nearly of same height, but 7″ is more broad; 3‴ symmetrical, with posterior angle projecting very little. *S. a.* long and narrow, with posterior branch perpendicular to mean length, rather narrow. *S. i.* is broad with solely a rough shaping of dorsal spines, having its posterio-dorsal side badly delimited from the ventral margin and its anterior side almost rectilinear; the plate is almost without reinforcement. *S. d.* is rather simple, particularly without membrane *S. p.* rather large in the shape of a lower maxilla.

Lenth 65-70μ; diameter 65-77μ; height of hypotheca is equal to half the epitheca.

The specimens encountered by Balech are relatively much larger than those described by Mangin, but Peters has observed at the same time much larger and much smaller specimens. The specimens have been collected earlier in the same region with some small differences also. Plate 1′ is wider and lateral angle smaller; other differences negligible. Sulcal plate thin, more angular and without round lobule and clear cut. However, differences too small for systematic value.

Antarctic region of Indian Ocean; Heard Island.

Section *Oceanica* Jörgensen

Antapical horns hollow. Epitheca with concave sides, tapering into a long or short apical horn. Girdle sinistral forming an oblique angle with the longitudinal axis. Tabulation : Ortho, mostly quadra, but also penta and hexa.

P. oceanicum and *P. depresssum* figured by Mangin (1911, 1913) are wrong. *P. pustulatum* Karsten is represented as meta by Karsten (1907, p. 417, pl. 52, fig. 5 *a, b.*) but description does not mention this.

Barrow's (1919, pl. 20, figs. 7 - 8) figure of *P. oceanicum* shows it to be para (closely related to a race of *P. deprsseum* Bailey?). Dangeard (1927 *c*, fig. 1) represents a "*P. depressum*" (?) Para.

P. grande, *P. elegans*, *P. fatulipes* and *P. tumidum* being meta are placed under Section *Divergentia*.

1. Cells depressed, girdle oblique to longitudinal axis :

P. brachypus Schiller.
P. depressum Bailey.

2. Cells not depressed :

(a) Cells nearly as broad as long, antapical horns thick and of unequal length :

P. claudicans Paulsen.

(b) Cells with long, thin antapical horns and elongated apical horn :

P. murrayi Kofoid.
P. oceanicum Vanhöffen.

Peridinium brachypus Schiller, 1937
(Pl. LIII, fig. 11 ; pl. LVI, fig. 12)

Schiller, 1937, p. 248, fig. 249.

Epitheca similar to that of *P. elegans* f. *granulatum*. Hypotheca, however, presents quite other features : both horns very short, thin, with short spine. The horns are the continuations of the head-like prominence of the hypotheca, over which ventrally the sulcus with winged margin runs. Length 100-130μ ; breadth 97-110μ.

Indian Ocean, Sumatra waters, Arabian Sea.

Peridinium depressum Bailey, 1885
(Pl. LIII, figs. 8 - 10, p. LV, figs. 1-10, dl. LVI, figs. 1 11; LXXVIII, figs.1, 2 & 4.)

Bailey, 1855, p. 12, fig. 33 - 34.
Jörgensen, 1899. p. 36; 1905, p. 109; 1913, p. 56.
Ostenfeld, 1900, p. 57.
Cleve, 1900 *b*, p. 257.
Gran, 1902, pp. 186, 191 - 192; 1933. pp. 162, 180.
Van Breeman, 1905, p. 43.
Broch, 1906, p. 151-157, fig. 1; 1908, p. 5; 1910 *a*, pp. 51-52, fig. 26.
Paulsen, 1907, pp. 11 - 15; 1908, pp. 39. 53, fig. 67. 1913, pp. 276 - 279, pl. 46; 1930, pp. 55, 68.
Meunier, 1910, p. 27.

Mangin, 1913, pp. 158-160, 162-64, 166-169, 171, 171-73, 187, 220-222, fig. 9.
Pavillard, 1916, p. 31; 1931; pp. 55, 64-65, *et seq.* pl. 2, figs. 6A - 6 E.
Forti, 1922, pp. 89, 188, 207, fig. 81.
Lebour, 1925, p. 119, pl. 23, figs *a* - *f*.
Dangeard, 1926 *c*, p. 322, fig. 10; 1027 *b*, p. 2, figs. 1A-1 C.
Peters, 1928, p. 63, figs. 17, 18, 20.
Matzenauer, 1933, 462.
Schiller, 1937, p. 250, fig. 251 *a* - *t*.
Graham, 1942, p. 18, fig. 14.
Kisselev, 1950, p. 203, fig. 340 a-e; 344 a-e.
Wood. 1954, p. 255, fig. 165 *a*, *b*.
Gaarder, 1954, p, 41.
Subrahmanyan, 1958, p. 439.
Ballantine, 1961.
Taylor, 1964, p. 461.
non Okamura, 1912, pl. 4, figs. 60 62.
non Dangeard. 1927 *c*, p. 351, fig. 17 *b*, *a*?

= ? *P. divergens* var. *reniforme* Ehrenberg, 1834 *a*, p, 240; Pouchet 1883. p. 40, pls. 20, 21. figs. 24 – 27; Meunier, 1910, p. 23, pl. 1, figs. 1-4,

= *Ceratium divergense* Claparéde *et* Lachmann 1861, p. 71, pl. 13, fig. 23.

= *Peridinium divergens* Bergh 1881 *a*, pp. 63 *et seq.*; 1881 *b*, pl. 15, fig. 45; ?Stein 1883, pl. 11, figs 1, 2; Vanhöffen, 1897 *a*, 267 - 268. pl. 5, fig. 1; Cleve 1900 *a*, figs. 16, 17; Meunier, 1910, p. 23, pl. 1, fig. 1 - 8; pl. 1 *b* figs. 1 - 8; pl. 2, figs. 45, 46; 1919, p. 12 – 14, pl. 15, fig. 1 - 5., Lebour, 1917, p. 186.

= *P.divergens* var. Pouchet, 1883. p. 40, pls. 20, 21, fig. 23; *non P. divergens* var *typus* Pouchet, 1883, p. 38, pls. 20, 21, figs, 20, 21; Ostenfeld, 1899, pp. 60, 84.

= *P. divergens* var. Schütt, 1895, pl. 13. figs. 43 (22, 23). 43 (24); Meunier, 1910, pl. 1, figs. 1, 2, 3, 4, 7, 8.

= *P. divergens* var. *depressa* (Bailey) Aurivillius; 1898, p. 55; Ostenfeld, 1899, pp. 60, 70.

= *P. elegans* Cleve, 1900 *a*, (in part), pl. 7, fig. 16.

= *P. depressa* Ostenfeld, 1900.

= *P. parallelum* Broch, 1906, pp. 153 - 57, fig. 2; 1908, p. 5; 1910 *a*,p. 52., Paulsen, 1907, p, 11, 15; 1908, pp. 39, 54, fig. 68; 1913, p. 279, pl. 47. Mangin, 1913, p. 221: Pavillard, 1913, pp. 56, *et seq.*, pl. 2, fig. 7 A,B;

= *P. antarcticum* Schimper in Karsten, 1905, pp. 37 *et seq.* pl. 19, fig. 1 - 4; Broch, 1906, p. 153; Paulsen, 1913, p. 55.

= *P. depressum* subsp. *parallelum* Broch, 1906, p. 151.
= *P. complanatum* Karsten, 1907, p. 416, pl. 53, fig ; 4 *a, b.*
= *P. divergens antarcticum* Karsten, 1907, pp. 225, 416.
= *P. (divergens) pustulatum* Karsten, 1907, p. 417, pl. 52, fig. 5 *a. b.*
= *P. kofoidii* Fauré - Fremiet, 1908, p. 224, 226, fig. 11. pl. 16, fig. 12 ; Mangin, 1913, p. 22.
= *P. marinum* Lindemann, 1925 *a*, pp. 98 - 99, figs. 7 - 11.
= *P. depressum* var *travectum* Lindemann, 1925, *a*, p. 99, fig. 12.
= *P. depressum* var. *parallelum* (Broch) Graham, 1942, p. 21, figs. 21, 22.
= *P. depressum* var *rectius* Graham, 1942, p. 22, fig. 25.
= *P. depressum* var. *convexius* Graham, 1942, p. 23, fig. 26.
= *P. depressum* f. *bisintercalares* Graham, 1942, p. 23, fig. 27.
= *P. depressum* f. *multitabulatum* Graham, 1942, p. 23, fig. 28.

Graham (1942, p. 18 *et seq*) gives a very detailed description of the species as also the varieties and formae he has recognized. For the present purpose, it is felt, the following description with the figures given, would suffice for diagnosis.

Cell short and broad, flattened obliquely dorsoventrally. Axis very oblique. Conspicuous apical horn. Girdle slightly left - handed, hardly excavated with broad membranous lists strengthened with fine spine-like thickenings scattered irregularly. Hypotheca with two long hollow antapical horns, each provided on the inside with a tooth, which is continuous with each side of the furrow. Theca reticulated. Intercalary striae large or small. Plasma colourless or pinkish, often with large oil globules. Pusule very large. Probably saprophytic. Diameter 116 - 144μ; length 116 - 200 μ.

Varieties and formae have been created based on slight differences in shape, extent of left side of the body, curving forward to a point about half way to the left side of the body, where it begins to turn gradually backward. This backward curvature is continued entirely around the body so that the distal end of the girdle terminates on the right side of the sulcus from 1.5 to 2.5 girdle widths behind the proximal end. This does not represent the maximum displacement of the girdle, however, which occurs between the distal end and the front of the curvature to the left of the sulcus.

In all the Oceans, cold and warm waters, neritic and oceanic . USSR waters also. Arabian Sea, Bay of Bengal, Indian Ocean.

Peridinium claudicans Paulsen, 1907
(Pl. LVII figs. 1 — 11).

Paulsen, 1907, p. 16, fig. 22; 1908, p. 55, fig. 71; 1930, p. 67, fig. 38.
Barrows, 1918, pl. 19, figs. 5 - 6.
Lebour, 1925, p. 123, pl. 25, fig. 1.
Lindemann, 1924 *e*, p. 2?8, figs. 63 - 64.
Schiller, 1937, p. 249, fig. 250 *a - g*.
Kisselev, 1950, p. 202, fig. 339 *a, b*, 343 *a, b*.
Wood, 1954, p. 255, fig. 154.
Gaarder, 1954, p. 439.
Subrahmanyan, 1958, p. 439.
=*P.* sp. Fauré-Fremiet, 1908, p. 224, fig. 10.
=*P. obliquum* Dangeard 1927 *c*, p. 353, fig. 19; Matzenauer. 1933, p. 463, fig. 44.
=*P. oceanicum* f. *claudicans* Meunier, 1919, p. 17, pl. 15, fig. 22 - 23.

Shape somewhat like *P. oceanicum*, but shorter and broader, with right posterior horn longer than the left; the posterior horns diverge more. Plasma light yellow to colourless. Girdle sinistral, slightly excavated with fairly conspicuous lists. Ventral plates similar to *P. oceanicum*; dorsal plates with the second anterior intercalary touching precingulars 3 and 4, therefore, belonging to the Section *Tabulata*. Plate 2 *a* often displaced left, 4 to 6 sided. Length 51 - 105μ.

Not easily distinguishable from *P. oceanicum*. The figures given by Paulsen in his accounts (1908, 1930) differ considerably. Lindemann (1924) figures a slender form. Dangeard's (1927 *c*) figures (as *P. obliquum*) appear to be the most clear, perhaps to be considered as *P. occanicum*.

Coastal waters of Europe, America, Africa, Australia; Pacific Ocean; frequent in brackish waters of Belgium and Holland; Indian Ocean; USSR waters.

Peridinium murrayi Kofoid, 1907
(Pl. LVIII, figs. 1-5, pl. LX, figs. 2-4; pl. LXI, fig. 4; pl. LXXVII, fig. 3.)

Kofoid, 1907 *a*, p. 176, pl. 5, fig. 29.
Pavillard, 1909, p. 282, figs. 3 *A*; 193 , p. 67, pl. 2, fig. 9 *A,B*.
Matzenauer, 1933, p. 464, fig. 46 *a*.
Schiller, 1937, p. 259, fig. 256 *a - e*.
Kisselev, 1950, p. 204, fig. 356.
Gaarder, 1954, p. 47.
Subrahmanyan, 1958, p. 439.

Wood, 1954, p. 256, fig. 156.
= *P. murrayi* var. *occidentalis* Pavillard, 1931, p. 67, pl. 2, fig. 9 *B*.
= *P. divergens* Ehrenberg, Murray and Whitting, 1899, pl. 29, fig. 4.
= *P. murrayi* var. *orientalis* Matzenauer, 1933, p. 465, fig. 46 *b*.
= *P. (divergens) gracilis* Karsten, 1907, pl. 50, fig. 9 *a*, *b*.

Cell body height and width about same or latter more, side convex dorsoventral if compressed, not marked. Apical horn long, hollow, rising steeply from the epitheca, end blunt, probably open. Posterior horns long diverging markedly from body, ends pointed. girdle sinistral, ends displaced 1 to 1½ girdle width, deeply excavated, winged with lists. Sulcus slightly inclined. reaches antapical end, ends with two tiny spines. L=125—250 μ, D = 75—110 μ.

Shows similarities with *P. oceanicum* but differs in the very long apical horn, marked divergence of posterior horns and the broad excavation between them.

Tropics of oceans; Indian Ocean, Arabian Sea, Bay of Bengal.

Peridinium oceanicum Vanhöffen, 1897
(Pl. LVII figs. 12-15; pl. LX, fig. 1; pl. LXI, figs. 1-3pl. LXXIX, figs. 1, 3)

Vanhöffen, 1897 *a*, pl. 5, fig. 2; 1897 *b*, p. 1.
Cleve, 1900 *a*, p. 17; pl. 7, figs. 17, 18.
Broch, 1906, p. 154, fig. 3; 1915 *b*, p. 190, fig. 7.
Paulsen, 1908, p. 54, fig. 69; 1930, p. 66, fig. 37.
Forti, 1922, p. 90, fig. 82.
Mangin, 1913, p. 156, fig. 10.
Meunier, 1919, p. 15, pl. 15, figs. 7 - 15.
Lebour, 1925, p. 120, fig. 36 *b*.
Lindemann, 1924, fig. 56 - 62.
Dangeard, 1927 *c*, p. 352, fig. 18 *c*.
Abé. 1927, p. 403, fig. 21.
Matzenauer, 1933, p. 463.
Schiller, 1937, p. 260, fig. 257 *a* – *k*.
Graham, 1942, p. 24, fig. 30.
Kisselev, 1950, p. 204, fig. 346 *a* – *d*.
Gaarder, 1954, p. 47.
Wood, 1954, p. 256, fig. 157 *a*, *b*.
Subrahmanyan, 1958, p. 439.
Taylor, 1956, p. 462.

= *P. divergens* var. **Bergh, 1881, figs. 39 - 40; Schütt, 1895, pl. 13, fig. 44. Murray and Whitting, 1899, pl. 29. fig. 4 *a*.**
= *P. divergens*, **Stein, 1883, pl. 10, fig. 7.**
= *P. divergens* var. *oceanicum* **Ostenfeld, 1899, p. 60.**
= *P. divergens* var. *oblongum* **Aurivillius, 1898, p. 96.**
= *P. depressa* var. *oceanica* **Ostenfeld, 1900, p. 57; Gran, 1902, p. 192.**
= *P. oblongum* **Cleve, 1900 *b*, p. 20.**
= *P. divergens* var. *elegans* **Cleve, 1900 *b*, p. 260; Karsten, 1906, p. 206, et seq.; 1907, p. 416.**
= *P. oceanicum* f. *oblonga* **Broch, 1906, p. 155 fig. 4.**
= *P. oceanicum* f. *arupinensis* **Broch, 1910, p. 190, fig. 7.**
= *P. elegans* var. **Karsten, 1905, pp. 34, 132, pl. 19, fis. 5, 6.**
= *P. elegans* **Karsten, 1905, pp. 179, 208.**
= *P. divergens elegans* **Karsten, 1906, p. 150.**
= *P. oceanicum* f. *typica* **Broch, 1900, p. 154, fig. 3; 1910, p. 190.**
= *P. divergens oceanicum* **Karsten, 1907, p. 224, *et seq.***
= *P. oceanicum* **Schröder, 1911, p. 16.**
= *P. oceanicum* var. *typica* **Paulsen, 1908, p. 55, fig. 69; Mangin 1913, Lebour, 1925. p. 121.**
= *P. oceanicum* **var. *oblongum* (Aurivillius) Paulsen, 1908, p. 56, fig. 70*a-e*.**
= *P. oblongum* **(Aurivillius) ? Dangeard, 1927 *c*, p. 353, fig. 18 *a*, *b*, including varieties *symmetricum* and var. *latidorsale*.**
= *P. oceanicum* var. *inaequipes* **Mangin, Matzenaur, 1933, p. 376, fig. 1.**
= *P. oceanicum* var. *parvulum* **Mangin, Matzenauer, 1933, p. 463.**

Cells longitudinally stretched, dorsoventrally flattened; all processes long and slender. Girdle oblique to sulcus, scarcely excavated. Longitudinal axis often considerably obliquely displaced. Sulcus generally with winged lists on both sides. Plasma purple-red. Length = 118 — 300μ.

The oceanic forms are slender; f. *typica* 200 — 300μ long, forms of obligotrophic waters; the neritic individuals are shorter, plumper, with thick small horns, 118 — 170μ long; forms of eutrophic waters. Hence the forms of Meunier from the extraordinary eutropic water of the Belgian coast short-horned and plump.

Böhm (1931, p. 194, fig. 12) records a form with apical horn bent forward.

Red Sea, Arabian Sea, Gulf of Aden, Malayan waters, Zanzibar, Bay of Bengal, Indian Ocean; Boeton Straits; Atlantic between Iceland and Labrador, N. Atlantic Drift ;Pacific. According to Graham, the specimens from the Pacific are *P. oceanicum* var. *tenellum* Graham.

Section *Divergentia* Jörgensen

Species with hollow antapical horns; often a deep indentation between them. The epitheca usually conical and only faintly tapering into an insignificant apical horn, or not at all. Tabulation meta, hexa or quadra. One group is para and had been ascribed to *Para - divergentia* Paulsen. This is now placed again with *Divergentia* by Paulsen (1949) for two reasons :

(1) *P. divergens* has been described and illustrated with para tabulation by Meunier (1910); Barrows, (1918); and Lindemann (1924). According to Peters (1928, p. 113), no such irregular variation of the ventral tabulation is known elsewhere and that for *P. divergens*; this is probably a matter of different species. *Para - divergentia* has (probably only one species) right-handed girdle. In addition, there are also some meta species that are right handed like the para species. Direction of girdle seems generally to be constant like the ventral tabulation; and if sections were to be set up based on these two characters, there should be three sections instead of original *Divergentia*; and as all the species as regards general structure are closely related, Section, *Divergentia* is divided into three groups :

1. *Meta* species with left-handed girdle :

   P. amplum Matzenauer
   P. crassipes Kofoid
   P. divergens Ehrenberg
   P. elegans Cleve
   P. elegans f. *granulata* (Karsten) Matzenauer
   P. fatulipes Kofoid
   P grande Kofoid
   P. remotum Karsten
   P. venustum Matzenauer

2. *Meta* species with right - handed girdle :

   P. brochii Kofoid and Swezy
   P. brochii f. *inflatum* (Okamura) Schiller
   P. retiferum Matzenauer
   P. soma Matzenauer.

3. *Para* species with right-handed girdle (*Paradivergentia*) :

   P. solidicorne Mangin

Peridinium amplum Matzenauer, 1933
(Pl. LXII, fig. 1 - 2)

Matzenauer, 1933, p. 468, fig. 53 *a, b.*
Schiller, 1937, p. 220, fig. 217.

Epitheca conical, in the girdle region slightly convex, transformed into a cone like horn as in *P. curtipes*, Girdle notched, slightly sinistral. Hypotheca slightly concave. Posterior horns each carry a smooth, long, solid process. Sulcus distal also terminates in small adjacent spines. In lateral view, the strong inclination of the longitudinal axis towards the girdle plane and the strong dorsiventral stretching are very striking in the girdle region. Surface finely reticulate. Species differs from *P. crassipes* in size, in its significant width, the long processes and demarcated apical horn; from *P. curtipes* in its tendency for elongation of right apical horn and the processes: from *P. crassum* Dangeard in its sharply bordered girdle regions and the notched girdle. L = 130μ; B = 120μ; D = 137μ; St = 15μ, L: B = 1.083.

Indian Ocean, between 5°36′ to 12°50′ N, and 49°30′ to 90°10′ E; Colombo.

Peridinium crassipes Kofoid, 1907
(Pl. LVIII, figs. 6 - 12, pl. LXI fig. 5)

Kofoid, 1907*b*, p. 309, pl. 31, fig. 46, 47.
Paulsen, 1907, p. 17, fig. 24; 1908, p. 57, fig. 73 *a-f*; 1930, p. 65, fig, 36.
Broch, 1910 *b*. p. 193, fig. 9 - 10.
Lindemann, 1927, p. 230, fig. 80 - 86. *non* 82.
Dangeard, 1926 *c*, p. 324, fig. 18 *a - c*; 1927 *c*, p. 365, fig. 32 *c*; 1932 *a*, p. 344, fig. 7.
Abé, 1927, p. 407, fig. 26, 27.
Peters, 1928, p. 42, fig. 11.
Matzenauer, 1933, 467, fig. 50 *a, b.*
Schiller, 1937, p. 223, fig. 220 *a - p.*
Kisselev, 1950, p. 192, fig. 323 *a-e*, 328 *a - u.*
Graham, 1942, p. 27, fig. 37.
Gaarder, 1954, p. 39.
Wood, 1954, p. 247, fig. 137 *a - d.*
Subrahmanyan, 1958, p. 439.
= *P. (divergens) asymmetricum* Karsten, 1907, p. 418, pl. 53, fig. 2; Matzenauer, 1933, p. 467, fig. 51.
= *P. crassipes* f. *asymmetrica* Matzenauer, 1933, p. 467, fig. 50 *c, d.*
= *P. curtipes* Jörgensen, 1912, p. 8; Lebour, 1925, p. 128, fig. 3 ; Dangeard, 1927 *c*, p. 365, fig. 32 *b.*

= *P. magnum* Schiller, 1929, p. 406, fig. 22.
= *P. curtipes* Paulsen, 1907 in Wood, 1954, p. 248 (The authority for the species quoted by Wood wrong.)

Cells in central view four-sided (rhombic), 80-118μ long, 67 - 109μ broad. Sides more or less straight to concave or at times wavy; same as regards the lower portion. Hypotheca with two thick horns, right usually longer and thicker, on the inside often with clear prominences of which two can be the prominent winged lists of the sulcus. The ends of horns blunt, with more or less blunt processes. Girdle concave; its ends more or less displaced, left more or less steeply ascending to almost run horizontal ; its inclination to the longitudinal axis has an angle of 11 - 16° to the long side. Plate sculpture net-like reticulations likewise on girdle. Plate 2 *a* four - sided, rarely five-sided. Plasma reddish. According to Jörgensen, northern forms yellow (chromatophores?). Abé found a typical Para form. Very variable, however, recognizable.

A comparison of the figures of Karsten (*l. c.*) for *P. (divergens) asymmetricum* and Matzenauer (*l. c.*) for *P. crassipes* f. *asymmetrica* show that the forms are identical and when considered with the species, there are no characters to justify separation. The same holds good as regards *P. crassipes and P. curtipes* Jörgensen.

Arabian, Sea, Indian Ocean; Pacific Ocean; Boeton Straits, West Coast of Australia, Heard Island, Antarctic; USSR waters.

Peridinium divergens Ehrenberg, 1840
(Pl. LIX, 1, 2; pl. LXI, fig. 6)

Ehrenberg, 1840 *b*, p. 204.
Bergh, 1881, *b*, p. 234, figs. 41-42.
Stein, 1883, pl. 10, fig. 1 - 5. *non cet* pl. 11, figs. 1 - 2.
Bütschli, 1885 *a*, pl. 53, fig. 1.
Schütt, 1895, pl. 13, fig. 43 (19, 21,22); *non*, 43 (1-12, 14, 18, 23,24); *nec.* 44; *nec.* 1896, fig. 16,32.
Paulsen, 1907, p. 16, fig. 23; 1908, p. 56, fig. 72; 1930, p. 63.
Lindemann, 1924 *g*, p. 229, figs. 71-79; *non* 78.
Lebour, 1925, p. 127, pl. 26, fig. 2.
Dangeard, 1927 *c*, p. 361, fig. 28.
Peters, 1930, p. 73, fig. 40A
Matzenauer, 1933, p. 466.
Schiller, 1937, p. 226, fig. 222 *a* - *g*.
Kisselev, 1950, p. 194, figs. 324 *a* - *c*; 329 *a* - *c*.

Gaarder, 1954, p. 42.
Wood, 1954, p. 248, fig. 139.
Subrahmanyan, 1958, p. 439.
= *P. divergens* var. *lenticulare* Ehrenberg, 1854, 2; p. 240.
= *P. lenticulare* (Ehrenb.) Jörgensen 1899, p. 400, (*partim*).
= *P. divergens* var. *berghii* and var. *bicuspidatum* Lemmermann, 1899 *a*, p. 369.
= *P. speciosum* Jörgensen, 1912.
non P. divergens var. *adriaticum* Schiller, 1929; p. 407, fig. 23 (= *P. brochii*).
= *P. (divergens) remotum* Karsten, 1907, p. 417, pl. 53, fig. 5 *a, b*.
= *P. (divergens) pulchellum* Karsten, 1907, p. 418, pl. 53, fig. 1.
= ? *Ceratium divergens* Claparède *et* Lachmann 1858—1861, p. 400, pl. 8 figs. 22, 24 - 26; Saville-Kent, 1880/82, p. 453, pl. 25, fig. 8, 13.

Very variable species. Sides of epitheca more or less concave, at times somewhat convex. Corresponding to this the horn is slender or sturdy. Divergence of posterior horns variable. Sides of hypotheca always concave. Girdle almost circular, inclined to be dextral, excavated, with conspicuous lists supported by spines. Sulcus with more or less developed lists ending in inconspicuous prominences having the appearance of spines. Theca sculpture: marked reticulations with spines at the junction of the reticulations. Intercalary striae broad. Plasma pinkish, chromatophores yellow - brown. Length 80 - 84μ; breadth about 56μ.

Species could be easily confused with *P. crassipes* and *P. depressum*.

Widely distributed. Red Sea, Arabian Sea, Gulf of Aden, Indian Ocean, Bay of Bengal, Malay region; Boeton Straits, Australian region; Atlantic; USSR waters.

Peridinium elegans Cleve, 1900
(Pl. LIX, figs. 3 - 4; pl. LXI, figs. 8-9)

Cleve, 1900 *a*, p. 16, pl. 7, fig. 15, 16.
Pavillard, 1931, p. 66, pl. 2. fig. 13.
Matzenauer, 1933, p, 471, fig 57 *a, b*.
Schiller, 1937, p. 254, fig. 252 *a - ɟ*.
Kisselev, 1950, p. 203, fig. 345 *a - e*.
= *P grande* Dangeard, 1927 *c*, p 366, fig. 32 ; Paulsen, 1930, p. 68, fig. 39.
= *P. fatulipes* Okamura, 1912, pl. 4, fig. 58 *a - c*.
= *P. elegans* f. *divergens* Matzenauer, 1933, p. 471, fig. 57 *c*.

Cells with long, slender processes, body proper low, towards the girdle keel-shaped to flat. Posterior horns diverge mostly at an acute angle, rarely

horns diverging strikingly as in *P. elegans* f. *divergens*, Matzenauer, (synonym) their pointedends often with ring and net-like sculpturing. Length 160–200μ; breadth 100–180 μ.

This species is nearly related to *P. divergens* and has been figured by Murray and Whitting (1892, pl. 19, fig 4 *a*) as a variety of this species. It differs from *P. divergens* in its larger size, absence of teeth at the bases of the posterior horns and in the ends of the girdle being not oblique. The longitudinal axis is slightly oblique to the plane of the girdle.

Pavillard (1931, pp 65, 66) has sought to bring some order for determination. Accordingly, *P. grande* Dangeard (1927 *c* ; Paulsen, 1930) belongs to *P. elegans*. The error of these two authors proves, how close are the two species and how difficult it is often to separate them. In both species the dorsal plate pattern obtains, according to the authors, similar to the variations between *Ortho* - and *Meta*.

Tropical regions of oceans spreading to subtropics through Currents. Red Sea, Gulf of Aden, Arabian Sea, Bay of Bengal. Malaya, Indian Ocean; USSR waters.

Peridinium elegans Cleve
f. *granulata* (Karsten) Matzenauer, 1933
(Pl. LIX, figs. 5, 6; pl. LX, figs. 5-8; pl. LXI, figs. 10-12 ; pl. LXXVII, figs. 1 & 3 ; pl. LXXIX, figs 2 & 4).

Matzenauer, 1933, p. 471, fig. 58.
Schiller, 1937, p. 265, fig. 253 *a* - *f*.
= *P. divergens granulatum* Karsten, 1906, p. 150, pl. 23, fig. 17 *a*, *b*.
= *P. depressum* Okamura, 1912, p. 15, pl. 4, fig. 61.

Differs from the species in the following characters : Girdle region very strongly flattened. Ventral side strongly compressed, so that on the right and left, the girdle part springs out wing-like. Apical horn more or less long and slender ; it arises as from a trough. Posterior horns likewise slender, not suddenly attenuated, often irregularly bent. Length 220 μ, breadth 200 μ.

Pacific and Indian Oceans ; occurs particularly in the fertile coastal waters of Sumatra ; Arabian Sea.

Peridinium fatulipes Kofoid, 1907
(Pl. LIX, figs. 7 - 10; pl. LX, figs. 9 - 13)

Kofoid, 1907 *a*, p. 174, pl. 5, fig. 30.
Pavillard, 1931, p. 66, pl. 2, fig. 14.
Matzenauer, 1933, p, 471, fig. 59.
Schiller, 1937, p. 256, fig. 254 *a* - *h*. *non* Okamura, 1912, pl. 4, fig. 58 (= *P. elegans* Cleve).
= *P. tumidum* Okamura, 1907, pl. 5, fig. 37 ; Matzenauer, 1933, p. 472, fig. 60.
= *P.* (*divergens*) *tesselatum* Karsten, 1907, pl. 50, fig. 11 *a*, *b*.

Cells markedly broadend, 150-250μ long. 100-170μ broad, Sides of epitheca and hypotheca concave. Epitheca ends ventrally in a long conical, apical horn; hypotheca ends in two long horns diverging, at the apex decorated with ring-and reticulate-like sculpturing. Body with a ventral excavation. Height of hypotheca variable. Girdle excavated, slightly dextral, widely winged, placed median. Sulcus deep, with winged lists on both sides not projecting below. At the base between the two posterior horns projects a membrane as a hyaline curtain. Armour with reticulations and pores.

Smaller plumper forms connect the species with *P. elegans*.

Warmer regions of Oceans; Indian Ocean, Arabian Sea.

Peridinium grande Kofoid, 1907.
(Pl. LIX, figs. 11, 12 ; pl. LXI, fig. 13; pl. LXIII, fig. 1)

Kofoid, 1907, *a*, p. 174, pl- 5, fig. 28.
Pavillard, 1916 *a*, p. 34; 1931, p. 64, pl. 2, fig. 12.
non Dangeard, 1927, *c*, p. 366, fig. 32.
non Paulsen, 1930, p. 68, fig. 39.
Schiller, 1937, p. 259, fig. 255 *a* - *e*.
Kisselev, 1950, p. 204, fig. 355 *a*, *b*.
Gaarder, 1954, p. 44.
Wood, 1954, p. 249, fig. 142.
Silva, 1955, p. 39, pl. V, fig. 8, 9.
Subrahmanyan, 1958, p. 439.
= *P.* (*divergens*) *grande* Kofoid, Karsten, 1907, pl. 52, fig. 4 *a*, *b*.
= *P. grande* Karsten, Matzenauer, 1933, p. 470. fig. 56 *a*, *b*, *c*.

Cells short and broad, rarely slender. Apical horn suddenly broadened towards base. Posterior horns likewise short, at the base thick, generally running into a sharp point. Girdle region of body often more or less flattend. Plates *Meta* or *Ortho*.

This form is very similar to *P. elegans* with which various intermediate forms are connected and from which it is often scarcely distinguishable. It differs in the shorter broader cells, in having shorter posterior horns unlike the more slender *P. elegans*.

P. grande Karsten in Matzenauer (*l. c.*) is really *P. grande* Kofoid. This appears to be an error in Matzenauer, probably a printing error.

In the tropical zone of oceans associated with warm currents.

Indian Ocean, Arabian Sea, Bay of Bengal; Boeton Straits, Great Australian Bight.

Peridinium remotum Karsten, 1907.
(Pl. LXII, figs. 3-4; pl. LXIII, fig. 2)

Matzenauer, 1933, p. 473, fig. 61 *a, b.*
Schiller, 1937, p. 262, fig. 258 *a, b.*
Taylor, 1966, p. 462.
= *P.* (*divergens*) *remotum* Karsten, 1907, p. 417, pl. 53, fig. 5 *a, b.*

Epitheca cone-shaped, rather passing over into a tapering cone without any definite order; with cuneiform hypotheca towards the hollow sinistral girdle. Posterior horns robust, carrying a short, robust, outwardly directed process. Hypotheca shortly sinuated by the sulcus, its margin ending in projecting edges of both horns. Plates finely reticulated. Length 145μ; B = 106μ.

Indian Ocean, Arabian Sea.

Peridinium venustum Matzenauer, 1933
(Pl. LXII, fig. 5-6; pl. LXIII, fig. 5-6)

Matzenauer, 1933, p. 464, fig. 45.
Schiller, 1937, p. 263, fig. 260 *a, b.*
Subrahmanyan, 1958, p. 439.

Small regular species of *Oceanica* type, closely related to *P. oblongum* Epitheca, both in ventral and dorsal aspect presents a beautiful cone shape which appears set up on a similar concave hypotheca because of the sharp delimitation of the girdle region. The girdle region of the species is characteristic. In strongly inclined position, the cells appear similar to those of *P. oblongum*, however, it is different in the strong dorso-ventral distinction. Girdle sinistral, end displaced 1·2 furrow width. Sulcus extends toward epitheca 1.5 girdle width over antapical horns regularly, tapering sharply convex. Sulcal lists terminate as teeth in the inner angle of the posterior

horns. Surface finely reticulate. Shell thin. Cells generally greenish. The shape of the girdle region, the upper part of the longitudinal furrow and the shape of the posterior horns are constant distinguishing characters for the species. L = 110 - 120μ. B = 75 - 80μ.

Indian ocean, Arabian Sea.

Peridinium brochii Kofoid and Swezy, 1921
(Pl. LXII, figs. 7-12; pl, LXIII, figs. 7, 10, 12)

Kofoid and Swezy, 1921, p. 183.
Paulsen, 1930, p. 66.
Schiller, 1937, p. 221, fig. 218 *a* - *i*.
Kisselev, 1950, p. 192, fig. 322 *a* - *e*.
Gaarder, 1954, p. 39.
Subrahmanyan, 1958, p. 439.
Wood, 1962, (?).
= *P. adriaticum* 1910 *b*, p. 191, fig. 8; Pavillard, 1916, p. 33; Forti, 1922, p. 91, fig. 84; Lebour. 1925, p. 128; Dangeard, 1927 *c*, p. 363, fig. 29 *c*; 1932 *a*, p, 343, fig. 6 *a* - *f*.
= *P. divergens* Lindemann, 1929, p. 229, fig. 78; Abé, 1927, p. 404, fig. 22.
= *P. divergens* var. *adriaticum* (Broch) Schiller, 1929 p. 407, fig. 23, 24; Matzenauer, 1933, p. 466.

Sides of epitheca and hypotheca slightly concave. Divergence of posterior horns variable. Girdle region rounded. Girdle flat, its ends slightly, half furrow width, displaced. Membrane with reticulate sculpture. Intercalary region wide, striated.

Specimens occur which seem to bridge this species with *P. divergens*.

Atlantic; Mediterranean; Arabian Sea, Bay of Bengal, Indian Ocean.

Peridinium brochii f. *inflatum* (Okamura) Schiller, 1937
(Pl. LXIII, figs, 8, 9, 11)

Schiller, 1937, p. 222,, fig. 219 *a* - *f*.
Gaarder, 1954, p. 39, fig. 47.
= *P. inflatum* Okamura, 1912, p. 15, pl 4, figs. 64 - 69; Matzenauer, 1933, p. 466, fig. 48 *a* - *d*.
P. crassum Dangeard, 1927 *c*, p. 364, fig. 31.

Epitheca in ventral view concave - convex or almost even; hypotheca convex-concave ending in two short horns with small spines (1 - 1½ times girdle

width). Girdle dextral. Sulcus somewhat extends into epitheca, winged. From the end of the longitudinal wing, the contour is more or less perpendicular to median plane upto the spines. Apical horn, more or less clearly demarcated. The form is distinguished from *P. crassum* Dangeard by the shape of the epitheca in the girdle region as also by the scarcely visible reticulations : from *P. adtriaticum* by the short posterior horns and broader body. L = 76 - 107 μ. B = 60 - 88 μ; D = 78 μ.

Warm water species. Arabian Sea, Indian, Pacific and Atlantic Oceans.

Peridinium retiferum Matzenauer, 1933
(Pl. LXV, fig. 1)

Matzenauer, 1933, p. 466, fig. 49.
Schiller, 1937, p. 225, fig. 221.

Cells shaped like those of *P. brochii* f. *inflatum* (Okamura) Schiller Girdle slightly dextral, Sulcus quardrangular, extends into epitheca. Plate surface bedecked with delicate sharp reticulations, however, with wide meshed branched lists. L = 82 μ; B = 71 μ.

Indian Ocean.

Peridinium somma Matzenauer, 1933
(Pl. LXV figs. 2 - 3)

Matzenauer, 1933, fig. 70.
Schiller, 1937, p. 220, fig. 216 *a, b.*

The concave cone-shaped epitheca sunk in the likewise concave hypotheca. Girdle region, therefore, broadened like a ridge. Posterior horns end in blunt processes. Sulcus lobe ends evident. Surface finely reticulate. L = 68 μ; B = 82 μ.

Indian Ocean.

Peridinium solidicorne Mangin, 1926
(Pl. LXIV. figs. 1—10)

Mangin, 1926, p. 80, fig. 23.
Schiller. 1929, p. 408, figs. 26, 27; including var *makronyx* and var. *mikrenyx ;* 1937, p. 218, fig. 215 *a-l.*
Dangeard, 1927 *a*, p. 7, fig. 5; 1927 *c*, p. 373, fig. 38 *c.*
Matzenauer, 1933, p. 478, fig. 69.
Kisselev, 1950, p. 190, fig. 317 *a, b.*

Silva, 1955, p. 40, pl. V, figs. 10-11.
Taylor. 1966 p. 462.
= *P. areolatum* Peters. 1928, p. 33, fig. 8.
= ? *P. divergens pallidum* Ostenfeld, 1903. pp. 581, 582, figs, 130, 131 ; Karsten, 1906, p. 150, pl. 23, fig. 13 *a, b.*
= *P. solidicorne* var. *bradyn*r Matzenauer, 1933, p. 479, fig. 69 *a, b.*

Cells similar to *P. divergens.* Posterior horns long, robust, ending in straight or bent solid processes. Dorsal intercalary always hexagonal. Plates border 3 *a*/ 3'' and 2 *a*/ 5'' variable. Horns rarely diverge. Plates type *Para.* L = 75 - 95 μ ; B = 48 - 62 μ.

Antarctic ; Atlantic; Mediterranen; Indian Ocean.

Insufficiently known Species

Peridinium bimucronatum Schiller, 1937
(Pl. LXV figs. 6-7)

Schiller, 1937, p. 226, figs. 265 *a, b.*

No diagnosis given by Schiller (1937) and Taylor (1966) L = B = 22 μ. Refer to figure.

Adriatic, S. W. Indian Ocean.

Peridinium orientale Matzenauer, 1933
(Pl. LXV, Fig. 8)

Matzenauer, 1933, p. 460, fig. 38.
Schiller, 1937, p. 271, fig. 275.

Body almost round, Apical part somewhat tapered gently, still remaining convex always, with an abrupt knick passing on to apical horn. Girdle slightly dextral. Sulcus slightly narrowing towards posterior end, beset with two tiny spines at terminus. L = 40μ, B = 38μ.

Indian Ocean.

Peridinium persicum Schiller, 1937

Schiller; 1937, p. 272.
= *P. schilleri* Böhm, 1931, fig. 49.
Similar to *P. subinerme.* Imperfectly described and figured by Böhm.
L = 80μ. No figure available.
Persian Gulf.

Peridinium pietschamanni Böhm, 1931
(Pl. LXV, figs. 9–11)

Böhm, 1931, p. 195, fig. 15.
Schiller, 1937, p. 272, fig. 277 *a* - *c*.

Insufficient diagnosis. Ventral view shows agreement with *P. sublnerme*. Dorsal plate arrangement quite different. Size ?

Persian Gulf.

Peridinium quadratum Matzenauer, 1933
(Pl. LXV, Fig. 12)

Matzenauer, 1933, p. 469, fig. 55.
Schiller, 1937, p. 272, fig. 278.

Cells in ventral view quadratical. Longitudinal axis diagonal. Gridle sinistral, $\frac{1}{4}$ gridle width displaced, excavated. Antapical section between the short horns are girdle width deep, $\frac{1}{2}$ gridle width broad, round. Horns carry two tiny spines. Type : *Meta*. L = 83μ, B = 80μ.

Indian Ocean.

Species recorded from Antarctic, Argentina Sector possibly occuring in the Indian Sector.

Peridinium adeliense Balech, 1958
(Pl. LXVI, figs- 1 - 12)

Balech, 1958 *b*, p. 396 pl. IV, fig. 101 - 102 ; 1962, p 35 ; 1965, p. 120, pl,II, fig. 34 - 41.

This elegant species has a long horn and its spines also are long and almost parallel between them ; they draw near to one another more than in *P. pellucidum* according to the figure given for the latter by Schütt but depart on the contrary the image given by the modern author. Its sulcus is only slightly open at the rear. It is slightly excavated and *quadra* above, misleads of *hexa*. The latter character permits is rapid and certain identification. Its 2 *a* is small, while 4'' is very high. The sculpture is represented by tiny alveoles-like markings and by very robust punctae and striae.

Sulcal *a* is long and narrow, pointed, with a posterior branch rather curved. *S. i.* is without double contour, with the process anterio-ventrally long. *S. d.* is rather narrowed with fins fairly developed, convex, the character variable according to position, without posterior projection. *S. p.* is

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rather large, its left branch is very large and longer than the right. C_1 and C_2 are very small. Length without spines 56-68 μ, with spines 68-82 μ; diameter, 49-56 μ.

Plate 2 *g* and that of sulcus in particular permit the distinction of this species clearly from *P. affine*.

Antarctic, Indian Sector?

Peridinium affine Balech, 1958
(Pl. LXVII, figs. 1, 5, 8-11, 13)

Balech, 1958 *b*, p. 395, pl. IV, figs. 91–100; 1962, p. 34, pl. III, figs. 68–77.

This species is very similar to *P. incertum* of which it has the shape. The epitheca is conical, having, occasionally, the sides a little concave, with a short neck, rather wide, poorly delimited. The hypotheca is rounded with two diverging winged spines: a third left and, at times, one other right, are in reality, projections of sulcal plates, rather characteristic, as in *P. incertum*. It is *para-hexa*, with cingulam ascendant, (the displacement is about one height) rather wide, with membrane well developed, sustained by small batons. The sulcus is wide, open behind. The sculpture is in the form of punctae and scattered.

S.a. is long, rather narrowed and regular, with a small posterior branch. *S.l.* is in the shape of *J* with double contour, recalling that of *P. pyriforme*. *S.d.* has the body rather wide and an edge rather than a wing. *S.p.* has two well developed branches that form the posterior accessory spines, the left having sometimes more width. The right has a groove in the internal margin.

Dimensions very variable. Length without spines, 44-59μ; with spines 65-71μ. Diameter 46-61μ.

This species is distinguished from *P. incertum* by its grand size and above all large width. The neck is less clear, it is *para* instead of *meta* and its plate 2*a* is asymmetrical (the edges for 1*a* and 3*a* are more long than those 3'' and 5''); *S. a.* as well as 1*a* and *S. l.* are rather different. *P. pellucidum* species very badly defined, according to the authors, is of diverse shape. It has its neck sometimes more long and its spines at times more robust, according to Schütt. The figures of this species, those given by Lebour, display a form rather different, having 2*a* very high, almost circular and sulcus more narrow. *P. pellucidum* according to Paulsen is equally very different, it is excavated, has the spines short clearly separated between them and parallel. As for Matzenauer, he designates under this name the *meta* forms.

Antarctic, Indian sector?

Peridinium archiovatum Balech, 1958
(Pl. LXVII, figs. 12, 14—16)

Balech, 1958 *a*, p. 84, pl. II, figs. 45—48; 1958 *b*, p 385, pl. I, figs. 23—26.

Species rather small, sub-lenticular, similar in shape and size to *P. ovatum* from which it differs by being a *Archiperidinium, i. e.* with only two intercalary plates in the epitheca. The second one is very wide but fairly low. Apical horn small, conical; antapical spines nil. *Meta*. Girdle circular. Sculpture scattered punctae. Length, 23.5-29μ; width 41.5-67μ. Collected from 63°43'S, 56°14'SW.

This species was found in the region of Adélie, in the Argentina sector of Antarctic, but extremely rare. Easily confused with *Diplopeltopsis minor*, more abundant in general, but much smaller. It is distinguished not solely by its tabulation; but equally by shape of its sulcus. In *P. archiovatum* the sulcus has an aspect sufficiently typical; it is curved, much shorter than that of same in *D. minor*. The small apical horn is more slender, losing its clarity towards the apex.

The tabulation of the sulcus has not been studied well; the sulcus anteriorly is somewhat much in the shape of S *italics*, is long, more broad in front. Sometimes it resembles the shape of a sickle, curved, broad, which is, probably, *S. p.*

Antarctic, Indian Sector ?

Peridinium charcoti Balech, 1958
(Pl LXVIII. figs. 1—12)

Balech, 1958 *b*, p. 394, pl. III, figs. 79-90.

This bizarre species is not likely to be confused with any other of the genus *Peridinium* known till now. It is *meta quadra*, ascendant, with a displacement of the girdle to almost one width, slightly excavated, and flattened to the body. The epitheca is a " body " flattened at base on which is set abruptly a zone somewhat inflated, to be continued by a neck so to say, cylindrical, enlarged at the summit. The two antapical spines very robust, long and slightly parallel, winged, and each implanted on an antapical horn. Girdle membrane very strongly, sustained by rather close lists. Sculpture represented by tiny alveoles, but strong, each with a pore. The plate 1′ is high and rather narrow. 7′ is relatively high, almost triangular, having an edge, somewhat marked in relation with 4′. 1″ is rather small,

S. a. is of average length, rather curved in the dorso-ventral plane, with a small posterior branch. *S. i.* is in the shape of J, with concave edge and mid dorsal much reinforced with tiny spinules at the two extremities. The dorsal edge is rectilinear forming rather visible angle, evidently with the posterior border which is little irregular, almost rectilinear; on that plate one perceives the strong pores. *S. d.* is long, slender with visible pores ; wing is large, divided strikingly into two parts almost equal and slightly concave ; the posterior border of the wing forms a very sharp angle. Viewed from profile, the neck and the body of the plate forms a marked angle. *S. p.* is curved reduced practically into a cresent shaped body with well visible pores. Protoplast opaque in preserved samples, contains refrigent globules, rather small, the largest of which are 5 - 6 μ in diameter.

L, without spine 60-67.5 μ. total 80-85.5 μ. Diameter 56-62 μ.

Species difficult to encounter. Remote resemblance to *P. paulsenii.*

Antarctic, Indian Sector ?

Peridinium curtum Balech, 1958
(Pl. LXIX, figs. 1-9)

Balech, 1958 *b*, p. 393, pl. III, fig. 62 - 70.

This species is ellipsoid in outline, rather flattened wider than high, provided with a small truncate neck, without antapical horns but with tiny spines, Its hypotheca is broadly rounded, slightly flattened at posterior pole. It is *meta-quadra,* ascendent, equatorial ; the girdle with a displacement of the width of girdle with ends overhanging, that is to say, that its extremities extend over one anothor or intercross. The girdle fins are broad reinforced by numerous lists. Sculpture of plates : robustly punctate.

C_1 is a little more than half of C_8. *S. a.* is very long, sigmoid, slightly evident, where the body is widened posteriorly to 2/7 ; the posterior branch is rather small. *S. i.* is the shape of J, with reinforced concave border, with rather numerous pores and with a ventral fringe of different refractivity. *S. d.* with a narrow neck, rather inclined ; the body equally narrow is reunited to the neck, and with regard to the union, is marked from the right side by a strong projection ; the plate with small pores, and the fin rather strong, slightly bilobed, having a posterior angle, rather projecting. *S. p.* is pointed, small reduced almost uniquely to the body.

L, without spines 53 - 62 μ; total = 58-60 μ; diameter 53-64 μ; spines, 3-6 μ; neck, nearly 2-3 μ. The spines are separated by about 11 μ.

This species is a relatively variable form ; certain samples are nearly globular, but more commonly they display a slight flattening as in *P. quarnerense* to which this is very close. Balech sees no similarity between the two species, in *P curtum* the plate 1'' is more large, 1' a little different with the right side lower, more or less concave, 5'' more lower, the divergence least to the cingulam, the neck more conical. When more is known of the sulcal plates of *P. quarnerense*, one can come to a conclusion on this Antarctic species with more certainty.

Peters found in the Weddel Sea, a species more or less lenticular to which was given the name *P. ovatum*. It appears to be a different species, having many more plates with strong antapical spines ; its tabulation has not been represented fully, but only an apical view. From all aspects it appears to be much different to *P. ovatum* proper. Caution has to be exercised in determining more or less lenticular species on the basic principle of general shape and without fair attention to differences that they present in their cingulam, the sulcus, tabulation, etc. One will be obliged to revise thus the specific validity of *P. globulus, P. sphaeroides, P. simulum, P. quarnerense, P. ovatum* etc. *P. quarnerense* is a species of warm water.

Antarctic, Indian Sector ?

Peridinium mediocre Balech, 1958
(Pl. LXX, figs, 1 - 4, 6, 13, 14 and 16)

Balech, 1958 *b*, p. 389, pl. II, figs. 54-61.

This is a species resembling *P. petersii*, but much smaller, more rounded, the epitheca relatively more high, having the posterior border rectilinear. 1' is more long and more narrow, because in *P. petersii* the ratio length/width is 1.3 : 1.2, while in *P. mediocre* it is a little more than two. Its posterior sulcal plate forms a sort of posterior wing.

This species is *meta-quadra*, ascendant, equatorial. The apical neck is short; antapical horns absent, but with the spines sharp, rather long, independent and somewhat parallel between them. The cingular wings are well developed.

S. a. long and narrow, at its right border almost rectilinear, while its left hand side presents two concavities, followed by an irregular convexity ; a narrow isthmus reunites its body to its posterior branches, rather small and curved to the right. *S. i.* is the shape of J, at the border much inclined

anteriorly terminating itself by a ventral vertical point and a dorsal rather horizontal; the middle dorsal edge is concave, reinforced with the small crests rather clear; the posterior dorsal border is small, rather curved, reinforced, separated from anterior dorsal border or middle, by a spine, continued imperceptably by the ventral border; the latter is divided into anterior rectilinear part and a posterior convex part. This plate presents the differences rather clearly with that of *P. petersii*, for the latter does not have the posterior spine and is supplied with, on the contrary, with a spine which separates the two parts from ventral border. *S. d.* is narrow with anterior apophysis long with the two right concavities (the anterior very small) and a body of the same length as the apophysis having the wing well developed from which the posterior part obviously more curved, forms an angle projecting backwards. *S. p.* is in the shape of a horse, with the left branch more long; its body forms an acute angle backwards, which does not exist in *P. petersii*.

Length without spines 56-62μ; with 65-65.8μ. Diameter 56-58μ.

Antarctic, Indian Sector?

Peridinium parvicollum Balech, 1958
(Pl. LXX, figs. 5, 7-12, 15).

Balech, 1958 *a*, p. 87, pl. IV, figs. 86–87; pl. V, figs. 92-99; 1958 *b*, p. 386, pl. I, figs. 27–31, pl. II, figs. 32–36.

In the plankton of Terre Adélie, this species is more variable than in the sector Argentina. It is seen in two shapes rather different. More rare is that which has been already described (Balech, 1958 *a*) which is outwardly related to the larger and is provided with rather well developed spines. The form which is more abundant is almost biconical, rather short and broad, more short than the first, and it has the spines rather short. From the point of view of tabulation, it is a species *ortho-hexa*, girdle circular having the plate 2 *a* wide, but low. On the contrary, 3′ pentagonal, is very large, more outward than the group 4″ and 2 *a*. Plate 1′ is rather characteristic, having, on its right side, near its posterior truncate apex, a curvature very typical which is not visible often. 3‴ is low, clearly asymmetrical, The groove is not visible on the posterior border of the hypotheca, which is on the contrary, almost convex. Sculpture generally represented by alveoles rather small, reinforced by strong punctae.

S. a. is rather short and simple, with the posterior branch mediocre *S. i.* is long, curved regularly, without clear posterior branch, feebly reinforced,

at its posterior border almost straight. *S. d.* is practically without wings, which appears replaced by a strong refringent zone; the anterior branch is rather short; the right margin presents a short concavity, corresponding to that branch of neck, the rest is scarcely straight, at times with a second concavity following the first; but least marked. *S. p.* is developed in the ventral plane in the shape of C, having the right branch more wide and dentate, the left, at the concave border, is entirely reinforced; the posterior border has two small crests. On the whole, the sulcal plates have a rather simple structure, for in them, wanting the large apophysis, the membranes develop in many planes; other complications also observed.

Length without spines 65-77μ. Diameter 68-87.5μ. This is a species abundant and relatively easy to identify by its plates and the dorsals; it is likewise so by its sulcal plates, but the study of those latter is always more difficult.

Antarctic, Indian Sector ?

Peridinium pseudoantarcticum Balech, 1958

(Pl. LXXI, figs. 1-13)

Balech, 1958 *a*, p. 85, pl. III, figs. 53-65; 1958 *b*, p. 385, pl. II, fig. 53.

Large species, rhomboidal, girdle descending, in shape very similar to *P. antarcticum*, in general shorter; with cingulars very much inclined, usually more than in *P. antarcticum*, shape more rounded, less abruptly expanded at the equator. 1'' more narrow, taller, sculpture alveolar with strong modules at the notch of the reticulae, perhaps pores which dominate the sculpture in some specimens. The alveolar sculpture often becomes very vague when perforations are the only visible things. Lists of cingulars well developed.

The above characters can be used only with difficulty to distinguish the two species. The sulcal plate although similar have some peculiar characteristics. The right and left side plates are shorter and wider; left with concave edge, more regular, shorter, wider, with dorsal and posterior zones with distinct refringence; with only a few poroids slightly detached, in contrast with the strong and dense punctae of the same plates of *P.antarcticum*. The right plate also shorter and wider, more angular with a posterior hyaline fringe not very punctated. Sulcal plate more narrower, sides almost parallel, not as open as in *P. antarcticum*. The anterior plates very similar in both.

The differences are small, however, constant. Hence new species erected by Balech (*l. c.*).

The angle *a* determined by Peters for *P. antarcticum* (subsp. *P. depressum*) varies from 29 to 52°. In general smaller angle corresponds to the larger specimens. Measured in the larger specimens of his fig. 19, it is approximately 30° and on the small specimens, corresponding to *P. pseudoantarcticum* it is found to be 40°. In the specimens of *P. pseudoantarcticum* in which Balech determined the angle, it is 41 - 45° while in *P. antarcticum* it is 30-35°.

This species is met with in the majority of samples from Terre Adélie and appears more abundant than the true *P. antarcticum*. One finds in them the same differences in the sulcal plates that have already been pointed out. With a little experience one can rather easily distinguish the two species. *P. pseudoantarcticum* is more smaller, its frontal contour is more rounded, without the relative dilation suddenly into the cingulam that *P. antarcticum* presents. Its protoplasm, opaque in the preserved state, fills scarcely completely the carapace, whereas it is generally contracted in this state in *P. antorcticum*. It is more difficult to maintain this species in a position to provide the observer the ventral region that gives one a clear idea of its contour. Its antapical horns are relatively more long, sub equal and more divergent than in *P. antarcticum* in which the horns are left - handed, clearly more short, a tendency to approach to the right (compare its figure with that of *P. antarcticum*, given earlier (Balech, 1947).

The length is generally from 142-145μ; diameter 89-92μ. It is seen that the samples from this region are rather more large than those described earlier.

Antarctic, Indian Sector?

Peridinium rosaceum Balech, 1958
(Pl. LXXII, figs. 1—9)

Balech, 1958 *a*, p. 87, pl. IV, figs. 81-85, 88-91; 1958 *b*, p. 388, pl. II, figs. 37-44.

= *P. subinerme* Paulsen, Peters, 1928, p. 52-59, figs. 15 *a*, *b*, *i*? (in part) *non P. subinerme* Paulsen, 1905.

In the samples from Terre Adélie this species is less homogeneous than that of Argentina sector. It is pentagonal, rather high, *ortho-hexa*, circular, or slightly ascendant, excavated. Plate 1′ with posterior triangle sometimes more low than anterior. 2 *a* is slightly *hexa*. 3′ has lateral sutures rather characteristic, striking, which one is able to distinguish as well in ventral view. 1‴ forms a sort of loop in the angle of cingulam-sulcus. 3‴ is a little

asymmetrical, its left side is more short. 1'''' and 2'''' form small antapical, spines. The sulcus rather deep, forms clearly an antapial notch, shallow, of uniform width. Sculpture generally is alveolar, rather fine. The suture of the epi-and hypo - theca are wide striated. The intermediate (transitional) plate is rather wide and short. *S. a.* is relatively wide, with a posterior branch of average size. *S. i.* is characteristic, angular, wide, with a sort of typical anterior cap. *S. d.* is rather wide, in the shape of a pig, with small neck, but very clear; the wing is narrowed. *S. p.* is situated almost in the ventral plane, with a certain curvature in its centre, and, with one, or more, frequently, two posterior projections. The right branch is more wide, its reinforcement which forms a small crest, starts at the anterior border.

The specimens in the samples from Terre Adélie are much larger than those encountered earlier. Length 55 to 80μ, diameter 53-69μ.

The hypotheca is rather lofty, the sutures wide; the shape of 1' where the posterior vertex rests rather high, characteristic of this species. Its sulcal plates are equally characteristic.

The protoplasm, fixed in alcohol or Barium, does not show the rose colour indicated by Balech earlier, *i. e.* in preserved condition, it is contracted and pink.

This species appears similar to Peters' small specimens. It is clearly differentiated from Paulsen's species by its *S. p.* which is of the type in that of *P. latistriatum* and from the latter for its size, characters of the protoplast, shape of cingulam and sulcus, sutures ; for being *hexa* and not *quadra* and for details of sulcus especially *S. a.* which is more similar to that of *P. punctulatum* that can be very well differenciated from the latter samples.

Antarctic, Indian Sector ?

ANNEXURE I

FRESHWATER SPECIES

Peridinium africanum Lemmermann, 1908
(Pl. LXXIII, figs. 1-5)

Lemmermann, 1908, p.188, pl. 9, figs.1 a - d ; 1910 *b*,p. 665, figs. 44 - 48.
Lindemann, 1919, p. 242, figs. 82 - 89; 1925 *c*, p. 179, figs. 148 - 149.

Lefèvre, 1932, p. 142, figs. 593, 642.
Schiller, 1937, p. 179, fig 183, *a*, - *n*.
Kisselev, 1950, p. 179, fig. 296 a - e.
= *P. intermedium* Playfair and
= *P. intermedium* var. *conicum* Playfair, 1919. p. 808, figs. 16, a - f.
= *P. ornamentosum* Lindemann, 1931, p. 708. figs. 25 - 28.
= *P. africanum* var. *contactum* Lindemann, 1919, p. 244, figs. 87, 88.
= *P. africanum* var. *javanicum*,
= ——— —— var. *intermedium*,
= ——— —— *f. spinulosum* and
= ——— —— *f. tatricum* Lefèvre, 1932, p 142.
= *P. marchicum* var. *javanica* Woloszynska, 1912, p. 703.
= *P. tabulatum* var. *intermedium* Playfair, 1912, p. 544.
= *P. tatricum* var. *spinulosa* Woloszynska, 1916, p. 270, pl. 11, flg. 19-25.
= *P. tatricum* Woloszynska, 1916, p. 269, pl. 11, fig. 10 - 18.
= *Gonyaulax jensenii* Nygaard, 1926, p. 206, pl. 4, fig. 34.

Cells in ventral view five-sided, 25-40μ broad. Epitheca cone-shaped, somewhat larger than the hypotheca, whose antapical portion is straight or concave. Girdle almost circular, sulcus broadened very much below on whose left antapical end a large, and on the right a small process or a tuft of spines present. Surface sculptured by finely punctate lines. Resting cell heart-shaped, with thick smooth membrane.

Europe (Germany, France, Poland) Africa (Lake Victoria, Madagascar); Malay Archipelago, Australia, USSR.

Peridinium baltense Lindemann, 1931
(Pl. LXXIII, fig. 6 - 9)

Lindemann, 1931, p. 712, figs. 38-41.
Schiller, 1937, p. 165, fig. 165 *a - d*.

Cells roundish-egg shaped, in cross section round, 45-55μ in length and breadth. Girdle median, slightly sinistral; sulcus very strongly widened towards posterior. Membrane smooth or areolated. Adjacent to the posterior end, three spines present connected by wing. Plate formula: 4' 3 *a*, 7'', 5'' 1, 2''''.

Malay Archipelago; Island of Bali.

Peridinium centenniale (Playfair) Lefèvre, 1928
(Pl. LXXIII figs. 10 - 13)

Lefèvre, 1928, p. 134, figs. 525–542.
Lindemann, 1931, p. 709, figs. 29-33.

Schiller, 1937, p. 176, fig. 178 *a - d.*
= *P. umbonatum* var. *centenniale* Playfair and
= *P. umbonatum* var. *ovale* Playfair, 1919, pp. 806, 807, figs. 14, 15.
= *P. umbonatum* var. *globosum* Lefèvre, 1928 *a*, p. 120.
= *P. centenniale* var. *fistulum* Lindemann, 1931, p. 711, fig. 32.

Small species, rounded and nearly globose, length and breadth often equal. Girdle shallow, divides cell into markedly unequal halves, the epitheca being quite two thirds of whole cell. Epitheca rounded and bow shaped, sides arched and with a subapical excentric pit. Hypotheca shallow, saucer-shaped, slightly narrower than epitheca, and gently arched posteriorly. Sulcus somewhat pyriform, broader end posterior. No conspicuous horns. Antapical plates convex, with scattered papillate sculpture. Intercalary region wide, clear, striated.

Europe (France, Spain); Madagascar, Malay Archipelago; Australia.

Peridinium cinctum (O .F. Müller) Ehrenberg, 1838
(Pl. LXXIV fig. 1—3)

Ehrenberg, 1838, p. 257, pl. 22, fig. 22.
Stein, 1883, pl. 12, fig. 9 - 10.
Schilling, 1891, p 70, pl. 3. fig. 22; 1913, p. 46, fig, 52.
Lemmermann, 1910, p. 677, figs. 14 - 16.
Lindemann, 1931, p. 716.
Kisselev, 1950, p. 167, fig. 260 *a - e*,
Schiller, 1937, p. 152, fig. 162 *a - k*.
= *P. tabulatum* Penard, 1891, p. 50 pl. 2, figs. 8 - 16; pl. 3, figs. 1 - 2.
= *P. cinctum* var *lemmermanii* G. S. West 1909, p. 190.
= *P. westii* Lemmermann var. *aureolatum* Lemmermann 1908, p. 180.
= *P. cinctum* var. *laesum* Lindemann 1918, p. 165.
= *P. germanicum* Lindemann, 1918, p. 169.
= *P. eximium* Lindemann, 1918, p. 167.
= *P. rhenanum* Lindemann, 1919, p. 249.

Cells globular to broadly egg-shaped, ventral side more or less flattened 40 - 60 μ long, 35 - 65 μ broad. Epitheca larger than hypotheca. Girdle ends displaced at least by a furrow width. Sulcus towards posterior widened, often not reaching to the very end. Rhomboid plate four sided with very variable side dimensions; plate orientation of epitheca asymmetrical, since plate 1 *a* at the left side appertains differently at the right side. Plate 3' lies apically and is three to five-sided. Armour often very thick and variously sculptured. Girdle and sulcus margin with more or

less large winged lists; at the left side of the sulcus at times a process present. Chromatophores brown, discoid, more or less numerous.

Whole of Europe. Java, East Africa, East Indies. USSR waters.

Large number of forms recognized.

Peridinium cinctum forma *tuberosum* (Meunier) Lindemann, 1928
(Pl. LXXIV figs. 4 - 6)

Lindemann, 1928 *d*, p. 260.
Schiller, 1937, p. 154, fig. 155 *a* - *c*. (as var, printing error?)
= *P. tuberosum* Meunier, 1919, p. 52, pl. 18, figs. 23 - 27.
= *P. cinctum* var *carinatum* Steinecke and Lindemann, 1923, p. 2.
= *P. cinctum* f. *tuberosum* (Meunier) Lefèvre, 1932, p. 93.
= *P. cinctum* var. *tuberosum* (Meunier) Lindemann, Kisselev, p. 167, figs. 271 *a* - *e*.

Distinguished from the species by the winged lists on girdle and sulcus and on the apical plates, as well as presence of 3 antapical humps.

Germany, Holland, Belgium; Madagascar; USSR waters.

Peridinium cinctum f. *westii* (Lemmermann) Lefèvre, 1925
(Pl. LXXIV figs. 7)

Lefèvre, 1925, p. 337, 1932, p. 89, fig. 230.
Schiller, 1937, p. 154, figs. 153 *h*.
= *P. westii* Lemmermann in W. *et*. G. S. West, 1905, p. 495, fig. *a* - *d*.
= *P. tabulatum* var, *maeandrica* Lauterborn, 1910.
= *P. maeandricum* Brehm. 1907, p. 112.
= *P. cinctum* f. *maeandricum* Lefèvre 1932, p. 91.

Distinguished from the species by the presence of twisted wormlike lists on the plates.

France; England; Switzerland; Tyrol; Norway; Lake Victoria, Africa.

Peridinium gatunense Nygaard, 1926
(Pl. LXXIV fig. 8 - 11)

Ostenfeld *et* Nygaard, 1926, p. 206.
Lefèvre, 1932, p. 94, figs. 269 - 284.
Schiller, 1937, p. 155, figs. 155 *a* - *j*.
= *P. cinctum* var. *gibbossum* Lifèvre, 1928 *a*, p. 121.

Cells egg-shaped. somewhat angular, apex flattened. Epi-and hypotheca little different in size, 45-80μ long, 55-80μ broad. Girdle markedly displaced, with more or less strongly protruding lists and deeply excavated furrow. Chromatophores yellowish brown. Armour thick, surface with reticulate meshes.

France; Africa (Camaroons and Madagascar); America (Amazon), Panama Canal (Lake Gatoum).

Peridinium gutwinskii Woloszynska, 1912
(Pl. LXXV, figs. 4 - 6)

Woloszynska, 1912, p. 701, fig. 22; 1923, p. 2, pl. 6, figs. 5-8; 1930 *a*, p. 161, fig. 1 *a*.
Lefèvre, 1932, p. 118, figs. 381-388.
Lindemann, 1931, p. 712, figs. 34-37.
Schiller, 1937, p. 161, figs. 159 *a-e*.

Cells elongated oval, with irregular outline, in cross-section almost circular, 40-60μ long, 35-60μ broad. Girdle very deeply excavated with drawn out margin; their ends displaced 1½ furrow width. Epitheca somewhat angular, apex slightly or clearly accuminate; hypotheca particularly on the left side, strongly concave, occasionally even right side, so that the lower end juts out hump-like. Sulcus with projecting spiniferous lists, rarely reaching antapex. Plates with net-like reticulations. Chromatophores brown. Nucleus elongated, saddle shaped.

Java, Madagascar.

Peridinium inconspicuum Lemmermann, 1899
(Pl. LXXV, figs, 7 - 11)

Lemmermann, 1899 *a*, p. 350; 1905 *b*, pl. 8, fig. 1; 1910 *b*, p. 667 figs. 28, 29.
Schilling, 1913, p. 42, fig. 48.
Lindemann, 1918, p. 141, figs. 62 - 67; 1925, p. 178, fig. 144 - 147.
Lefèvre, 1932, p. 126, figs. 446 - 509.
Schiller, 1939, p. 173, fig. 175 *a - w, z*.
Kisselev, 1950, p. 176, fig. 280 *a - d*; 290 *a - d*, 291 *a - t*; 292 *a - b*; 293 *a, b*.
Wood, 1954, p. 234, fig. 105 *a - c*.
= *P. minimum* (Schilling) Woloszynska, 1916, p. 276, pl. 11, figs. 26-29.

= *P. minusculum* Lindemann, 1918, p. 143, fig. 68, *bis* 70.
= *P. minusculum* var. *contactum* Lindemann, 1918, p. 144, fig. 75, 76.
= *P. minusculum* f. *spiniferum* Lindemann, 1918, p. 144.
= *P. inconspicuum conjunctum* (Lemm.) Lefèvre, 1928 *a*, p. 119.
= *P. inconspicuum* var *contactum* Lindemann, 1918, p. 144.
= *P. inconspicuum remotum* (Lemm.) Lefèvre, 1928 *a*, p. 119.
= *P. inconspicuum* var. *armatum* Lemmermann, 1910 *b*, p. 668, fig. 33-35.
= *P. inconspicuum* f. *marchicum* (Lemm.) Lindemann, 1918, p. 142.
= *P. caudatum* Playfair, 1919, p. 799 et
= *P. caudatum* var. *morsum* Playfair, 1919, p. 802.
= *P. geminum* var. *excavatum et*
= *P. geminum* var. *angulosum* Playfair, 1919, p. 805.
= *P. tabulatum* var. *caudatum* Playfair, 1919, p. 800.
= *P. marchicum* Lemmermann, 1910 *b*, p. 666, figs. 16-19; Schilling, 1913, p. 42, fig. 47.
= *P. marchicum* var. *ceyense* Nygaard, 1926, p. 209 (cited from Schiller, 1937)
= *P.inconspicuum* var. *balatonicum* Entz, 1927, p. 298, figs. 17-19.
= *P. steinmanni* et *P. st.* var. *armatum* Wołoszynska, 1930 *a*, p. 165, figs. 4, 5.
= *P. parvulum* Wolosyzynska 1930 *a*, p 168, fig. 6.

Cells-egg shaped, apex tapered, in cross-section very little flattened, 15-30μ long, 12-25μ broad. Epitheca somewhat higher than the hypotheca; girdle broad, moderately excavated, without or with delicate lists; their ends displaced only very slightly. Sulcus towards posterior mostly strongly widened, and always reaching the apex. Plates concave or convex. On the hypotheca at somewhat prominent edge almost always three more or less long spines, rarely more (f. *armatum*). Under high magnifications fine, punctate, longitudinal running lines may be seen. Chromatophores appear to exist rarely. Round resting cells observed.

Probably cosmopolitan. In cold as well as tropical inland waters.

In Malay Archipelago frequent.

Peridinium keyense Nygaard, 1926
(Pl. LXXV, figs. 12-14)

Nygaard, 1926, p. 208, pl. 4, fig. 32 (in Schiller, 1937).
Lefèvre, 1932, p. 170, figs. 831-141.
Schiller, 1937, p. 164, fig. 163 *a-e*.
= *P. keyense* var. *gonyaulacoides* Nygaard, 1926.

Cells roundish-egg shaped, 45-67μ long, 47-54μ broad, in cross-section almost circular. Plates more or less concave.

Malay Archipelago.

Peridinium madagascariensis (Lefèvre) Subrahmanyan comb. nov.
(Pl. LXXV, figs. 1-3)

= *P. gatunense* var. *madagascariensis* (Lef.) Lefèvre, 1932, p. 97, figs. 281-282; Schiller, 1937, p. 156, fig. 155, *n*, *o*.
= *P. cinctum* var. *madagascariensis*. Lefèvre, 1928 *a*, p. 122.

Cells in outline somewhat rhombic, surface undulating, apex slightly flattened and no differentiation into a horn. Epi-and hypo-theca about equal size. Girdle markedly displaced with more or less strongly protruding lists and deeply excavated furrow. Plates sculptured with longitudinally running ribs.

The sculpturing is very characteristic and totally unlike *P. gatunense*, hence the status is raised to that of a species.

In the opinioon of the writer *P. gatunense* var. *zonatum* (Playfair) Lefèvre also is to be raised to species level as considered by Playfair (1919) and designated *P. zonatum* Playfair.

Madagascar.

Peridinium playfairi Lindemann, 1931
(Pl. LXXVI, figs. 1-2)

Lindemann, 1931, p. 715; figs. 43, 44.
Lefèvre, 1932 p. 183, figs. 899-900.
Schiller, 1937, p. 160, fig. 158 *a* - *b*.

Cell round to egg - shaped, in section almost circular, ventral somewhat flattened, 40 - 50μ long and broad. Epitheca and hypotheca nearly same. Girdle ends strongly displaced. Sulcus somewhat encroaching on epitheca, reaching upto almost the posterior end. Plates finely reticulate sculptured, concave or convex.

Malay Archipelago, Bali Island.

Peridinium umbonatum Stein, 1883
(Pl. LXXVI, figs. 3 - 6)

Stein, 1883, pl. 12. figs. 1 - 8.
Lemmermann, 1910 p. 669, figs. 36, 39.

Schilling, 1913, p. 39. fig. 43.
Lefèvre 1932, p. 120, figs. 389 - 445.
Schiller, 1937, p. 171, fig. 174 *a* - *l*.
Kisselev, 1950, p. 176, figs 285 *a*- *h*; 287, 288, 289.
= *P. geminum* Playfair, 1919, p, 803.
= *P. caudatum* Playfair var. *guildfordense* Playfair, 1919, p. 800.
= ——— var. *planktonicum* Playfair, 1919, p, 802.
= *P. lubieniense* var. *inaequale* (Lef.) Lindemann, 1928 (?) p. 260.
= *P. umbonatum* var. *papilliferum* Lemmermann, 1908, p. 180. Wołoszynska, 1930, p. 166, fig. 3.
= *P. linzium* Lindemann, 1918, p. 137, figs. 40 - 43.
= *P. ambiguum* Lindemann, 1931, p. 707, pl. 23, 24.
= *P. umbonatum* var. *spiniferum* Lefèvre, 1928*a*, p. 120.
= *P. umbonatum* var. *inaequale* Lemmermann 1910, p, 669.
= *P. umbonatum* var. *inaequale remotum* (Lemm.) Lefèvre, 1928*a*, p. 119.
= *P. umbonatum contactum* (Stein) Lefèvre, 1928*a*, p. 119.
= *P. umbonatum* var. *armatum* Lefèvre, 1928a, p. 120; 1932, p. 125.
= *Glenodinium geminum* (Playfair) Lindemann, 1931, p. 697, figs. 5 - 9.
= *G. guildfordense* (Playfair) Lindemann, 1931, p. 700, figs. 10, 11.

Many formae are decribed by Lefèvre and Lemmermann all of which are valueless.

Cells longish - egg shaped, 25 - 35μ long, 21 - 31μ broad slightly compressed dorso - ventrally. Epitheca always far larger than hypotheca. Girdle with or without winged lists, relatively broad, its ends at the most half the furrow-width displaced. Sulcus extends slightly into epitheca; on the hypotheca reaches up to posterior end and then strikingly broadened or reaches only up to middle of hypotheca. Posterior region either flatly rounded or emarginated by the sulcus and at times armoured with small or large spines. Plates' sculptures under strong magnification rows of raised punctae series, which are often connected by very tender longitudinally running punctae lines. Chromatophores red brown. Resting cells round or elongated with firm cover.

The *formae* and *varieties* brought together by Lefèvre (1932) have very little systematic value. var. *inaequale* of Lemmermann, characterised by smaller hypotheca have been met with in same collections with transition forms. The *spiniferum* forms are striking with the strong spination at the posterior end. The manner of formation of sulcus merits particular consideration: the very long reaching posterior end and the very short.

Cosmopolitan form. In swamps and ponds, rarely lakes, Java.

Peridinium volzii Lemmermann, 1905
(Pl. LXXVI, fig. 7, 8.)

Lemmermann, 1905 *d*, p. 166; 1910 *b*, p. 675, figs. 14-17.
Schiller, 1937, p. 147, fig. 149 *a-k*.
Kisselev, 1950, p. 166, figs. 257 *a, b*.
= *P. gustrowiense* Lindemann, 1918, p. 153, figs. 103-133; 1925, p, 186, figs. 179-183. Lefèvre, 1932, p. 73, figs. 122-171.
= *P. kincaidi* Wailes, 1933 (?), p. 3, fig. 8-11. (from Schiller 1937).

Cells round, ventrally somewhat flattened, 38-60μ long and almost as broad. Girdle strongly sinistral, excavated. Sulcus short, extends slightly into epitheca, at the lower end not emarginated. Epitheca always larger than hypotheca. Rhomboid plate small, crest absent. Shell strongly areolated; intercalary striae mostly clear. Chromatophores brown, disc-shaped.

Freshwater form with world wide distribution in lakes and ponds. In the Indian Ocean region in Africa, Madagascar, Malay Archipelago, Australia.

Peridinium volzii Lemmermann var. *cinctiforme* Lefèvre, 1928
(Pl. LXXVI, figs. 9, 10)

Lefèvre, 1928 *a*, p. 132; 1922, p. 76, figs. 141-145.
Schiller, 1937, p. 148, fig. 149 *e, f*.
The two upper sides of the rhomboid plate unequal. Otherwise like species.

Germany, Poland, Kraken, Madagascar.

Peridinium volzii Lemmermann var. *botanicum* (Playfair) Lindemann, 1931
(Pl. LXIV fig. 12, 13)

Lindemann, 1931, p. 715.
Schiller, 1937, p. 149, fig. 149 *g. h*.
= *P. tabulatum* Playfair, 1912, p 542 (cited *from* Schiller, 1937).
= *P. willei* var. *botanicum* Playfair, 1919. p. 813; Lefèvre, 1932, p. 76, figs. 146–147.
non *P. tabulatum* Clap. et Lachm.

Characterised by two short process at the lower end of the sulcus. Otherwise like species.

Australia, Malay Archipelago.

Read line 25 Pl. LXXIV Fig. 12, 13 as Pl. LXXIV Fig. 12, 13

Peridinium volzii Lemmermann f. *sinuatum* (Lindemann) Lefèvre, 1932
Lefèvre, 1932, p. 78, figs. 156 - 160.
Schiller, 1937, p. 149.
= *P. guestrowiense* f. *sinuatum* Lindemann, 1918, p. 156, fig. 128 - 129.

Distinguished by the longitudinally oriented ventrally placed indentation No figure available for author for reproduction.

Africa, Malay Archipelago, Siberia.

Peridinium willei Huitfeldt-Kass, 1900
(Pl. LXXVI, figs 11 - 13)

Huitfeldt-Kass, 1900, p. 5, figs. 6-9.
Lemmermann, 1910 *b*, p. 675, figs. 10-13.
Lindemann, 1925, p. 185, figs. 175-178.
Lefèvre, 1932, p. 70, figs. 101-121.
Schiller, 1937, p. 146, fig. 148 *a* - *e*.
Kisselev, 1950, p. 164, fig. 256 *a* - *d*.
= *P. alatum* Garbini, 1902, p. 122, fig. *a*, *b*.

Cells almost round, often broader than long. Girdle strongly sinistral; sulcus broad, extends from the indented posterior end to slightly over the epitheca. Hypotheca smaller than epitheca. Margin of apical plates as well as antapical margin of sulcus at times also still other plate margins 1·5 – 4μ high, hyaline, carrying crests hardened with processes. Plates strongly areolate. Chromatophores brown. Resting stages exist. L = 40-60μ, B = 45-70μ.

Europe, America, Indonesia.

Some authors (Lindemann, 1918, p. 151) and Lefèvre (1932, p. 73) recognise some formae. *Sphaericum* with round cells, and *lineatum* and *stagnale* based on small differences.

Family *Peridiniaceae* Schütt emend Lindemann 1928

Taxa occuring in the Indian Ocean region

GENUS DIPLOPELTA Jörgensen, 1913

1. *bomba* Stein, 1883

GENUS DIPLOPELTOPSIS Pavillard, 1913

2. *minor* (Paulsen) Pavillard, 1913

GENUS DIPLOPSALIS Bergh, 1881

3. *lenticula* Bergh, 1881
4. *pilula* Ostenfeld, 1908
5. *saecularis* Murray & Whitting, 1889

GENUS DIPLOPSALOPSIS Meunier, 1909

6. *orbiculare* (Paulsen) Meunier, 1909

GENUS PERIDINIOPSIS Lemmermann, 1904

7. *rotunda* Lebour, 1922

GENUS PREPERIDINIUM Mangin, 1913

8. *asymmetricum* Mangin, 1913

GENUS PERIDINIUM Ehrenberg, 1832

9. *abei* Paulsen, 1930
10. *achromaticum* Levander, 1902
11. *adeliense* Balech, 1958
12. *adense* Matzenauer, 1933
13. *affine* Balech, 1958
14. *africanum* Lemmermann, 1907
15. *amplum* Matzenauer, 1933
16. *ampulliforme* Wood, 1954
17. *applanatum* Mangin, 1914
18. *archiovatum* Balech, 1958
19. *avellana* (Meunier) Lebour, 1925
20. *baliense* Lindemann, 1931
21. *biconicum* P. Dangeard, 1927
22. *bimucronatum* Schiller, 1937
23. *brachypus* Schiller, 1937
24. *breve* Paulsen, 1907
25. *brevipes* Paulsen, 1908
26. *brochii* Kofoid *et* Swezy, 1921
27. *centenniale* (Playfair) Lefèvre, 1932
28. *cerassus* Paulsen, 1907
29. *cinctum* (O.F. Müller) Ehrenberg, 1838

30. *cinctum* f. *tuberosum* (Meunier) Lindemann, 1938
31. *cinctum* f. *westii* (Lemmermann) Lefèvre, 1925
32. *claudicans* Paulsen. 1907
33. *colombense* Matzenauer, 1933
34. *conicoides* Paulsen, 1905
35. *conicum* (Gran) Ostenfeld *et* Schmidt, 1900
36. *conicum* f. *guardafuiana* Matzenauer 1933
37. *crassipes* Kofoid, 1907
38. *curtum* Balech, 1958
39. *curvipes* Ostenfeld, 1906
40. *depressum* Bailey, 1855
41. *diabolus* Cleve, 1900
42. *divergens* Ehrenberg, 1840
43 *elegans* Cleve, 1900
44. *excentricum* Paulsen, 1907
45. *fatulipes* Kofoid, 1907
46. *gatunense* Nygaard, 1925
47. *gibbosum* Matzenauer, 1933
48. *globulus* Stein, 1883
49. *granii* Ostenfeld, 1906
50. *grande* Kofoid, 1907
51. *bulla* Meunier, 1910
52. *gutwinskii* Woloszynska, 1912
53. *heteracanthum* P. Dangeard, 1927
54. *heteroconicum* Matzenauer, 1933
55. *humile* Schiller, 1937
56. *hyalinum* Meunier, 1910
57. *inclinatum* Balech, 1964
58. *inconspicuum* Lemmermann, 1899
59. *keyense* Nygaard, 1926
60. *latispinum* Mangin, 1926
61. *leonis* Pavillard, 1916
62. *leonis* f. *matzenaueri* (Matz.) Schiller, 1937
63. *madagascariensis* (Lefèvre) Subrahmanyan, 1971
64. *marielebourae* Paulsen, 1930
65. *matzenaueri* (Matzenauer) Gaarder, 1954
66. *mediocre* Balech, 1958
67. *mediterraneum* (Kofoid) Balech, 1964
68. *minusculum* Pavillard, 1905
69. *minutum* Kofoid, 1907
70. *murrayi* Kofoid, 1907
71. *nipponicum* Abé, 1927

72. *nux* Schiller, 1927
73. *obesum* Matzenauer, 1933
74. *obovatum* Wood, 1954
75. *oceanicum* Vanhöffen, 1897
76. *orientale* Matzenauer, 1933
77. *ovatum* (Pouchet) Schütt, 1855
78. *pallidum* Ostenfeld, 1899
79. *parvicollum* Balech, 1957
80. *patens* P. Dangeard, 1927
81. *pedunculatum* Schütt, 1895
82. *pellucidum* (Bergh) Schütt, 1895
83. *pentagonum* Gran, 1902
84. *pentagonum* var. *latissimum* (Kofoid) Schiller, 1937
85. *persicum* Schiller, 1937
86. *pietschmanni* Böhm, 1931
87. *playfairi* Lindemann, 1931
88. *pseudoantarcticum* Balech, 1958
89. *pyriforme* Paulsen, 1904
90. *quadratum* Matzenauer, 1933
91. *remotum* Karsten, 1907
92. *retiferum* Matzenauer, 1933
93. *rosaceum* Balech, 1957
94. *roseum* Paulsen, 1904
95. *sanguinneum** Carter, 1858
96. *sinaicum* Matzenauer, 1933
97. *solidicorne* Mangin, 1926
98. *somma* Matzenauer, 1933
99. *steinii* Jörgensen, 1899
100. *subinerme* Paulsen, 1904
101. *subpyriforme* P. Dangeard, 1927
102. *tennuissimum* Kofoid, 1907
103. *thorianum* Paulsen, 1905
104. *tristylum* Stein, 1883
105. *trochoideum* (Stein) Lemmermann, 1910
106. *turbinatum* Mangin, 1926
107. *umbonatum* Stein, 1883
108. *variegatum* Peters, 1928
109. *ventricum* Abé, 1927
110. *venustum* Matzenauer, 1933
111. *volzii* var. *cinctiforme* Lefèvre, 1928

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* Diagnosis and figure not available. Not described here.

112. *volzii* var *sinuatum* (Lindemann) Lefèvre, 1932
113. *volzii* Lemmermann, 1905
114. *willei* Huitfeldt.—Kaas, 1900

Taxa known exclusively from areas other than Indian Ocean

GENUS ENTZIA Lebour. 1922

1. *acuta* (Apstein) Lebour, 1922

GENUS HETEROCAPSA Stein, 1883

2. *triquetra* (Ehrenberg) Stein, 1883

GENUS MINUSCULA Lebour, 1925

3. *bipes* (Paulsen) Lebour, 1925

GENUS PERINIDIUM Ehrenberg, 1832

4. *acanthophorum* Balech, 1962
5. *aciculiferum* Lemmermann, 1900
6. *allorgei* Lefévre, 1927
7. *americanum* Gran *et* Braarud, 1935
8. *anguipes* Balech, 1967
9. *anomaloplaxum* Balech, 1964
10. *anthonyi* Fauré – Fremiet, 1908
11. *aspidiotum* Balech, 1964
12. *balticum* (Levander) Lemmermann, 1910
13. *berolinense* Lemmermann, 1910
14. *bipes* Stein, 1833
15. *bispinum* Schiller. 1937
16. *brintoni* Balech, 1962
17. *bullosum* Gaarder, 1954
18. *capdevillei* Balech, 1959
19. *caburroi* Balech, 1959
20. *chinense* Schiller, 1937
21. *claudicanoides* Graham, 1942
22. *crassum* Balech, 1959
23. *dakariensis* P. Dangeard, 1927
24. *decipiens* Jörgensen, 1899
25. *defectum* Balech, 1965
26. *deficiens* Meunier, 1919
27. *deflandrei* Lefèvre, 1927
28. *denticulatum* Gran *et* Braarud, 1935
29. *divaricatum* Meunier, 1919

Read No. 17 bullosum as bulbosum

112. *volzii* var *sinuatum* (Lindemann) Lefèvre, 1932
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9. *anomaloplaxum* Balech, 1964
10. *anthonyi* Fauré – Fremiet, 1908
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25. *defectum* Balech, 1965
26. *deficiens* Meunier, 1919
27. *deflandrei* Lefèvre, 1927
28. *denticulatum* Gran *et* Braarud, 1935
29. *divaricatum* Meunier, 1919

Read No. 17 bullosum as bulbosum

30. *elegantissimum* Balech, 1958
31. *elongatum* Meunier, 1910
32. *exiguum* Cleve, 1900
33. *exiquipes* Mangin, 1930
34. *fimbriatum* Meunier, 1919
35. *godlewskii* Woloszynska, 1916
36. *goslaviense* Woloszynska, 1916
37. *grenlandicum* Woloszynska, 1916
38. *hangoei* Schiller, 1937
39. *helix* Balech, 1962
40. *hemisphericum* Abé, 1927
41. *heterospinum* Gaarder, 1954
42. *hirobis* Abé, 1927
43. *incertum* Balech, 1958
44. *incognitum* Balech, 1959
45 *inflatiforme* Böhm, 1936
46. *islandicum* Paulsen, 1904
47. *joubini* P. Dangeard, 1927
48. *karianum* (Meunier) Schiller, 1937
49. *laticeps* Gröntved, 1948
50. *latipyrum* Balech, 1959
51. *latistriatum* Balech, 1958
52. *latum* Paulsen, 1908
53. *limnophilum* Lindemann, 1924
54. *lipopodium* Balech, 1964
55. *lomnickii* Woloszynska, 1916
56. *longispinum* Kofoid, 1907
57. *lubiniense* Woloszynska, 1916
58. *monovelum* Abé, 1927
59. *morzinense* Lefèvre, 1928
60. *munobis* Abé, 1927
61. *mutsuensis* Abé 1927
62. *mutsui* Schiller, 1937
63. *nanum* Balech, 1965
64. *nasutum* Mangin, 1922
65. *nipponicum* Abé, 1927
66. *nivale* (Meunier) Schiller, 1927
67. *norpacense* Balech, 1962
68. *novascotiense* Gran *et* Braarud, 1935
69. *nudum* Meunier, 1919
70. *obliquiforme* Schiller, 1937

71. *obtusipes* Mangin, 1930
72. *ovum* Schiller, 1911
73. *parvispinum* Gaarder, 1954
74. *palatinum* Lauterborn, 1896
75. *palustre* (Lindemann) Lefèvre, 1932
76. *parvicollum* Balech, 1958
77. *parvispinum* Gaarder, 1954
78. *patagonicum* Balech, 1959
79. *paulseni* Pavillard, 1909
80. *pentagonoides* Balech, 1949
81. *perbreve* Balech *et* Soares, 1966
82. *petersi* Balech, 1958
83. *pseudolaeve* Lefèvre, 1925
84. *pusillum* (Penard) Lemmermann, 1901
85. *pyrum* Balech, 1959
86. *quinquecorne* Abé, 1927
87. *rampii* Balech, 1959
88. *raphanum* Balech, 1958
89. *robustum* Meunier, 1910
90. *roscoffiense* Balech, 1962
91. *saltans* Meunier, 1910
92. *simplex* Gran *et* Braarud, 1935
93. *spiniferum* Schiller, 1937
94. *striolatum* Playfair, 1919
95. *subsalsum* Ostenfeld, 1908
96. *subsphaericum* Balech, 1959
97. *sympholis* Hermosilla *et* Balech, 1969
98. *tatrae* Schillar, 1937
99. *thulense* Balech. 1958
100. *tregouboffi* Halim, 1955
101. *treubi* Wolosznska, 1912
102. *triquetrum* (Ehrenberg) Lebour, 1925
103. *tuba* Schiller, 1937
101. *unipes* Balech, 1962
102. *verrucosum* Meunier, 1910
103. *wierzejskii* Woloszynska, 1916
104. *wiesneri* Schiller, 1911
105. *wildmani* Woloszynska, 1923
106. *wisconsinense* Eddy, 1930
107. *yserense* Meunier, 1919

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PLATES

I—LXXIX

PLATE I

Figs. 1, 2, 3, 5, 7, 8, 9, 16. *Diplopsalis lenticula* Bergh. 1, ventral view ; 2, 5, side views ; 3, dorsal view; 7, 8, 9, 16 apical views ; (1, 2, 3, 7, 9, after Lebour, 1925 ; 5, 8, 16, affer Pavillard in Schiller, 1937. Magnification not known.

Figs. 4, 6, 12, 13, 14. *Diplopeltopsis minor* Pavillard. 4, dorsal view ; 6, side view ; 12, 14 apical views; 13, vental view; (after Lebour, 1925) ; magnification not known.

Figs. 10, 11, 15. *Preperidinium asymmetricum* Mangin. 10, ventral view; 11, apical view ; 15, antapical view. (after Lebour, 1925 as *Peridiniopsis asymmetrica* Mangin) ; magnification not known.

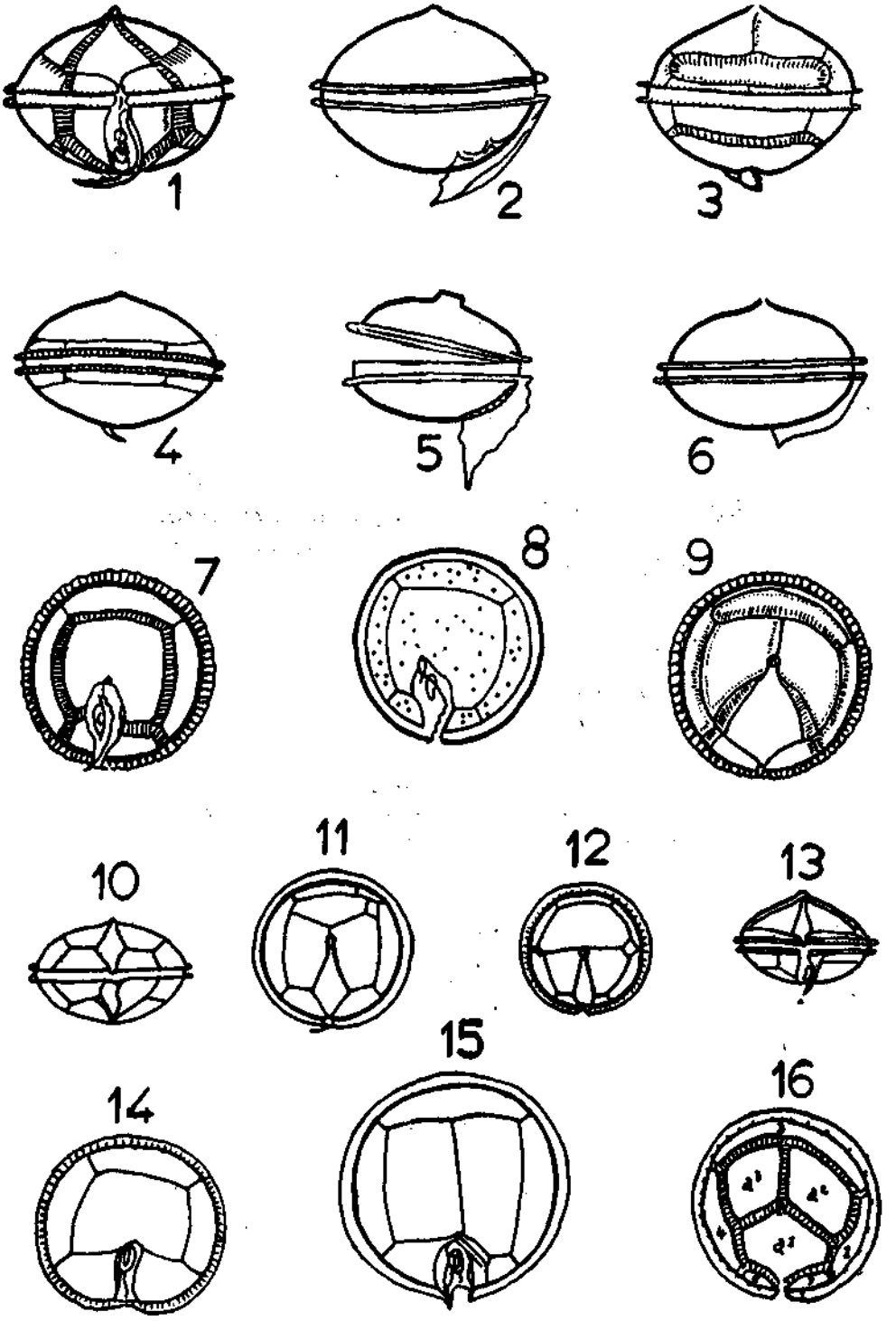

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PLATE II

Figs. 1 - 4, 6, 8, 10. 12 - 15. ***Preperidinium asymmetricum*** Mangin; 1, side view; 2. 3, 12 (contents divided, reproduction?) dorsal views; 4 and 8, apical views; 6, antapical view; 10, oblique ventral view; 13 (contents divided) 14, 15, ventral views. (1, 3 after Lebour, 1925); 4, 6, 8 after Schiller, 1937); 1. 3, 4, 6 and 8, magnification not known; rest original x 760.

Figs. 5, 7, 9 and 11. ***Diplopeltopsis minor*** (Paulsen) Pavillard.5, 7, 9, apical views; 11, ventral view; (after Silva, 1955). magnification not known.

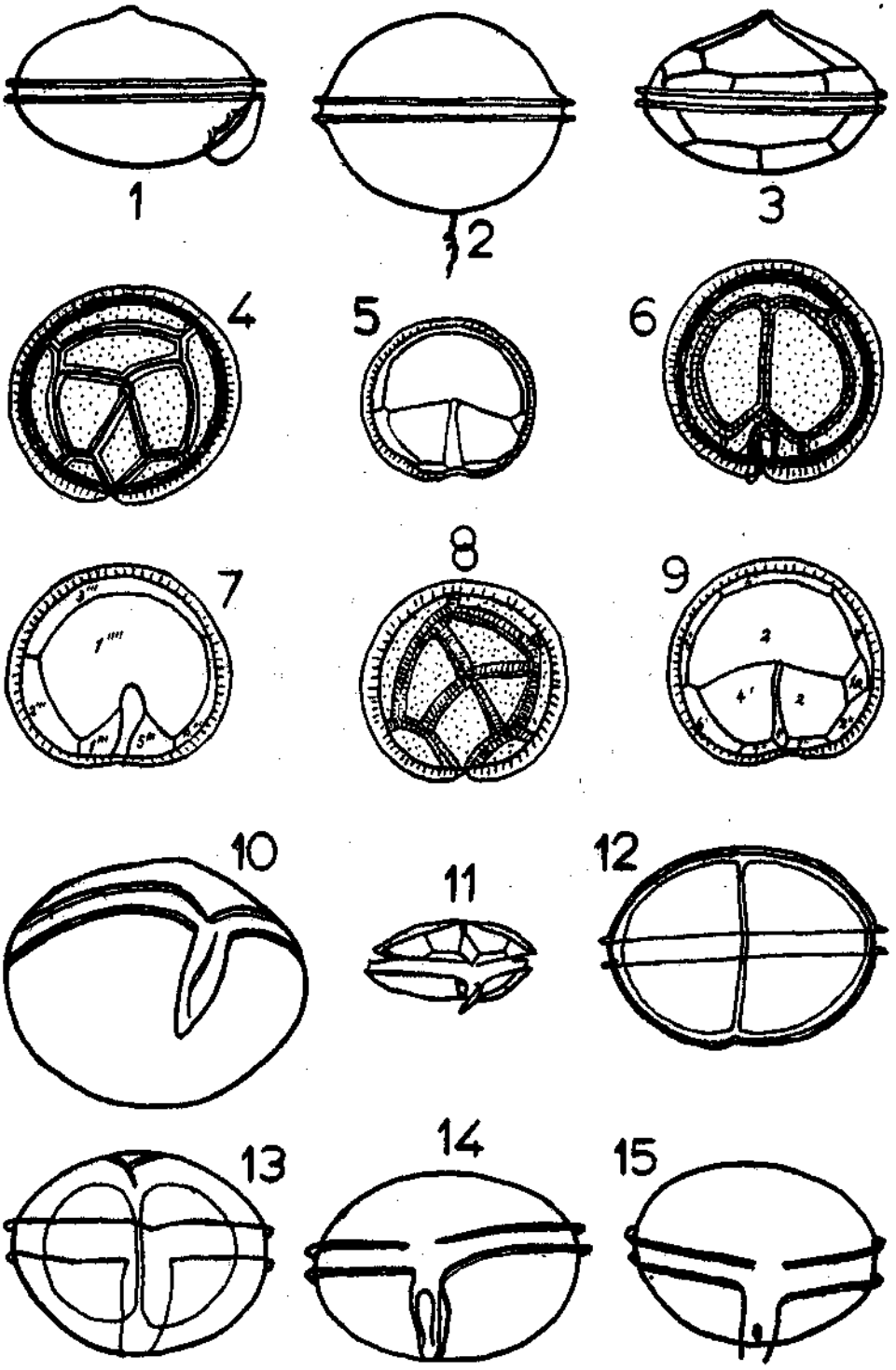

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PLATE III

Figs. 1, 2, 3, 8, 10. *Diplopsalis lenticula* Bergh; 1, 8, 10 apical views; 2, dorsal view; 3 apical view (contents of cell divided); (original). x 760.

Figs. 4, 5, 9, 11. *Preperidinium asymmetricum* Mangin; all apical views; contents shown divided in 4; (original); x 760.

Figs. 6, 7. *Dipopeltopsis minor* Pavillard; apical views; (original); x 760.

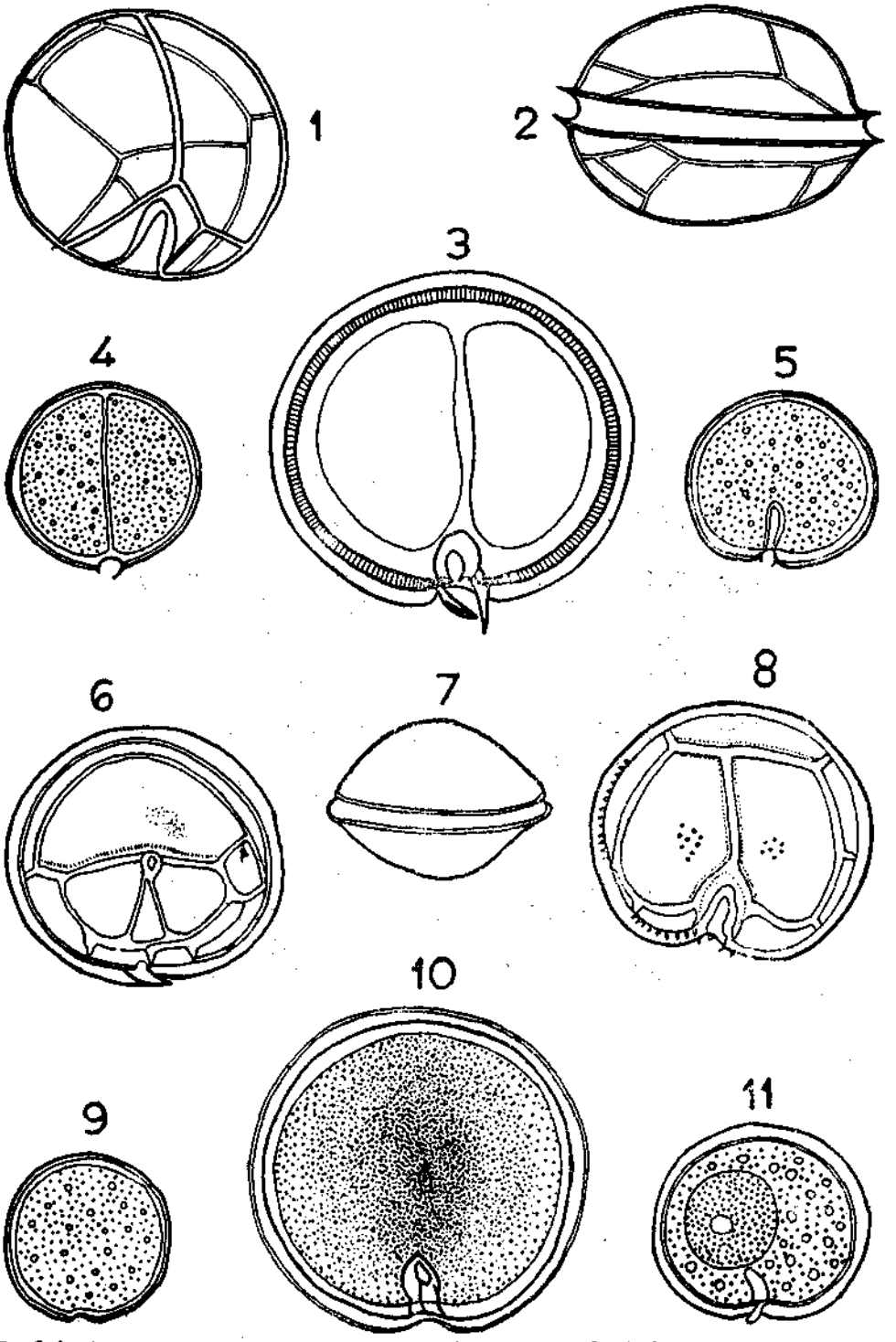

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PLATE IV

Figs. 1, 4, 5, 6, 7. *Diplopsalis pilula* Ostenfeld; 1, ventral view; 4, dorsal view; 5, 6. 7 apical views; (after Ostenfeld in Schiller, 1937); x 1920.

Figs. 8, 13, 15, 17. *Diplopsalopsis orbiculare* (Paulsen) Meunier; 8, ventral view; 13, 17 apical views; 15, dorsal view; (after Lebour, 1925); magnification not known.

Figs. 9, 10 - 12, 14. *Peridiniopsis rotunda* Lebour; 9, dorsal view; 10, side view; 11, ventral view; 12, 14, apical views; (after Lebour, 1925); magnification not known.

Figs. 2, 3, 16, 18. *Diplopsalis saecularis* Murray and Whitting; 2, 3 oblique ventral views; 16, apical view; 18, vental view; (after Murray and Whitting in Schiller, 1937); magnification, not known.

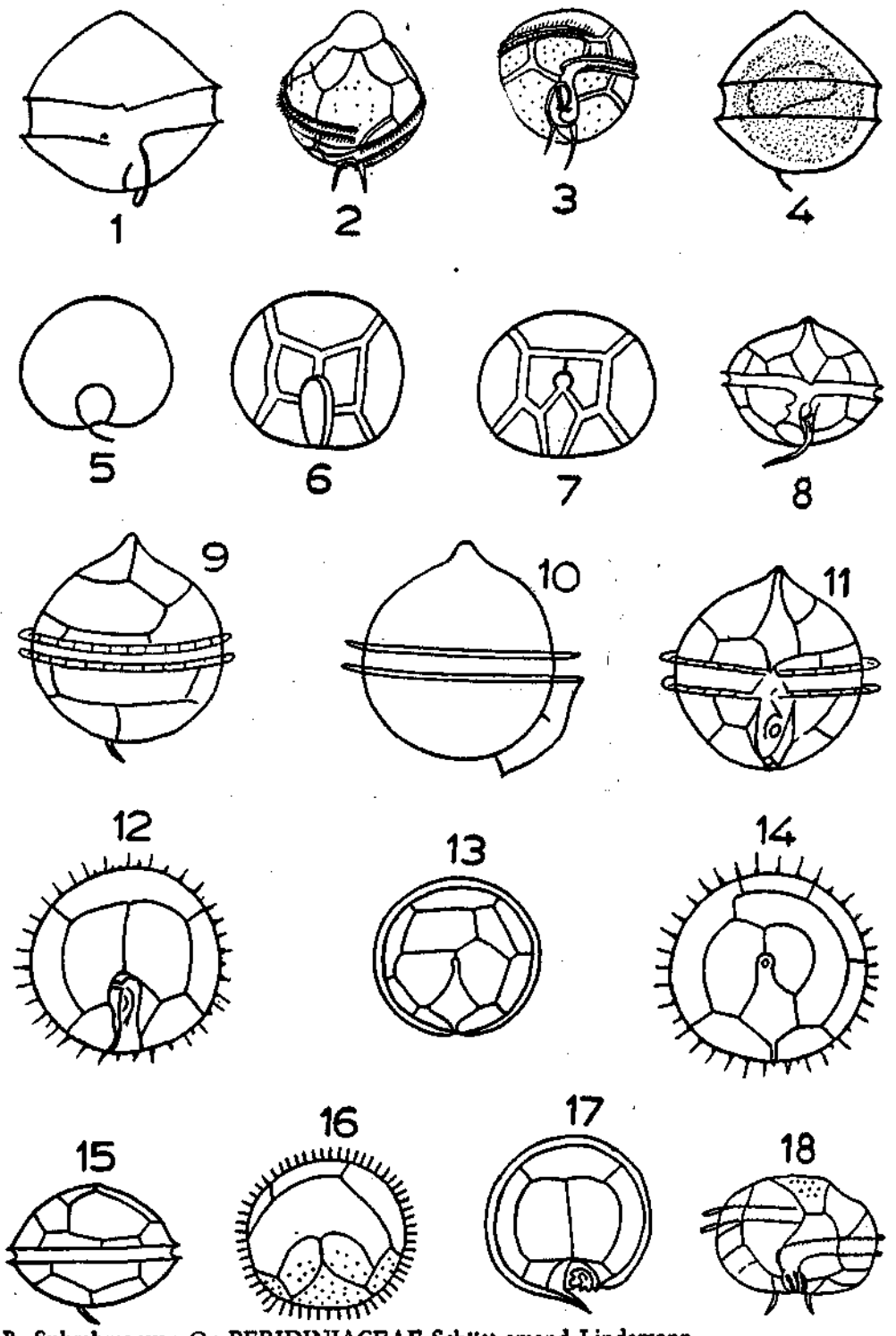

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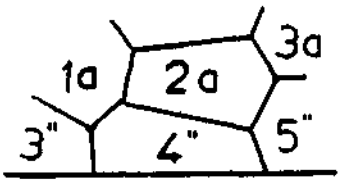
PLATE V

Figs. 1, 2, 7, 8. Diagram showing arrangement of the second anterior intercalary plate in the section of *Orthoperidinium* and *Metaperidinium*. 1 and 2 *Orthoperidinium tabulatum*; *Metaperidinium pyriforma*. 7. *Orthoperdinium conica*, *Metaperidinium para-peridinium*. 8- *Orthoperidinium oceanica*, *Metaperidinium divergens* and *Humilia*.

Figs. 3. Outline of a freshwater species (*P. cinctum*, outer) and a marine species (*P. divergens*, inner); shows that interval of cross lines from centre to surface is more in freshwater species); (after Schiller, 1937).

Figs. 4, 5, 6– *Ortho-Meta* and *para-peridinium* respectively.



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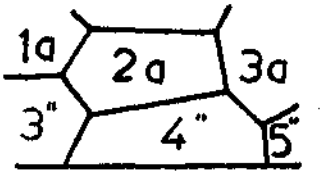

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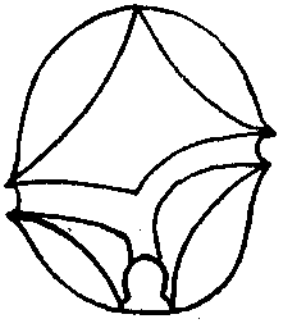

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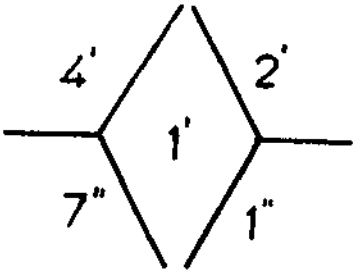

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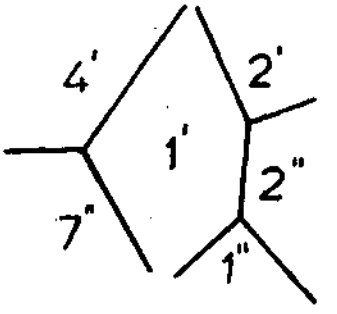

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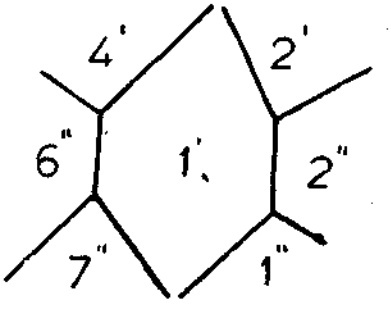

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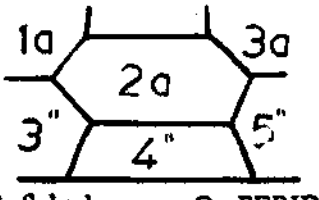

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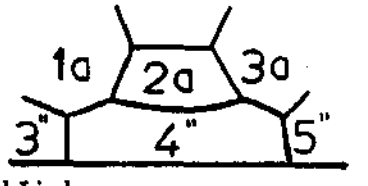

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PLATE VI

Figs. 1, 4, 9, 11. Diagrams to show numbering plates of *Peridinium*; (after Labour, 1925).

Figs. 2, 5, 6. Examples of three types of first apical plate.
2- *Metaperidinium.*
5- *Orthoperidinium.*
6– *Paraperidinium.*
(After Graham, 1944).

Figs. 3, 7, 8. Examples of three types of dorsal epithecal tabulation used by Jörgensen, Paulsen *et al* in subdividing the Subgenera of *Peridinium*; (after Graham, 1944).

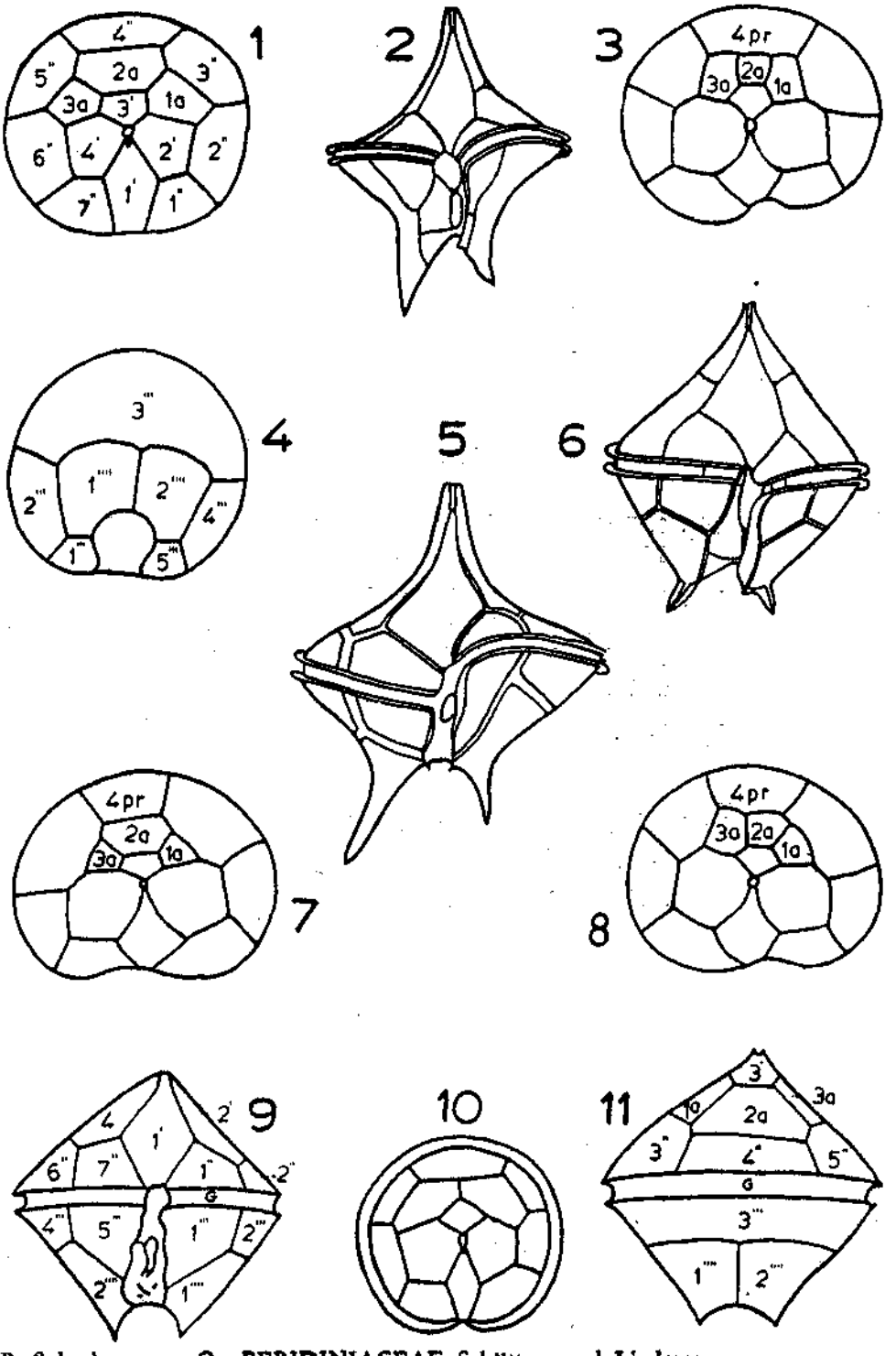

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PLATE VII

Fig. 1. *Peridinium adense* Matzenauer; ventral view (after Matzenauer, 1933); x 1000.

Figs. 2- 6. *Peridinium bulla* Meunier; 2 and 5, ventral views; 3 and 4, dorsal views; 6, apical view; (2 and 3 original; rest after Meunier in Schiller, 1937), 2 & 3, x 1370; rest x 1000.

Figs. 7- 10. *Peridinium globosum* Dangeard; four views; (after Dangeard, 1927 *c*); magnification not given.

Figs. 11- 15. *Peridinium hyalinum* Meunier; 11 and 13 ventral views; 12, oblique and 14, dorsal view; 15, apical view; (11 and 12, original; rest after Meunier in Schiller, 1937) 11 & 12, x 760; rest, x 1000.

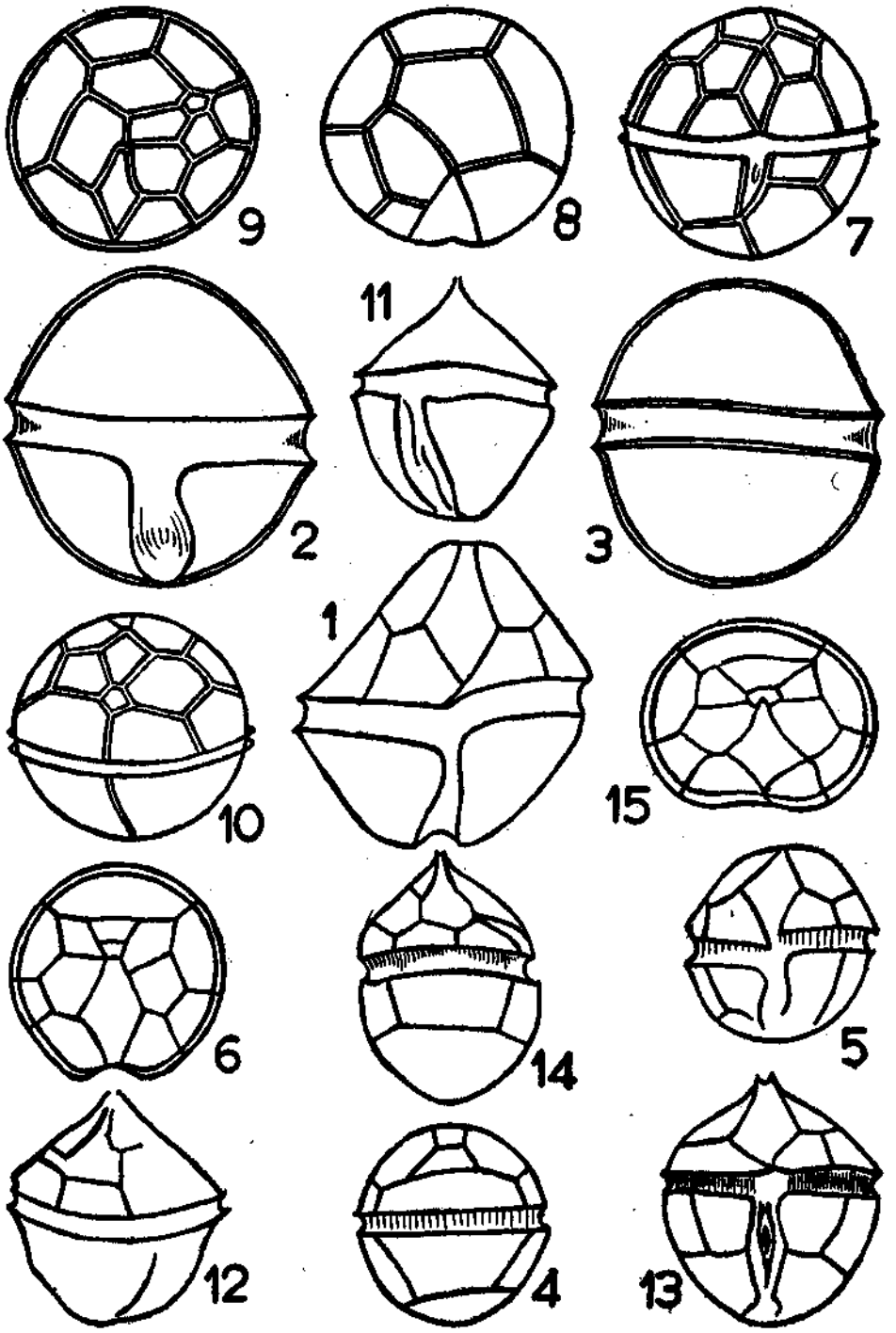

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PLATE VIII

Figs. 1-7. *Peridinium trochoideum* Lebour; 2, 3, 4, ventral views; 1, 5, dorsal views; 6 & 7, apical views; (3 & 5, after Schiller, 1937; rest after Lebour, 1925); x *ca* 1000.

Figs. 8-12. *Peridinium ventricum* Abé; 8, dorsal view; 11, ventral view; 12, side view; 9 & 10, apical and antapical views respectively; (all after Abé in Schiller, 1937); all x 600.

Figs. 13-15. *Peridinium nux* Schiller; 13, ventral view; 14, apical view; 15, left side view; (after Abé in Schiller, 1937); magnification not shown.

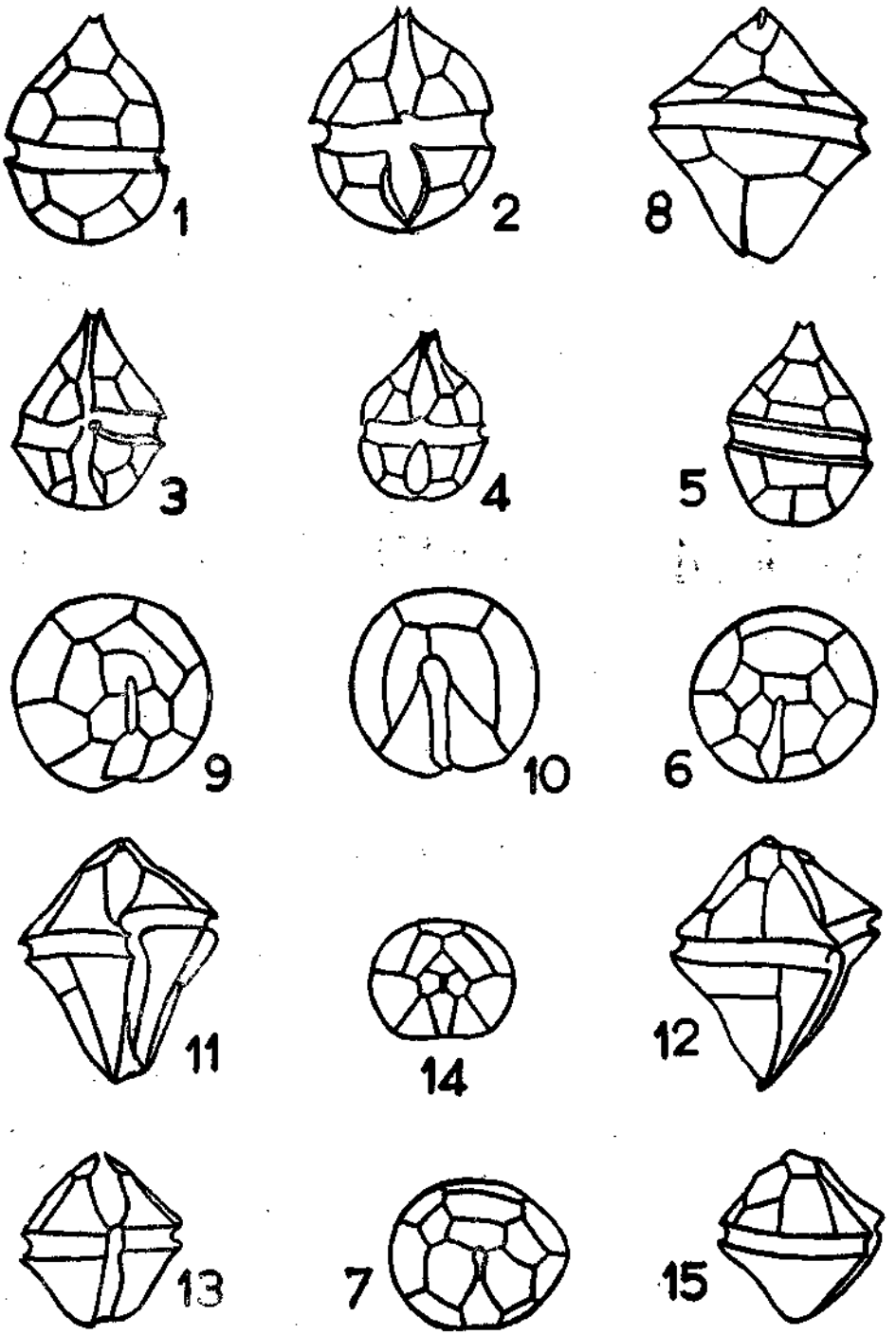

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PLATE IX

Figs. 1-8. *Peridinium abei* Paulsen; 1, 2, 3, 5, 6, ventral views; 4, lateral view; 7 & 8, apical and antapical views respectively; (3, 5, and 8, after Abé in Schiller, 1937, Japanese waters; 1, 4, 6 and 7, after Matzenauer, 1933, Indian Ocean; 2 after Schiller, 1937, eutrophic waters of Sumatra); 3, 5 & 8, x 600; rest not known.

Figs. 9-13. *Peridinium avellana* (Meunier) Lebour; 9 and 12, dorsal views; 10, ventral view; 11 and 13, apical and antapical views respectively; (after Lebour, 1925); all x *ca* 500.

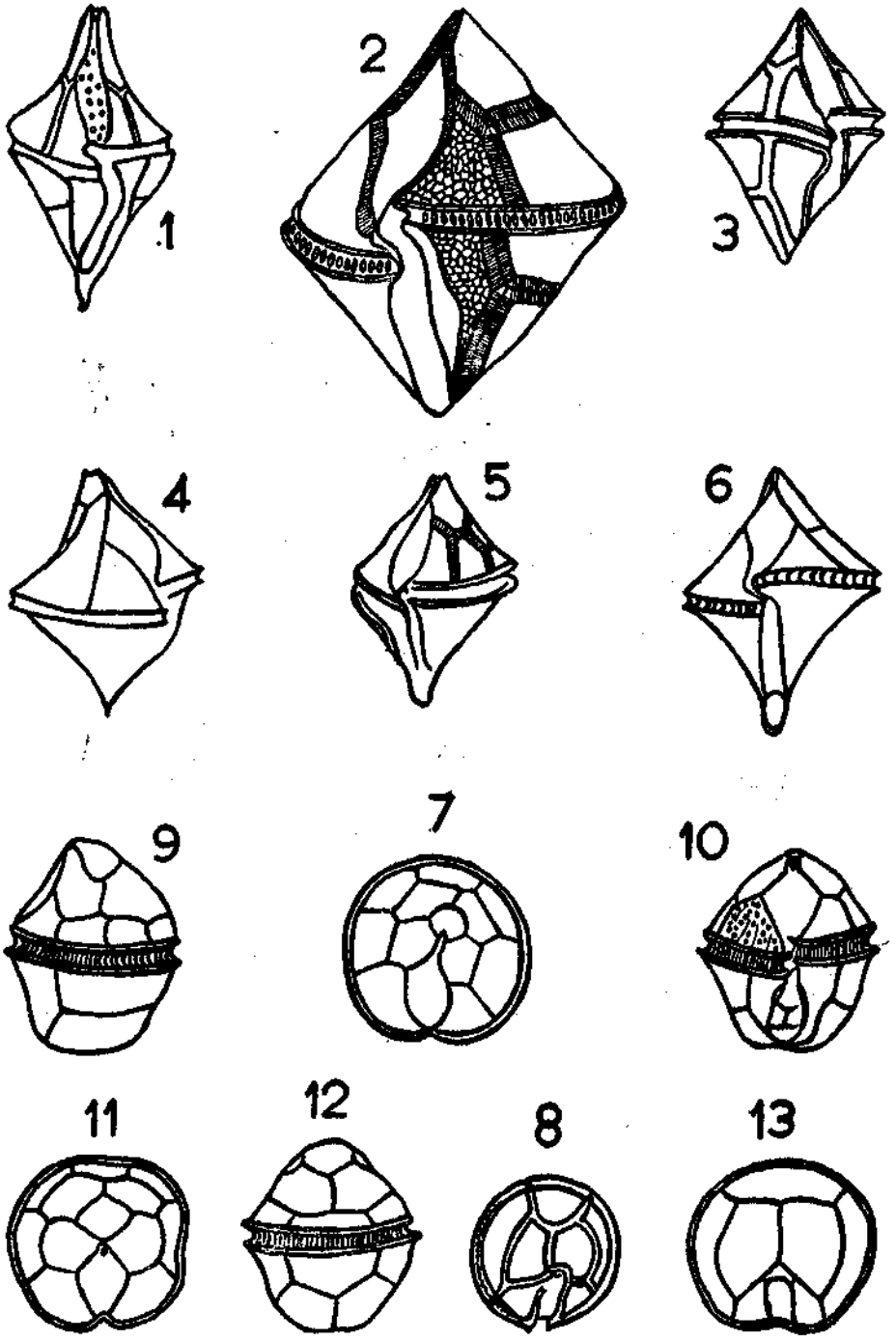

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PLATE X

Figs. 1–5. *Peridinium thorianum* Lebour; 1, dorsal view; 2, ventral view; 3 & 4, apical views; 5, antapical view; (1, 2, 3 & 5, after Lebour, 1925; 4, after Dangeard, 1927 *c*); magnification not known.

Figs. 6-8. *Peridinium colombense* Matzenauer; 6, dorsal view; 7, epitheca; 8, ventral view; (after Matzenauer, 1933); magnification not known.

Figs. 9-13. *Peridinium minutum* Kofoid; 9 & 13 ventral views; 10 & 12, dorsal views; 11, antapical view; (12 & 13, original; 9 after Kofoid, 1907 *b* ; 10 & 11, after Lebour, 1925); 12 & 13, x 760; 9, x 750; 10 & 11, x *ca* 600.

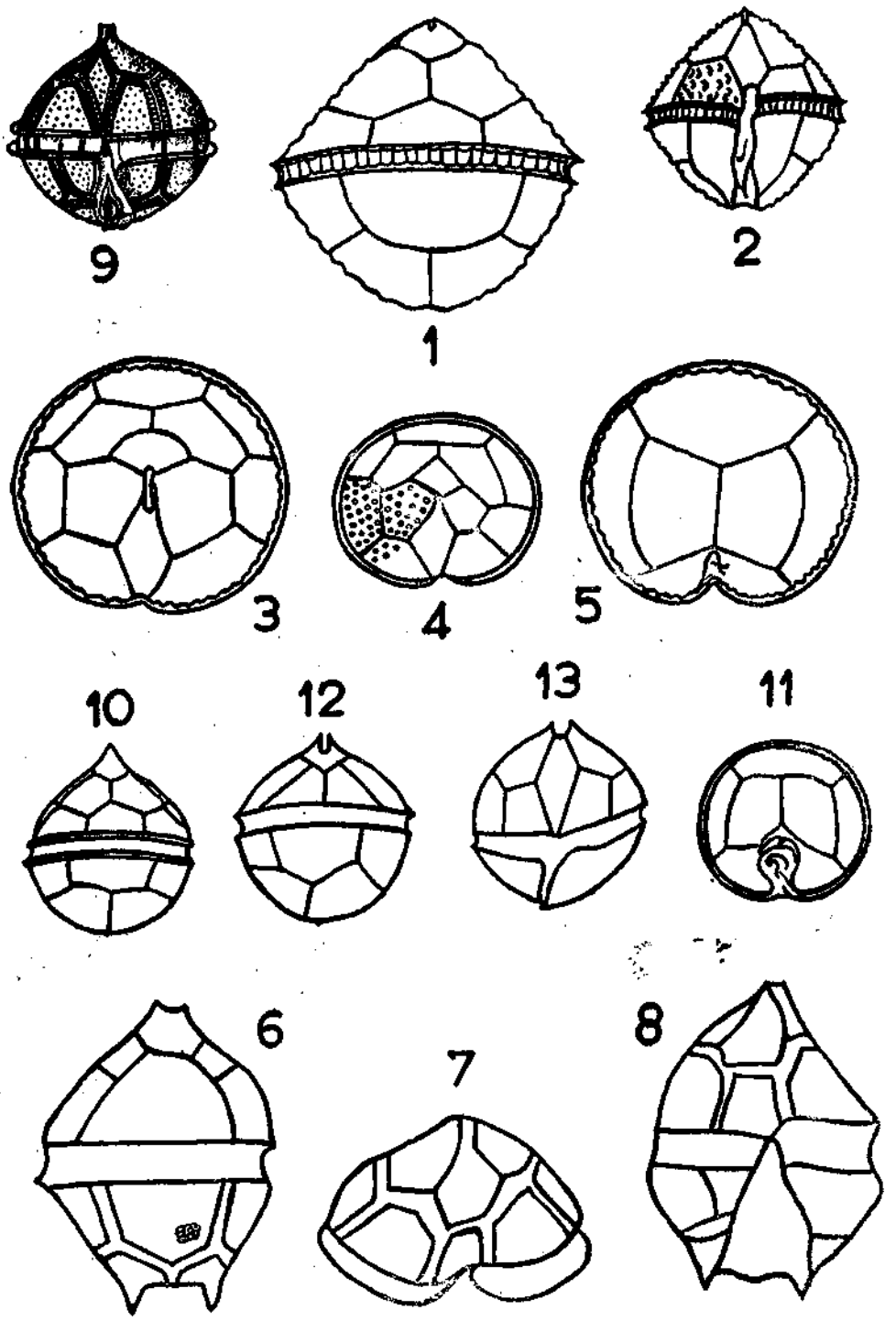

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PLATE XI

Figs. 1 & 2. *Peridinium minutum* Kofoid ; apical and ventral views respectively with plate numbers ; (from Schiller, 1937) ; magnification not known.

Figs. 3 - 11. *Peridinium excentricum* Lebour; 4, 5, 8 & 9; ventral views ; 3 & 6, dorsal views ; 7, lateral views; 3 & 6, dorsal views ; 7, lateral view; 10 & 11, antapical and apical views : (3 & 4, original; 5 & 7 after Meunier in Schiller, 1937 ; 6, after Dangeard in Schiller, 1937 ; 8, 9. 10 & 11, after Lebour, 1925); 3 & 4, x 600 ; 5 & 7, x 850 ; 8, 9, 10 & 11 x 1000 ; 6, not known.

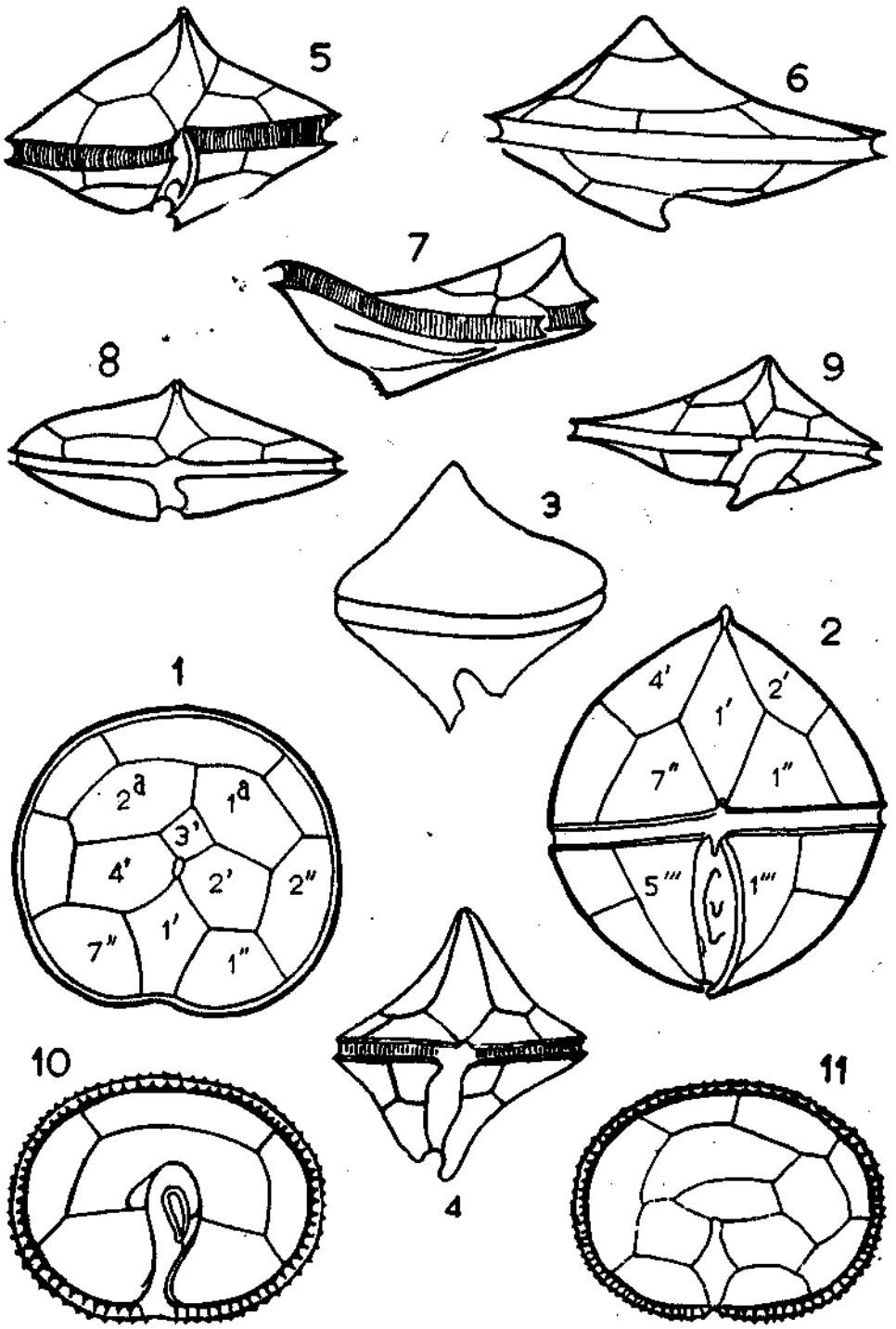

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PLATE XII

Figs. 1, 2, 5, 6, 7, 9, 11, 12 & 13, *Peridinium globulus* Stein; 1, 11 & 13, dorsal views; 2-7, ventral views; 9, apical view; 12, oblique view; (1 & 2, after Stein in Schiller, 1937; 5, after Broch in Schiller, 1937; 6 & 9, after Lindemann in Schiller, 1937; 7, after Paulsen in Schiller, 1937; 11-13, original); 5, x 460; 7, x 312; 11-13, x 760; rest not known.

Fig. 3. *Peridinium simulum* Paulsen; ventral view; (after Paulsen in Schiller, 1937); x 312.

Figs. 4, 8 & 10, *Peridinium sphaeroides* Dangeard; 4, ventral view; 8, ventral oblique view; 10, apical view; (4, after Dangeard, 1927 *c*; 8 & 10, after Matzenauer, 1933); magnification not known.

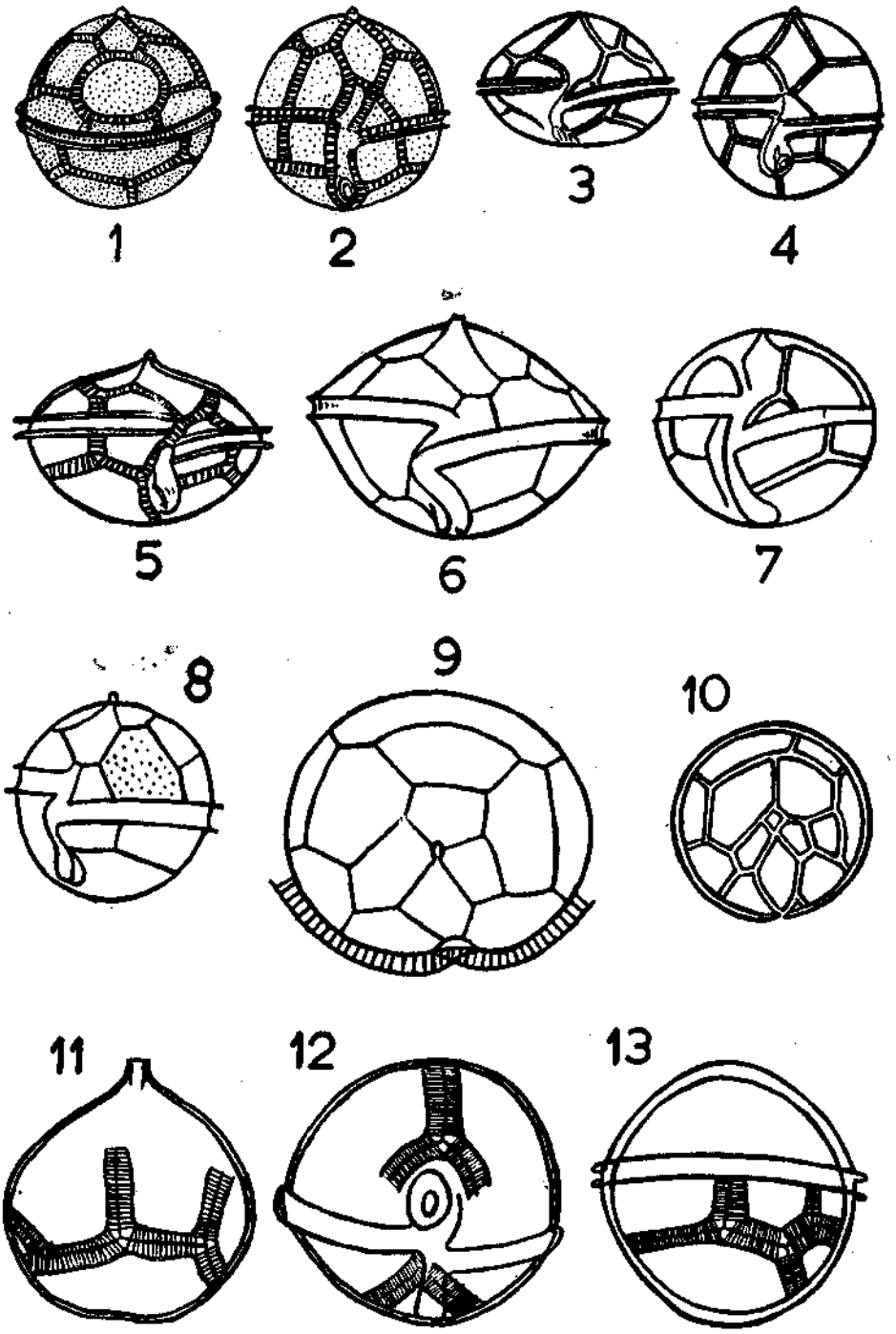

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PLATE XIII

Figs. 1-9. *Peridinium ovatum* (Pouchet) Schütt; 1, 3, 7 & 9, ventral views; 2, 5, 6 & 8, apical views; 4, antapical view?; (1, 5 & 7, after Peters, 1928; 2 & 3, after Dangeard, 1927 *c*; 4, 6 & 9, after Matzenauer, 1933; 8, after Lebour, 1925); 1, 5 & 7, x 500; 4, 6 & 9, x 315; 8, x 600.

Figs. 10 and 11. *Peridinium quarnerense* Br Schröder; two dorsal views; (original); x 760.

Figs. 12. *Peridinium cerasus* Paulsen; dorsal view; (original); x 1500.

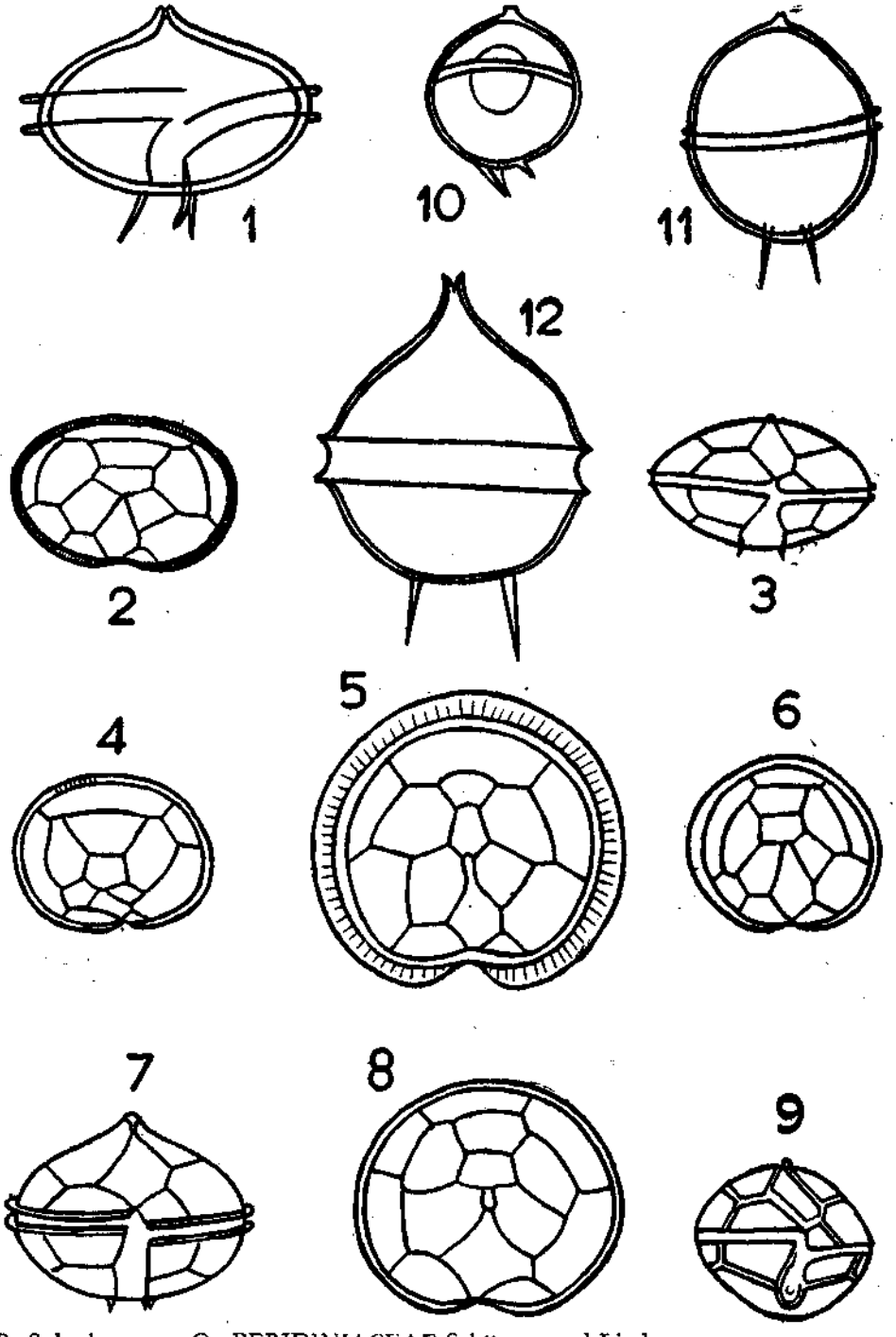

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PLATE XIV

Figs. 1, 2, 3, 5, 8, 9 & 12. *Peridinium quarnerense* (Schröder) Broch; 1. 2, 3 and 12, ventral views; 5 & 9, oblique views; 8, apical view; (1, 5, 8 & 9, after Broch in Schiller, 1937; 2 & 3, after Matzenauer, 1933; 12, after Dangeard, 1927 *b*); 1 & 8, x 510; 5 & 9, x 420; rest not known.

Figs. 4, 6 and 10. *Peridinium cerasus* Paulsen; 4 & 10 ventral views; 6, dorsal view; (4 & 6, after Peters, 1928; 10, after Lebour, 1925); 4 & 6, x 600; 10, not known.

Figs. 7 & 11. *Peridinium subpyriforme* Dangeard; 7, dorsal view; 11 ventral view; (after Dangeard, 1927 *c*); magnification, not known.

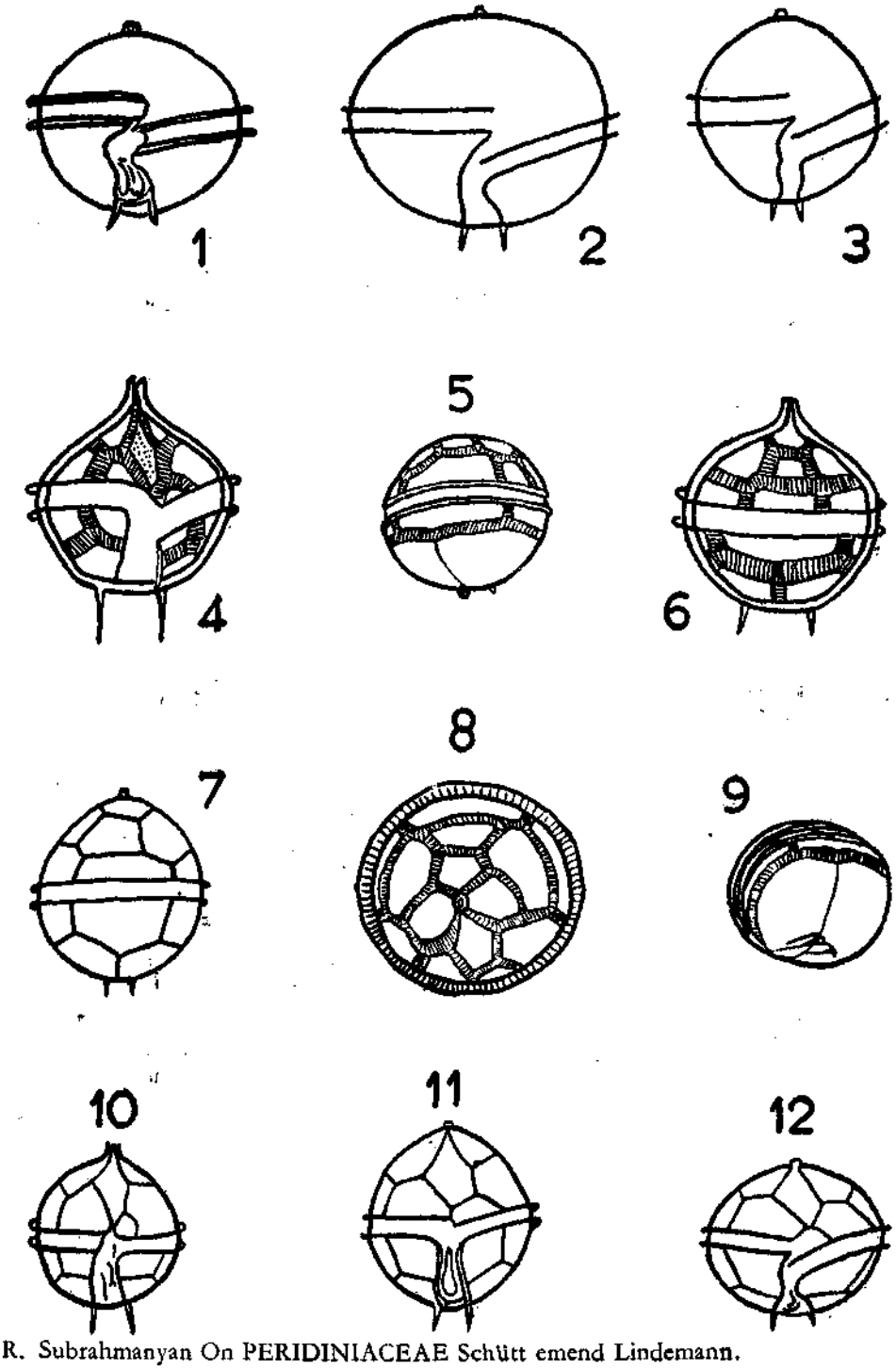

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PLATE XV

Figs. 1, 2, 5, 6, 8, 10, 11 & 12. *Peridinium quarnerense* (Schröder) Broch; 1, 2, 6, 8 and 11, ventral views; 5, dorsal view; 10 & 12, apical views; (1 & 8, after Matzenauer, 1933; 5 & 6, after Dangeard, 1927 *b*; 2, 10 & 12, after Broch; 11, after Stein in Schiller, 1937); 2 & 12, x 150; 10, x 420; rest not known.

Figs. 3 & 4. *Peridinium patens* Dangeard; 3, ventral view; 4, dorsal view; (after Dangeard, 1927 *c*); magnification not known.

Fig. 9. *Peridinium cerasus* Paulsen; apical view; (after Lebour, 1925); x 900.

Fig. 7. *Peridinium subpyriforme* Dangeard; dorsal view; (after Dangeard, 1927 *b*); magnification not known.

Figs. 13-16. *Peridinium monocanthum* Broch; 13, ventral view; 14 & 15, apical views; 16, antapical view; (after Broch in Schiller, 1937); all x 510.

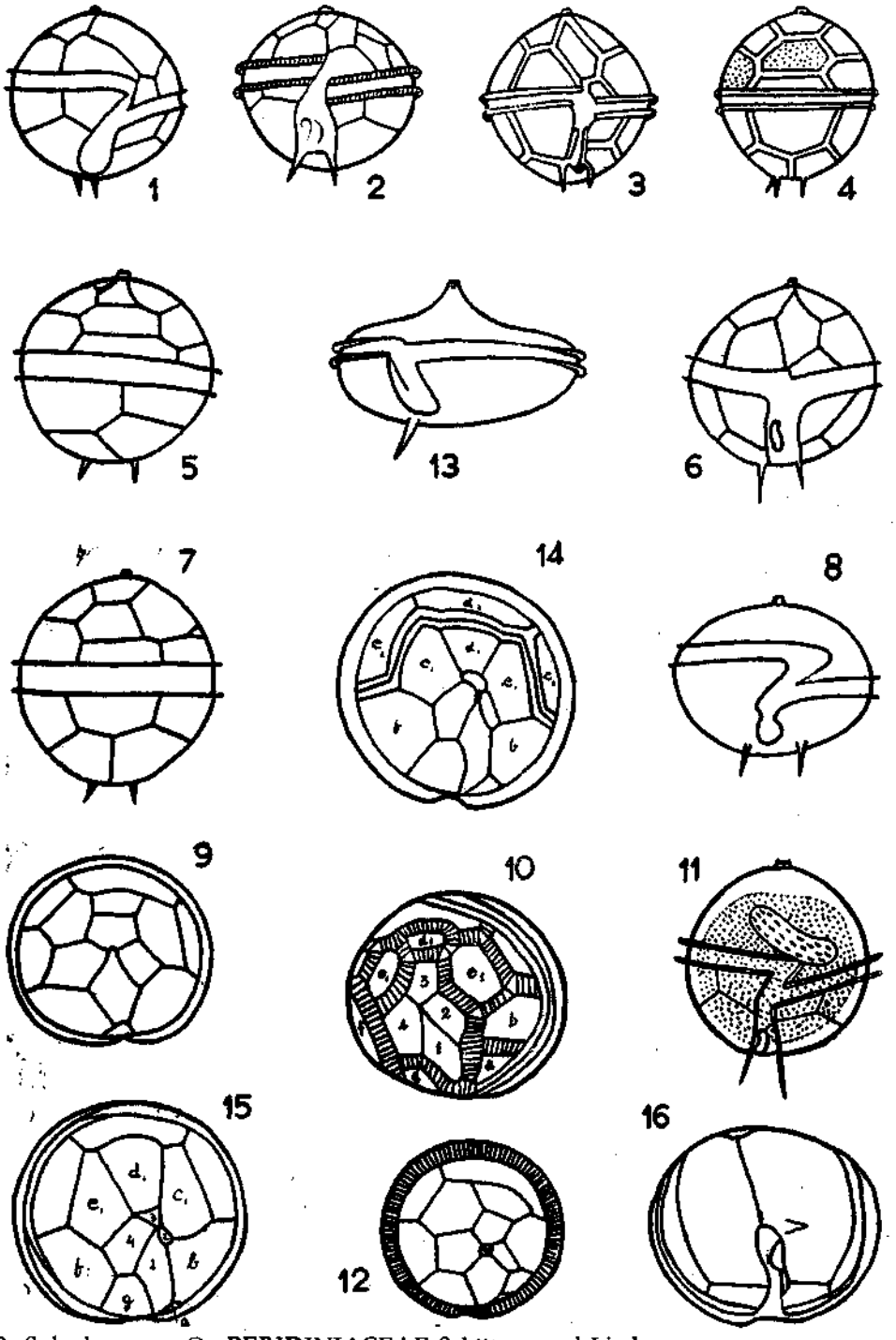

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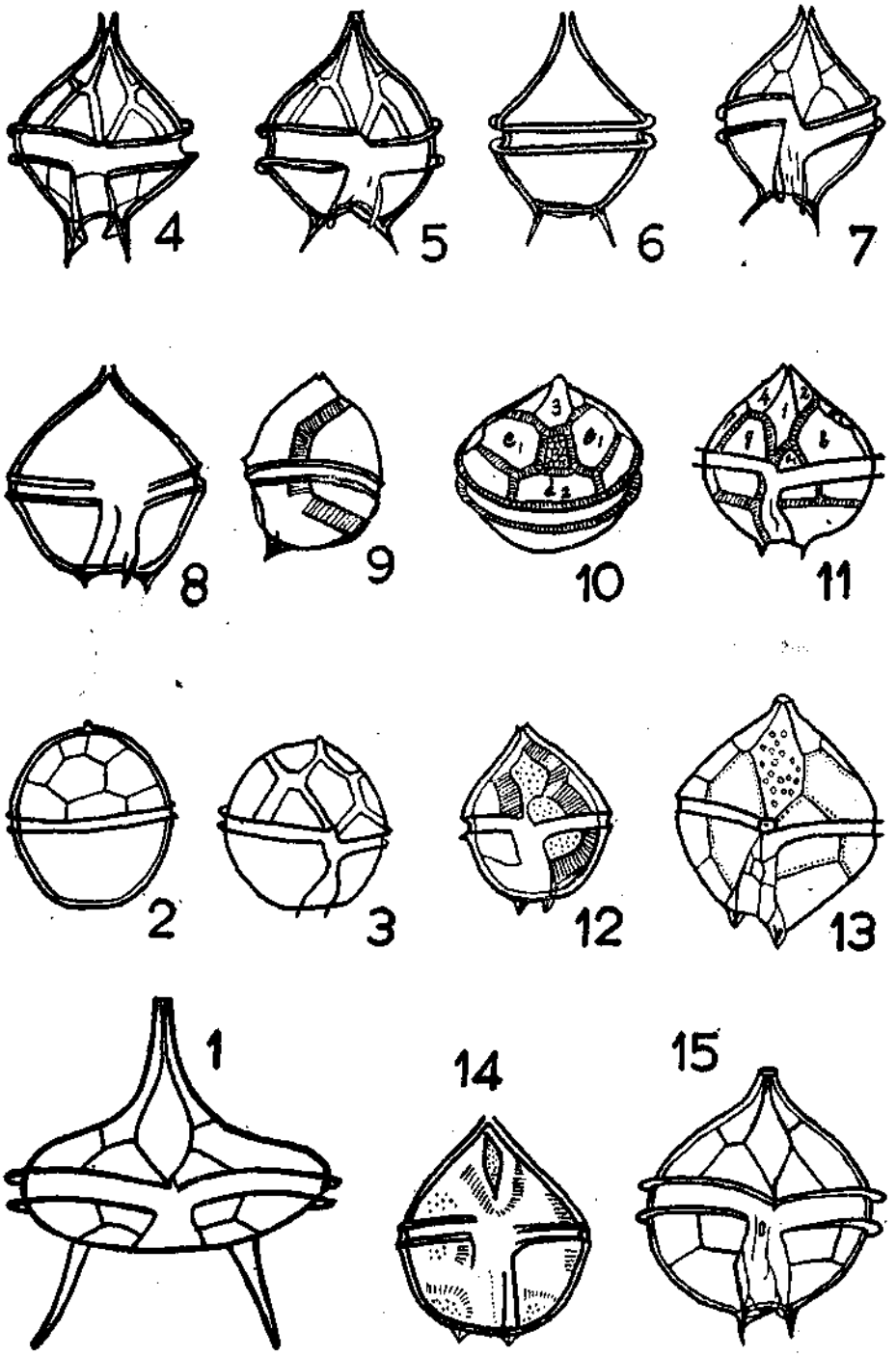
PLATE XVI

Fig. 1. *Peridinium obovatum* Wood; ventral view; (after Wood, 1954); magnification not known.

Figs. 2 & 3. *Peridinium gibbosum* Matzenauer; 2, dorsal view; 3, ventral view; (after Matzenauer, 1933); both, x 460.

Figs. 4-15. *Peridinium breve* Paulsen; 4, 5, 7, 8, 12, 13 & 15, ventral views; 6, dorsal view; 9, side view; 10, partial apical view; (9 & 12, after Paulsen in Schiller 1937; 8 & 14, after Paulsen, 1908; 10 & 11, after Broch in Schiller, 1937; 4-7 & 15, after Schiller, 1937; 13, after Fauré-Fremiet in Schiller, 1937); 9, 8, 12 & 14, x 420; 4–7 & 15, x 800; 13, not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

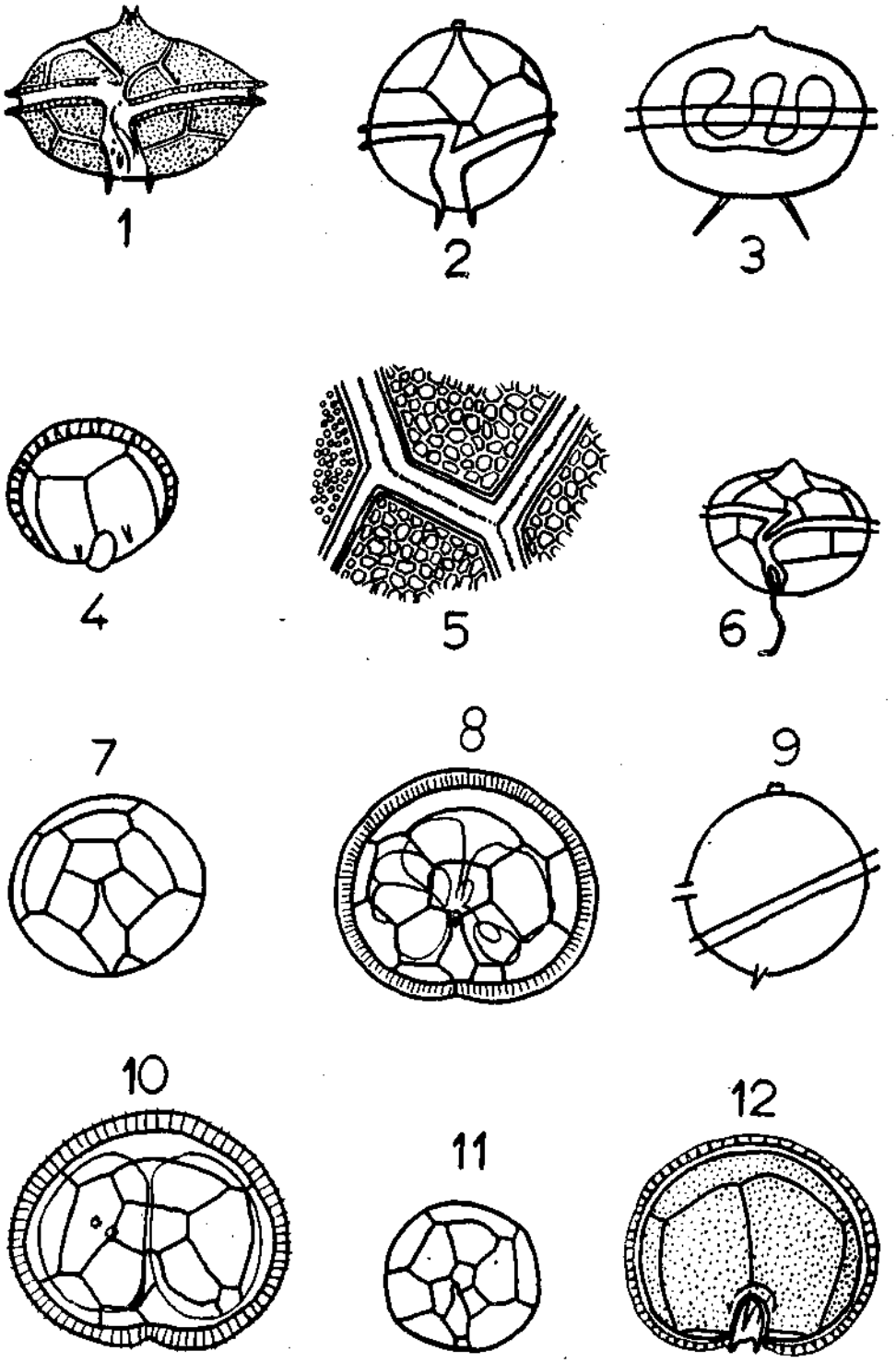
PLATE XVII

Figs. 1 & 12. *Peridinium ovatum* (Pouchet) Schütt; 1, ventral and 12, antapical views; (after Paulsen, 1908); x 450.

Figs. 4 & 11. *Peridinium cerasus* Paulsen; 4, antapical view; 11, apical view; (after Paulsen, 1908); x 700.

Figs. 2, 7 & 9. *Peridinium quarnerense* (Schröder) Broch; 2, ventral view; 7, apical view; 9, lateral view; (after Dangeard, 1927 *c*); magnification not known.

Figs. 3, 5, 6, 8 & 10. *Peridinium ovatum* (Pouchet) Schütt; 3, view; 5, sculpture; 6, ventral view with flagellum; 8 & 10, apical views with contents shown divided (spores ?); (after Schütt, 1895); magnification not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE XVIII

Figs. 1, 2, 3, 7, 10 A, B, C, & D, & 14. *Peridinium obovatum* Wood; 1, 2, ventral views; 3, dorsal view; 7, lateral view; 10 A, B, C & D, sulcal plates; 14, tabulation epitheca, ventral; (1, 3, 7 & 14, after Balech, 1962; 2, 10 A–D, after Balech & El-Sayed, 1965); magnification not known.

Fig. 4. *Peridinium applanatum* Mangin; dorsal view; (after Balech, 1958 *b*); magnification not known.

Figs. 5, 6, 8, 9, 11–12, 15 & 16. *Peridinium simulum* Paulsen; 5, epitheca; 6, ventral oblique view; 8, apical view, plates apart; 9, sulcal plates; 11, *S. i.*; 12, sulcal region; 13, plates 1′, 2′ and 7′; 15, *S. p.*; 16, *S. a.*; (after Balech, 1959); magnification not known.

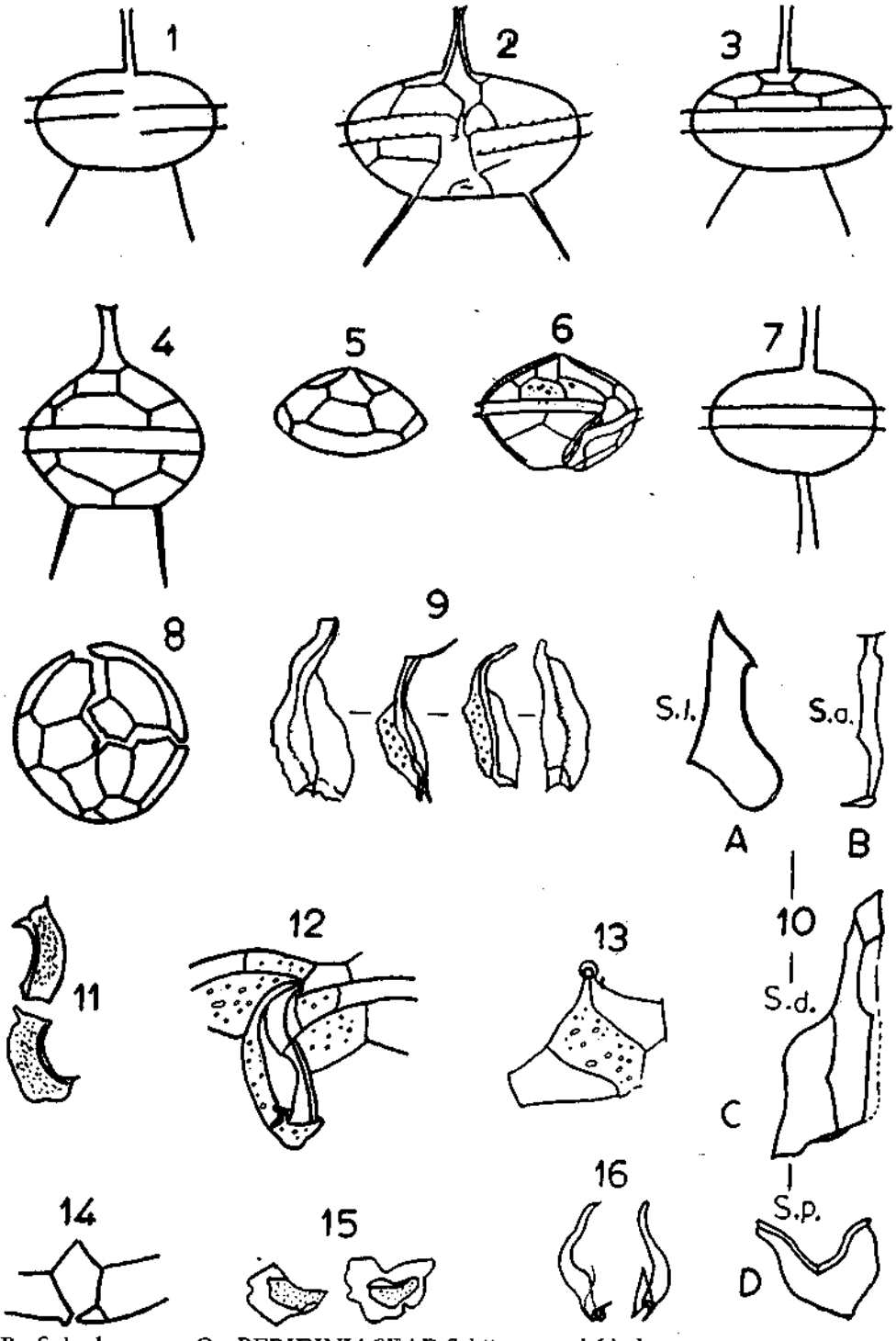


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PLATE XIX

Figs. 1, 2, 3, 4. *Peridinium sphaeroides* Dangeard; 1, dorsal 2, antapical, 3, ventral and 4, apical views; (after, Dangeard, 1927 *a*); magnification not known.

Figs. 5, 6, 7. *Peridinium globulus* (Stein) Dangeard; 5, ventral, 6, dorsal and 7, apical views; (after; Dangeard, 1927, *b*); magnification not known.

Figs. 8, 9, 10. *Peridinium heterocanthum* Dangeard; 8, lateral, 9 hypotheca dorsal and 10, apical views (after Dangeard, 1927 *a*); magnification not known.

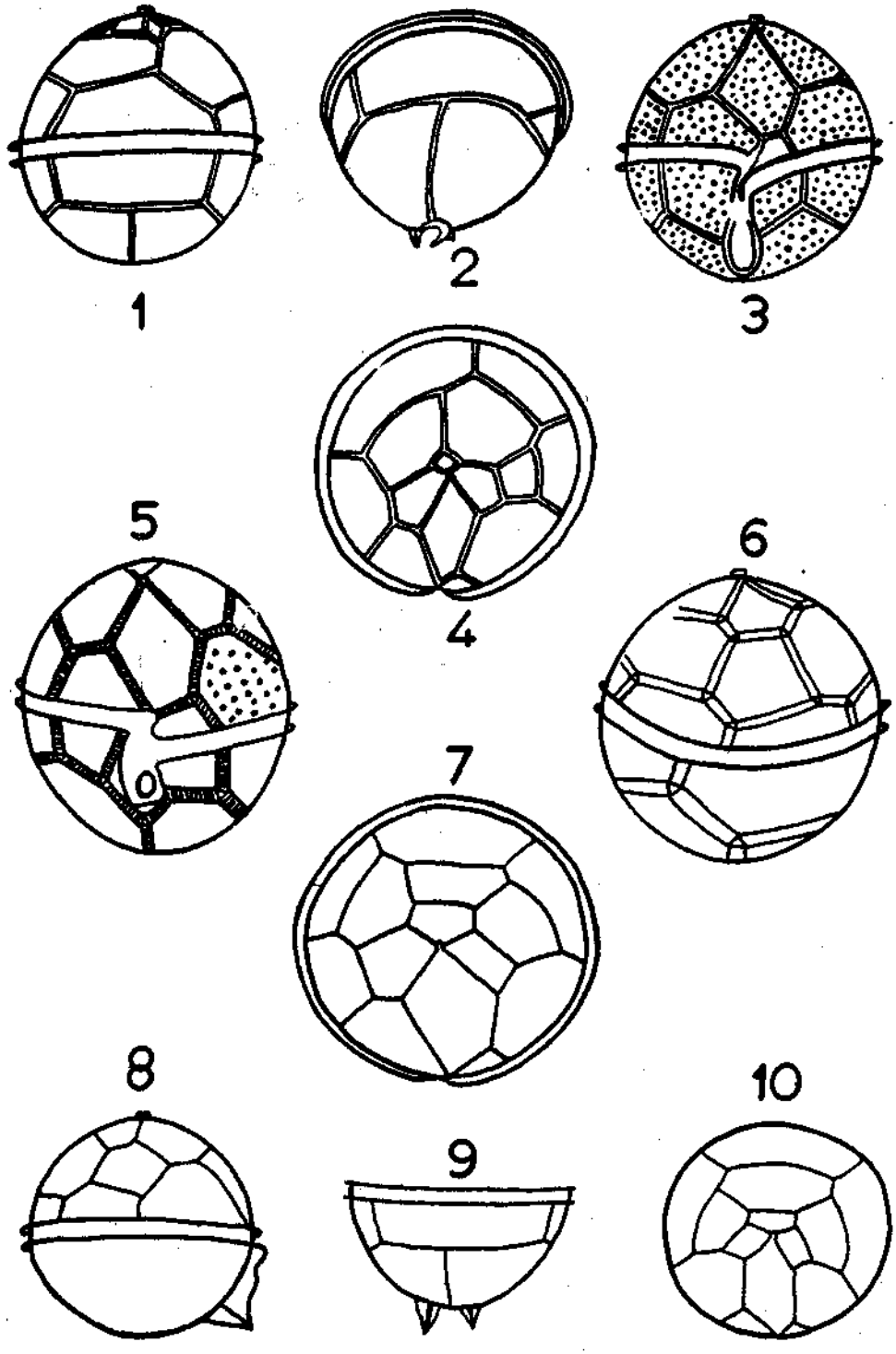

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PLATE XX

Figs. 1–12. *Peridinium brevipes* Paulsen; 1, 2, 4, 7 & 8, ventral views; 3, 5 & 6, dorsal views; 9 & 12, apical views; 11, shows intercalary striae; (5, 8, 9 & 12, after, Lebour, 1925; 7 & 11, after Broch in Schiller, 1937; 1, 3 & 10, after Woloszynska in Schiller, 1937; 2. after Paulsen, 1908); 1, 3 & 10, x 1000; 2, x 610; 4, 6, 7 & 11 x 760; 5, 8, 9 & 12, x 2000.

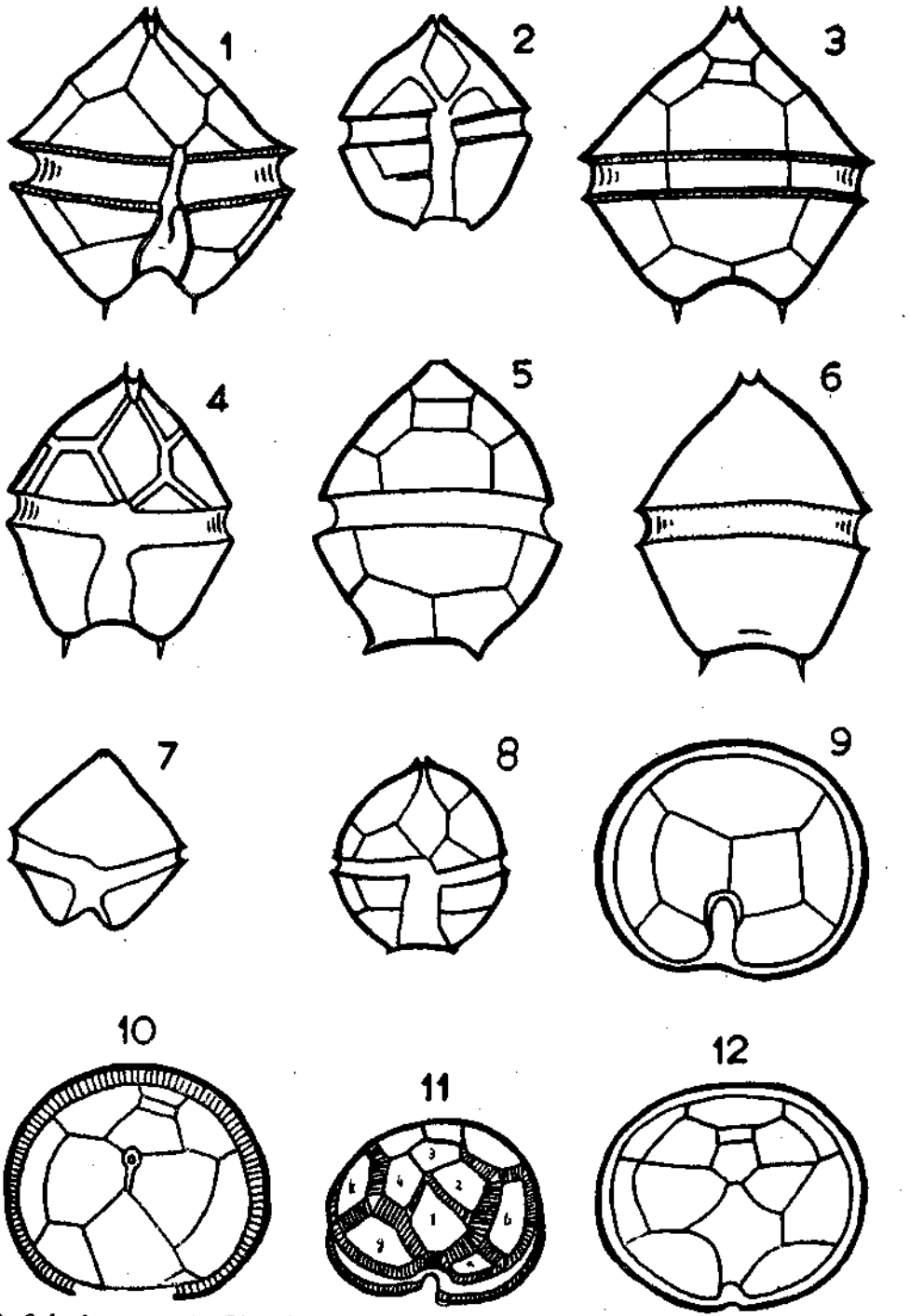

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PLATE XXI

Fig. 1. *Peridinium brevipes* Paulsen; ventral view; (after Paulsen in Schiller, 1937); x 500.

Figs. 2–8. *Peridinium latispinum* Mangin; 2, 3, 4 & 6, ventral views; 5, 7 & 8, dorsal views; (2, 3 & 4, original; 5, after Mangin, 1922; 6, 7 & 8, after Dangeard, 1927 *c*); 2, 3 & 4, x 450; rest not known.

Figs. 9–13. *Peridinium roseum* Paulsen; 9 & 10, ventral views; 11, dorsal view; 12 & 13, apical (?) and antapical views respectively); x 460.

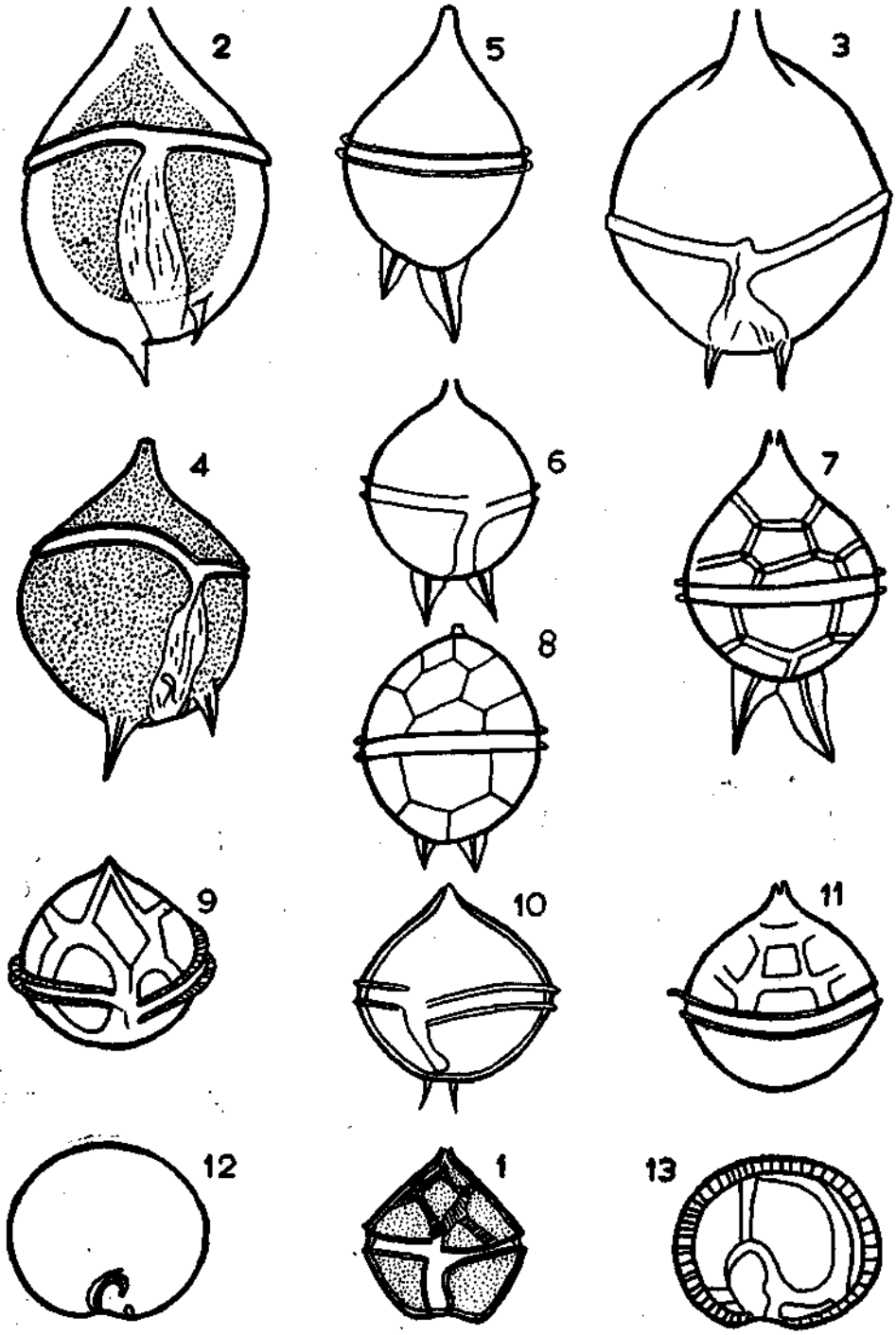

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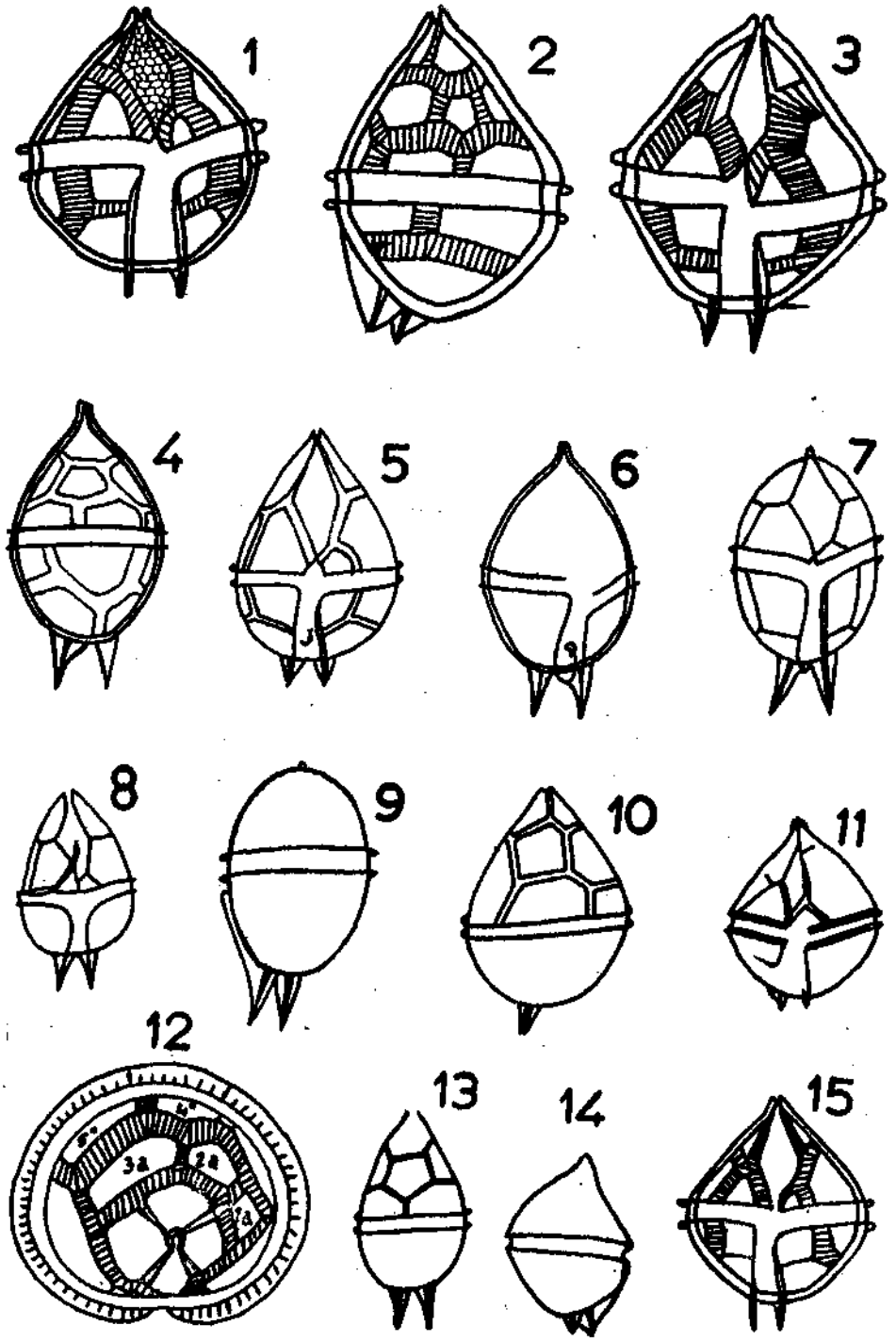
PLATE XXII

Figs. 1–15. *Peridinium pyriforme* Paulsen ; 1, 3, 5, 7, 8, 11 & 15, ventral views ; 2, 9, 10 & 14, side views ; 4 & 13, dorsal views ; 12, apical view ; intercalary striae seen in 1, 2, 3, 12, & 15 ; (1, 2, 3, 12 & 15, after Peters, 1928 ; 11 & 14, after Paulsen 1908 ; 4 & 6, after Paulsen in Schiller, 1937 ; 8, after Dangeard in Schiller, 1937 ; 5, 10 & 13, after Dangeard, 1927 *a* ; 7, after Dangeard, 1927 *c*) ; 1, 2, 3, 12 & 15, x 600 ; 11 & 14. x 315 ; 4 & 6 x 312 ; rest not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE XXIII

Figs. 1-13. *Peridinium steinii* Jörgensen; 1, 2, 3, 6, 8 & 9, ventral views; 4, partial side view; 10, side view; 7 & 11, dorsal view; 5 & 12, apical views; 13, antapical view; (1 - 5, original; 8, 11, 12 & 13, after Lebour, 1925; 6, after Stein in Schiller, 1937; 7, 9 & 10, after Broch, in Schiller, 1937); 1 - 5, x 760; 8, 11 - 13, x 800; 6, x 440; rest not known.

Fig. 14. *Peridinium mediterraneum* (Kofoid) Balech; ventral view; (original); x 500.

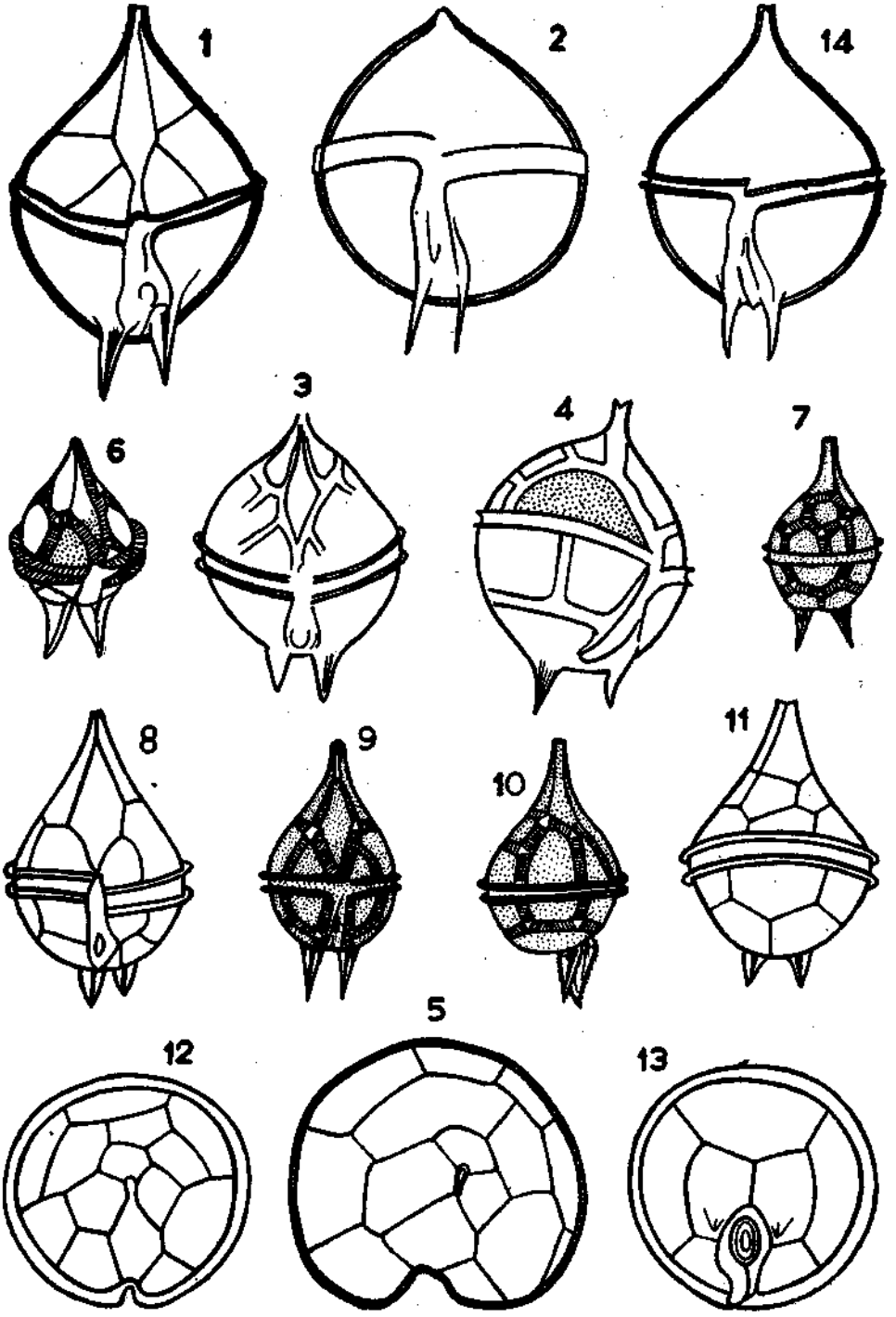


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PLATE XXIV

Figs. 1—6. *Peridinium mediterraneum* (Kofoid) Balech; 1 & 2, ventral views; 3, partial ventral view; 4 & 5, dorsal views; 6, lateral view; (1, original; 2, after Kofoid, 1909; 3, 5 & 6, after Dangeard, 1927 *c*; 4, after Pavillard in Schiller, 1937); 1, x 760; 2 x 500; 3, 5 & 6, x 400; 4, not known.

Figs. 7 & 8. *Peridinium ampulliforme* Wood; dorsal and ventral views respectively; (after Wood, 1954); magnification not known.

Figs. 9 & 10. *Peridinium sinaicum* Matzenauer; dorsal and ventral views respectively; (after Matzenauer, 1933); magnification not known.

Figs. 11, 12 & 13. *Peridinium tenuissimum* Kofoid; 11, dorsal view; 12, ventral view; 13, lateral view; (11, after Matzenauer, 1933; 12 & 13, after Dangeard, 1927 *c*); 11 x 490; 12 & 13, not known.

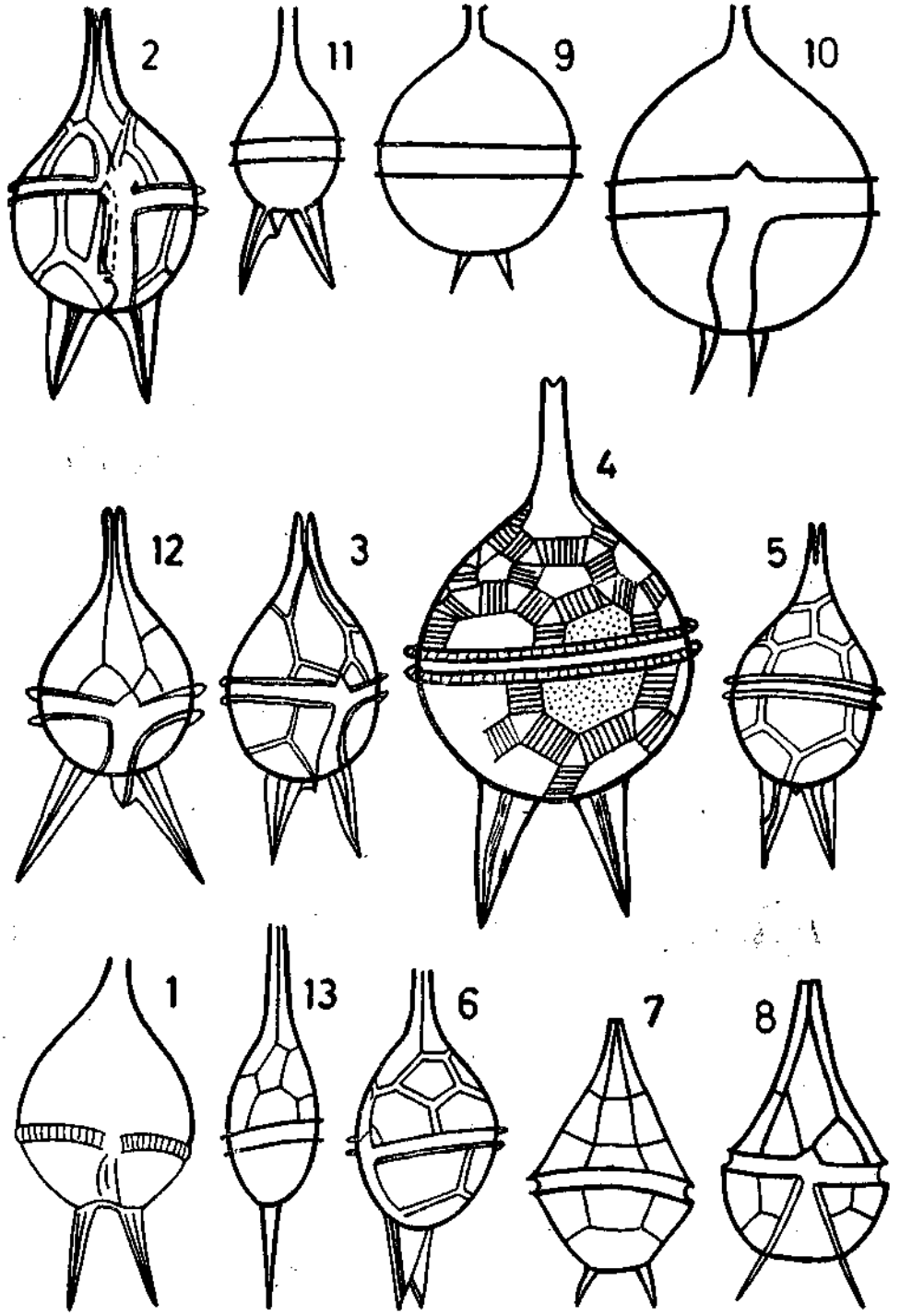

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PLATE XXV

Figs. 1—10, *Peridinium mediterraneum* (Kofoid) Balech ; 1, dorsal, 2, lateral and 3, ventral views. 4—*S. p.* in two views ; 5, 1'' and 2'' ; 6, *S. i. and S. p. a* ; 7, plate of apical pore; 8. *S. d.* in two positions; 9, *S. l.* front and profile. 10, *S.a.* (After Balech, 1964 *a*) 5 – 10 x 1000 ; rest not known.

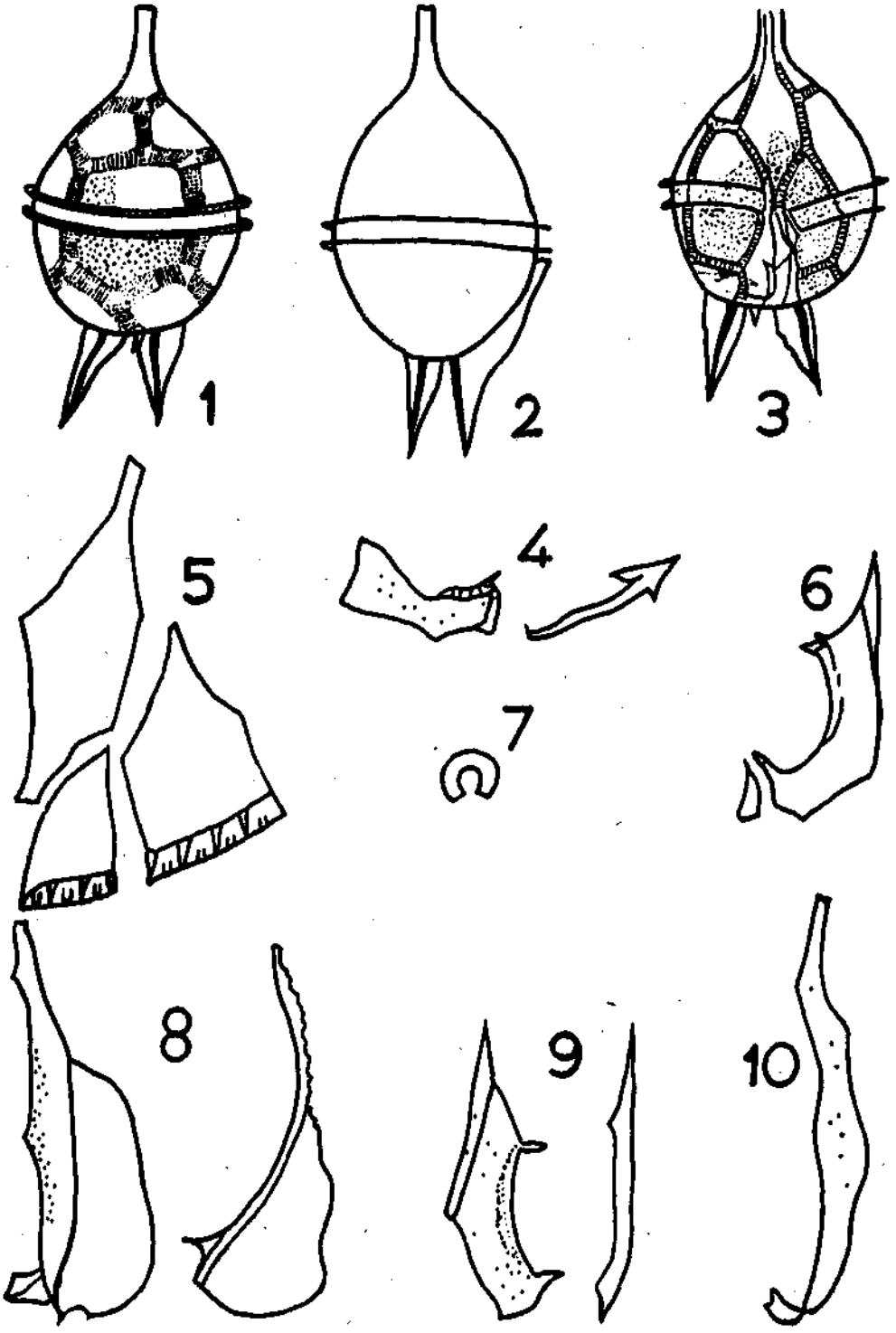

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PLATE XXVI

Figs. 1—17. *Peridinium granii* Ostenfeld : 1, 3, 4, 7 & 8, ventral views ; 2, 6, 10 & 11 dorsal views ; 5, partial antapical view ; 9 & 14, lateral views ; 12, partial apical view ; 13, 16 & 17, apical views ; 15, antapical view : (5, 8, 9, 10, 12 & 17, after Peters, 1928 ; 1 & 2 after Lebour, 1925 ; 4, 6 & 13, after Woloszynska in Schiller, 1937 ; 3, after Lindemann in Schiller, 1937 , 7, 11,14, 15 & 16 after Paulsen, 1908); 1 & 2, x 700; 3, not known; 4, 6 & 13, x 600 ; 5, 8, 9, 10, 12 & 17, x 290 ; 7, 11, 14—16, x 460.

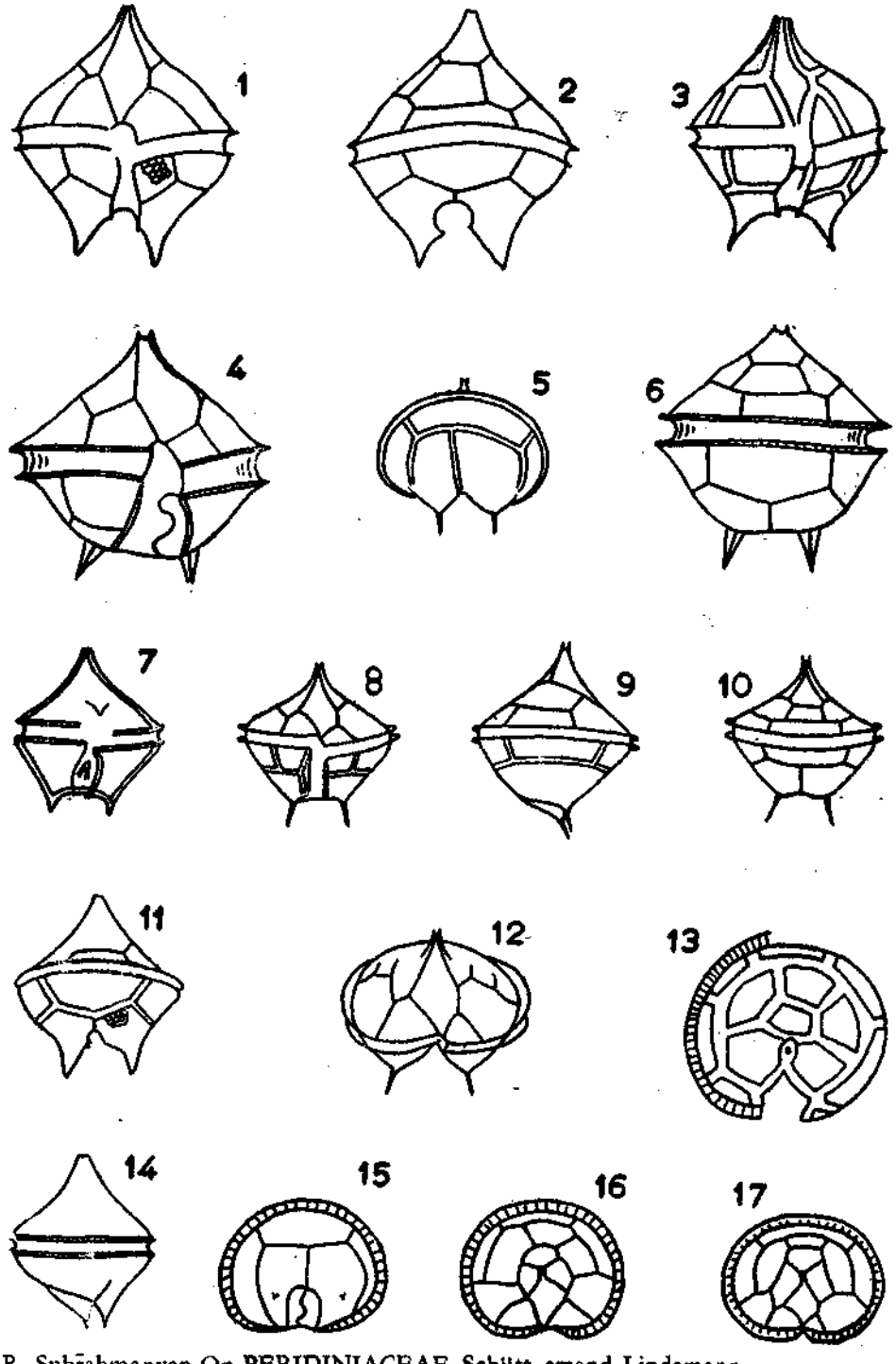

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PLATE XXVII

Figs. 1—11. *Peridinium mite* Pavillard ; 1, 3, 4, 5,7,9, & 10. ventral views ; 2, 6 & 8, dorsal views ; 11, apical view; (1, original ; 7, 8, & 9, after Paulsen in Schiller, 1937; 3, 10 & 11, after Pavillard in Schiller, 1937 ; 4 & 6, after Lebour, 1925 ; 2, after Dangeard, 1927 *c* ; 5, after Matzenauer, 1933); 1, x 760 ; 7, 8 & 9, x 310 ; 4 & 6, x 700 ; 5, x 509 ; rest not known.

Figs. 12–14. *Peridinium okamurai* Abé ; 12, dorsal. 13, apical and 14, ventral views ; intercalary striae clearly seen in all esp. 14; (after Abé in Schiller, 1937). Magnification not known.

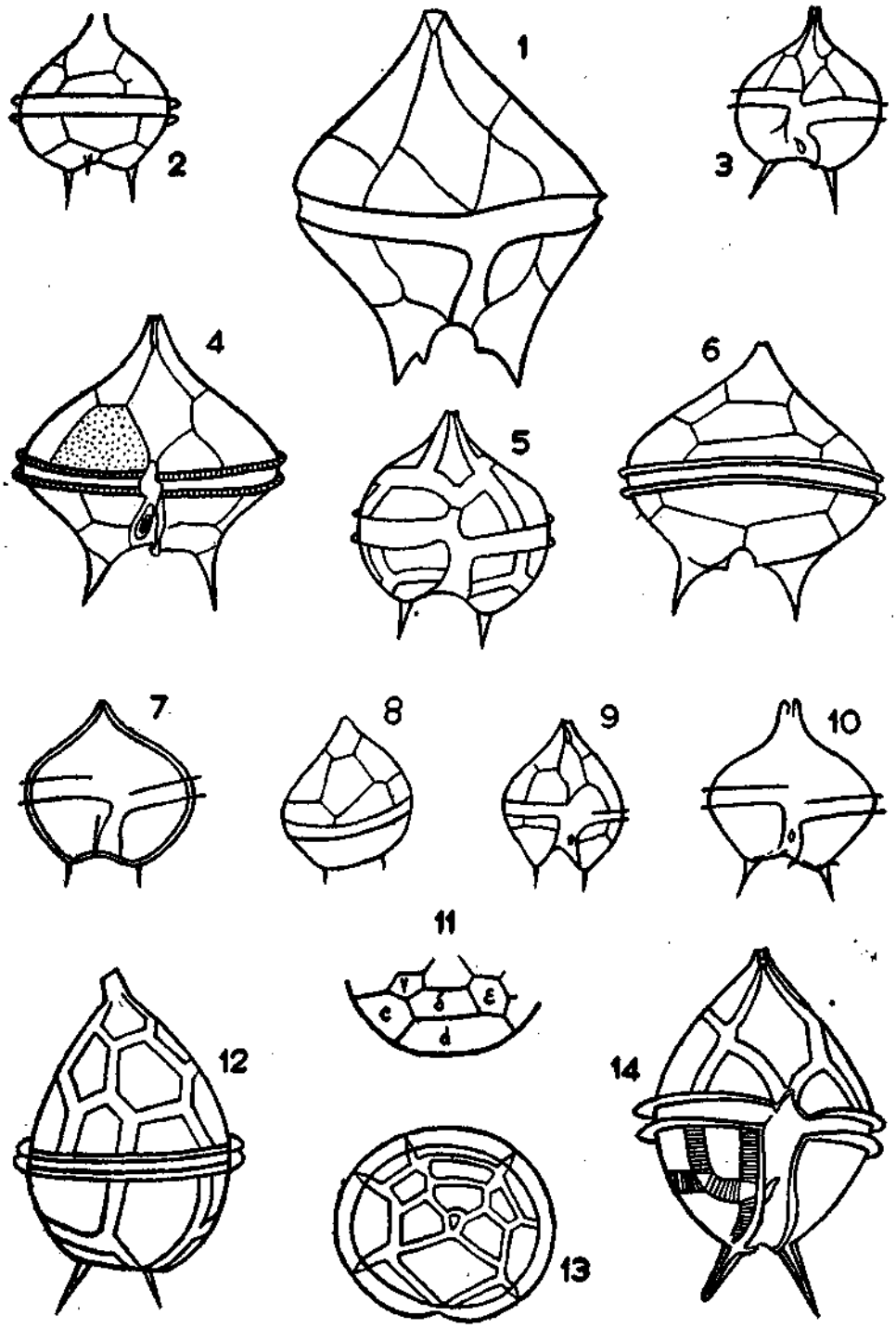

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PLATE XXVIII

Figs. 1-5, 8, 10-12, 14. *Peridininum sub-curvipes* Lebour; 1, 11, dorsal views; 2-6, ventral views; 8 & 12 apicial views; 10, antapical view; note intercalary striae; 2 a great variant due to development of intercalary striae (?); (2 & 8, after Broch in Schiller, 1937; 14, after Dangeard, 1927 *c*; 4, 10-12, after Lebour, 1925; 1, 3 & 5, after Woloszynska in Schiller, 1937); 2, 7 & 8, x 345; 1, 3 & 5, x 480; 4, 10-12, x 650; 14, not known.

Figs. 6, 9, 13, 15 & 16. *Peridinium curvipes* Ostenfeld; 6, 13 & 15, ventral views; 16, dorsal view; 9, apical view; (6 & 9, after Lebour, 1925; 13 & 16, after Woloszynska in Schiller, 1937; 15, after Paulsen, 1908); 13&16, x 440; 15, x 210; rest not known.

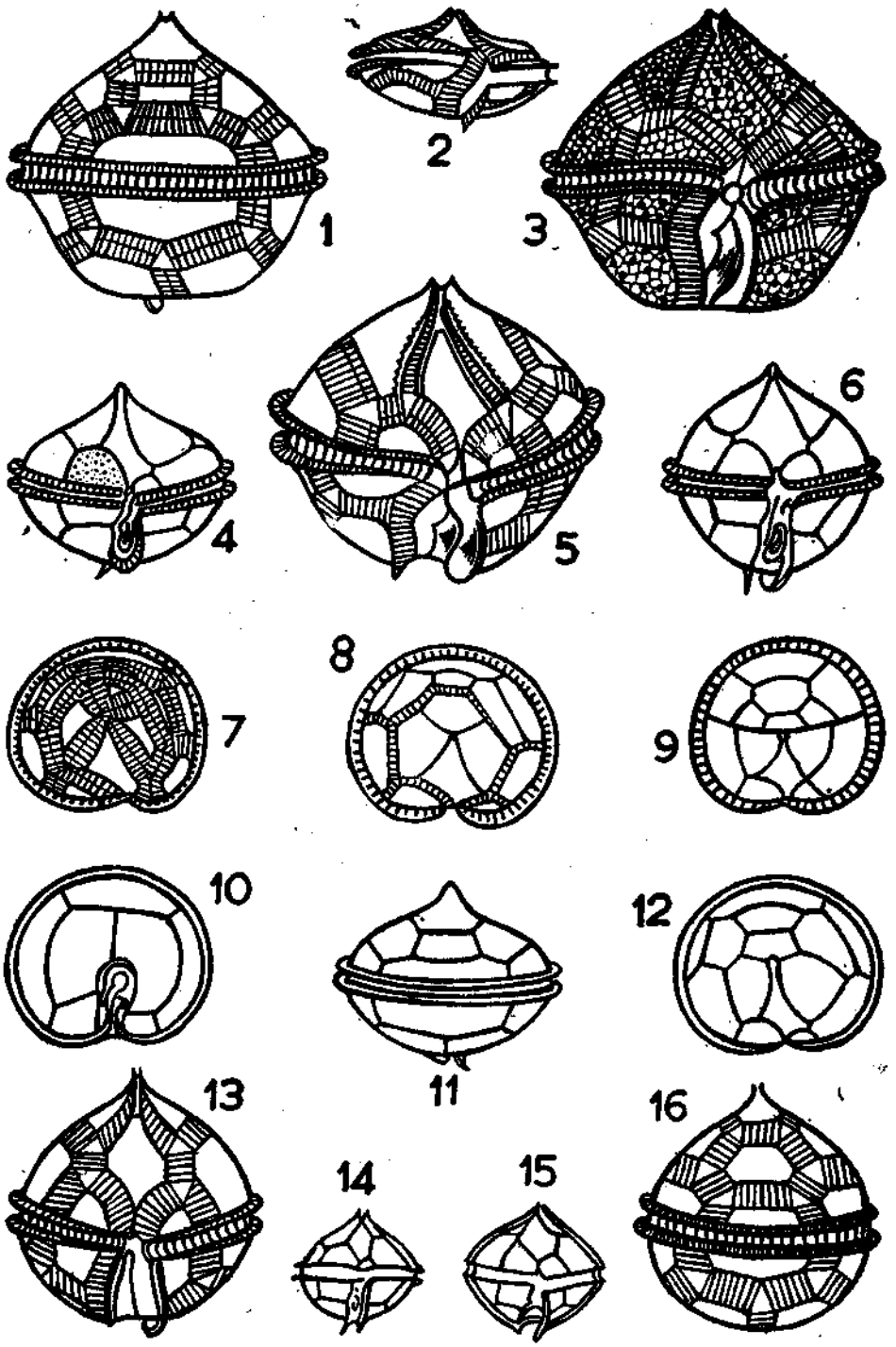

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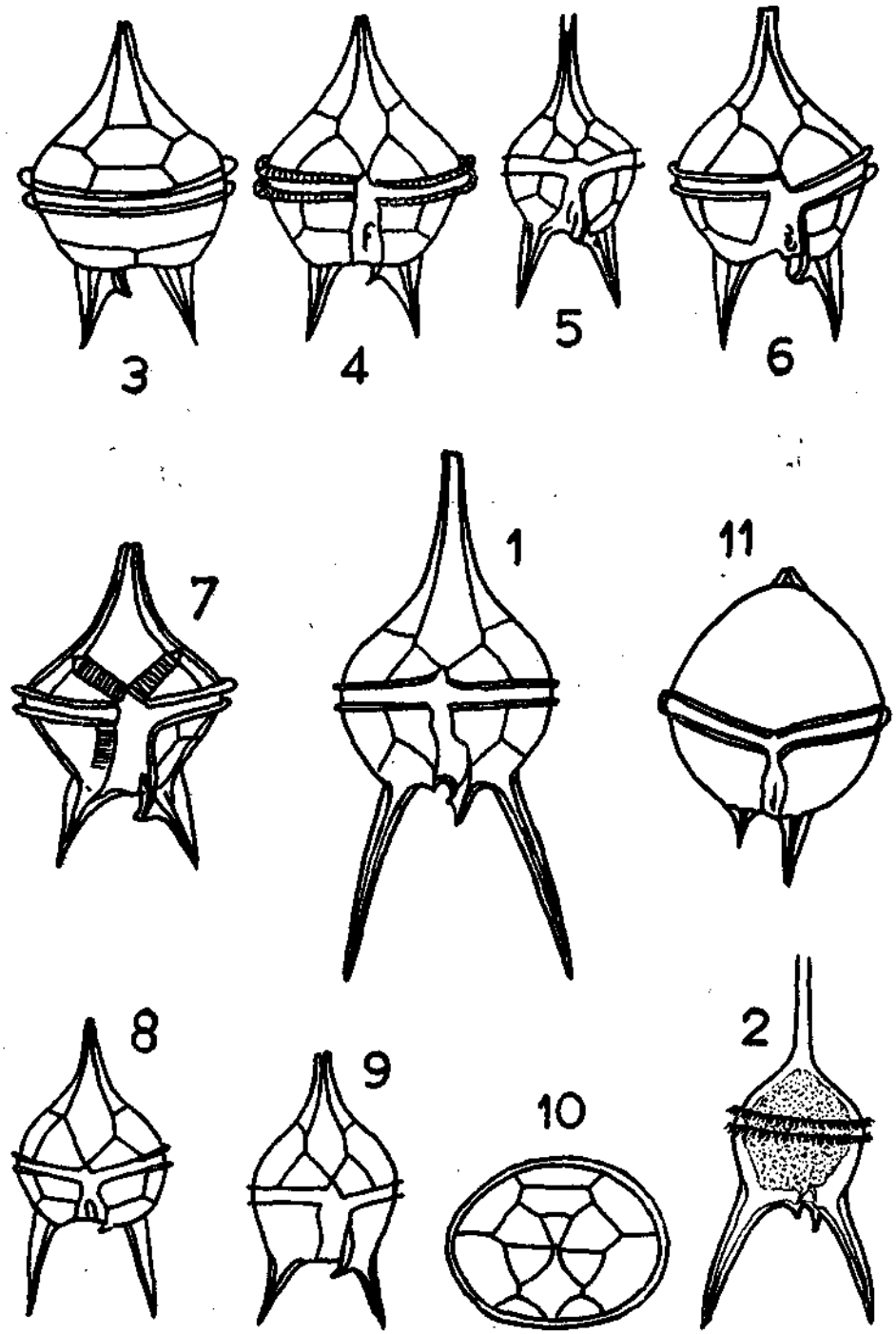
PLATE XXIX

Figs. 1 & 2. *Peridinium longipes* Karsten; 1, ventral view ; 2, partial ventral view with protoplast ; (original) ; x 540. *See also* Plate LXXVII, figs. 2 & 4.

Figs. 3-10. *Peridinium diabolus* Cleve ; 3, dorsal view ; 4 - 9, ventral views; 10, apical view; (3, 4 & 10, after Lebour, 1925 ; 6 & 7, after Pavillard in Schiller, 1937 ; 5, after Dangeard, 1927 *c* ; 8, after Mangin, 1922 ; 9, after Matzenauer, 1933) ; 3, 4 & 10, x 600 ; 6 & 7, x 480 ; 5, x 310 ; 8, not known ; 9, x 400.

Fig. 11. *Peridinium heteracanthum* Dangeard ; ventral view; (original); x 540.



R, Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE XXX

Figs. 1-10. *Peridinium longipes*. Karsten; 1, 2, ventral views; 3 & 10, dorsals view ; 7, lateral view: 4, 5. 6, 8, 9, sulcal plates ; 4, two views of *S.i.* 5, *S.p.* in distinct position; 6, C_1, C_2, *t* and 1‴; 8, *S. a.* in distinct position ; 9, views of *S.d.*; (1 & 3, after Karsten, 1907; rest after Balech 1964 *a*) ; magnification, not known.

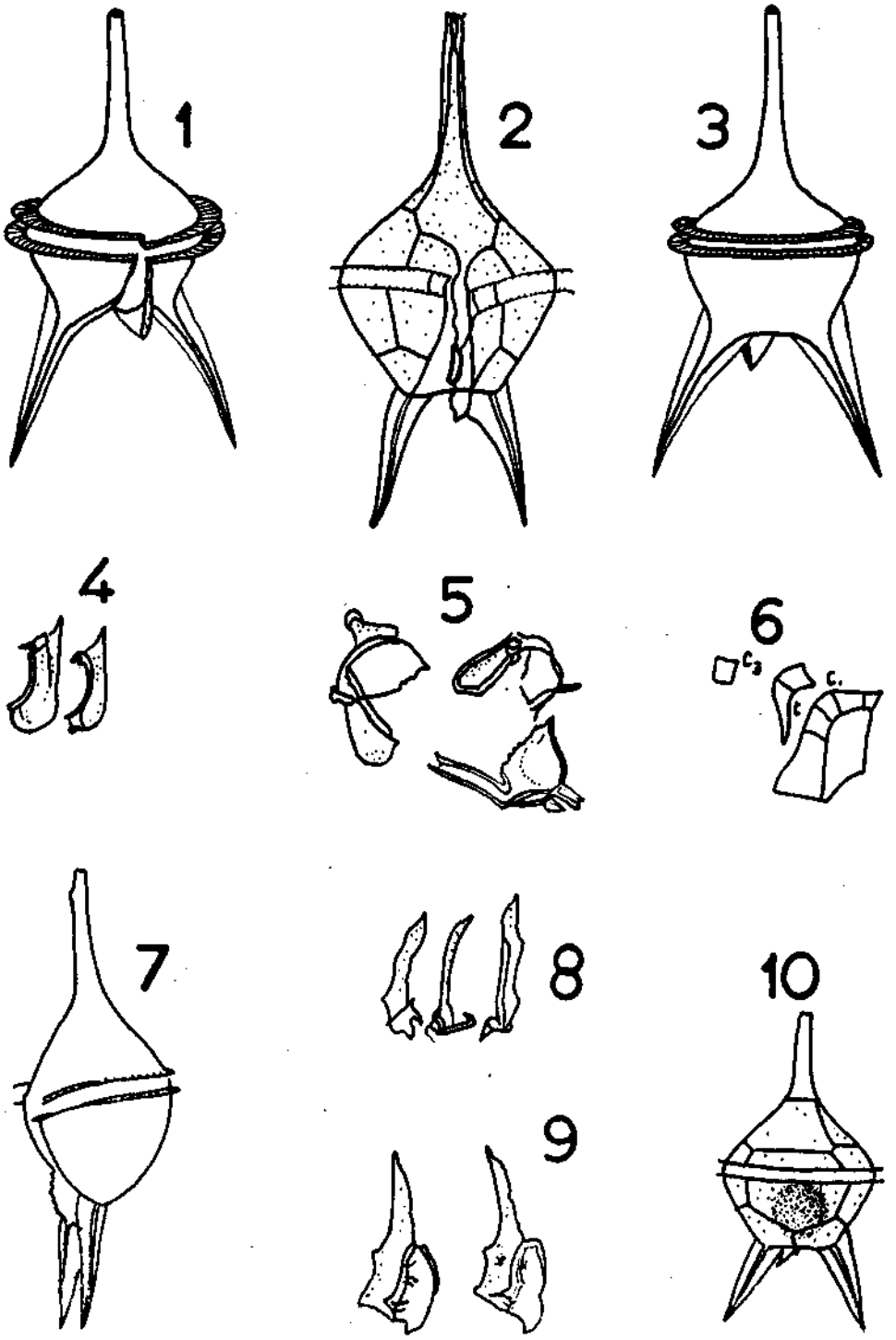


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PLATE XXXI

Figs. 1-8. *Peridinium pallidum* Ostenfeld ; 1, 7, dorsal views; 2, 4 & 8, ventral views ; 6, lateral view ; 3 & 5. apical views ; (3, 7 & 8, after Lebour, 1925 : 4 & 5, after Paulsen in Schiller, 1937 ; 1, 2 & 6, after Peters, 1928) 3, 7 & 8, x 540 ; 4 & 5, x 360 ; 1, 2 & 6, x 600.

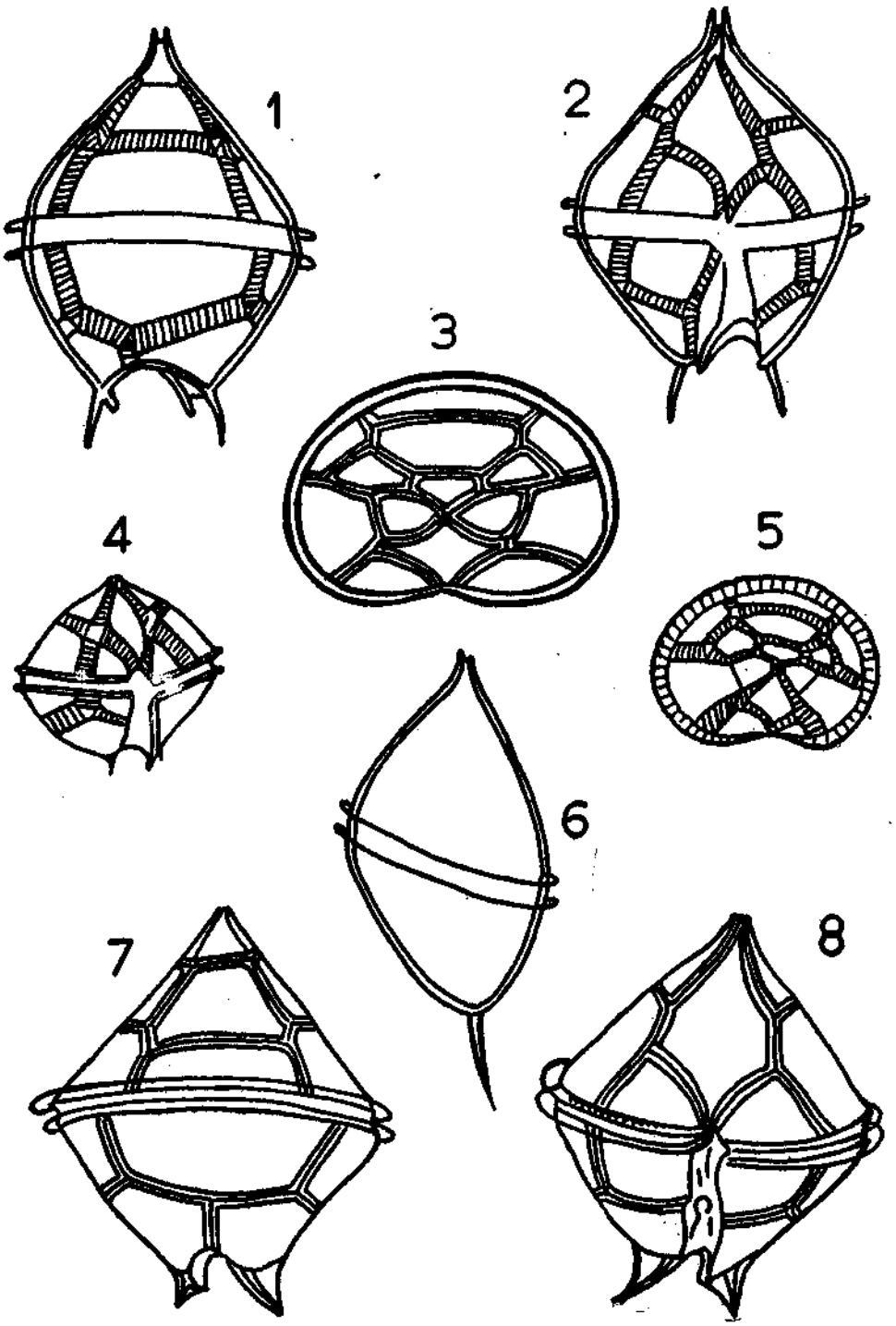

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PLATE XXXII

Figs. 1-5. *Peridinium pallidum* Ostenfeld; 1, 2 & 3, ventral views; 4, dorsal view; 5, girdle from apex; (1, 2 & 5, after Paulsen, 1908; 3 & 4, after Peters, 1928); 1, 2 & 5, x 350; 3 & 4, not known.

Figs. 6-11. *Peridinium pedunculatum* Schütt; 6, dorsal view; 7, 9 & 10, ventral views; 8 & 11, lateral views; (6, Criginal; 7 & 8, after Jörgensen in Paulsen, 1908; 9, after Schütt, 1895; 10 & 11, after Matzenauer 1933); 6, x 720; 7 & 8, x 450; 9, x 480; 10 & 11, x 860.

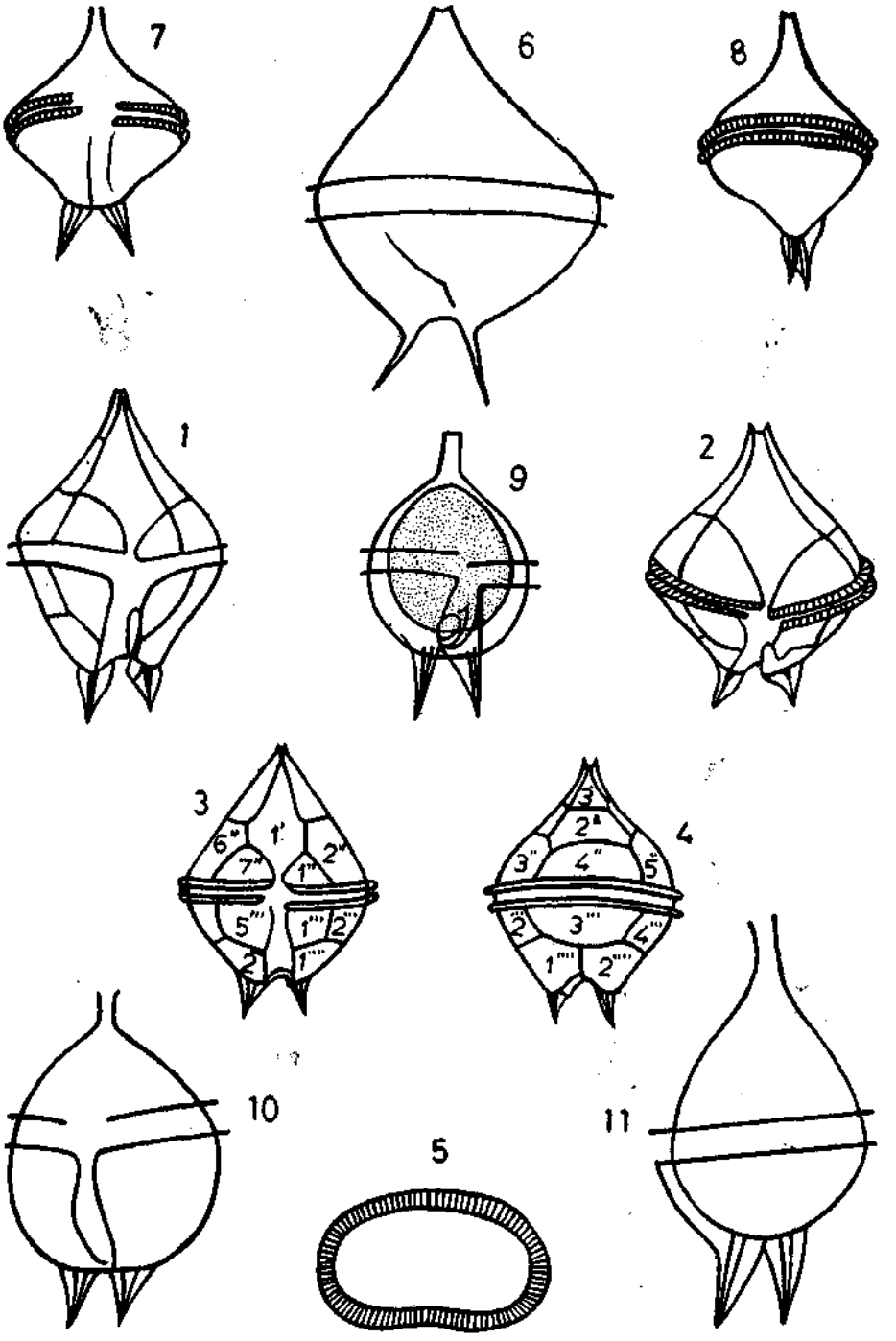

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PLATE XXXIII

Figs. 1-11 *Peridinium pellucidum* (Bergh) Schütt ; 1, 2, 4, 5, 9 & 10, ventral views; 3 & 6, dorsal views ; 7, apical view ; 8, antapical view ; 11, lateral view ; (4, 6—8, after Lebour, 1925 ; 9 & 11, after Schütt, 1895 : 10, after Paulsen in Schiller, 1937 ; 1 & 3, after Matzenauer, 1933) ; 1 & 3, x 600 ; 2 & 5, x 460 ; 4, 6–8, x 700 ; 9 & 11, x 700 ; 10, x 375.

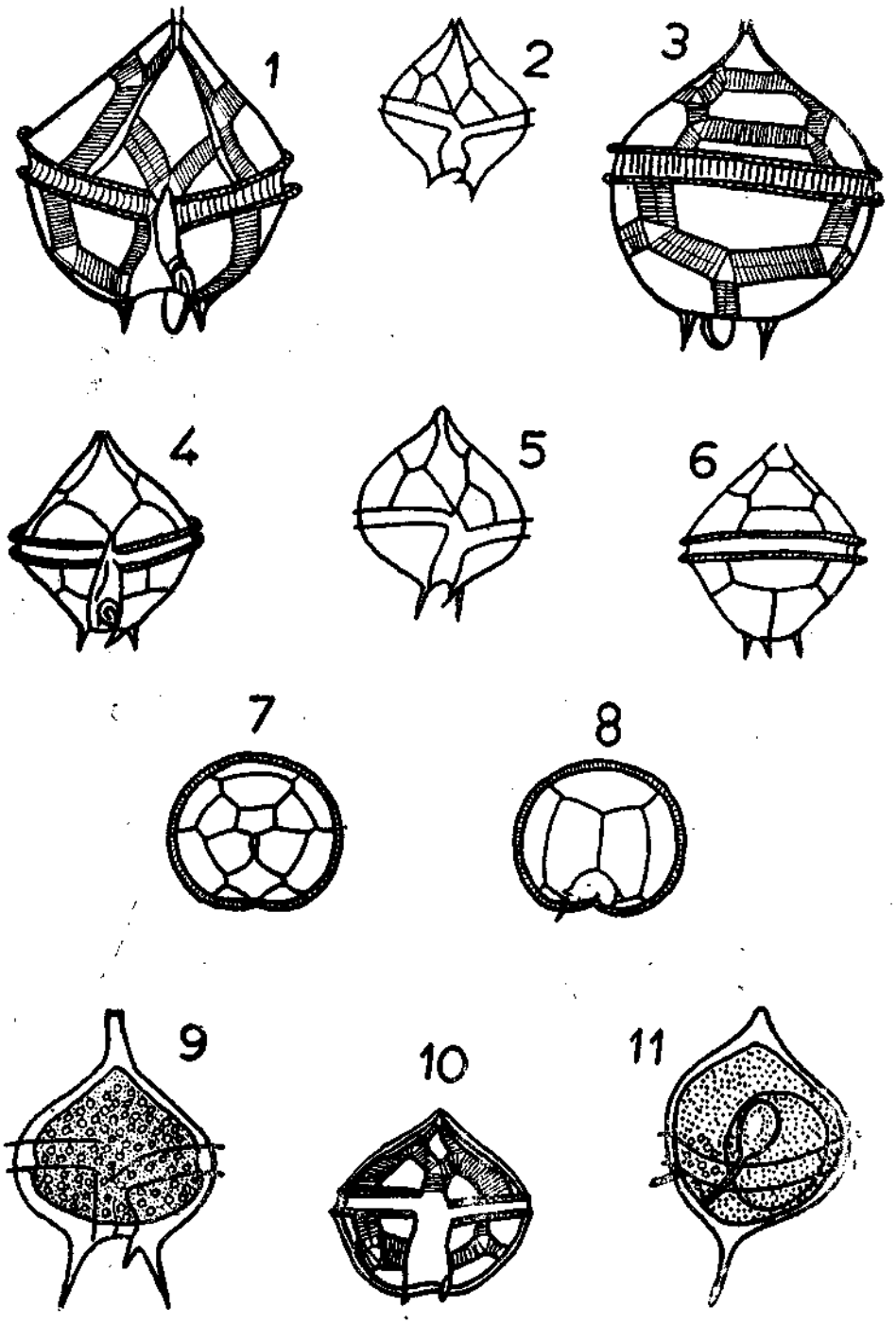

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PLATE XXXIV

Figs. 1–12. *Peridinium pellucidum* (Bergh) Schütt ; 1, 2, 4, 9 & 11, ventral views ; 3, 6 & 7, dorsal views ; 5 & 8, partial lateral views ; 10 & 12. apical views ; 12 shows intercalary striae ; (1, 3, 4, 5, 8, 10 & 11, after Broch in Schiller, 1937 : 7, after Matzenauer, 1933 ; 9 & 12, after Paulsen in Schiller, 1937) ; 1, 3, 4, 5, 10 & 11, x 760 ; 2 & 6, x 185 ; 7, x 900 ; 9 & 12, x 690.

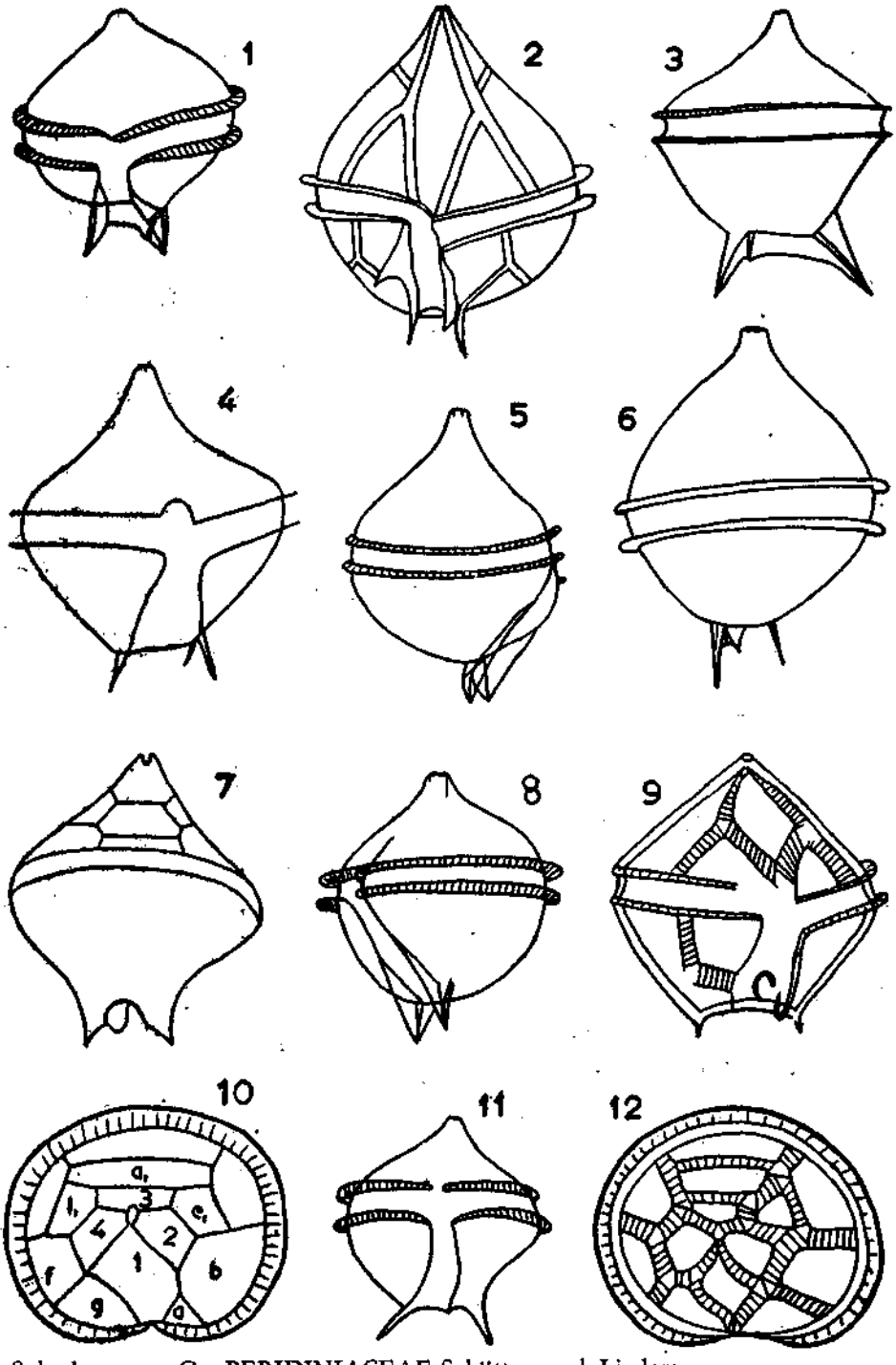

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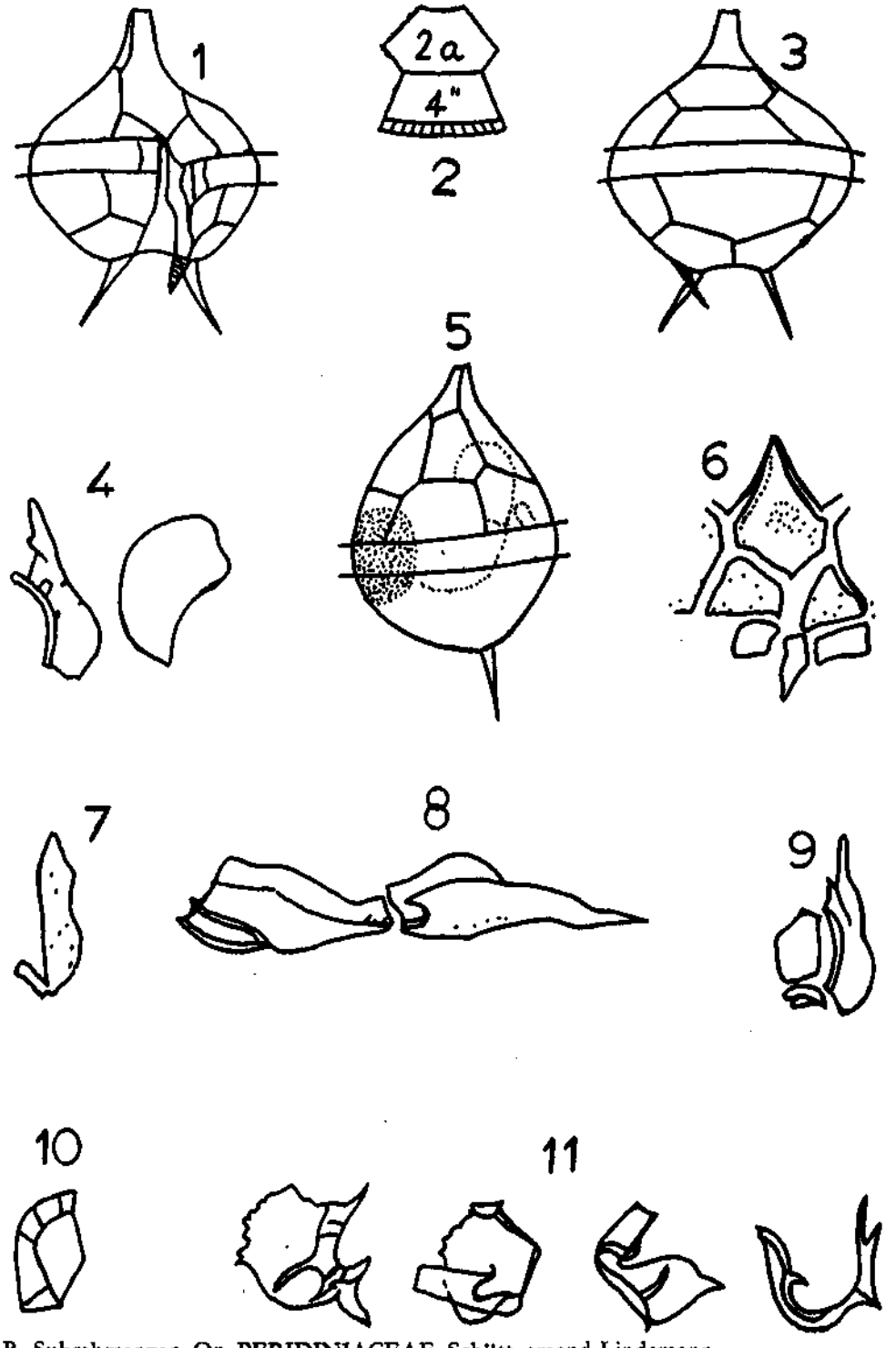
PLATE XXXV

Figs. 1—11. *Peridinium pellucidum* (Bergh) Schütt; 1, ventral, 3, dorsal, 5 lateral views of cells; 2, 4 '' and 2 *a*; 4, *S. i.* and *S.m.*; 6; 1', 1'' 1''. 7'' *C*, *C* and *t*; 7, *S.a*; 8, *S.d.*. two aspects; 9, *S.i*; *S.m.* and *S.p.a.* 10, 1'''; 11, *S.p.* in distinct positions., (after Balech, 1964 *a*); 1, 3, 5 x 1000; rest not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE XXXVI

Figs. 1.4. *Peridinium tristylum* Stein ; 1 & 3, ventral views ; 2 & 4, dorsal views ; (1 & 2, after Stein in Schiller, 1937 ; 3, after Broch in Schiller, 1937 ; 4, after Dangeard, 1927 *c*); 3. x 570 ; 4, x 375; 1 & 2, not known.

Figs. 5 & 6. *Peridinium heteracanthum* Dangeard; 5, ventral view ; 6, partial ventral view ; (5, after Dangeard, 1927 *c*); 6, after Matzenauer, 1933); 5. x 630 ; 6, x 135.

Figs. 7-13. *Peridinium nipponicum* Abé ; 7, 9 & 10, dorsal views ; 8 & 11, ventral views ; 12 & 13, antapical and apical views respectively ; (7, original ; 8 & 9, after Matzenauer, 1933 ; 10-13. after Abé in Schiller, 1937) ; 7, x 320 ; 8 & 9, not known ; rest, x 670.

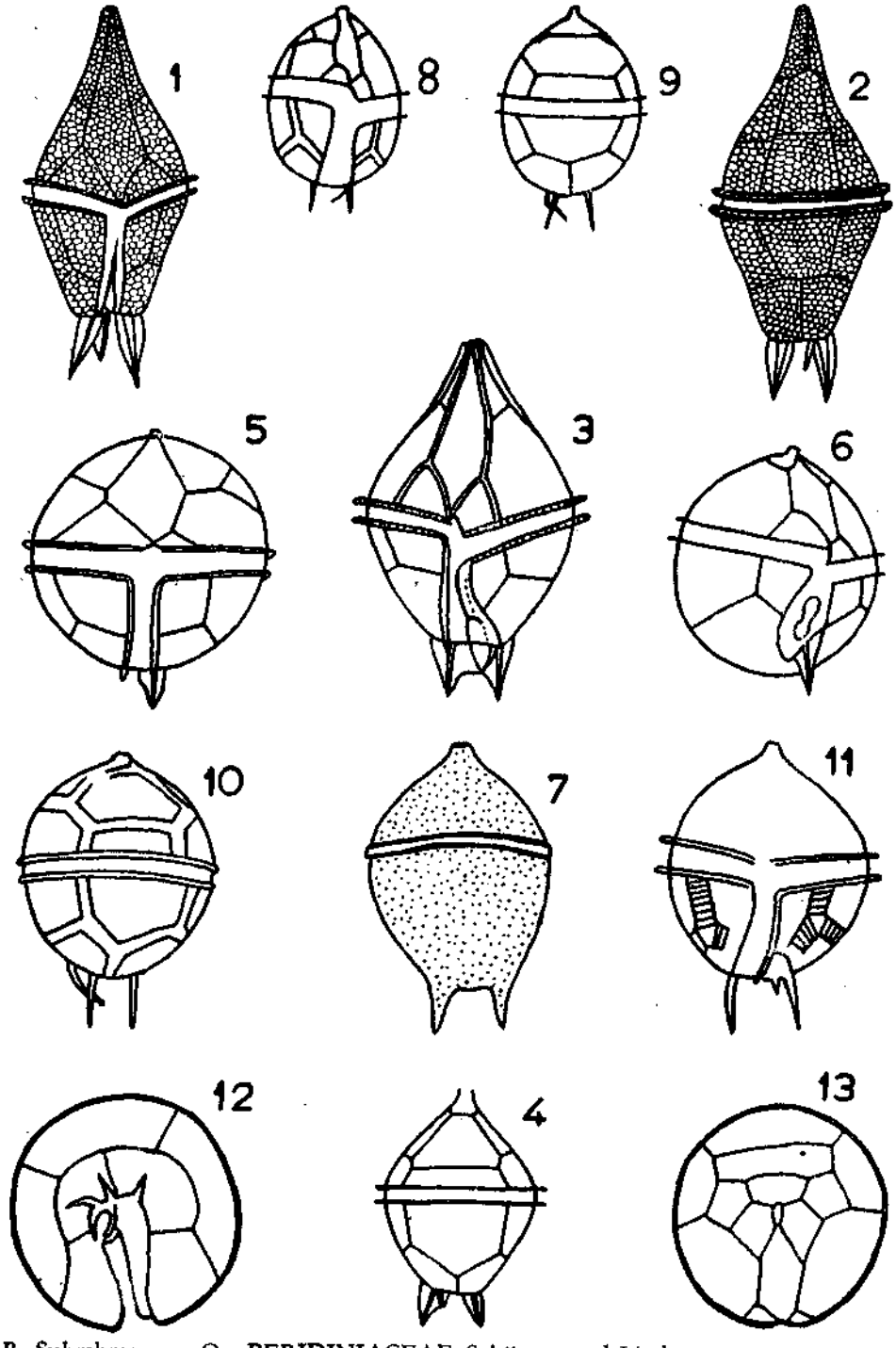


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PLATE XXXVII

Fig. 1. *Peridinium nipponicum* Abé; dorsal view; (original); x 430.

Figs. 2-10 *Peridinium inclinatum* Balech ; 2, 5 & 9, partial ventral views; 3, 6 & 7, ventral views : 4, dorsal view ; 8, antapical view ; 10, apical view ; (5, 7 & 9, after Matzenauer, 1933; 6,8 & 10, after Abé in Schiller 1937; 2, 3 & 4, original) ; 5, 7 & 9, x 500 ; 6, 8 & 10, x 400; 2 & 3, x 760 ; 3, x 430.

Figs. 11 & 12. *Peridinium obesum* Matzenauer ; 11, dorsal view ; 12 ventral view ; (after Matzenauer, 1933) ; x 750.

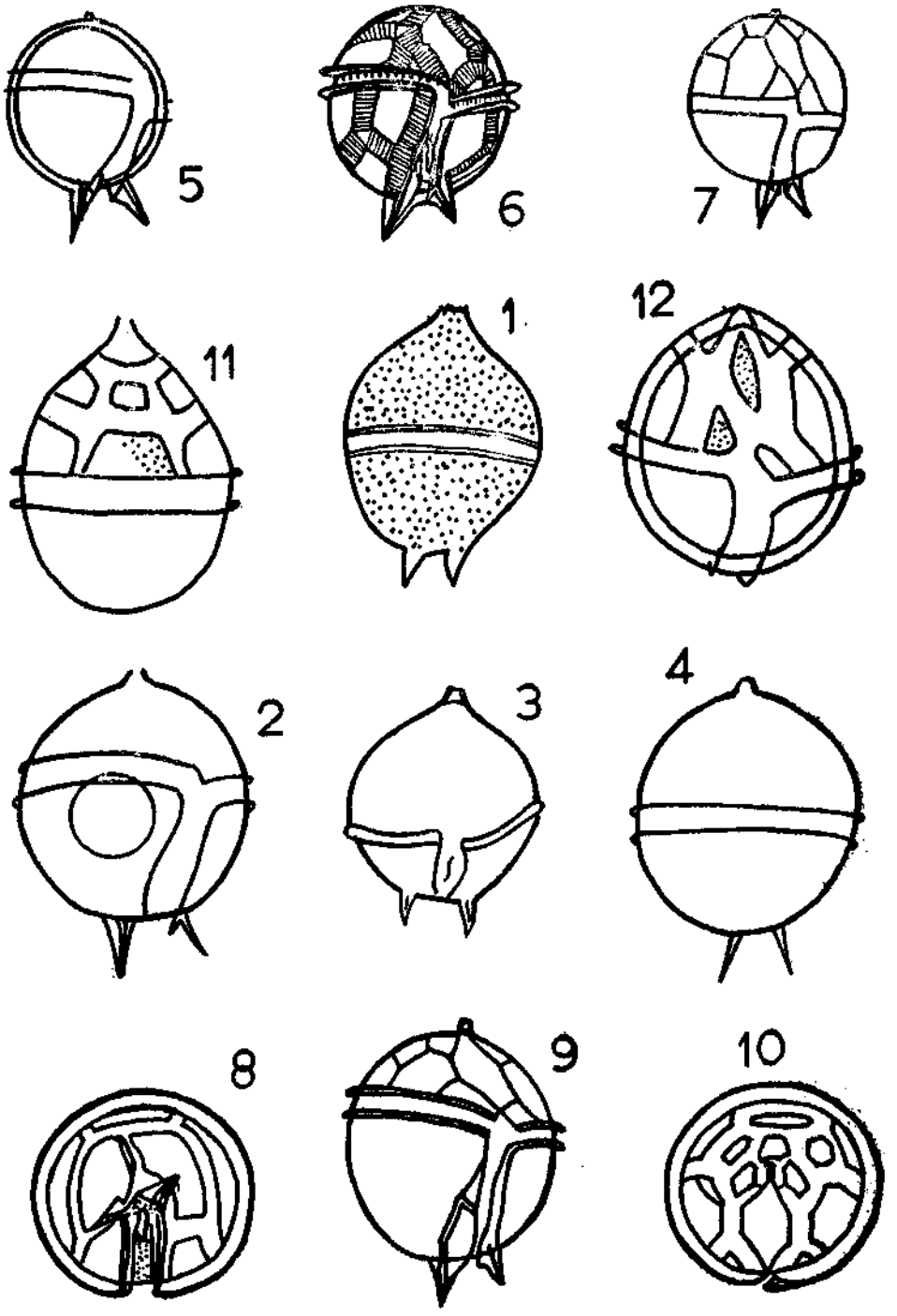

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PLATE XXXVIII

Figs. 1-4 ; 12-15 *P. ovum* Schiller ; 1 & 13 ventral 2 & 12 lateral, 3, dorsal, 4 & 15, apical views; (After Dangeard 1927 *a*, as *P. ellipsoideum* ; 12-15, after Schiller, 1937) ; 12-15, x 450 ; rest not known.

Figs. 5-11. *P. inclinatum* Balech; 5, *S. p.* in distinct position 8, 3''' ; 9, *S. a.* ; 10, *S. d.* in distinct position ; 11, hypothecal ventral region, plates dissected ; (after Balech, 1964 *a*) ; magnification not known.

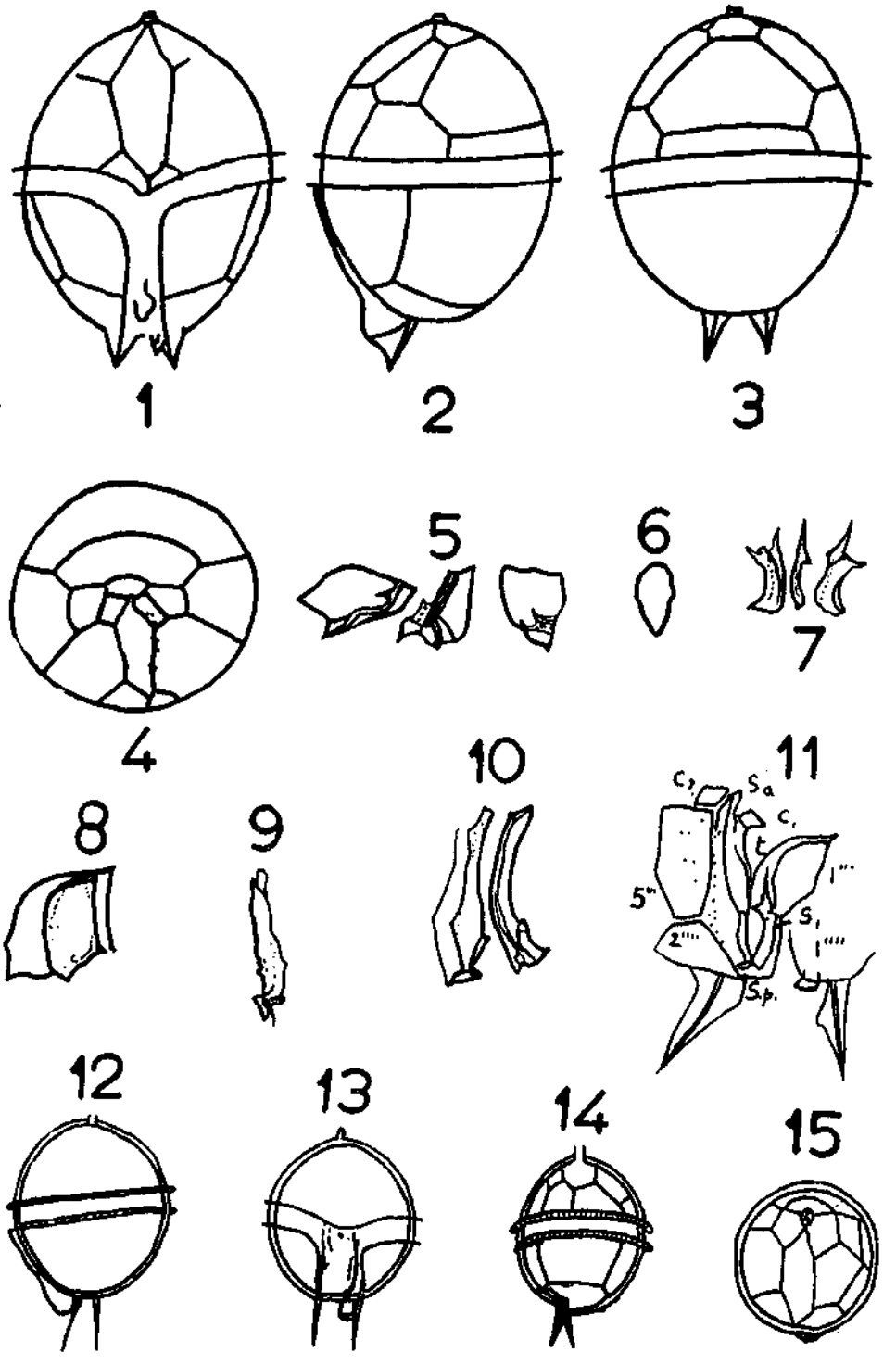

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PLATE XXXIX

Figs. 1-13. *Peridinium variegatum* Peters ; 1, lateral view ; 2, ventral view ; 3, 1′ neck suture ; 4, epitheca, dorsal aspect left-side 1′ and the pore ; 5, epitheca dorsal aspect ; 6, details of ventral region; 7, sulcus ; 8, *S. m.*; 9, *S. p. a.*; 10, *S.p.* 11, *S. a.* ; 12, *S. d.*; 13, *S. i.*, (after Balech, 1958 *a*) ; 1-x 280 ; 4, 5, 6 x 390 ; rest x 980.

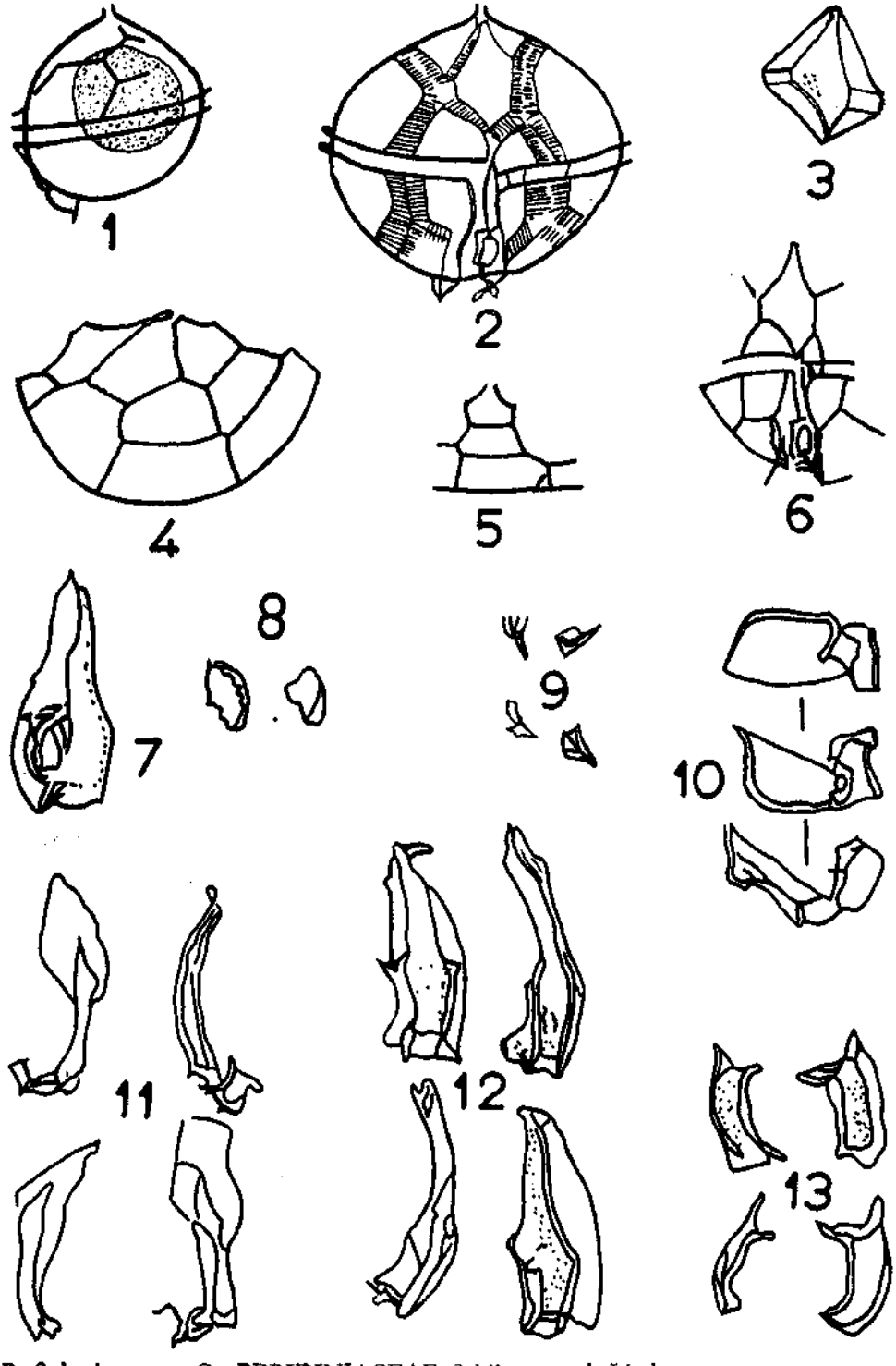

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PLATE XL

Figs. 1-8 *Peridinium variegatum* Peters ; 1, 2, 3, 5, 6 & 7, ventral views ; note the prominent intercalary striae 4, dorsal view ; 8, apical view ; (after Peters, 1928) ; all x 600.

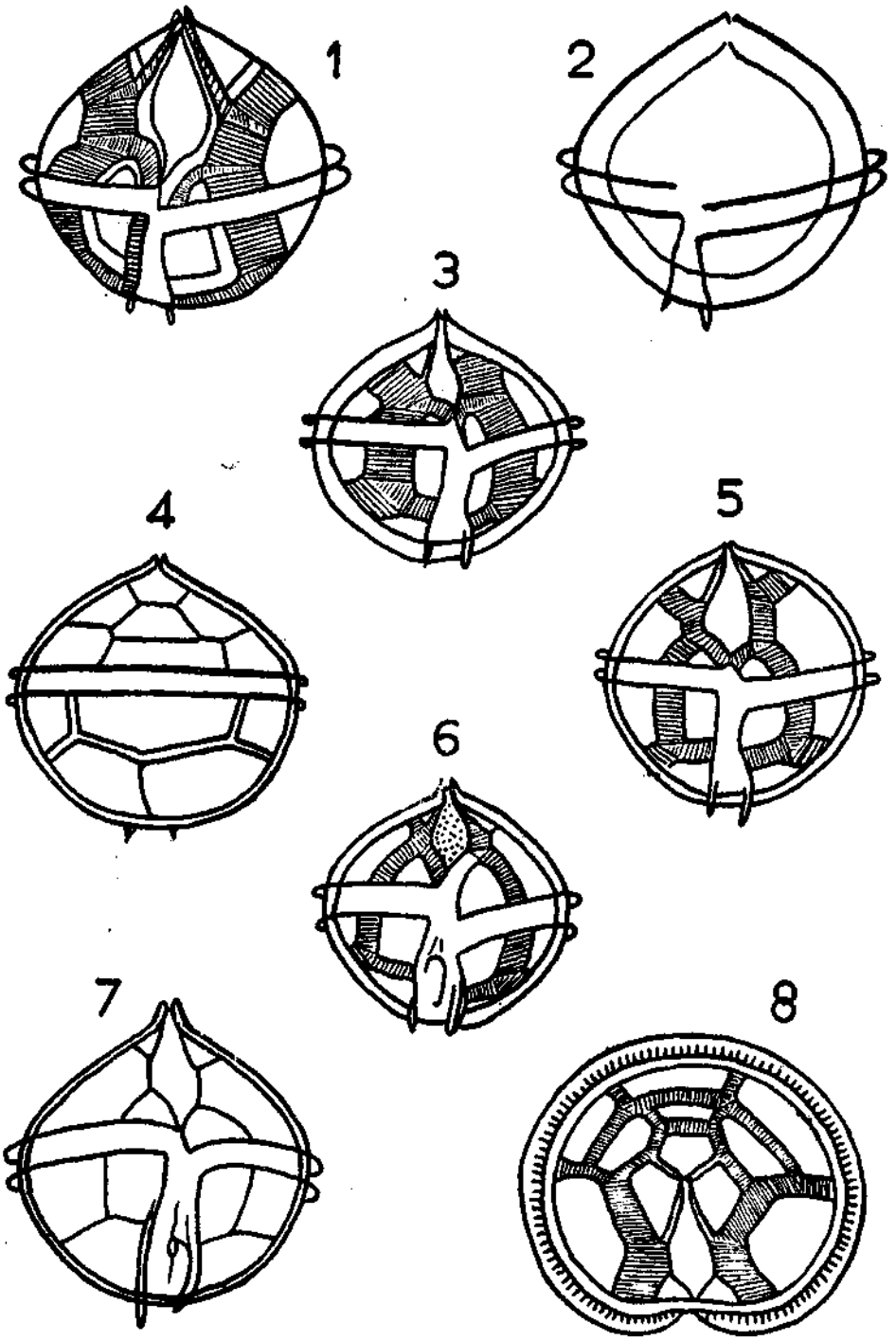

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PLATE XLI

Figs. 1-8. *Peridinium conicoides* Paulsen ; 1, 3 & 6, ventral views : 2, 4 & 5, dorsal views ; 7, antapical view ; 8, apical view ; (1-4, original ; 5-8, after Lebour, 1925) ; 1-4, x 760 ; 5, 7 & 8, x 660 ; 6, x 530.

Figs. 9-11. *Peridinium matzenaueri* Gaarder ; 9, lateral view; 10, ventral view ; 11, antapical view ; (after Gaarder, 1954) ; x 400.

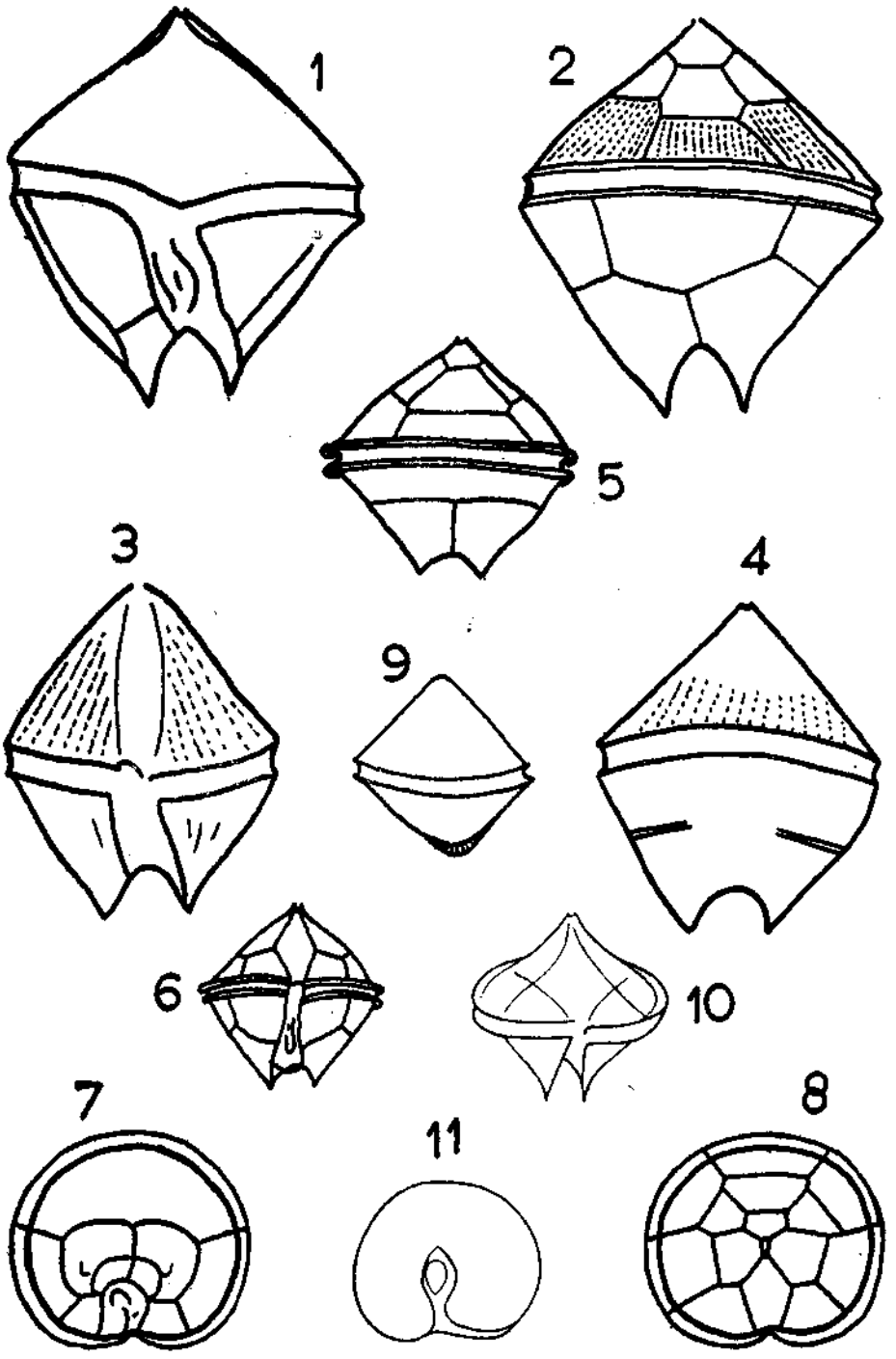

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PLATE XLII

Figs. 1-9. ***Peridinium conicum*** (Gran) Ostenfeld *et* Schmidt; 1, 3 & 6, ventral views; 2, 4 & 5, dorsal views; 7 & 8, apical views; 9, antapical view; note sculpturing in figs. 6 & 7; (3 & 4. after Lebour from Schiller, 1937; 8 & 9, after Lebour, 1925; 5, after Matzenauer, 1933; 1, 2, 6 & 7, after Schiller, 1937); 8 & 9, x 640; 5, x 500; 1, 2, 6 & 7, x 400; 3 & 4, not known.

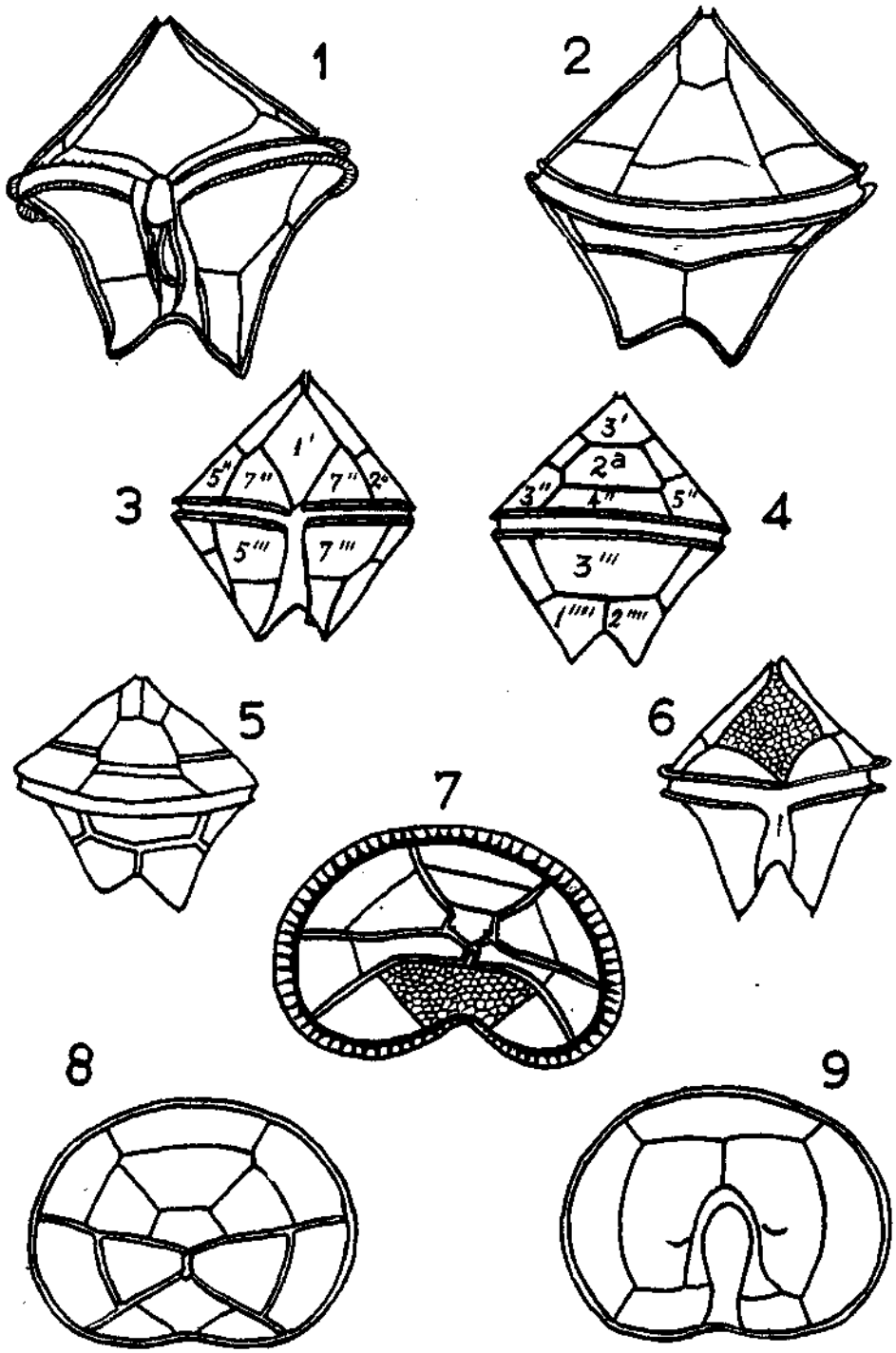

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PLATE XLIII

Figs. 1-9, 11 & 13. *Peridinium leonis* Pavillard ; 1 - 5 & 7, ventral views ; 6, dorsal view ; 1, partial lateral ventral view ; 9, side view ; 11 & 12, apical views ; 13, oblique apical view ; (1, after Lebour,1925; 2, after Matzenauer, 1933 ; 3, after Schiller, 1937 ; 4 & 12, after Pavillard in Schiller, 1937; 5, 6, 8, 11 & 13, after Paulsen in Schiller, 1937 ; 7 & 9, after Dangeard, 1927 *b*) , 1, x 430; 2, 420; 3, x 450; 4 & 12, x 535; 5, 6, 8; 11 & 13, x 500 ; 7 & 9, x 600.

Fig. 10 *Peridinium leonis* f. *matzenaueri* (Matz.) Schiller ; ventral view : (after Matzenauer, 1933) ; x 420.

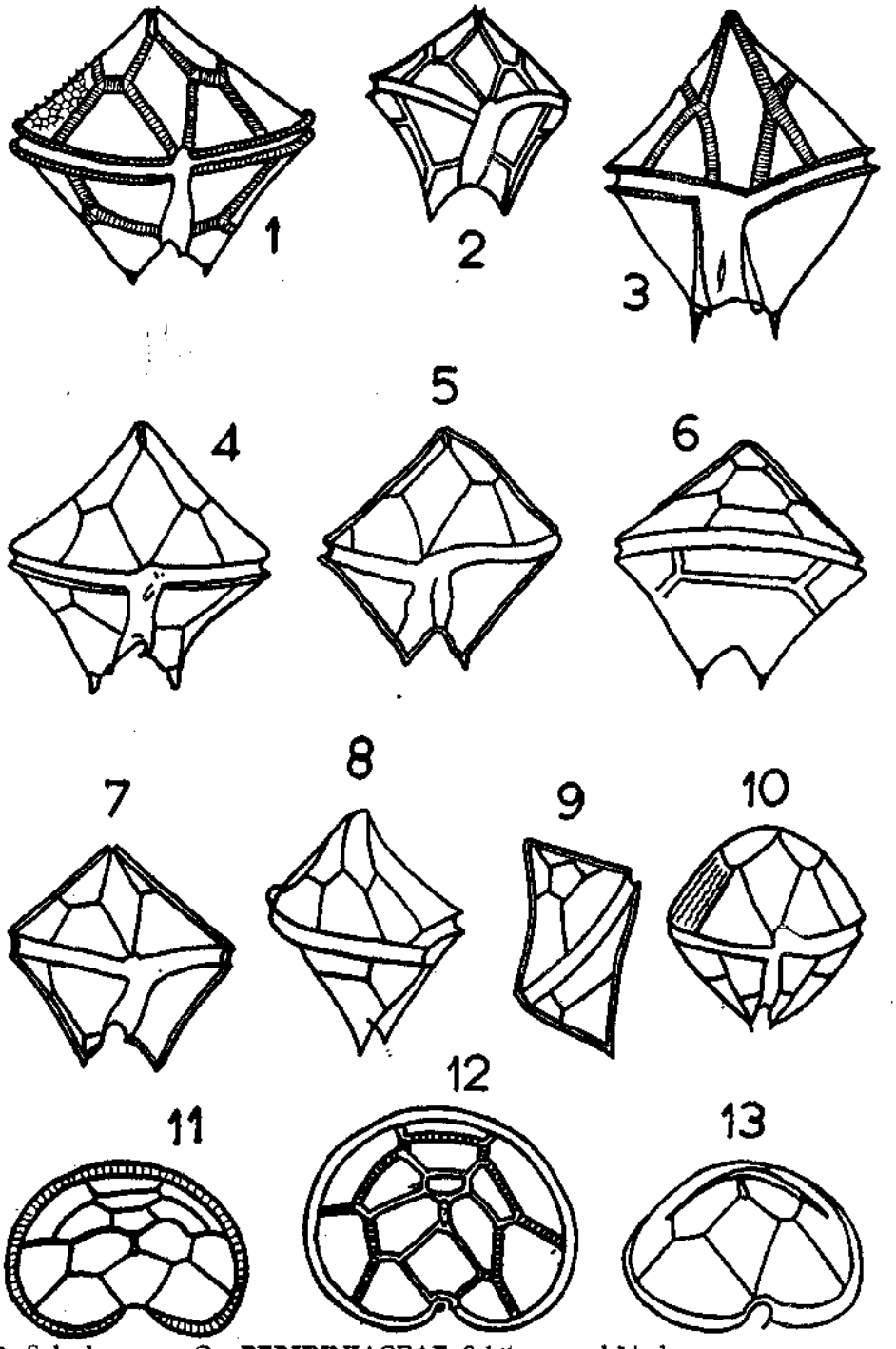

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PLATE XLIV

Fig. 1. *Peridinium conicum* (Gran) Ostenfeld *et* Schmidt; ventral view; (original); x 300.

Figs. 2-9. *Peridinium conicum* f. *guardafuiana* Matzenauer; 2, 4, 7 & 9, dorsal views; 3, 5, 6, & 8, ventral views; (2-5, original; 6 & 7, after Matzenauer, 1933; 8 & 9, after Schiller. 1937) ; 2-5, x 380 ; 6 & 7, x 400; 8 & 9, x 200.

Figs. 10-14. *Peridinium leonis* Pavillard; 10, 12, 13 & 14, ventral views; 11, dorsal view; (original) ; x 380.

Figs. 15-19. *Peridinium leonis* f. *matzenaueri* (Matz.) Schiller; 15 & 16, dorsal views; 17, 18 & 19, ventral views; (original); x 380.

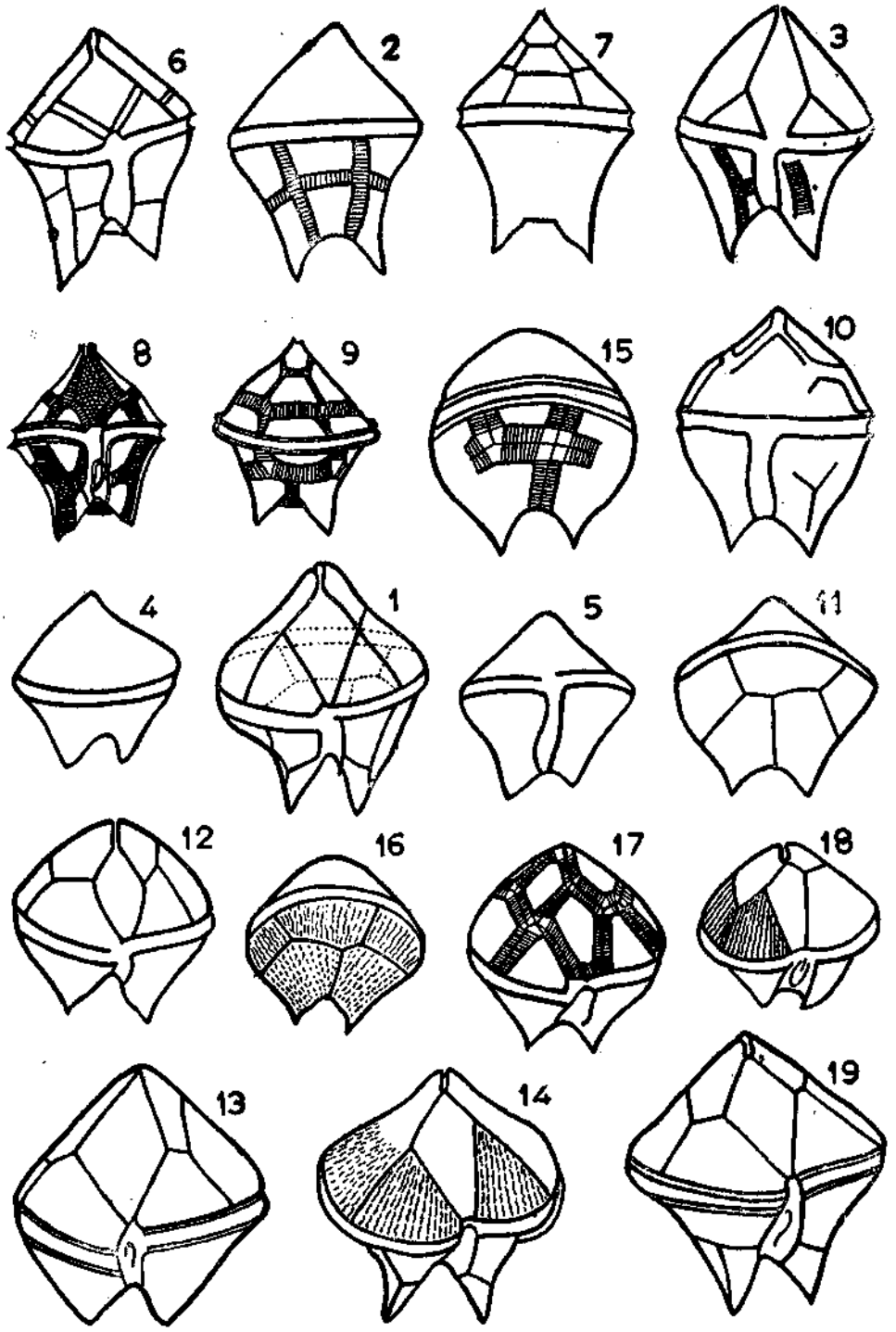

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PLATE XLV

Figs. 1 & 2, 12 & 13. *Peridinium leonis* f. *matzenaueri* (Matz.) Schiller; 1 & 2, ventral views: 12, ventral view from above; 13, apical view; (1 & 2, after Matzenauer, 1933; 12 & 13, after Karsten, 1907); 1 & 2, x 420; 12 & 13, not known.

Figs. 3 - 11. *Peridinium marielebourae* Paulsen; 3 , 6 & 8, ventral views; 4, 5 & 11, dorsal views; 7 & 9, apical views, latter oblique; 10, ventral oblique view; (3 & 7, after Lebour, 1925; 4, 5, 6 & 10, after Schiller, 1937; 8, 9 & 11, after Paulsen in Schiller, 1937); 3 & 7, x 760; 8, 9 & 11, x 310; rest not known.

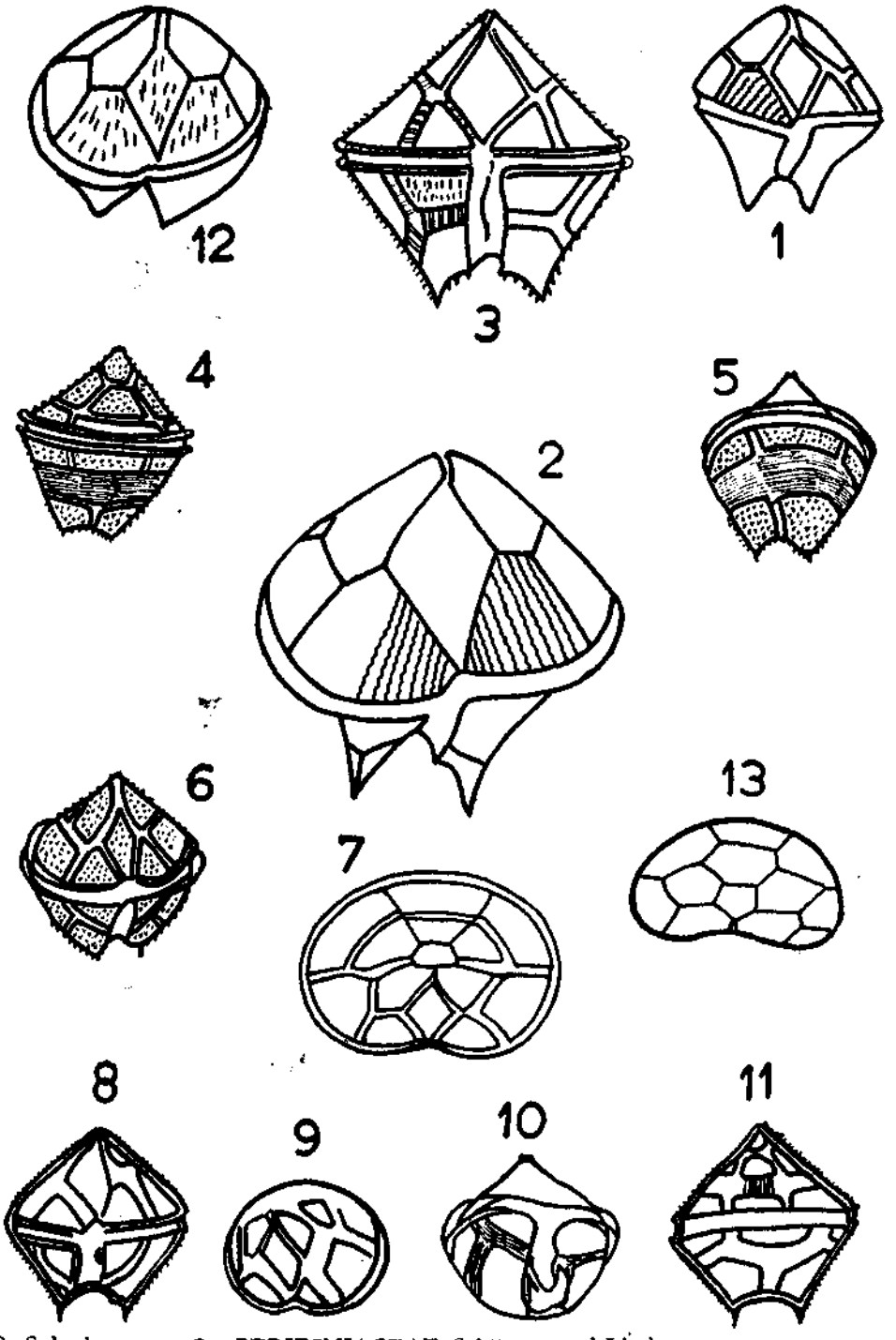

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PLATE XLVI

Fig. 1. *Peridinium leonis* f. *matzenaueri* (Matz.) Schiller; ventral view ; (Original) ; x 450.

Figs. 3-12 *Peridinium marielebourae* Paulsen; 2, 5, 8, 10 & 11, ventral view ; 3, 7, 9 & 12. dorsal view ; 4, ventral oblique view ; (original) ; 6, dorsal oblique view ; (original) ; 2 & 3, x 810 ; rest x 450.

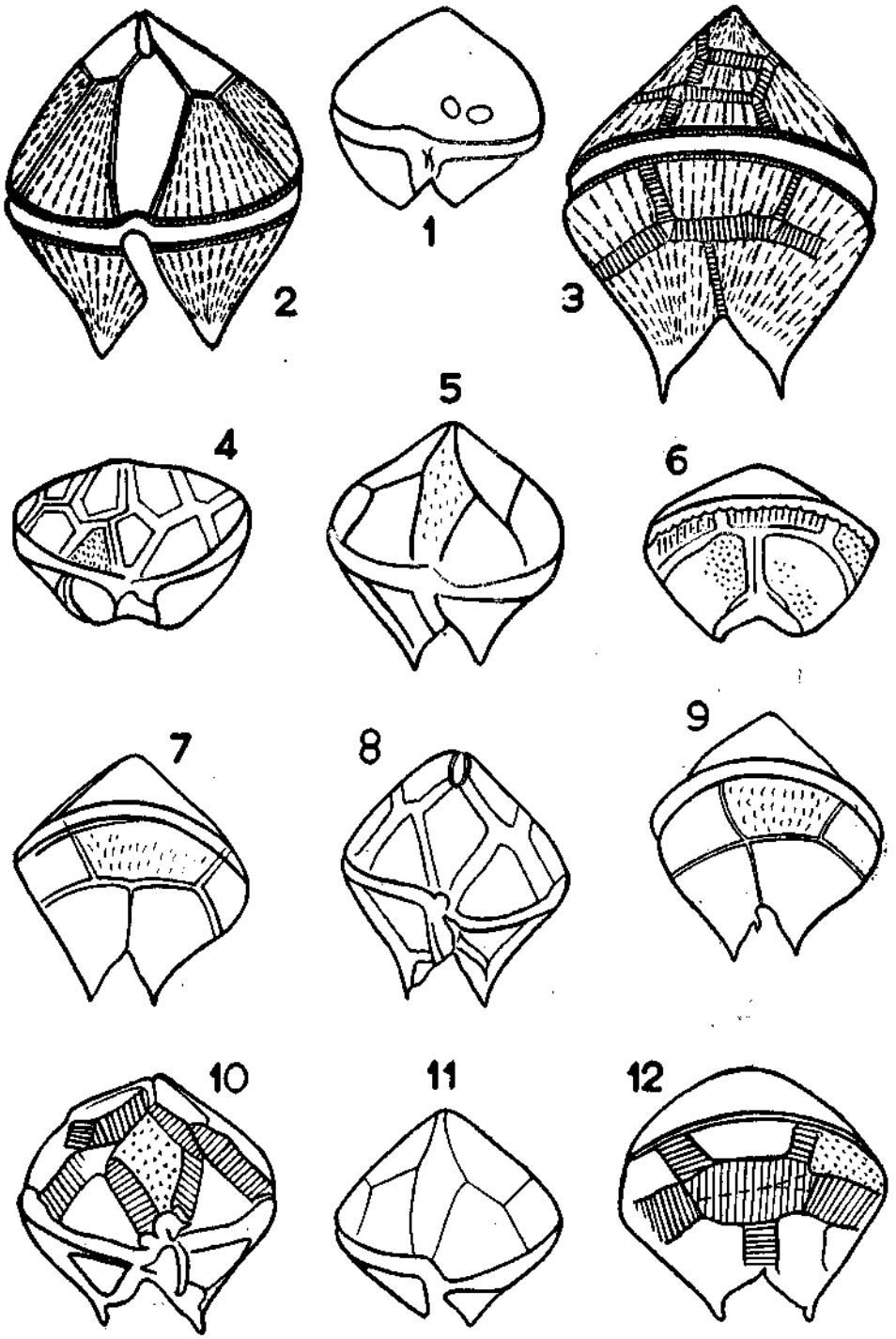

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PLATE XLVII

Figs. 1,2 &3 *Peridinium heteroconicum* Matzenauer; 1, dorsal view; 2. apical view; 3, antapical view;(after Matzenauer, 1933) ; all x 500.

Figs. 4 - 9. *Peridinium pentagonum* Gran ; 4, 6 & 7, ventral views ; 5, dorsal view ; 8, apical view ; 9, antapical view ; (4, original ; 5, 6, 8 & 9, after Lebour, 1925 ; 7, after Meunier in Schiller, 1937) ; 4, x 430 ; 5, 6 8 & 9, x 500 ; 7, x 500.

Fig. 10. *Peridinium humile* Schiller ; ventral view ; (after Matzenauer, 1933) ; magnification not known.

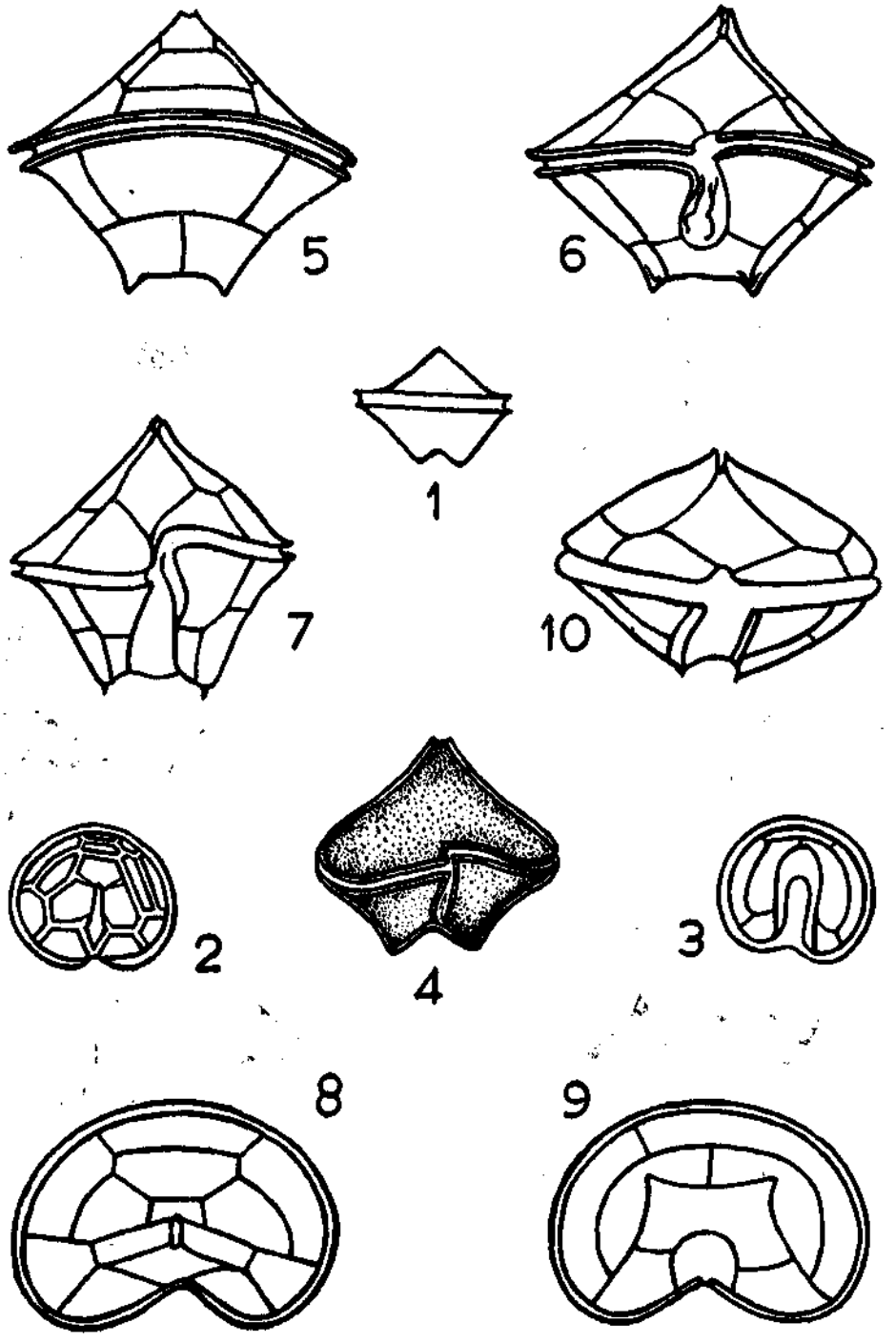

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PLATE XLVIII

Figs. 1-3. *Peridinium pentagonum* Gran ; 1 & 2, ventral views ; 3, dorsal view ; (original) ; all x 410.

Figs. 4-11. *Peridinium pentagonum* var. *latissimum* (Kofoid) Schiller ; 6, 7, 8 & 10, ventral views ; 4, oblique ventral view ; 5 & 9, epitheca ; 11, hypotheca, ventral aspect ; (original) ; 6 & 7, x 600 ; rest, x 410.

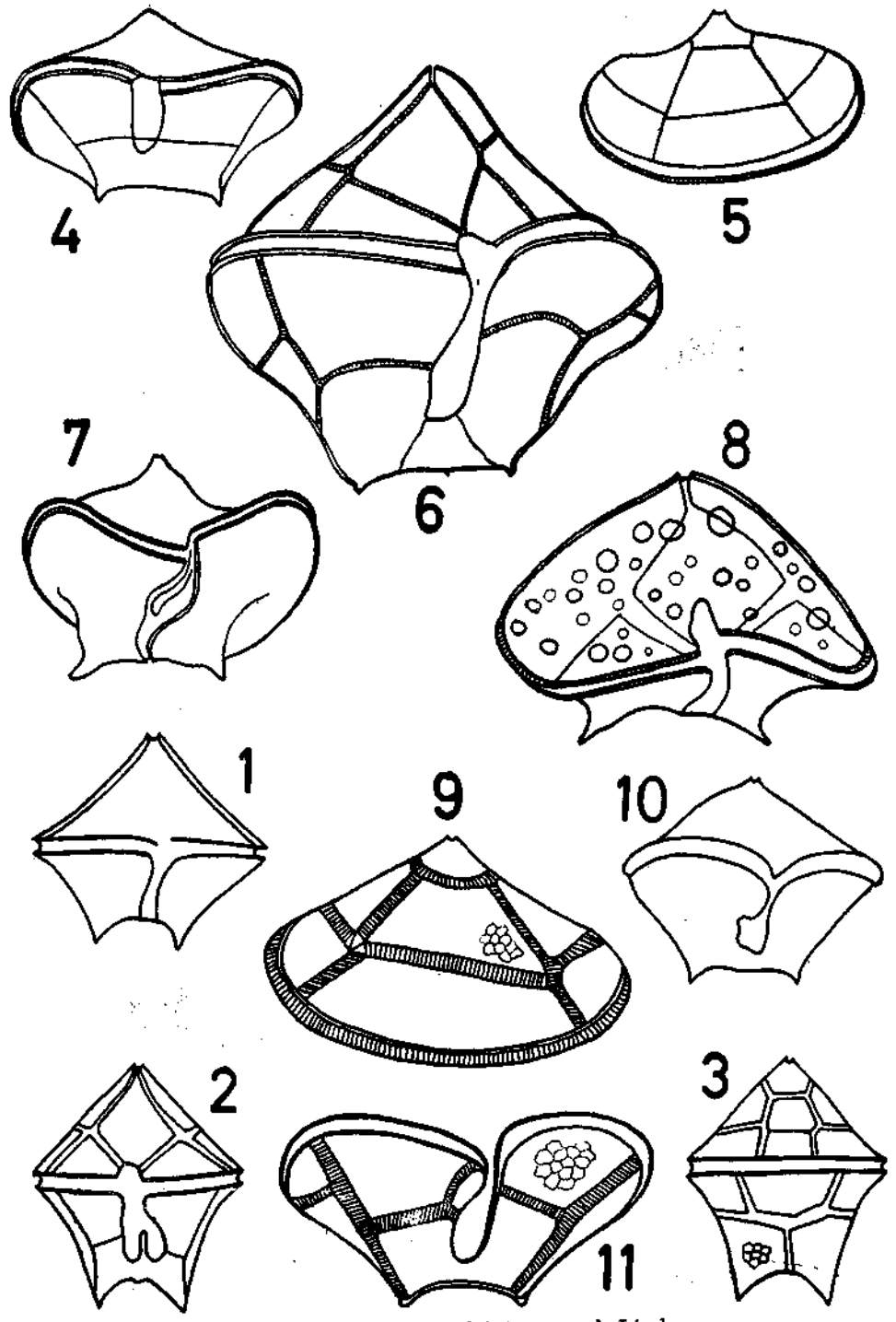

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PLATE XLIX

Figs. 1-10. *Peridinium pentagonum* var. *latissimum* (Kofoid) Schiller ; 1 & 3, dorsal views ; 2, 4, 5 & 6, ventral views ; 7, ventral apical view ; 8, 9 & 10, apical views, section of cells ; (1, 2, 8 & 10, after Abé in Schiller, 1937 ; 3, 4, 5 & 9, after Matzenauer, 1933 ; 6, after Kofoid in Schiller, 1937 ; 7 after Pavillard in Schiller, 1937) ; 1, 2, 8 & 10, x 280 ; 3, 4, 5 & 9, x 350 ; 6, x 295 ; 7, x 450.

Figs. 11-15. *Peridinium biconicum* Dangeard ; 11 & 14, ventral views ; 12 & 13, side views ; 15, apical view ; (11, 12, 13 & 15, after Dangeard, 1927 *c* ; 14, after Matzenauer, 1933) ; 11, 12, 13 & 15, x 330 ; 14, not known.

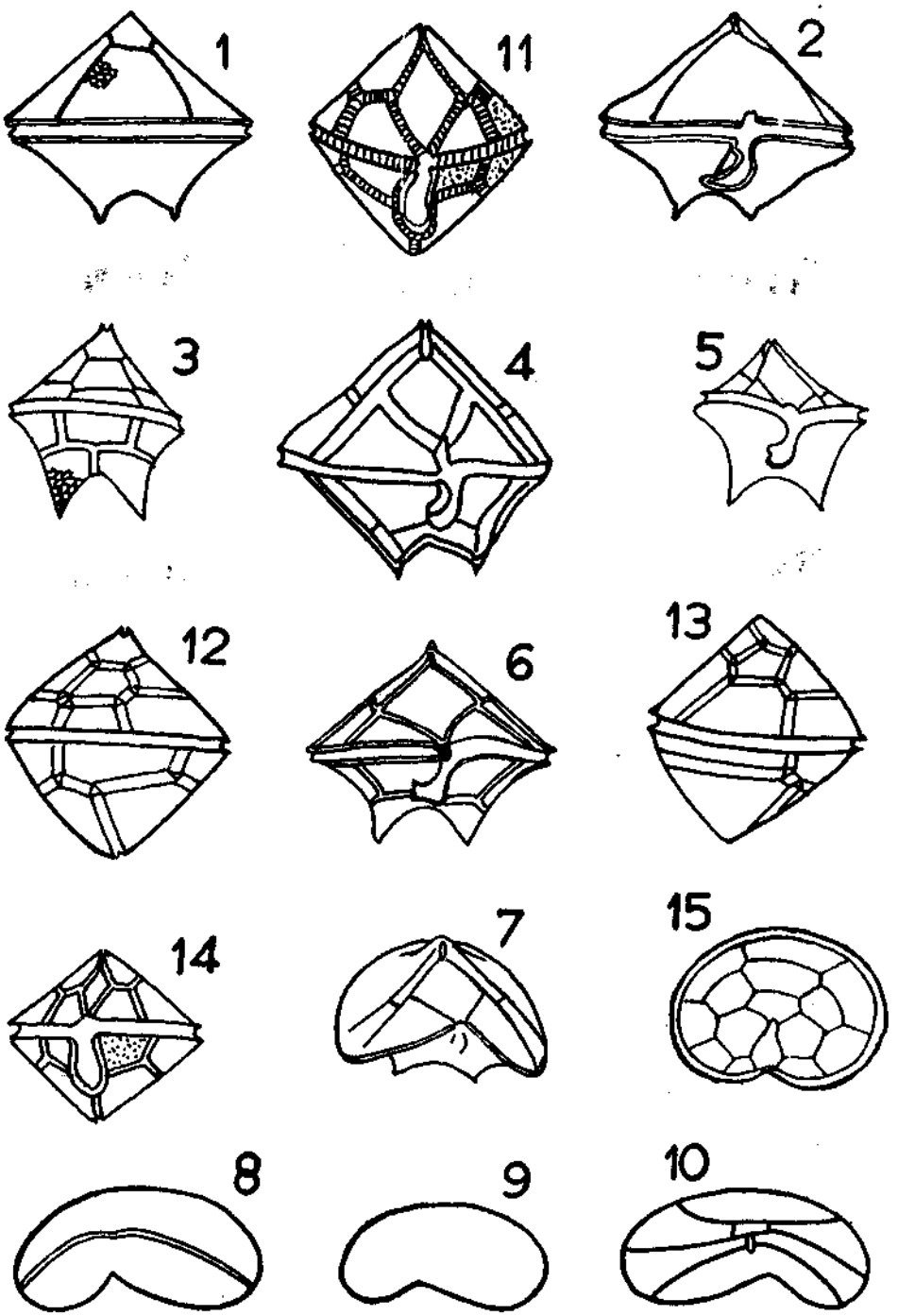

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PLATE L

Figr. 1-7. ***Peridinium achromaticum*** Levander ; 1-4 & 6, ventral views ; 7, dorsal view ; 5, apical view ; (1, 2, 3 & 7, after Lebour, 1925) , 1, 2, 3 & 7, x 900; 4, 5 & 6, x 680.

Figs. 8-14. ***Peridinium subinerme*** Paulsen ; 8, 13 & 14, ventral views; 9, apical view ; 10, dorsal view; 11, ant-apical view ; 12, lateral view; (8-11, after Lebour, 1925; 12 & 13. after Meunier in Schiller, 1937 ; 14, after Matzenauer, 1933) ; 8-11, x 700 ; 14, x 400 ; rest not known.

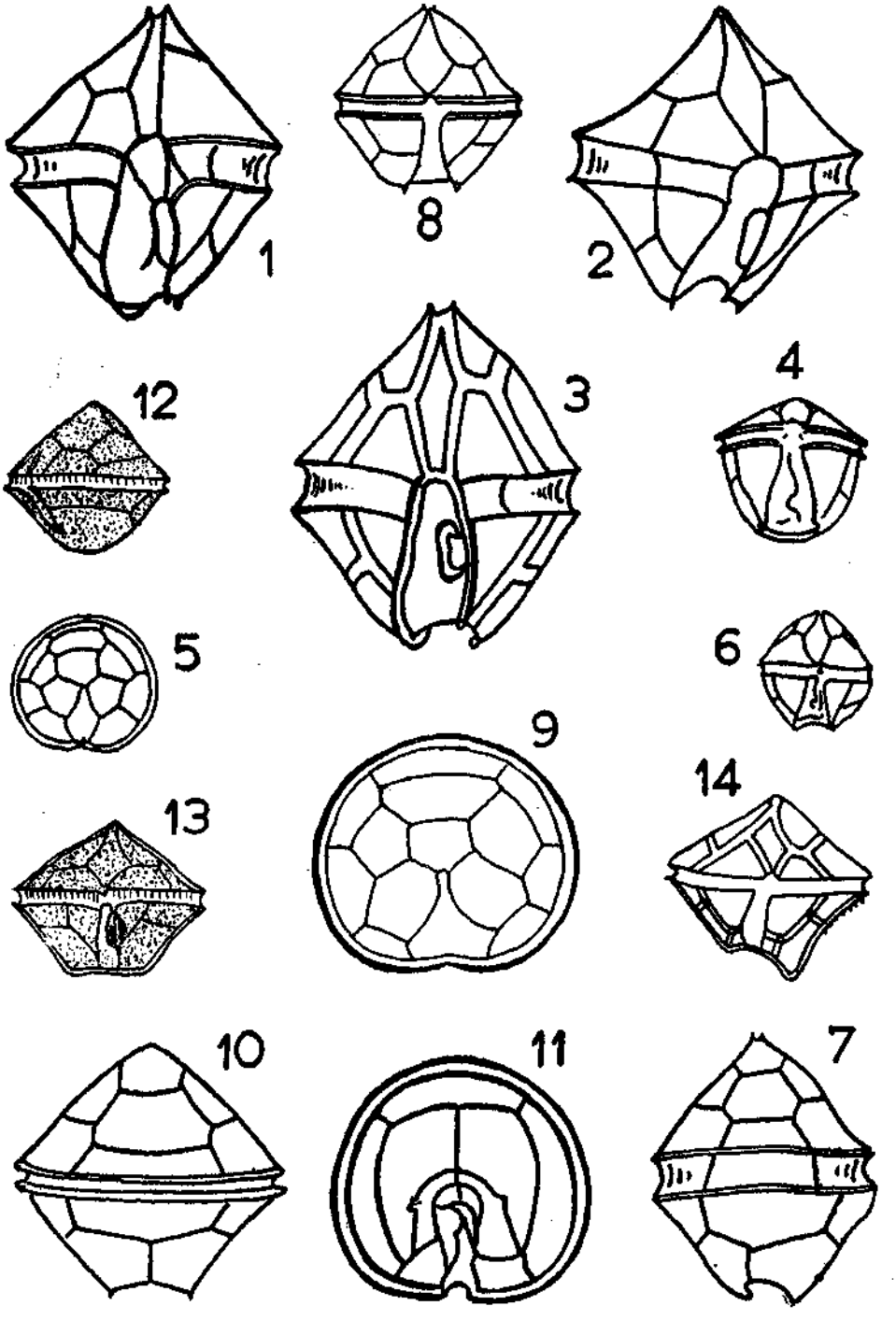

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PLATE LI

Fig. 1. *Peridinium achromaticum* Levander ; antapical view; (after Wolozynska in Schiller, 1937) ; x 630.

Figs. 2-15. *Peridinium subinerme* Paulsen ; 2, partial apical view ; 3, 5, 7, 8, 12, 13 & 15, ventral views ; intercalary striae seen in 13 & 15 ; 4, 6, 9, 11 & 14, dorsal views ; intercalary striae seen in 14 ; 10, antapical view ; (2-12, original ; 13-15, after Peters, 1928); 2-12, x 530; 13-15, x 420.

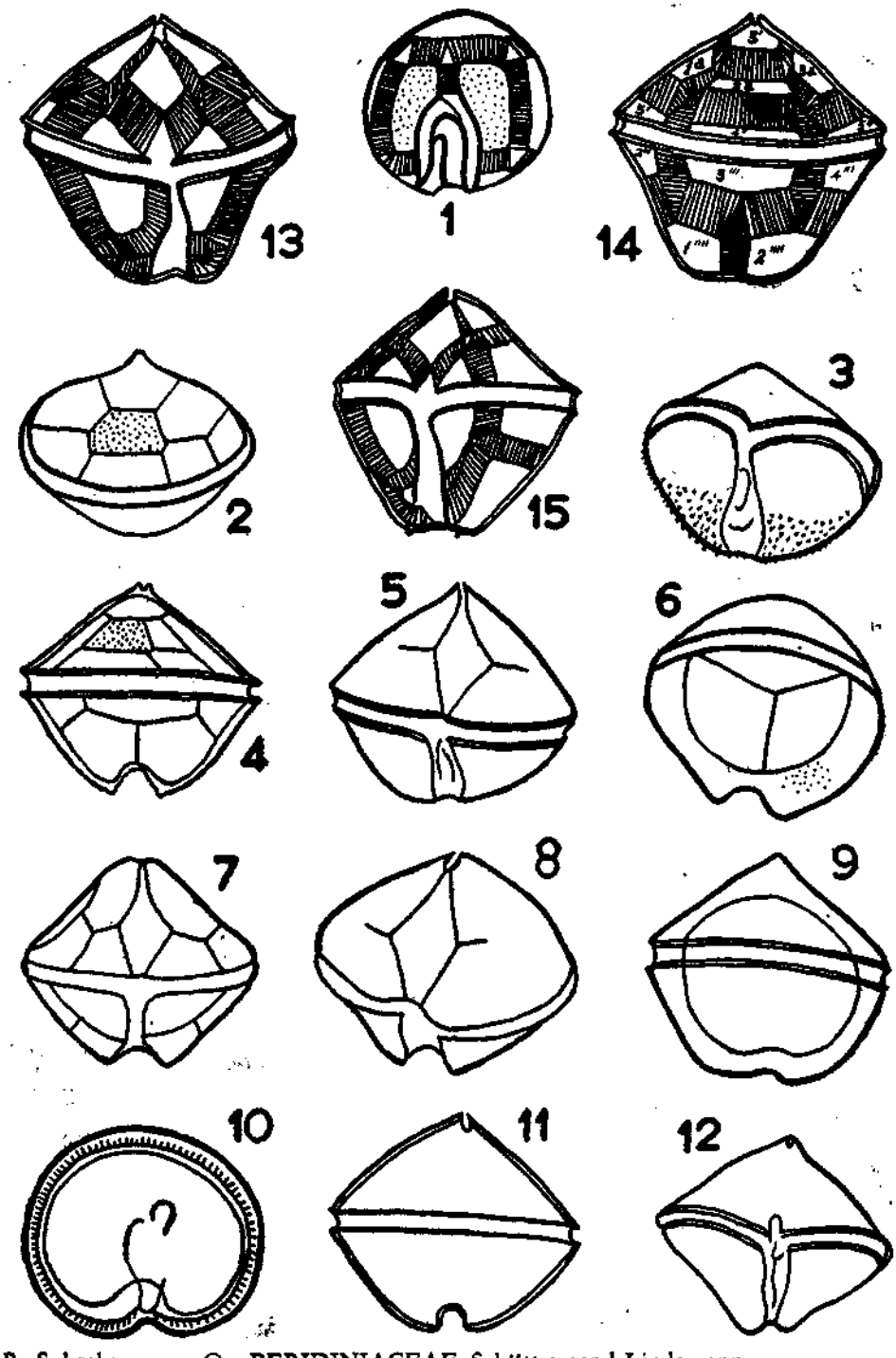

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PLATE LII

Figs. 1-6, 8 *Peridinium subinerme* Paulsen; 1 & 5, ventral views; 2, hypotheca, ventral; 3, lateral view; 4, hypotheca dorsal; 6, apical view; 8, dorsal tabulation; (after Peters, 1928); magnification not known.

Figs. 7, 9–16, *Peridinium achromaticum* Levander; 15, ventral view; 14, 16, apical views; 9, hypotheca dorsal; 7, ventral cingulars, transitional and anterior sulcal; 10, posterior accessary sulcal; 11, three views of *S. p.*; 12, *S.d.*; 13, *S.a.* (after Balech, 1963); magnification not known.

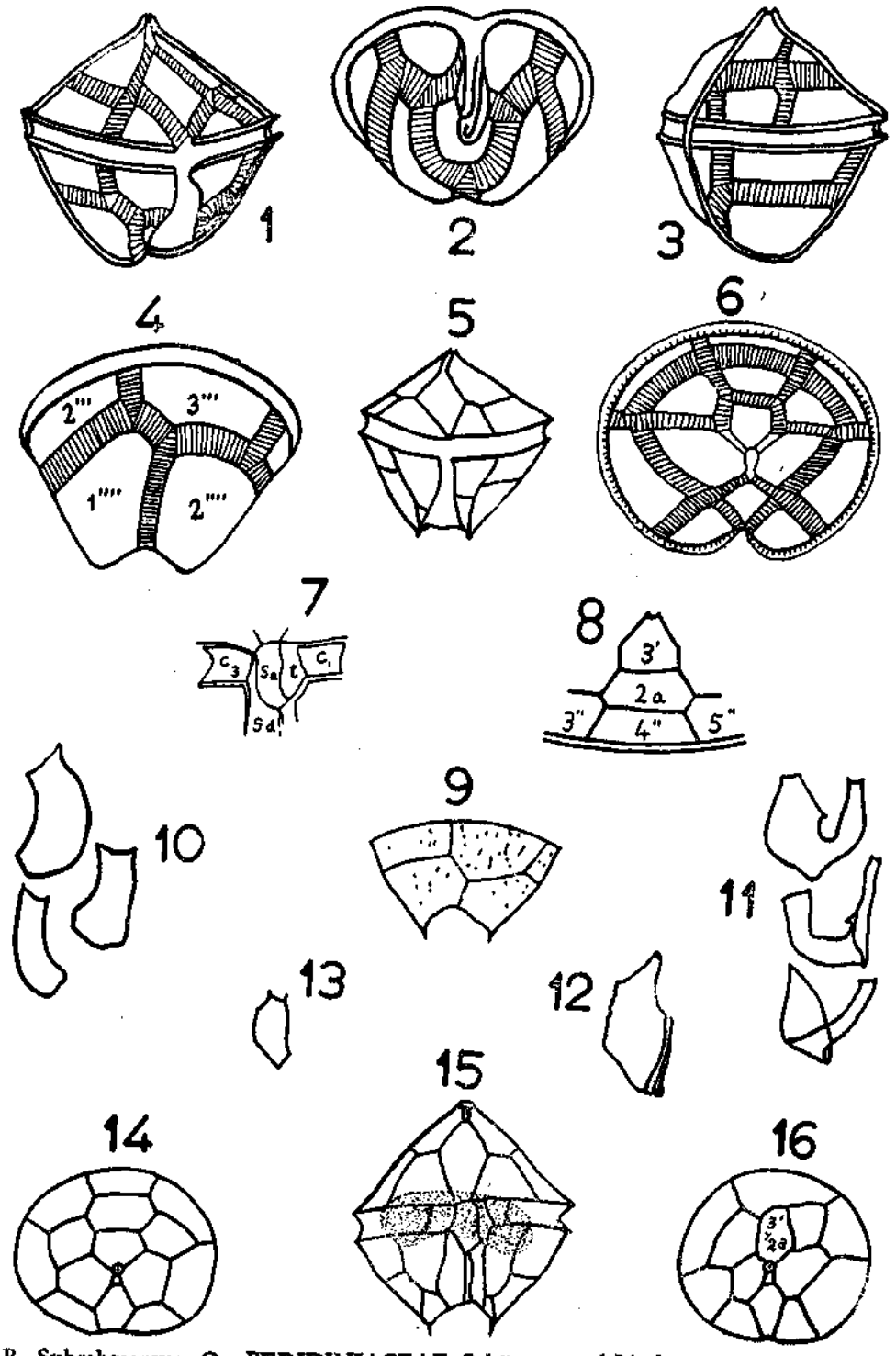

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PLATE LIII

Figs. *Peridinium turbinatum* Mangin; 1 & 2, dorsal views; 3, 4 & 5, ventral views; 6, antapical view; 7, apical view; (all after Peters, 1928); all x 600.

Figs. 8—10 *Peridinium depressum* Bailey; ventral views; (after Peters, 1928); all x 400.

Figs. *Peridinium brachypus* Schiller; ventral view; (after Schiller, 1937), x 800.

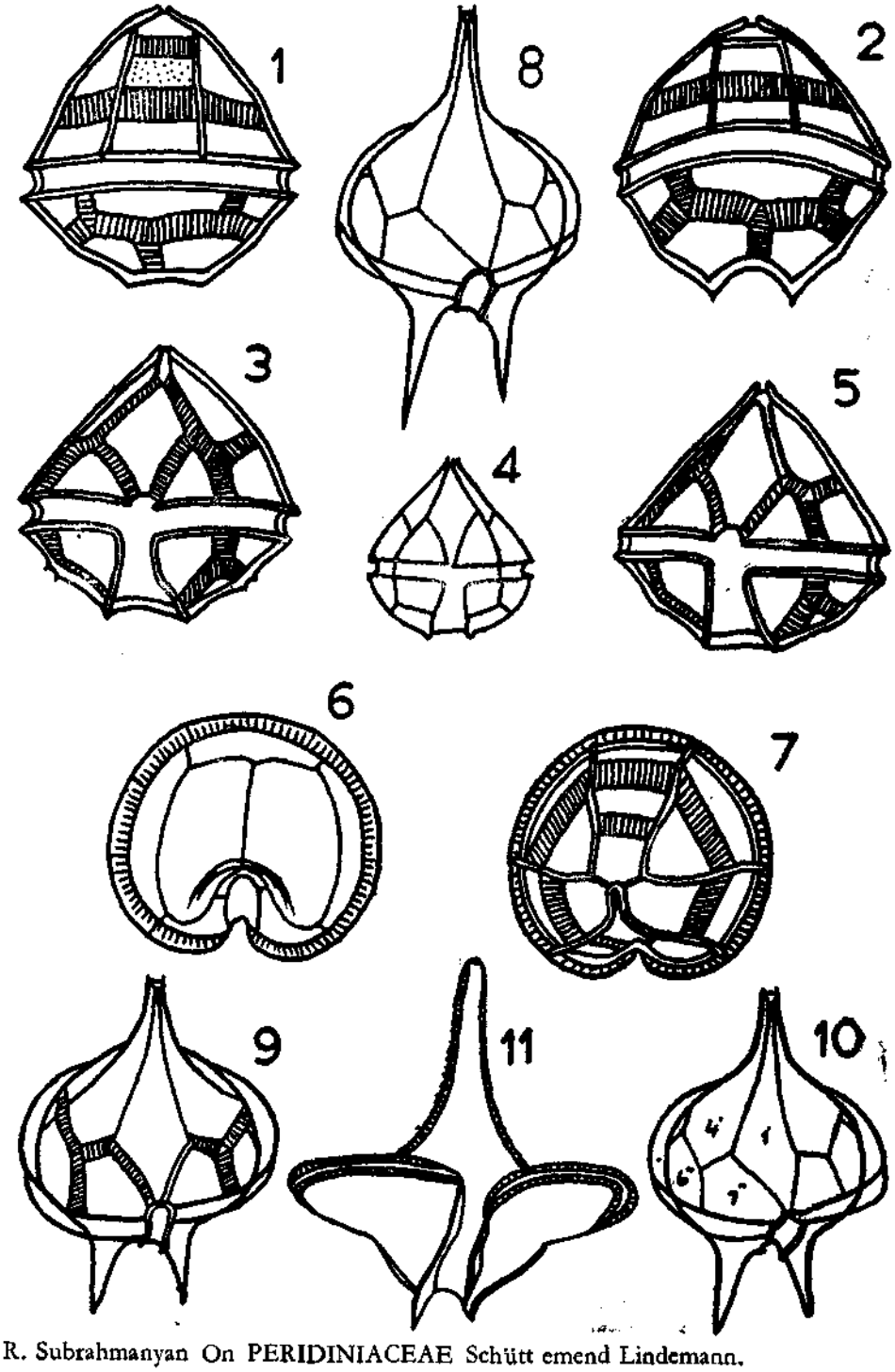

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PLATE LIV

Figs. 1—11. *Peridinium turbinatum* Mangin; 1, ventral view; 11, dorsal view; 2 - *S.i*; 3–1′; 4 & 7, sulcals; 5, sulcal neck 1′, 7″ C_s & 5‴; 6, *S.d*; 8, *t*; 9, *S.a*; 10 - *S. p*; (after Balech, 1958 *a*) x ca 980.

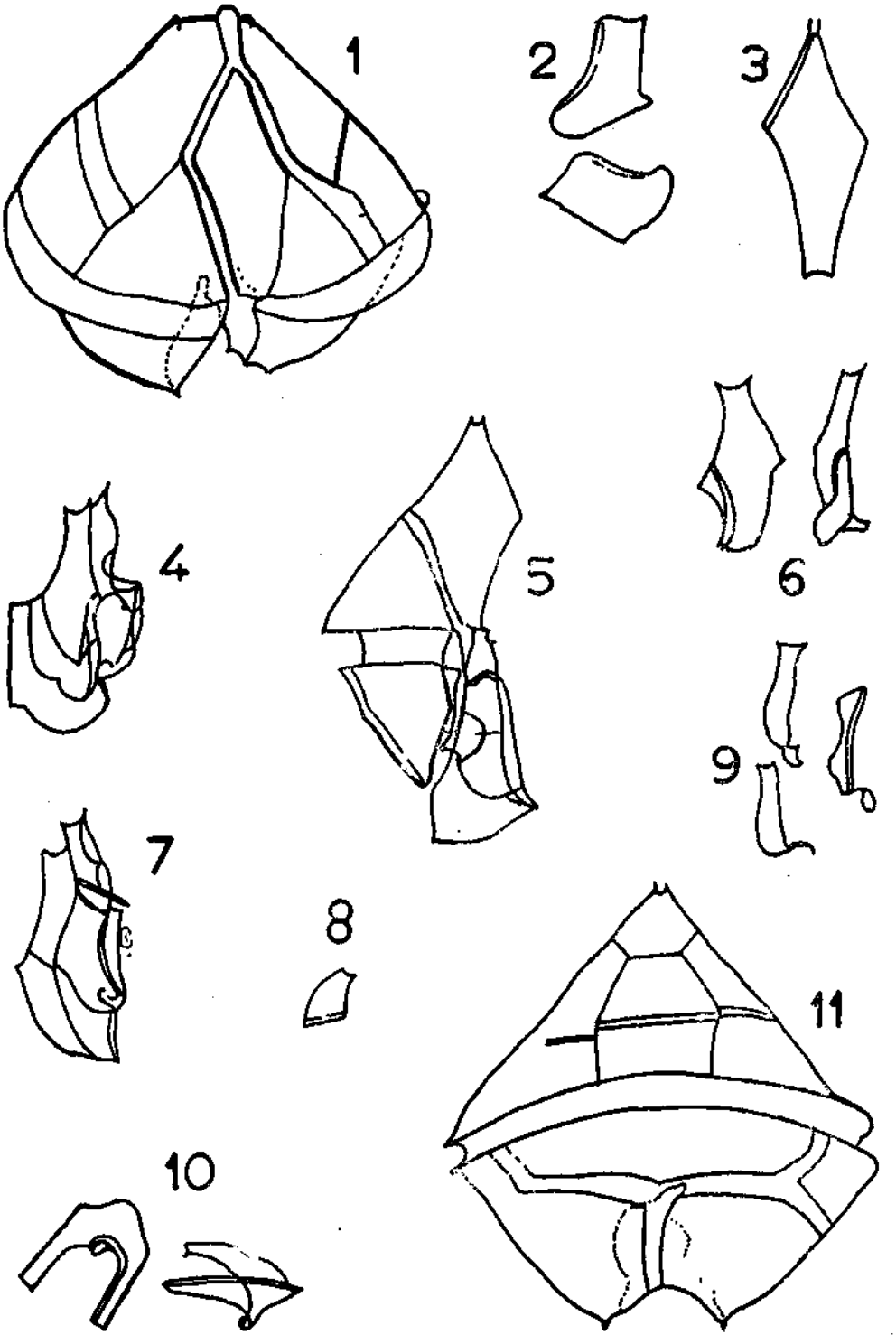

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PLATE LV

Figs. 1—10. *Peridinium depressum* Bailey ; 3 & 9, dorsal views ; rest ventral views, different aspects - sculpture shown in 1 & 3 ; (all original) ; all x 300.

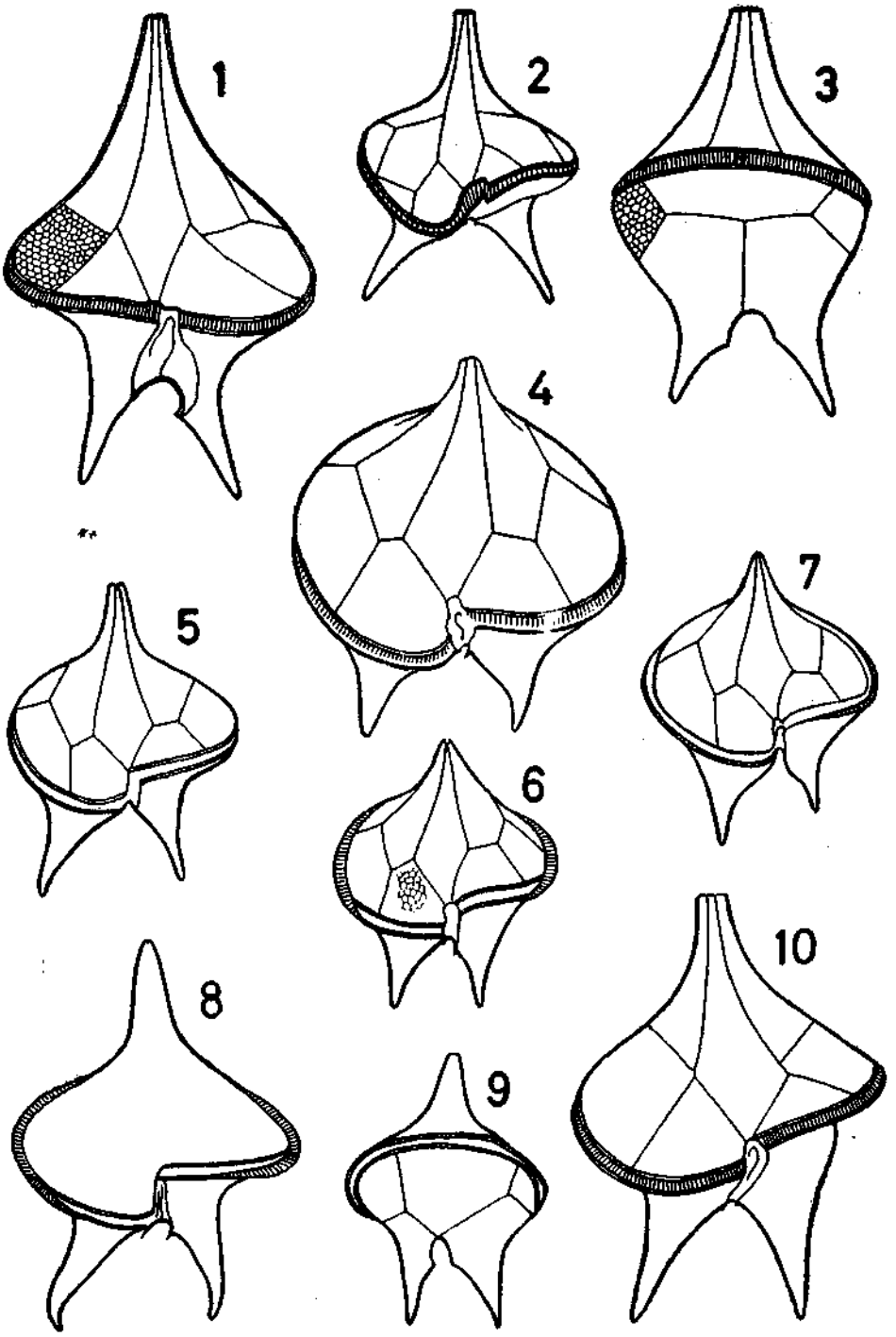

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PLATE LVI

Figs. 1—11 *Peridinium depressum* Bailey; 1, 2, 3, 6, & 8, ventral views, different aspects; 8 with sculpture; 4, 5 & 7, dorsal views; 4 with protoplast; 9 & 10; apical aspect with tabulation; 11, apical view; (1–8; original; 9, 10 & 11, after Peters, 1928); 1, 2 & 6, x 540; 3, 4, 7 & 8, x 230; 9, 10 & 11, x 320.

Fig. 12. *Peridinium brachypus* Schiller; ventral view; (original); x 230.

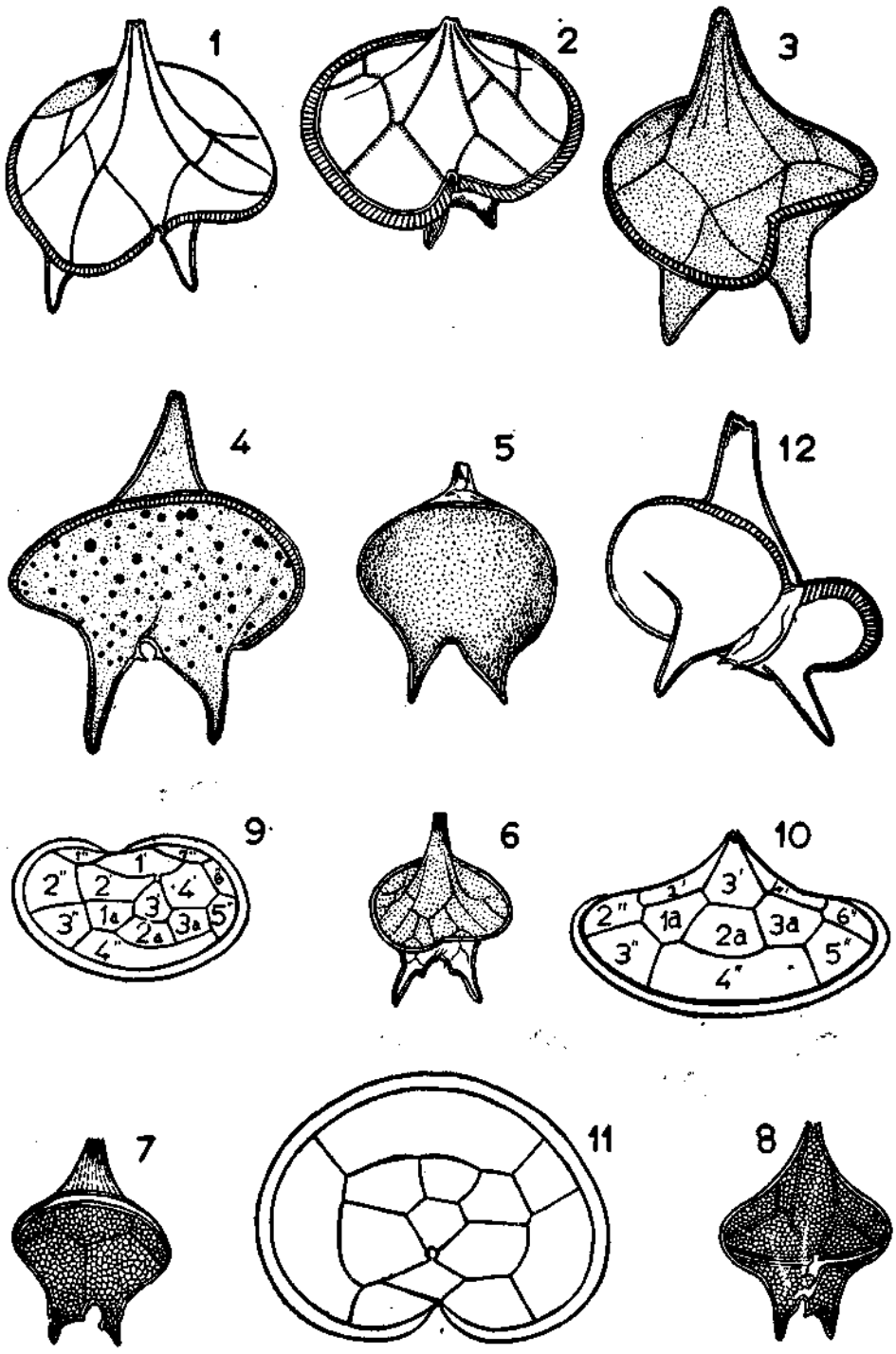

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PLATE LVII

Figs. 1–11. *Peridinium claudicans* Paulsen; 1, 2, 3, 5, 8, 10 & 11, ventral views of varying cells; 4, 6, 7 & 9, dorsal views; (1–4, original; 5, 7 & 8, after Paulsen in Schiller, 1937; 6 & 11, from Schiller, 1937; 9 & 10, after Dangeard, 1927 *c*; 1–4, x 840; 5, 7 & 8, x 375; 6 & 11, 610; 9 & 10, not known.

Figs. 12–15. *Peridinium oceanicum* Vanhöffen; 12, 13 & 15, ventral views; 14, dorsal view; (12, after Matzenauer, 1933; 16, after Paulsen, 1908; 14 & 15, after Lebour, 1925; 12, from Schiller, 1937—Schiller states that figure is after Matzenauer; but there is no such figure in Matzenauer); 13, x 390; rest not known.

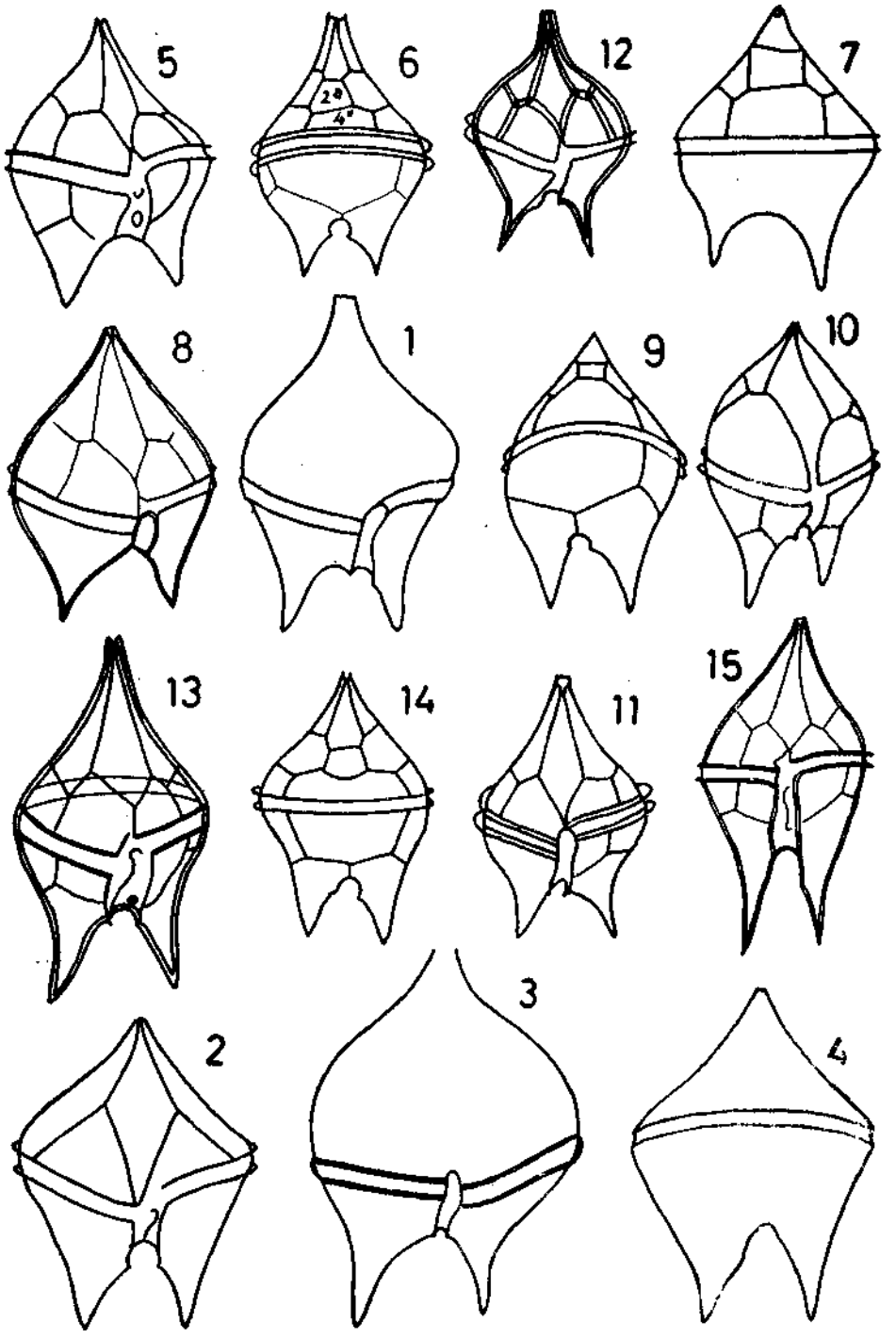

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PLATE LVIII

Figs. 1—5. *Peridinium murrayi* Kofoid ; all ventral views ; (1 & 2, original ; 3. after Pavillard in Schiller, 1937 ; 4, after Matzenauer, 1933; 5, after Kofoid in Schiller, 1937); 1 & 2 , x 340 ; 3, x 230; 4, x 245; 5, x 155.

Figs. 6—12. *Peridinium crassipes* Kofoid ; 6 & 9, dorsal views ; 7, 8 & 10, ventral views ; 11, antapical view ; 12, apical view ; (6, original; 7 after Kofoid in Schiller, 1937 ; 8, 11 & 12, after Peters, 1928 ; 9 & 10, after Schiller, 1937); 6, x 340; 7, x 370 ; 8, 11 & 12, x 465; 9 & 10, x 310.

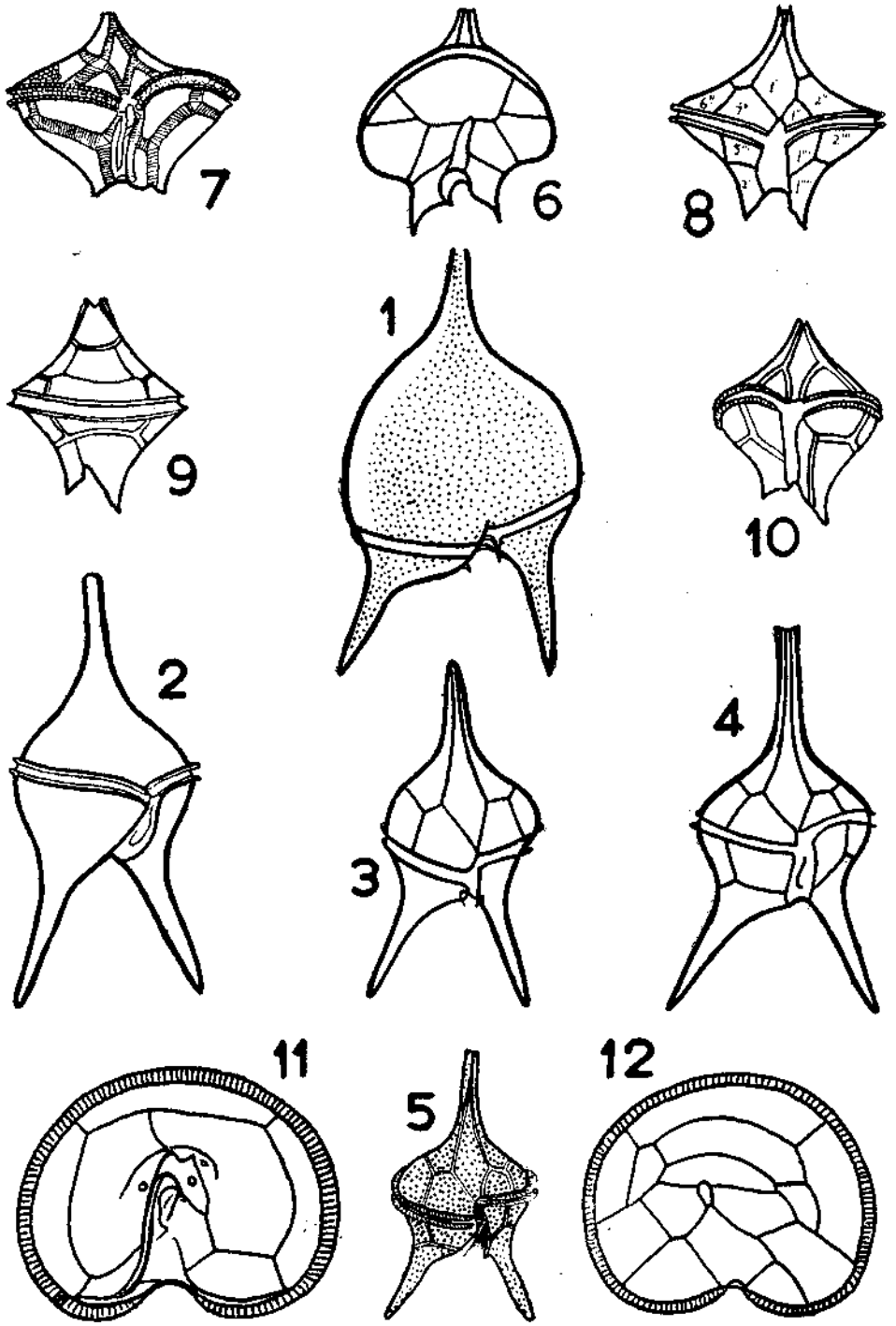

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PLATE LIX

Figs. 1 & 2. *Peridinium divergens* Ehrenberg ; ventral & dorsal views ; (after Stein in Schiller, 1937 ; magnification not known.

Figs. 3 & 4. *Peridinium elegans* Cleve ; 3, dorsal view ; 4, ventral view ; (original) ; both x 430.

Figs. 5 & 6. *Peridinium elegans* f. *granulata* (Karsten) Schiller ; ventral view ; (original) ; 430.

Figs. 7—10. *Peridinium fatulipes* Kofoid ; 7, 8 & 10, ventral views ; 9, dorsal view ; (7, 9, & 10, after Matzenauer, 1933 ; 8, after Kofoid in Schiller. 1937) ; 7, 9 & 10, x 220 ; 8, x 260.

Figs. 11 & 12. *Peridinium grande* Kofoid , 11, ventral view; 12. dorsal view ; (11, after Matzenauer, 1933; 12, after Kofoid in Schiller, 1937) ; x 260.

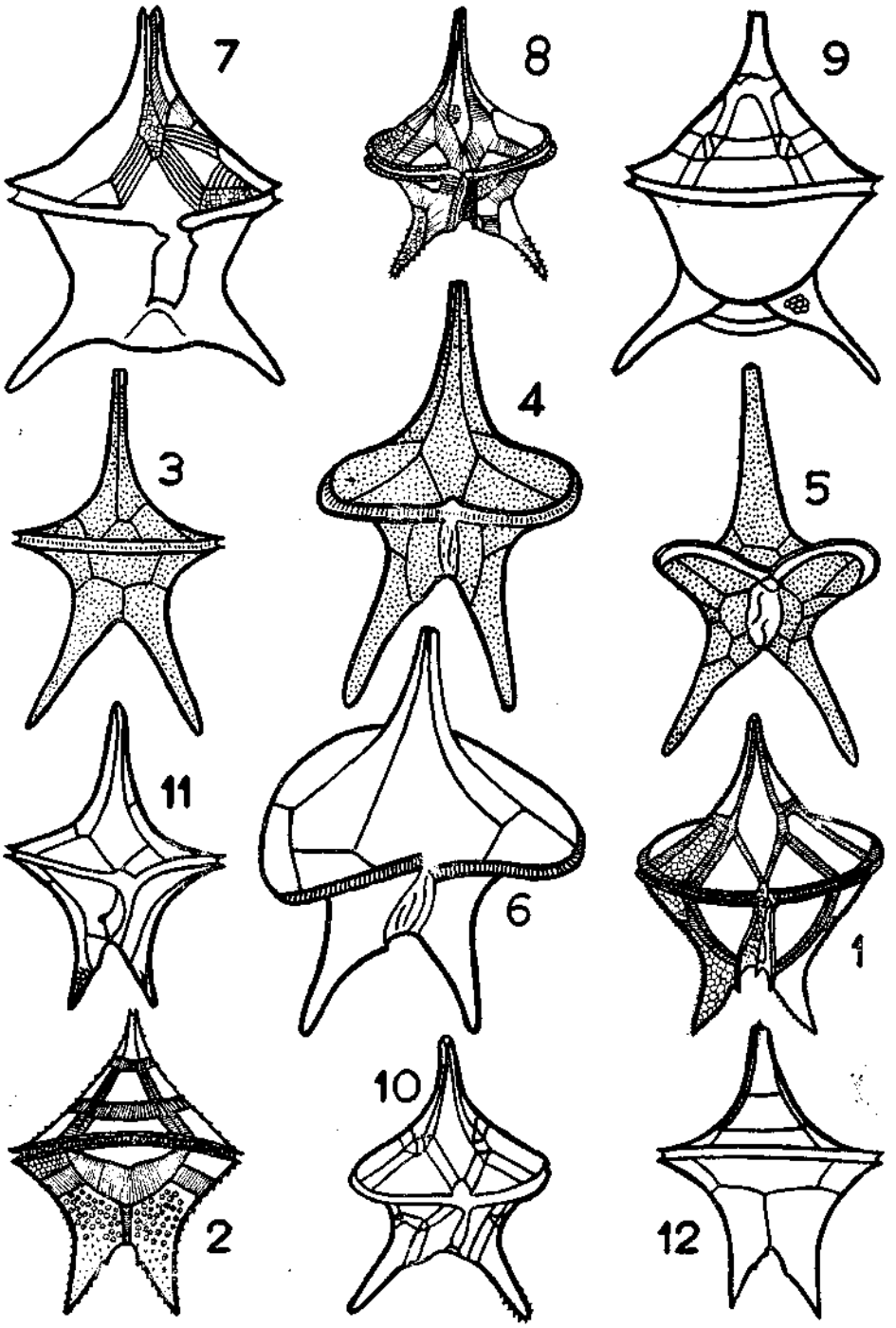

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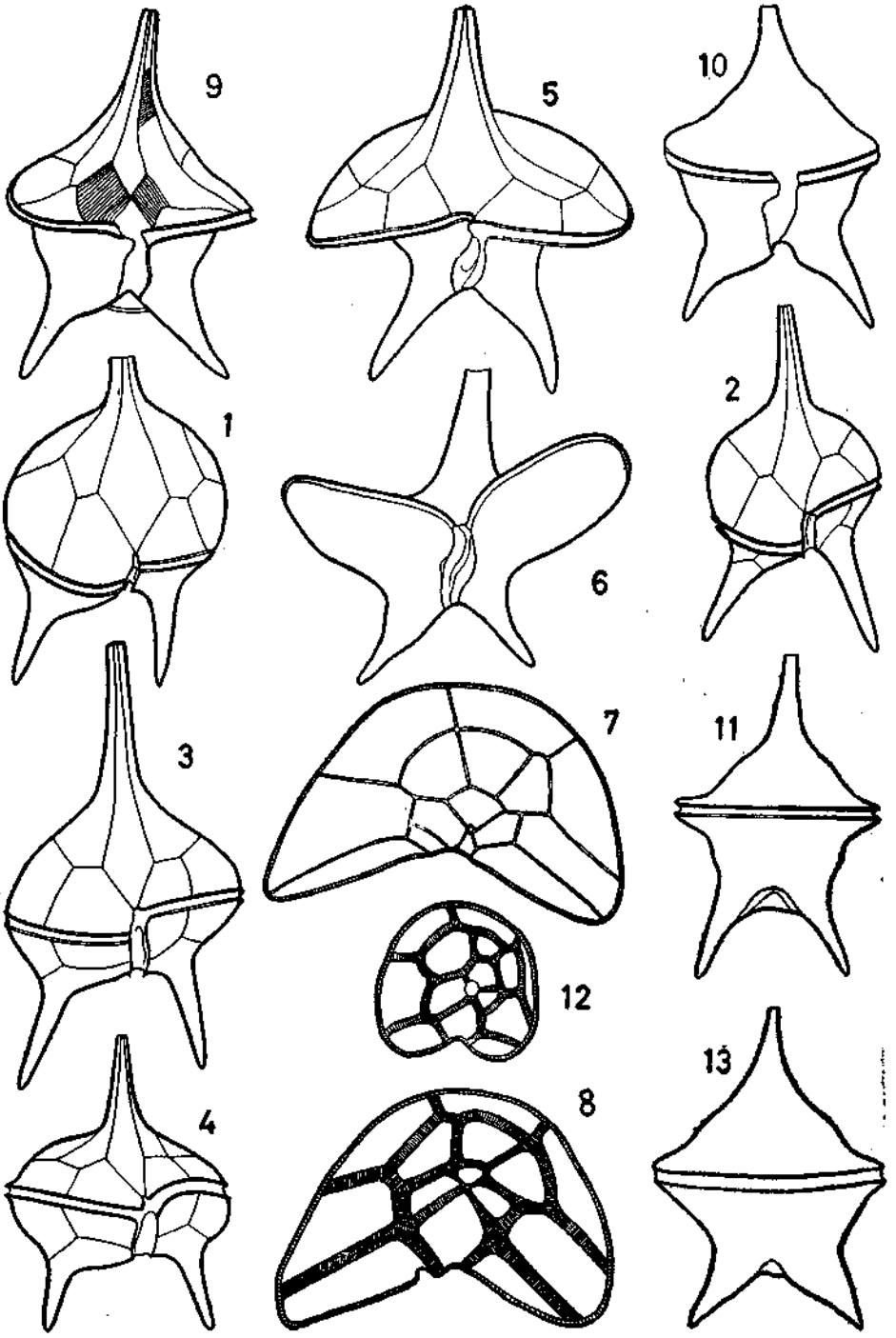
PLATE LX

Fig. 1. *Peridinium oceanicum* Vanhöffen ; ventral view ; (original) ; x 280.

Figs. 2—4. *Peridinium murrayi* Kofoid; ventral views ; (original) ; x 280.

Figs. 5—8. *Peridinium elegans* f. *granulata* (Karsten) Schiller ; 5 & 6, ventral views ; 7 & 8, apical views ; (original) ; x 280.

Figs. 9—13. *Peridinium fatulipes* Kofoid ; 9 & 10, ventral views ; 11 & 13, dorsal views ; 12, apical view ; (original) ; x 280.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXI

Figs. 1 – 3, *Peridinium oceanicum* Vanhöffen ; 1 & 3, dorsal views ; 2, ventral view ; (original) ; x 230.

Fig. 4. *Peridinium murrayi* Kofoid; ventral view ; (original) x 385.

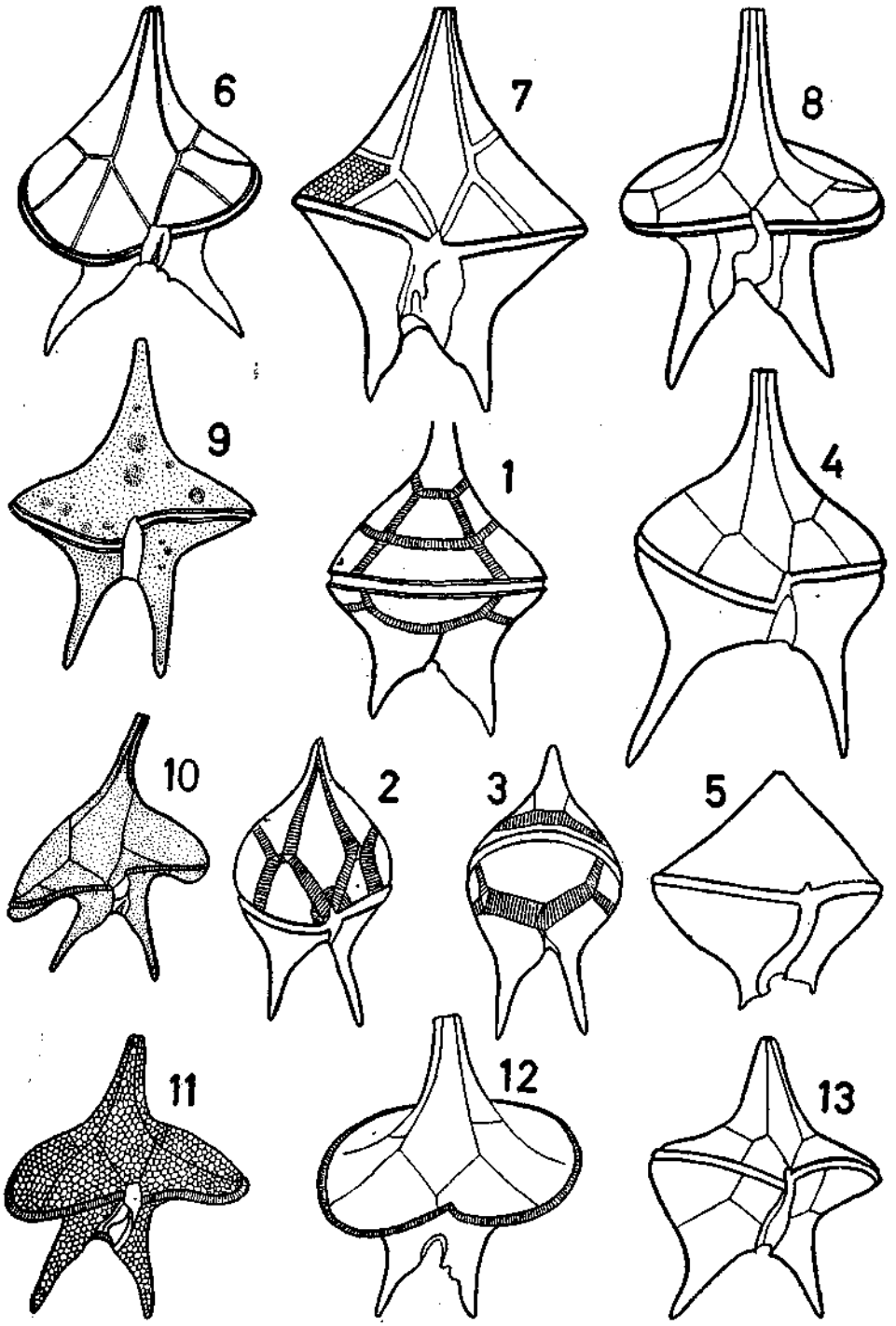
Fig. 5. *Peridinium crassipes* Kofoid; ventral view; (original) x 385.

Fig. 6. *Peridinium divergens* Ehrenberg ; ventral view ; (original) ; x 385.

Fig. 7. *Peridinium venustum* Matzenauer ; ventral view ; note sculpture , (original) , x 165.

Figs. 8 & 9. *Peridinium elegans* Cleve ; ventral view : 9, with contents ; (original) ; x 165.

Figs. 10—12. *Peridinium elegans* f. *granulata* (Karsten) Schiller ; 10 & 11, ventral views, 11 with sculpture ; 12, ventral view, oblique ; (original) ; all x 165.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

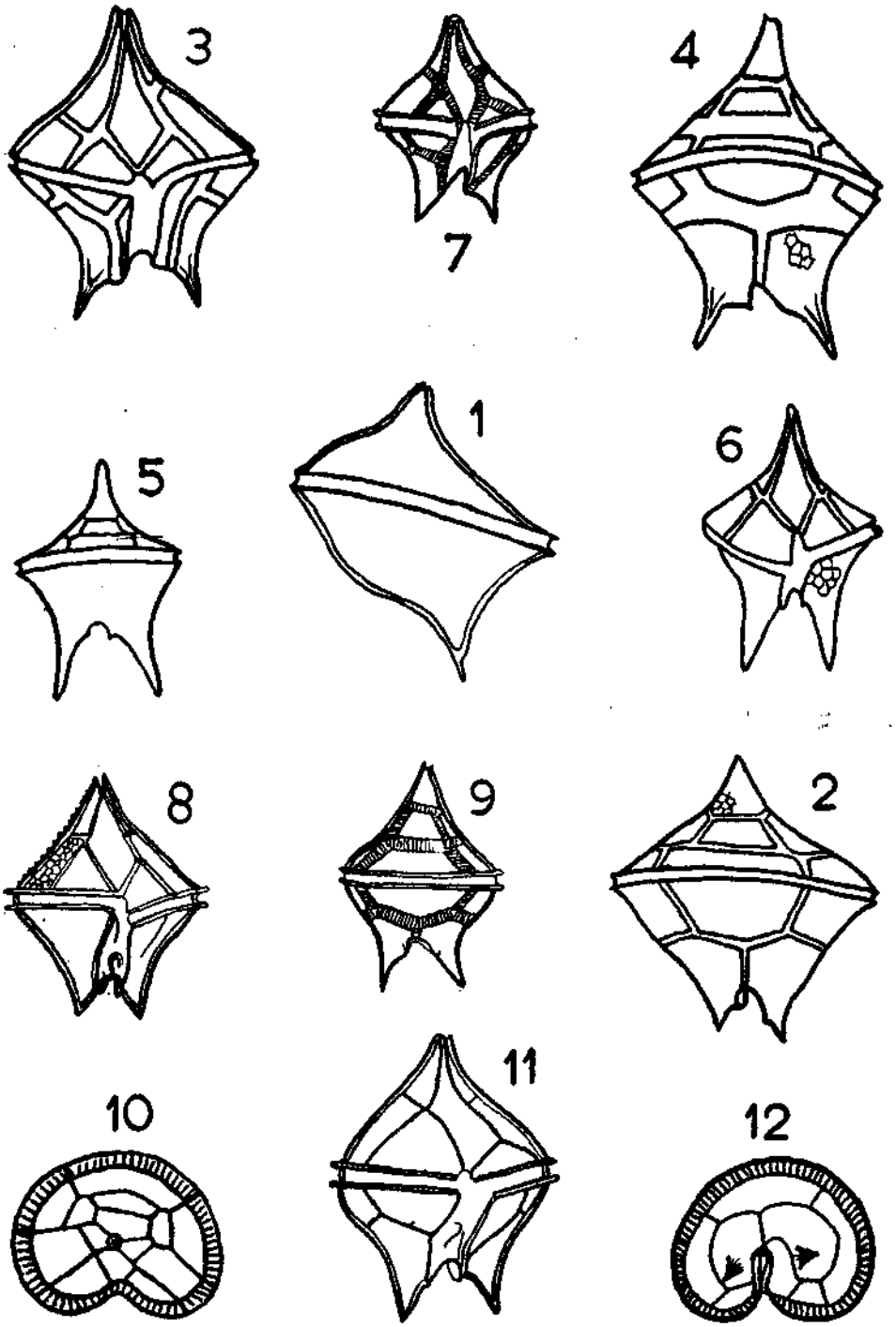
PLATE LXII

Figs. 1 & 2. *Peridinium amplum* Matzenauer ; lateral and dorsal views; respectively (after Matzenauer, 1933); magnification not known.

Figs. 3 & 4. *Peridinium remotum* Karsten; ventral & dorsal views respectively; (after Matzenauer, 1933) ; x 315.

Figs. 5 & 6. *Peridinium venustum* Matzenauer. 5, dorsal & 6, ventral views ; (after Matzenauer, 1933) ; magnification not known.

Figs. 7—12. *Peridinium brochii* Kofoid & Swezy; 7, 8 & 11, ventral views , 9, dorsal view ; 10, apical view ; 12, antapical view; (11 after Broch in Schiller, 1937; 7, 9, 10 & 12, after Schiller, 1937); 7, 9, 10 & 12, x 530; 8, not known; 10 & 12, x 580.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXIII

Fig. 1. *Peridinium grande* Kofoid ; ventral view with contents ; (original) ; x 240.

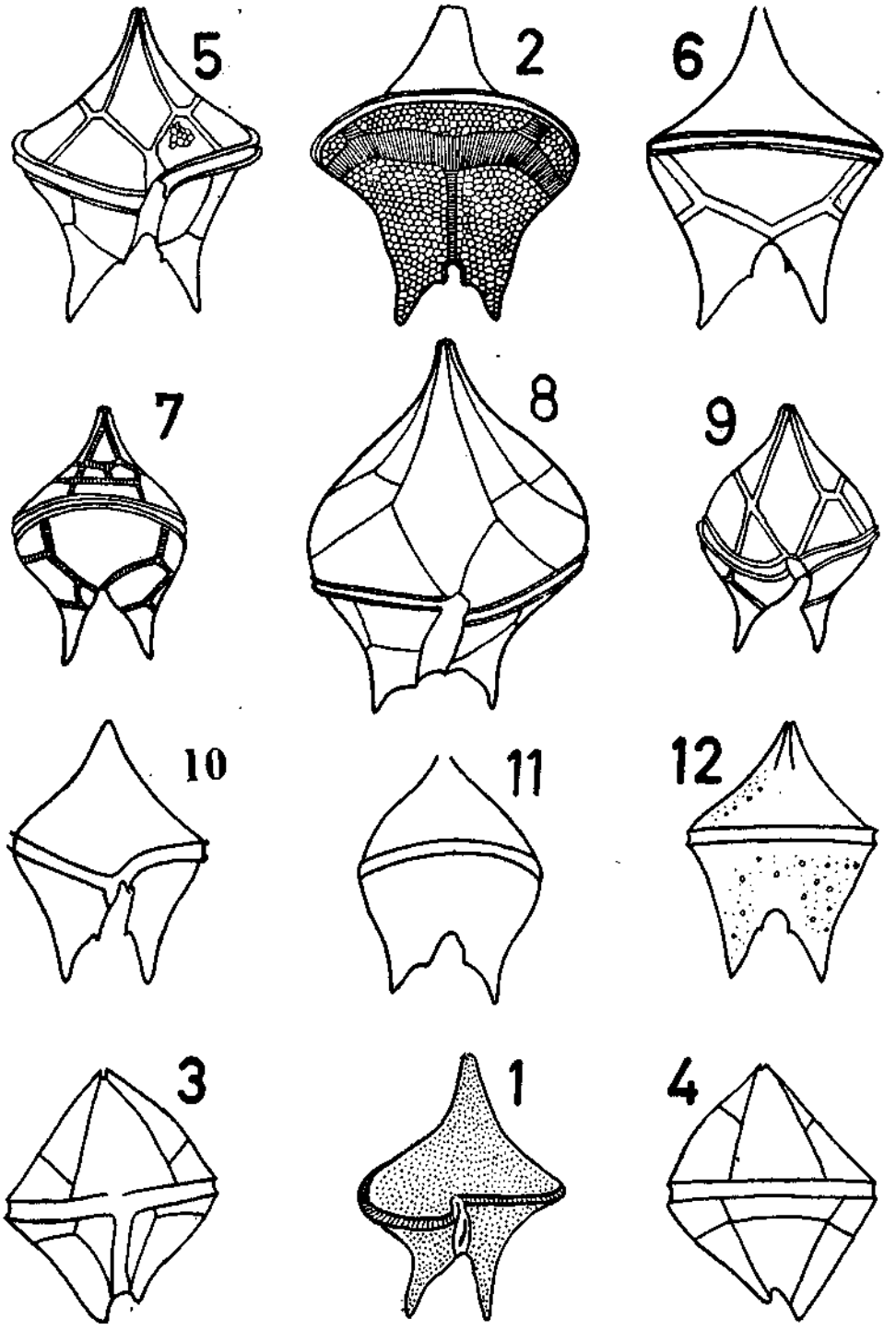
Fig. 2. *Peridinium remotum* Karsten ; dorsal view ; (original) ; note sculpture ; x 240.

Figs. 3 & 4. *Peridinium quadratum* Matzenauer ; ventral & dorsal views respectively ; (original) ; x 420.

Figs. 5 & 6. *Peridinium venustum* Matzenauer ; ventral & dorsal views ; (original) ; x 420.

Figs. 7, 10 & 12. *Peridinium brochii* Kofoid & Swezy ; 7 & 12, dorsal views ; 10, ventral view ; (original) ; x 420.

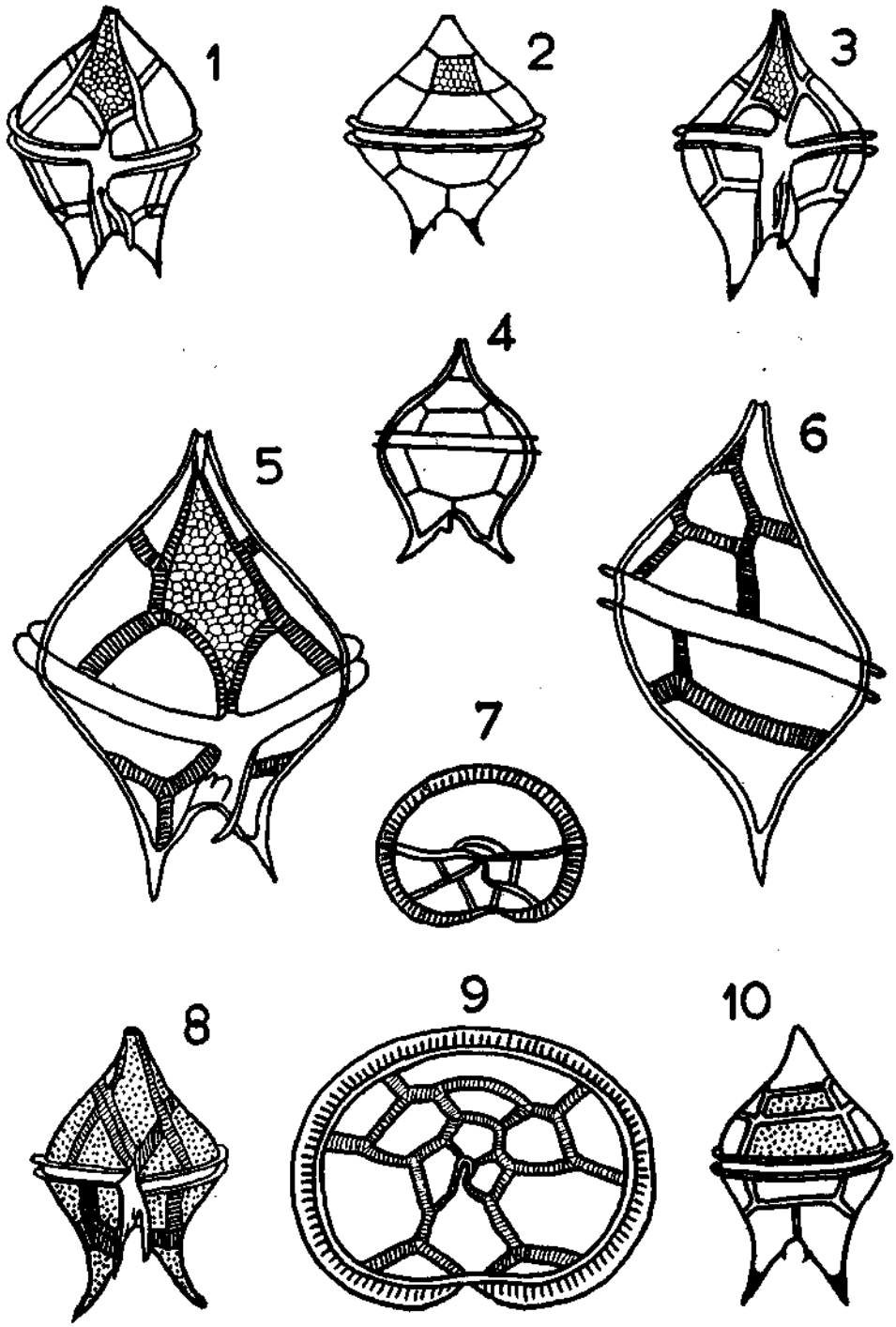
Figs. 8, 9 & 11. *Peridinium brochii* f. *inflatum* (Okamura) Schiller ; 8 & 9, ventral views ; 11. dorsal view ; (original) ; 8, x 550 ; 9 & 11, x 420.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXIV

Figs 1–10. *Peridinium solidicorne* Mangin; 1, 3, 5 & 8, ventral views ; 2, 4 & 10, dorsal views; 6, lateral view; 7 & 9, apical views ; (5, 6 & 9, after Peters, 1928 ; 1, 2, 3, 4, 7, 8 & 10, after Schiller, 1937) ; 1, 2, 3, 7, 8 & 10, x 530 ; 5, 6 & 9, x 600 ; 4, x 315.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann

PLATE LXV

Fig. 1. *Peridinium retiferum* Matzenauer ; ventral view ; (after Matzenauer, 1933) ; x 315.

Figs. 2 & 3 *Peridinium somma* Matzenauer ; ventral & dorsal views, both somewhat oblique ; (after Matzenauer, 1933) ; x 315.

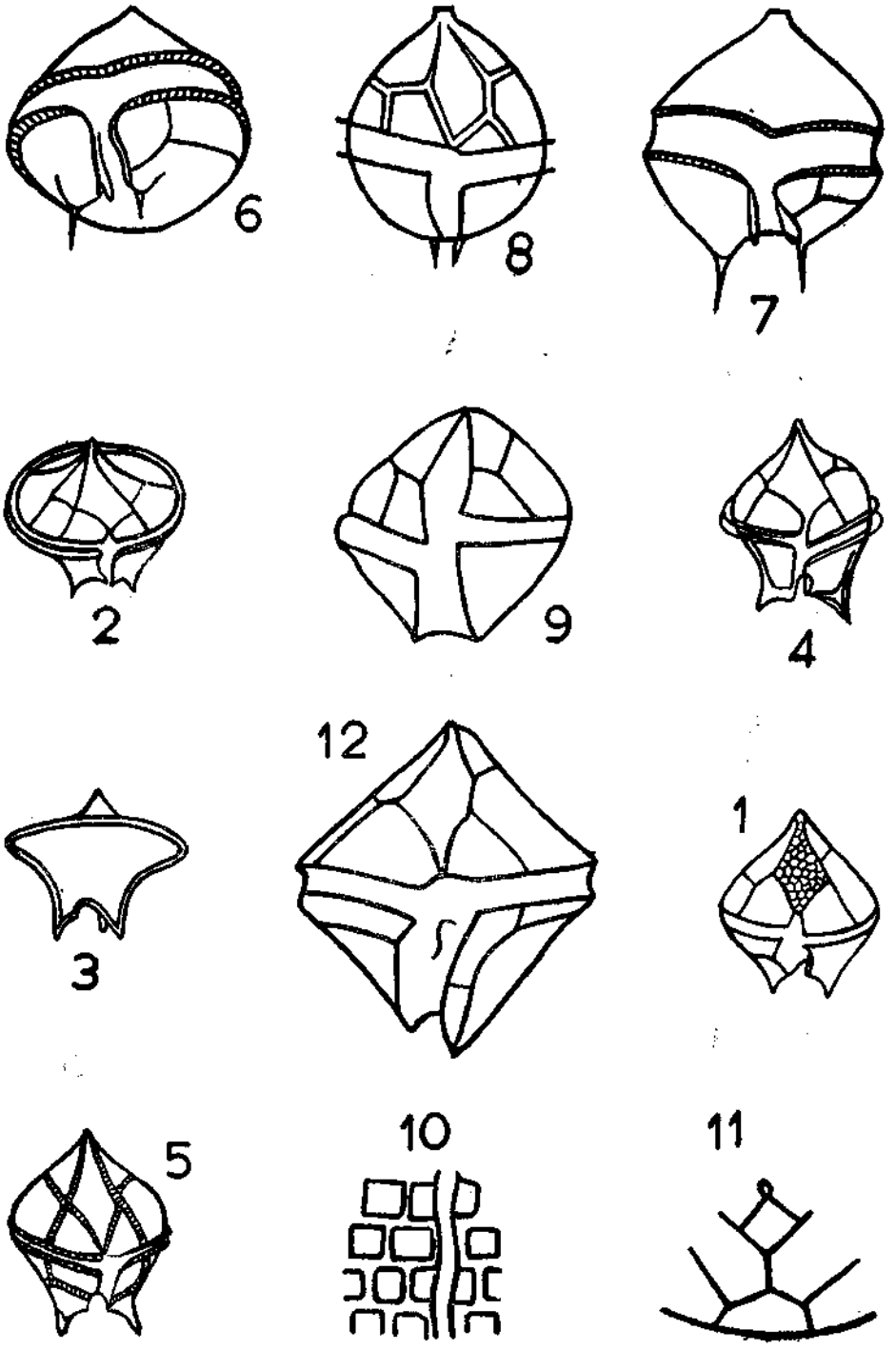
Figs. 4 & 5. *Peridinium solidicorne* Mangin ; ventral views; (4, after Matzenauer, 1933 ; 5, after Mangin, 1922) ; 4, x 315 ; 5, not known,

Figs. 6 & 7. *Peridinium bimucronatum* Schiller ; ventral views ; (after Schiller, 1937) ; magnification not known.

Figs. 8. *Peridinium orientale* Matzenauer ; ventral view ; (after Matzenauer, 1933) ; x 1000.

Figs. 9–11. *Peridininum pictschmanni* Böhm ; 9, ventral view ; (after Böhm in Schiller, 1937) ; 10 & 11, plates ; magnification not known.

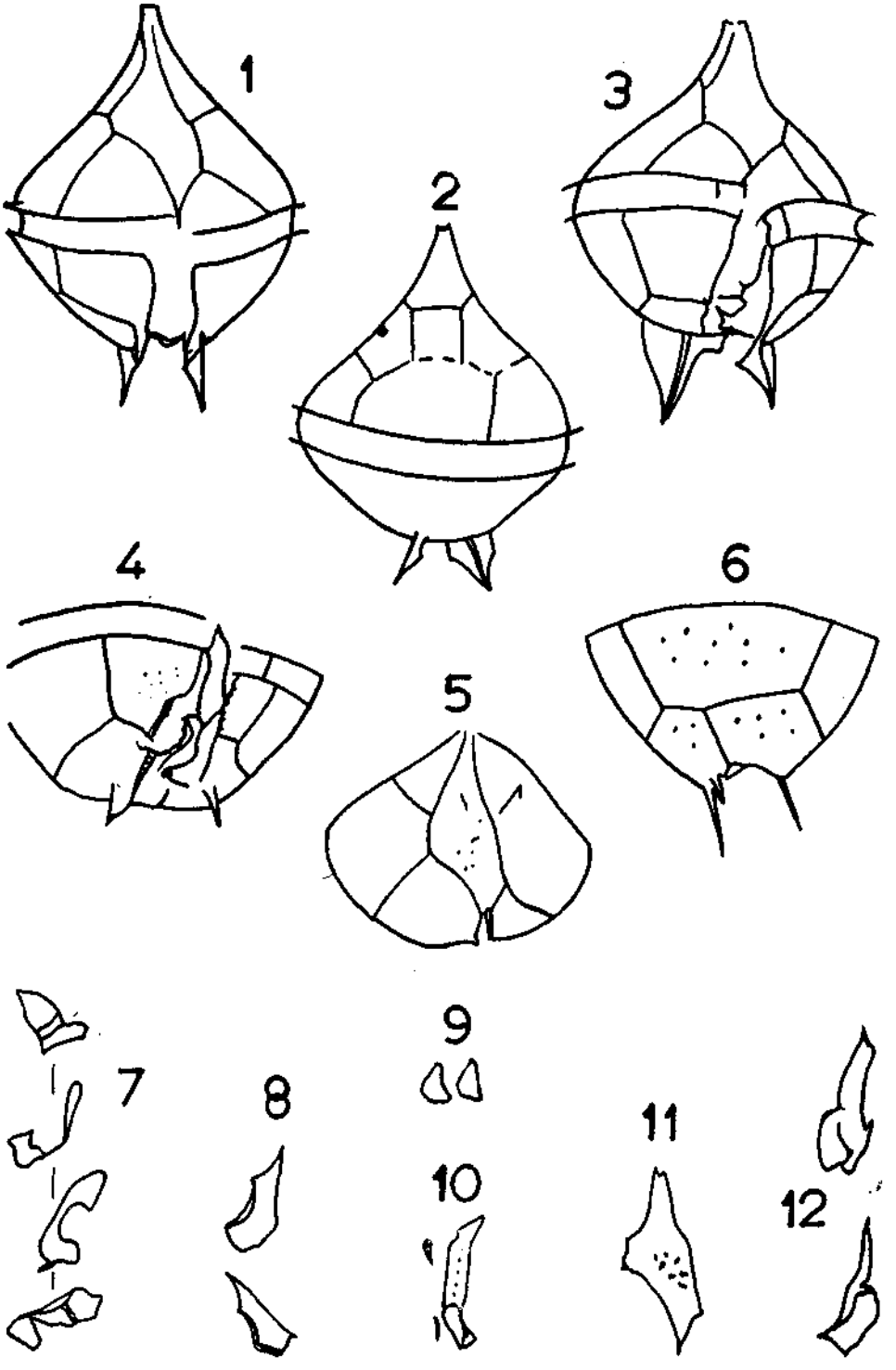
Figs. 12, *Peridinium quadratum* Matzenauer ; ventral view ; (after Matzenauer, 1933) ; magnification not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXVI

Figs. 1—12. *Peridinium adeliense* Balech; 1 - 3, ventral views 2, dorsal view. 4, hypotheca ventral; 5, epitheca ventral view; 6, hypotheca dorsal; 7, *S.p.*, 8, *S.i.* 9-*T*, 10-*S.a.*; 11, 1′; 12, *S.d.* (after Balech, 1958 *b*); magnification not known.



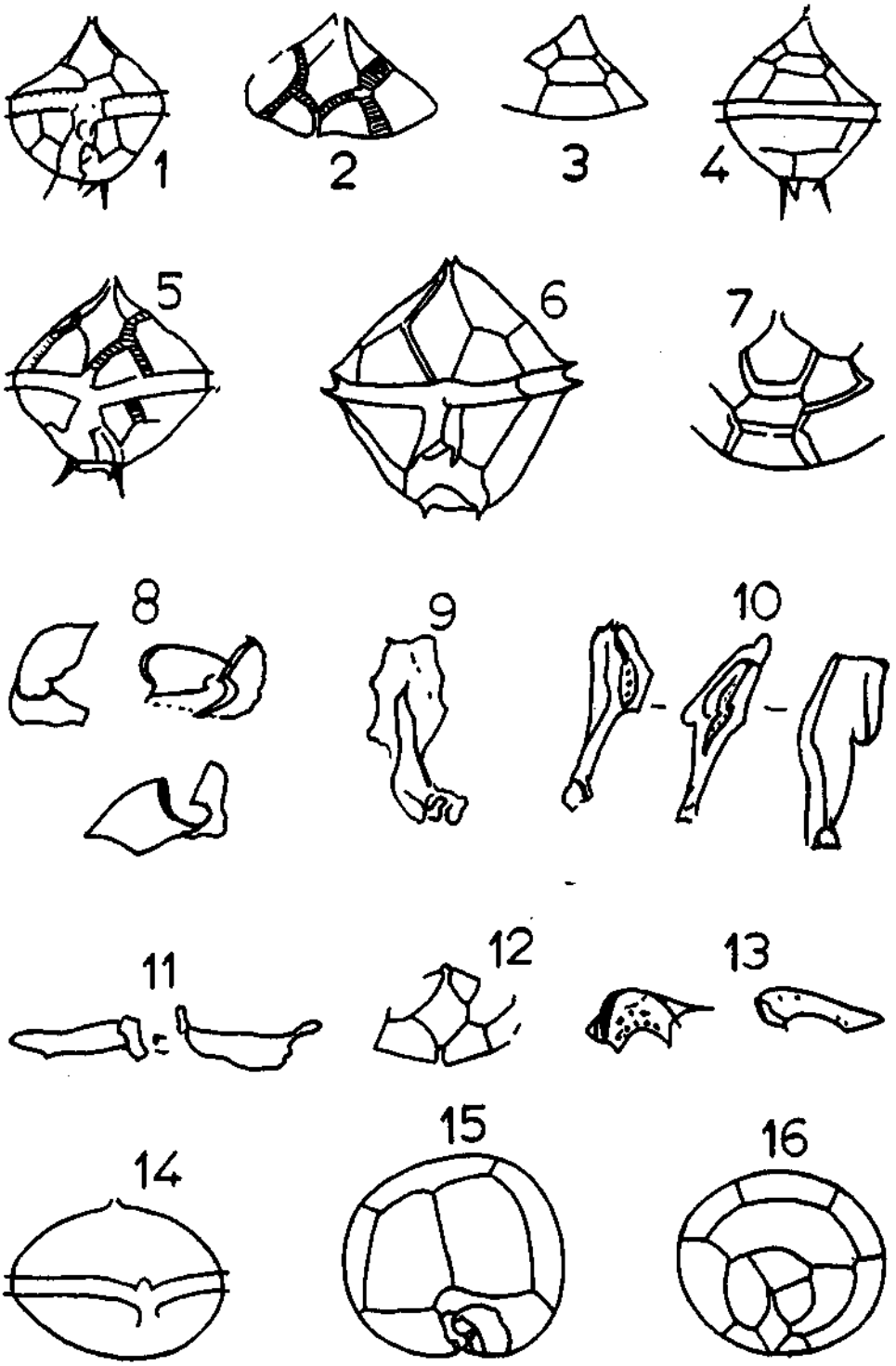
R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann,

PLATE LXVII

Figs. 1–5, 8-11 & 13. *Peridinium affline* Balech ; 1 & 5, ventral views ; 2, epitheca ventral ; 3, epitheca dorsal ; 4, dorsal view , 8, *S.p.*; 9 - 11. *S.a.*; 10. *S.d.* 13, *S.i* ; (after Balech, 1958 *b*) ; magnification not known.

Figs. 12, 14–16, *Peridinium archiovatum*, Balech. 12, epitheca ventral; 14, ventral view; 15, antapical view ; 16, apical view ; (after Balech, 1958 *a*) ; magnification not known.

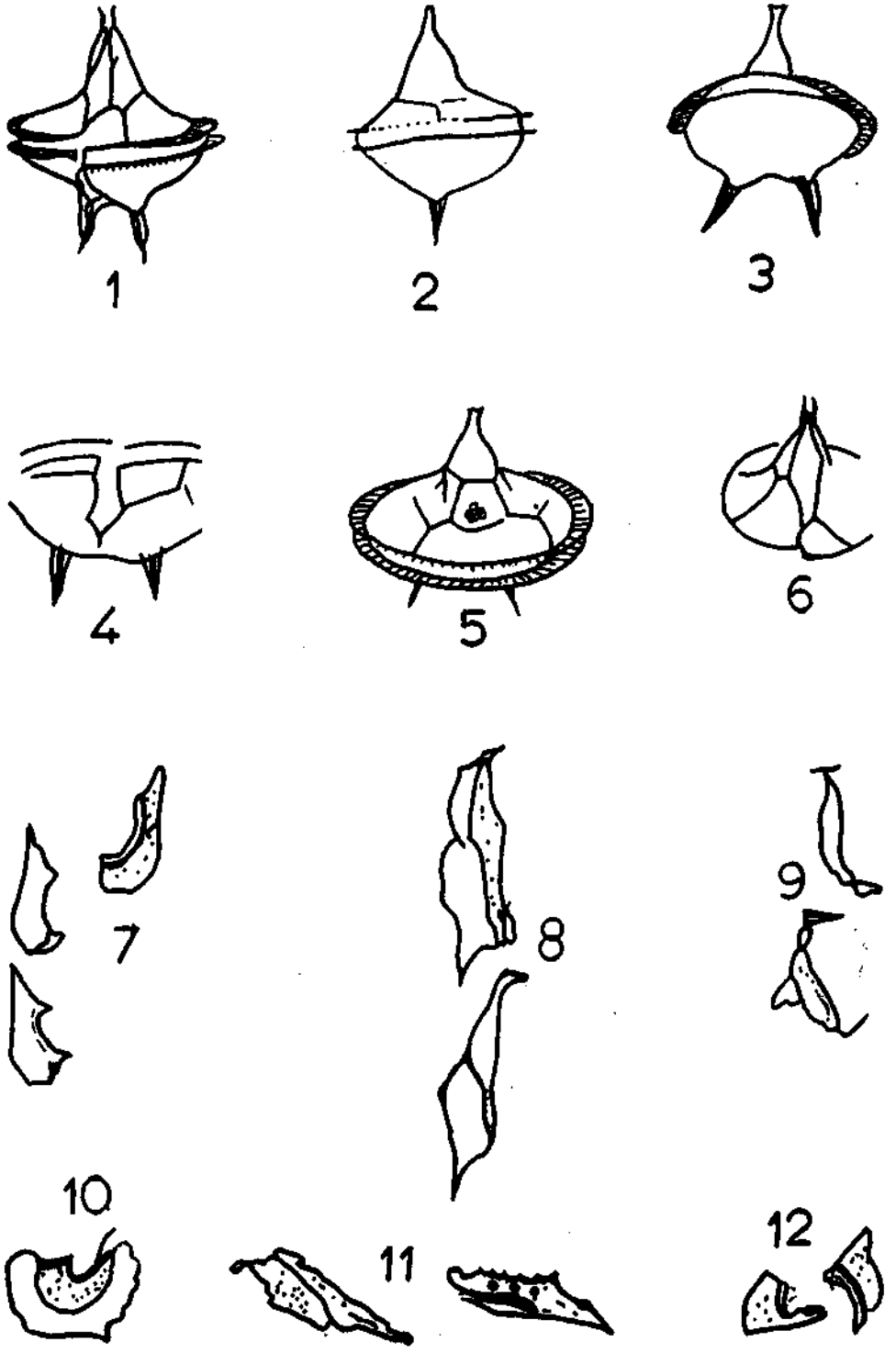
Figs. 6, 7. *Peridinium parvicollum* Balech ; 6, ventral view; 7, epitheca dorsal ; (after Balech, 1958 *a*) ; x 490.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

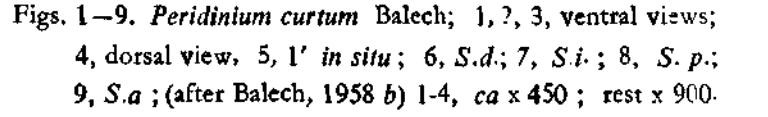
PLATE LXVIII

Figs. 1–12. *Peridinium charcoti* Balech; 1, ventral view; 2, lateral view; 3, dorsal view; 4, hypotheca ventral; 5, epitheca dorsal; 6, epitheca ventral; 7, *S.i.*; 8 & 11, *S. d*; 9, *S.a.*; 10, *S.p.* with suture membrane very well developed; 12, *S. p.*; (after Balech, 1958 *b*); 1 - 6, *ca* x 450; 7–12 x 900.

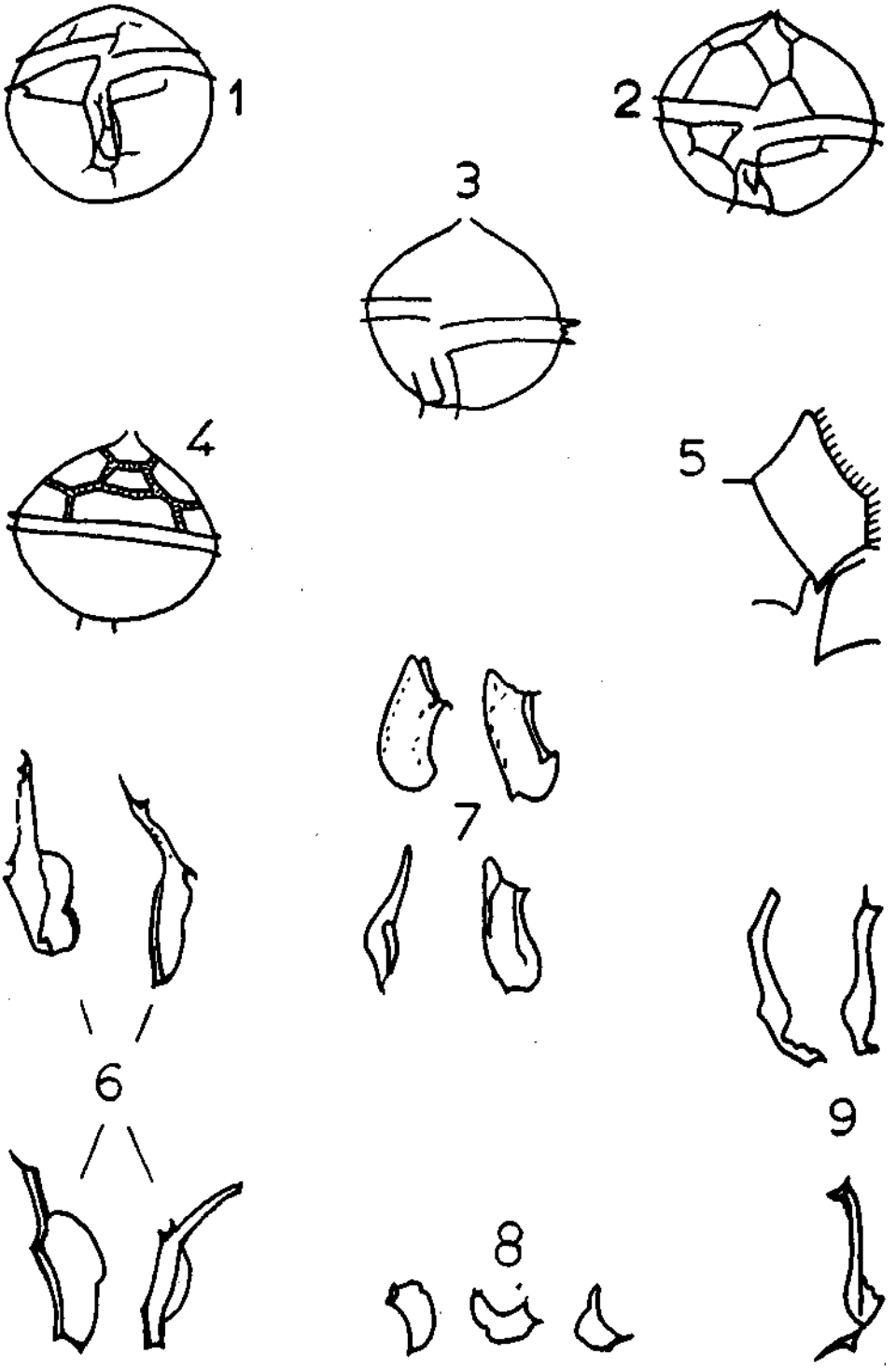


R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXIX



Figs. 1—9. *Peridinium curtum* Balech; 1, ?, 3, ventral views; 4, dorsal view, 5, 1′ *in situ*; 6, *S.d.*; 7, *S.i.*; 8, *S. p.*; 9, *S.a*; (after Balech, 1958 *b*) 1-4, *ca* x 450; rest x 900.

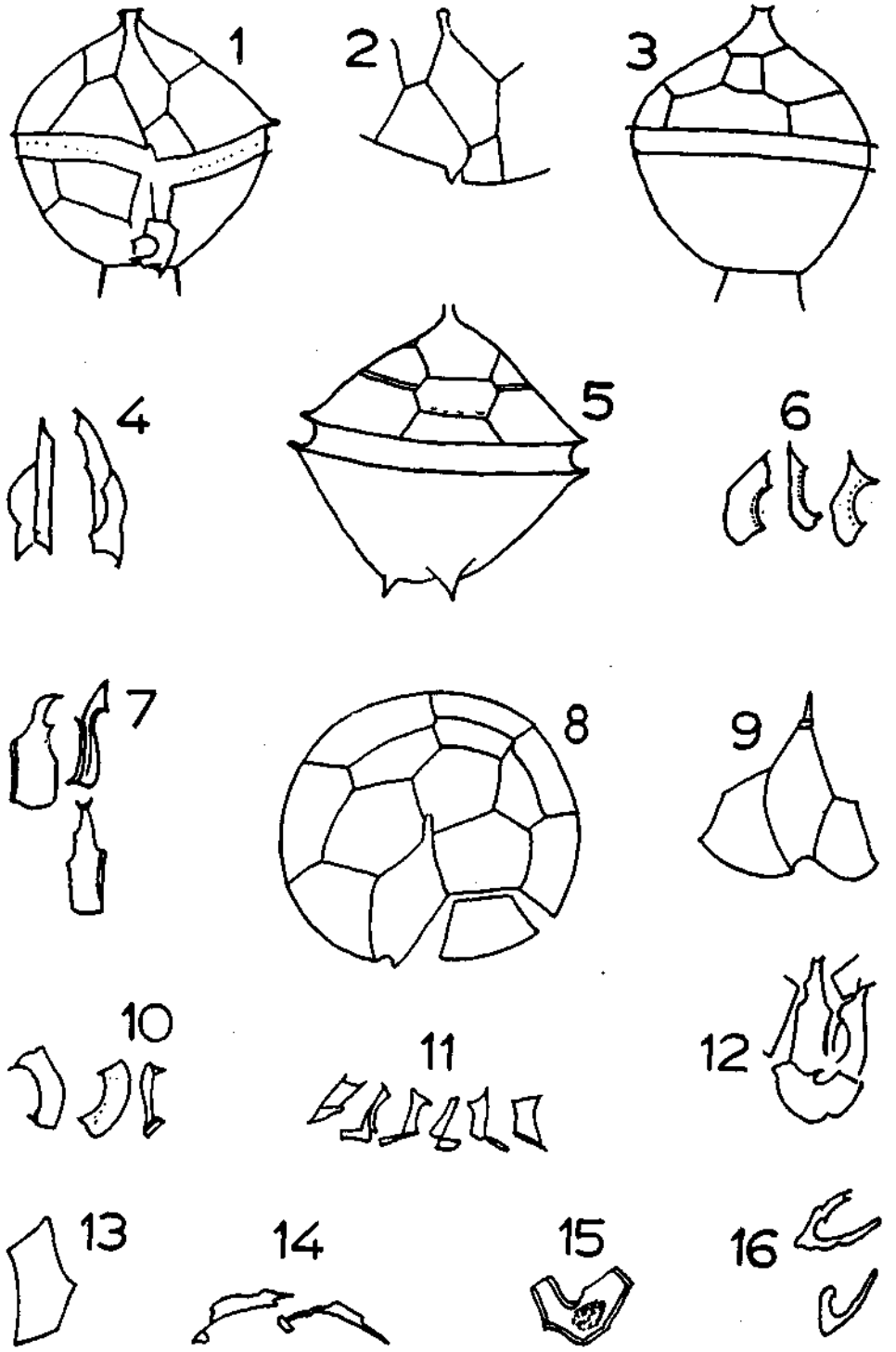


R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXX

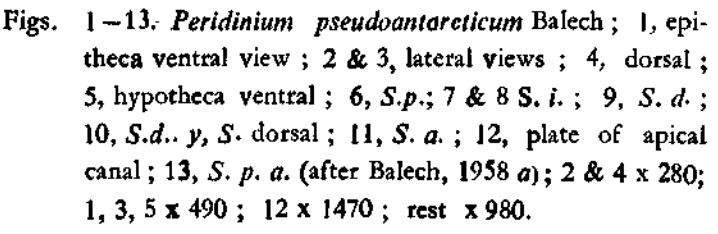
Figs. 1 – 4, 6, 13, 14, 16 - *Peridinium mediocre* Balech ; 1, ventral view ; 2, vental epithecal plate. 3,dorsal view; 4, *S.p.* 6, *S.i.*; 13, 1′; 14, *S.e.* ; 16, *S.p.* ; (after Balech 1958 *b*) ; all x 900.

Figs. 5, 7 - 12, 15 *P. parvicollum* Balech ; 5, dorsal view ; 7, *S.d*; 8, apical view ; 9, 1, 1″ and 7″ ; 10, *S.i* ; 11, *S.d.* ; 12, sulcals ; 15, *S.p.*; (after Balech 1958 *a*) ; magnification not known.

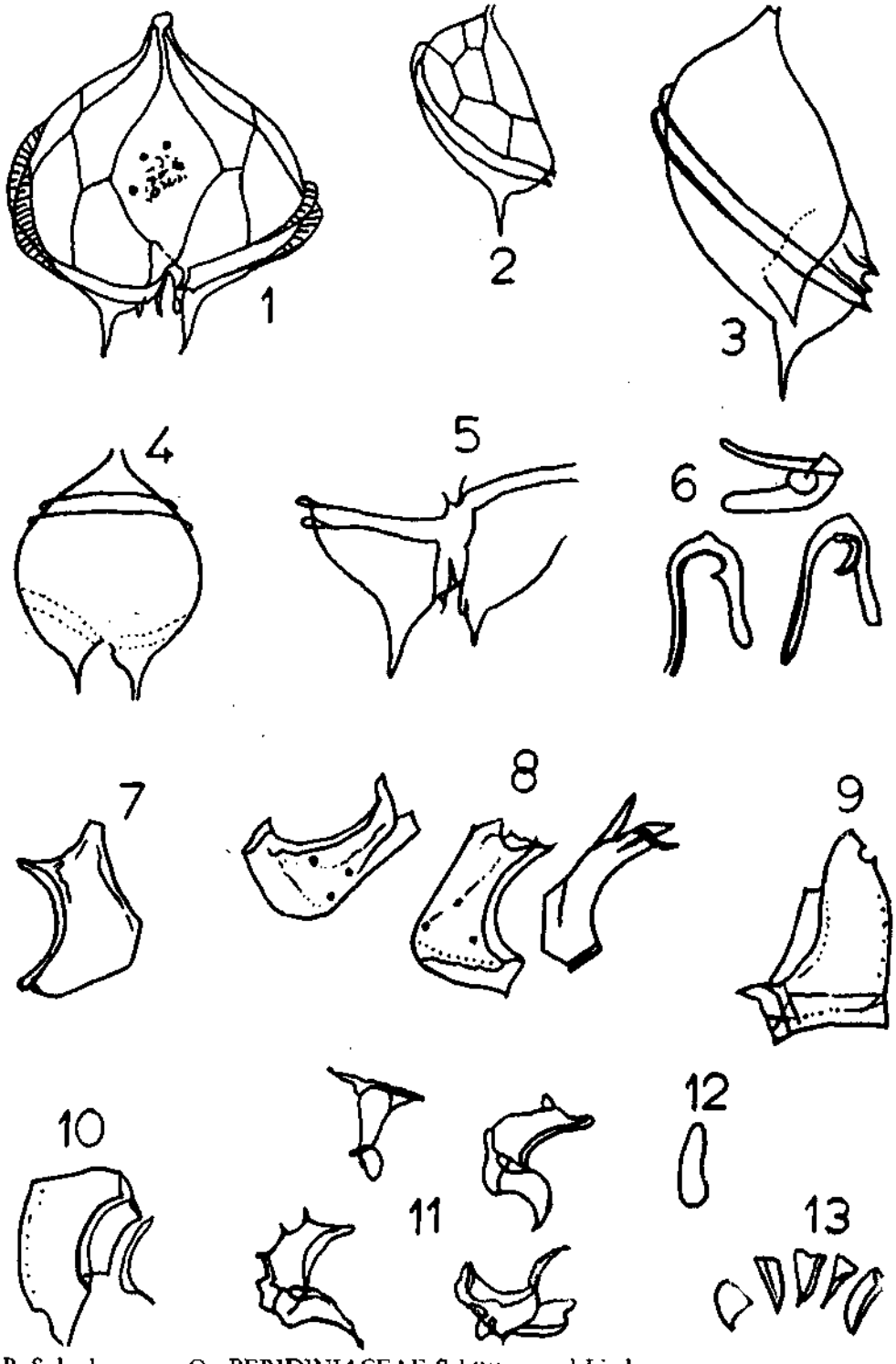


R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXI



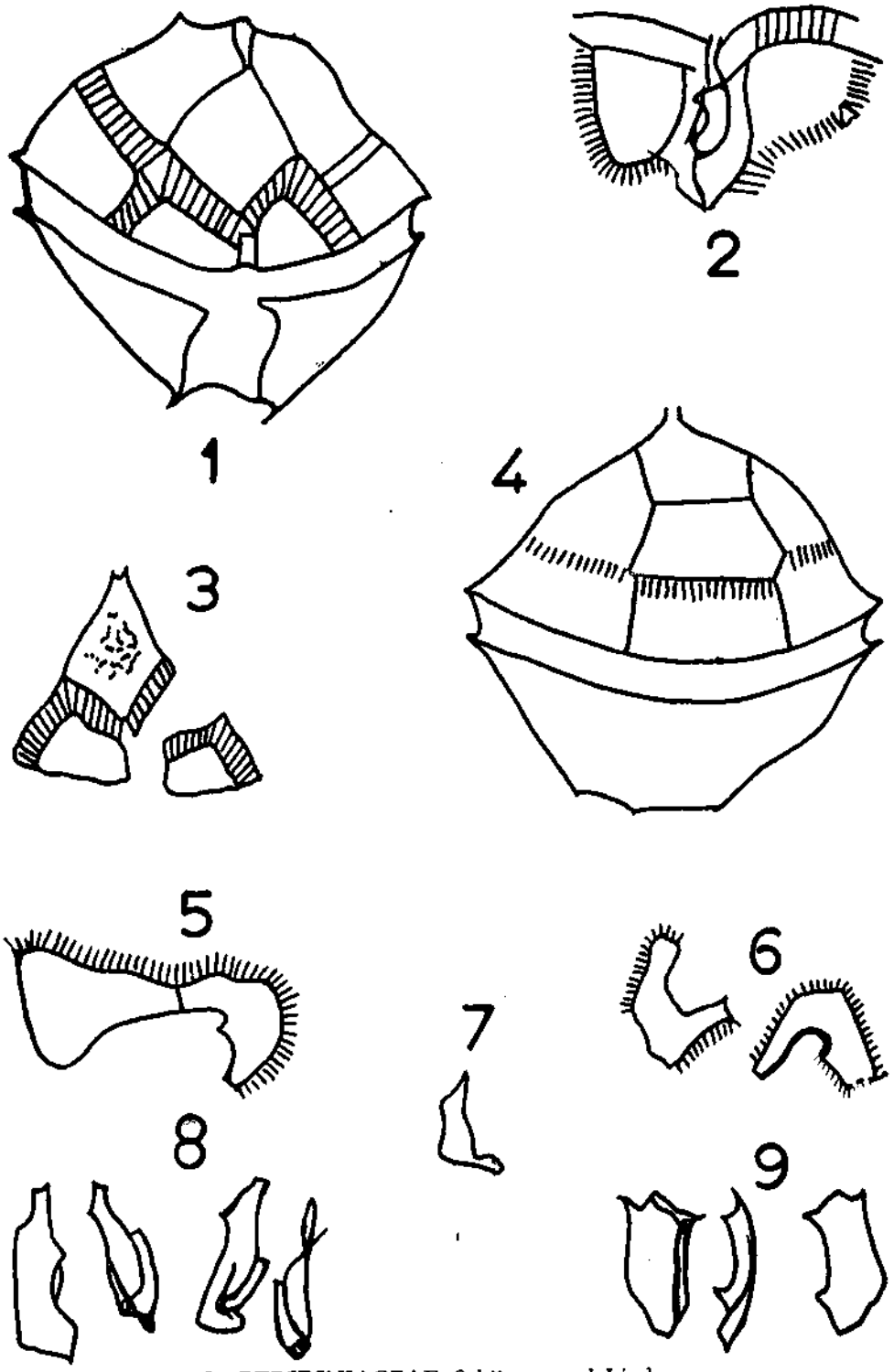
Figs. 1–13. *Peridinium pseudoantareticum* Balech ; 1, epitheca ventral view ; 2 & 3, lateral views ; 4, dorsal ; 5, hypotheca ventral ; 6, *S.p.*; 7 & 8 *S. i.* ; 9, *S. d.* ; 10, *S.d.. y, S.* dorsal ; 11, *S. a.* ; 12, plate of apical canal ; 13, *S. p. a.* (after Balech, 1958 *a*) ; 2 & 4 x 280; 1, 3, 5 x 490 ; 12 x 1470 ; rest x 980.



R Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXII

Figs. 1—9. *Peridinium rosaceum* Balech ; 1, ventral view. 2, sulcal region and limiting plates 3, 1′, 1″ and 7″ ; 4, dorsal view ; 5, 1‴ and *S. p.* ; 6, *S. p.* ; 8, *S. d.* ; 7 & 9, *S. i.* (after Balech 1958 *b*) all *ca* x 980.



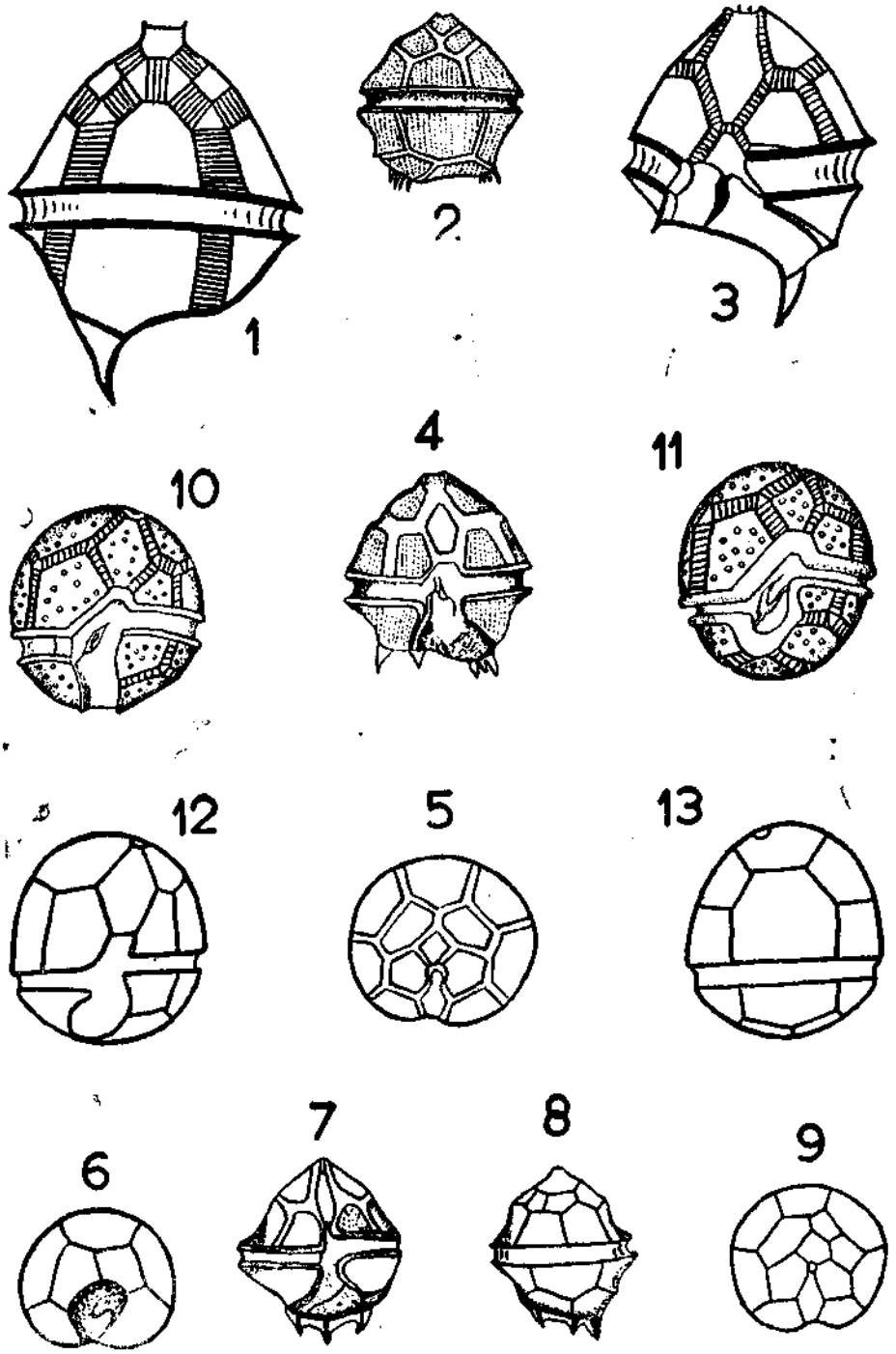
R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXIII

Figs 1—5. *Peridinium africanum* Lemmermann ; 1 & 2, dorsal views ; 3 & 4, ventral views ; 5, apical view ; (1 & 3, after Woloszynska in Schiller, 1937 ; 2, 4 & 5, after Lefèvre in Schiller, 1937) ; magnification not known.

Figs. 6—9. *Peridinium baliense* Lindemann ; 6, antapical view ; 7, ventral view ; 8, dorsal view : 9, apical view; (after Lindemann from Lefèvre in Schiller, 1937) ; magnification not known.

Figs. 10—13, *Peridinium centenniale* (Playfair) Lefèvre ; 10, 11 & 12, ventral views ; 13, dorsal view ; (10 & 11 after Lefèvre in Schiller; 12 & 13, after Playfair in Schiller, 1937); magnification not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXIV

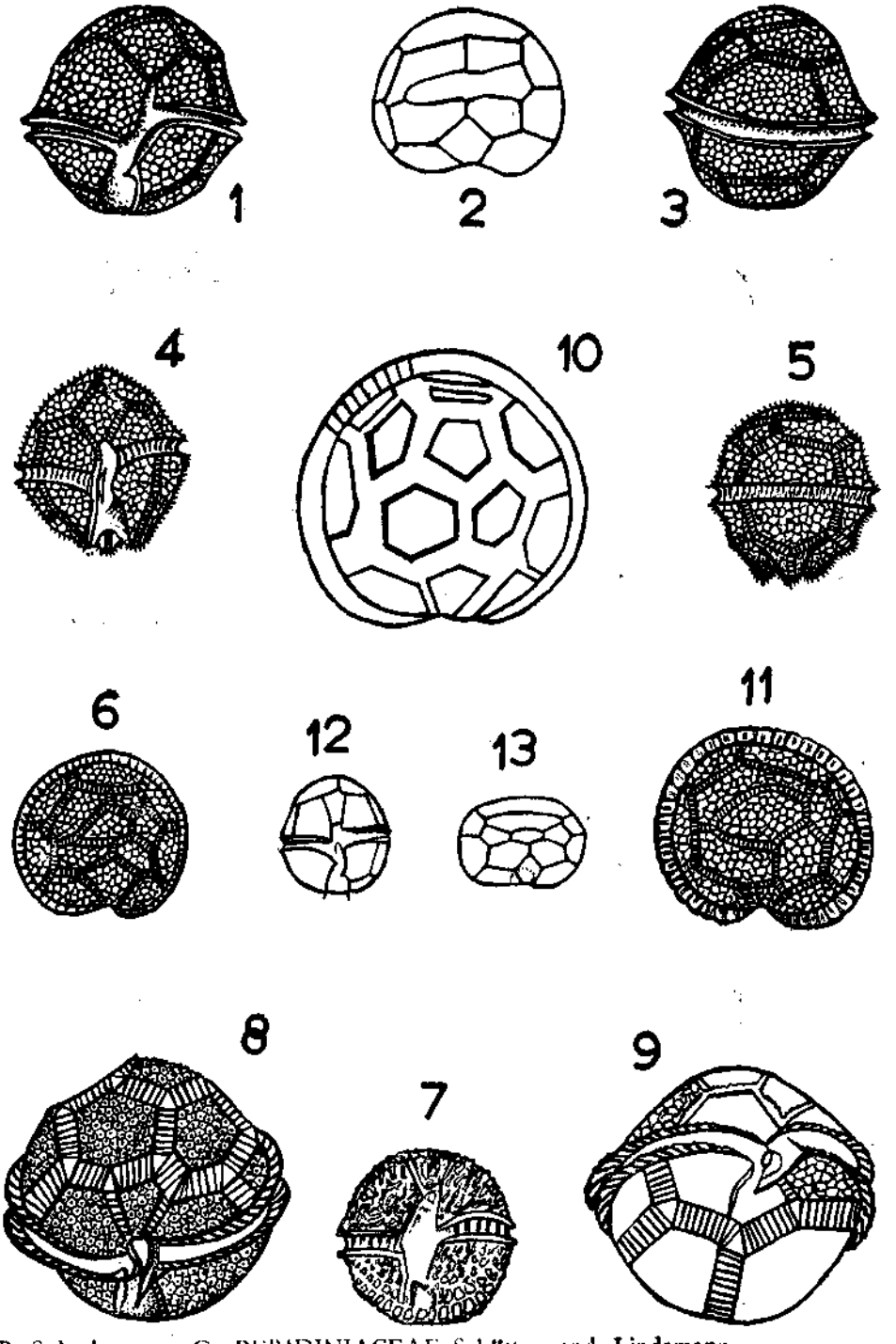
Figs. 1–3. *Peridinium cinctum* (O. F. Müller) Ehrenberg; 1, ventral view ; 2, apical view ; 3, dorsal view ; (after Lefèvre in Schiller, 1937) ; magnification not known.

Figs. 4–6. *Peridinium cinctum* f. *tuberosum* (Meunier) Lindemann ; 4, ventral view ; 5, dorsal view ; 6, apical view ; (after Meunier in Schiller, 1937) ; all x 500.

Fig. 7. *Peridinium cinctum* f. *westii* (Lemmermann) Lefèvre ; ventral view ; (after Lindemann in Schiller, 1937) ; magnification not known.

Figs. 8–11. *Peridinium gatunense* Nygaard ; 8 & 9, ventral oblique views ; 10 & 11, apical views, sculpture shown in 11 ; (8–10, after Schiller, 1937 ; 11 after Lefèvre in Schiller, 1937) ; 8–10, x 530 ; 11, not known.

Figs. 12 & 13 *Peridinium volzii* var. *botanicum* (Playfair) Lindemann ; 12, ventral view ; 13, apical view ; (after Playfair in Schiller, 1937) ; magnification not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

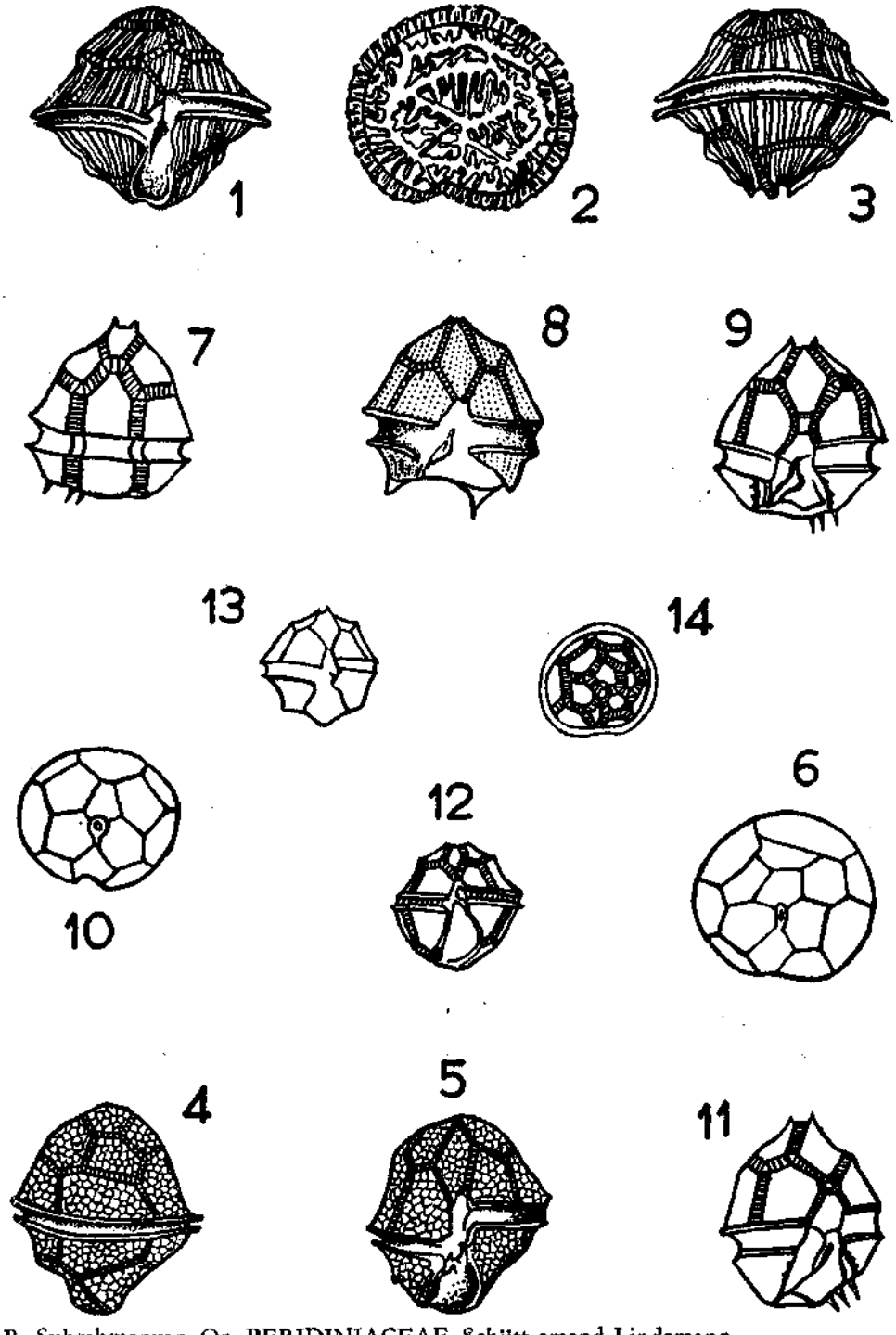
PLATE LXXV

Figs. 1—3. *Peridinium madagascarensis* (Lefèvre) Subrahmanyan, n. nov.; 1, ventral view; 2, apical view; 3. dorsal view; (after Lefèvre in Schiller, 1937; magnification not known.

Figs. 4—6. *Peridinium gutwinskii* Woloszynska; 4, dorsal view; 5, ventral view; 6, apical view; (4 & 6, after Lefèvre in Schiller, 1937; 5, after Woloszynska in Schilier, 1937); magnification not known.

Figs. 7—11. *Peridinium inconspicuum* Lemmermann; 7, dorsal view; 8, 9 & 11, ventral view; 10, apical view; (7, 9, 10 & 11, after Woloszynska in Schiller, 1937; 8, after Lefèvre in Schiller); magnification not known.

Figs. 12—14. *Peridinium keyense* Nygaard; 12 & 13, ventral views; 14, apical view; (after Nygaard in Schiller, 1937); magnification not known.



R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXVI

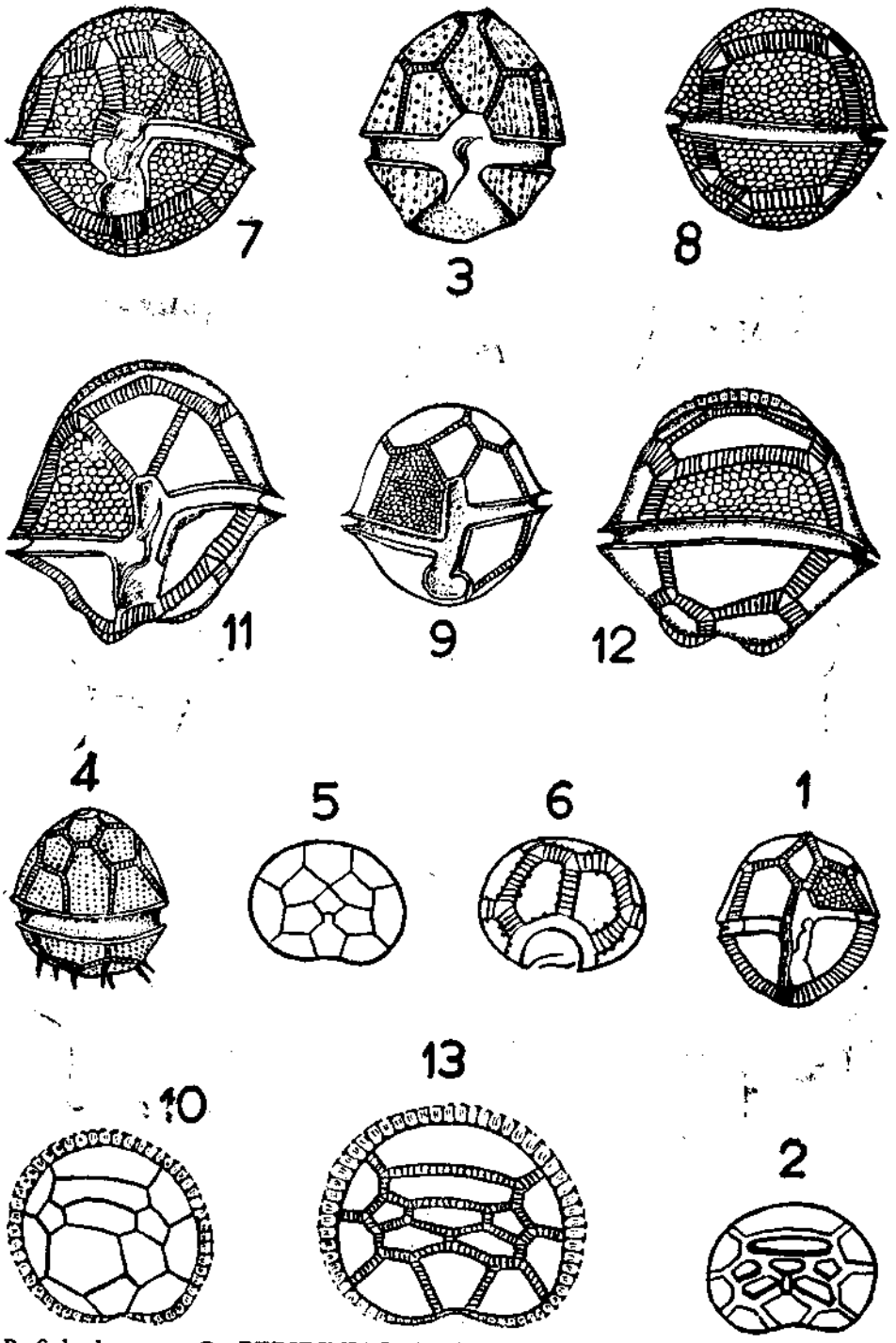
Figs. 1 & 2. *Peridinium playfairi* Lindemann et Lefèvre ; 1, ventral view ; 2, apical view ; (after Lindemann et Lefèvre in Schiller, 1937) ; magnification not known.

Figs. 3—6. *Peridinium umbonatum* Stein ; 3, ventral view; 4, dorsal view : 5, apical view ; 6, antapical view ; (3, 4 & 5, after Lefèvre in Schiller, 1937) ; magnification not known.

Figs. 7 & 8. *Peridinium volzii* Lemmermann ; 7, ventral view : 8, dorsal view ; (after Lefèvre in Schiller, 1937); magnification not known.

Figs. 9 & 10. *Peridinium volzii* var. *cinctiforme* Lefèvre ; 9, ventral view : 10, apical view ; (after Lefèvre in Schiller, 1937) ; magnification not known.

Figs. 11—13. *Peridinium willei* Huitfelt-Kaas ; 11, ventral view ; 12. dorsal view ; 13, apical view (after Lefèvre in Schiller, 1937) ; magnification not known.

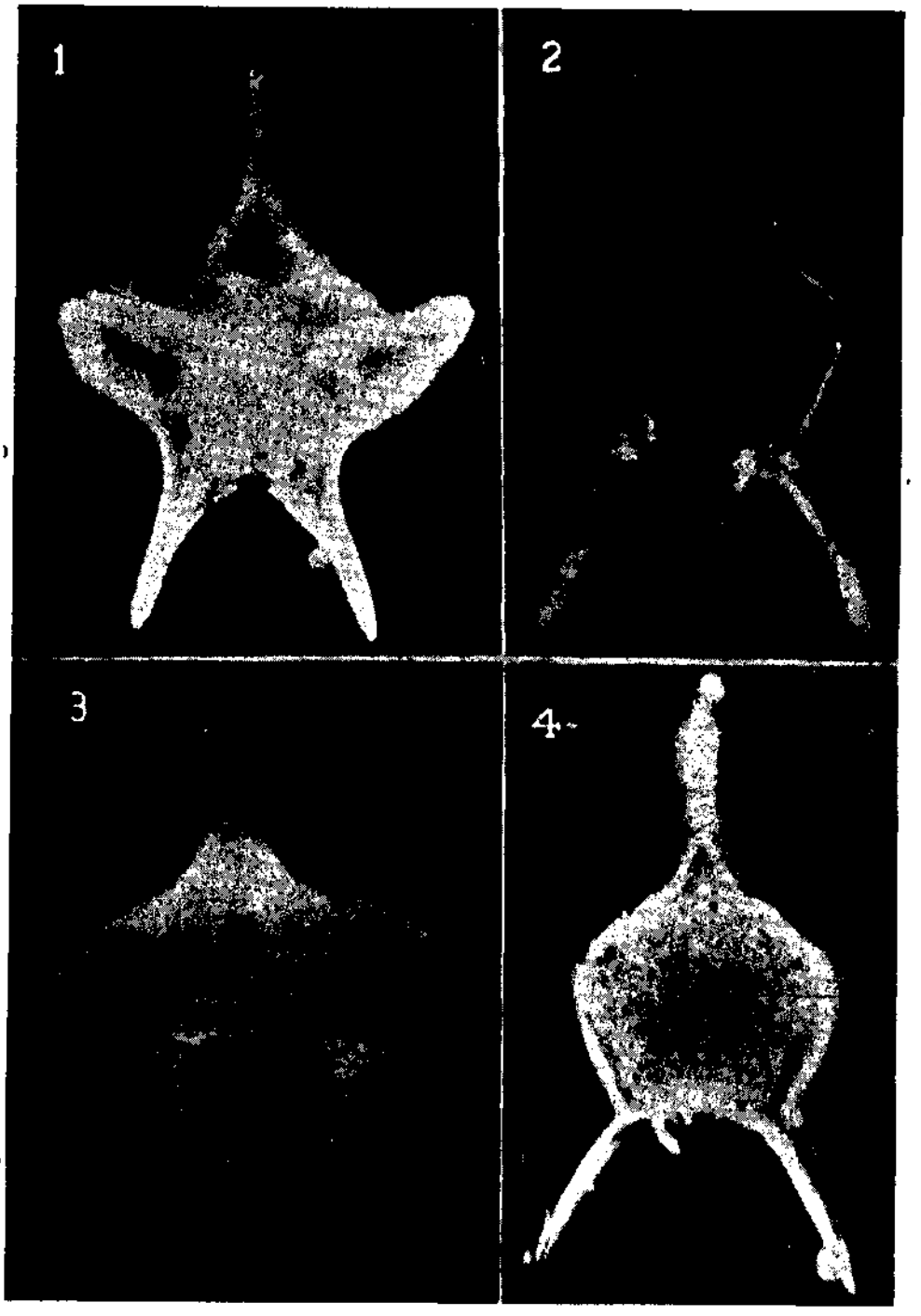


R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXVII

Figs. 1 & 3. *Peridinium elegans* f. *granulata* (Karsten) Schiller. Photomicrograph under dark ground illumination ; two views.

Figs. 2 & 4. *Peridinium longipes* Karsten. 2, photomicrograph under phase contrast & 4, under dark ground illumination.

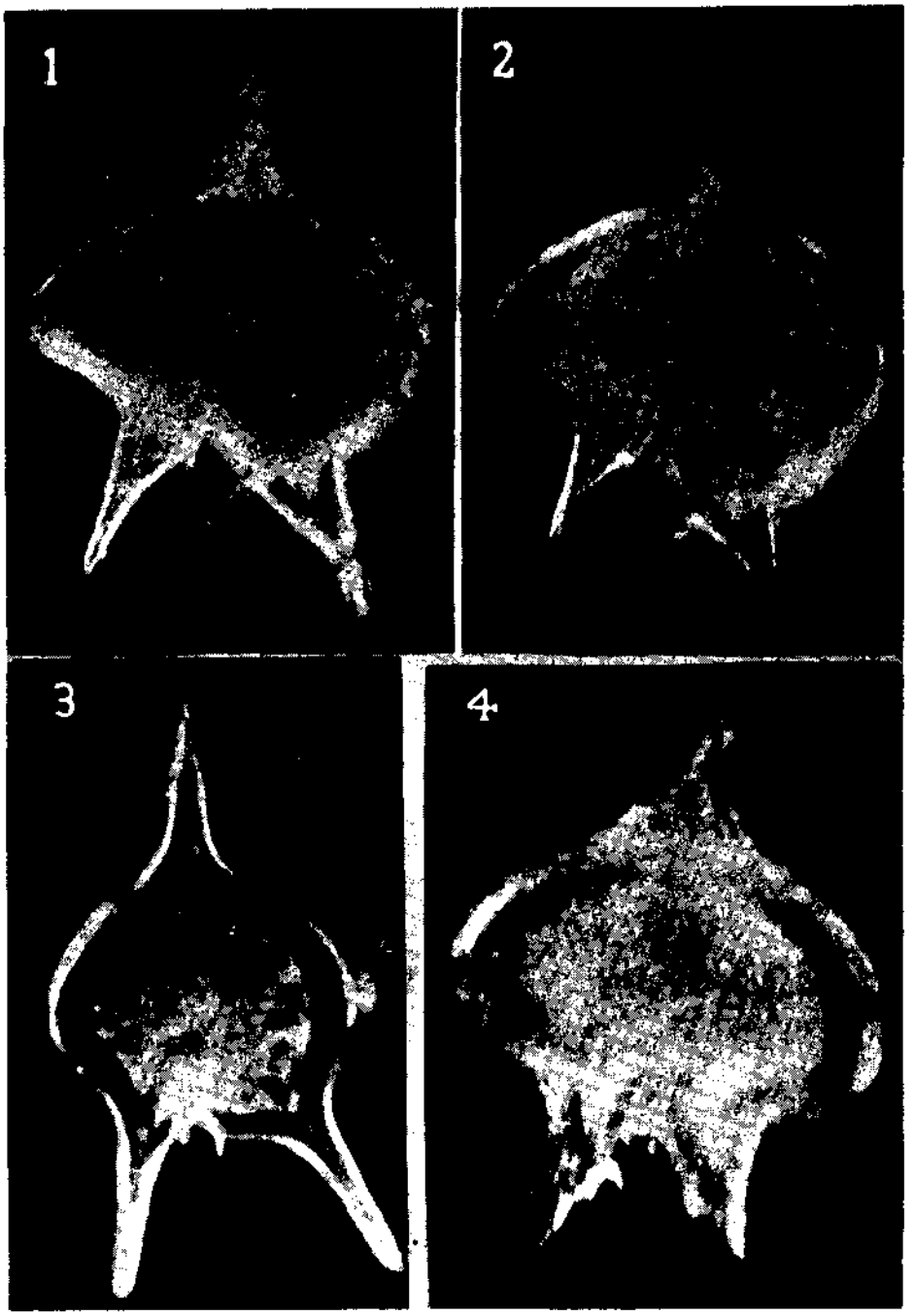


R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXVIII

Figs. 1, 2 & 4. *Peridinium depressam* Bailey. Photomicrographs under dark ground illumination, three views.

Fig. 3. *Peridinium murrayi* Kofoid. Photomicrograph under dark ground illumination.

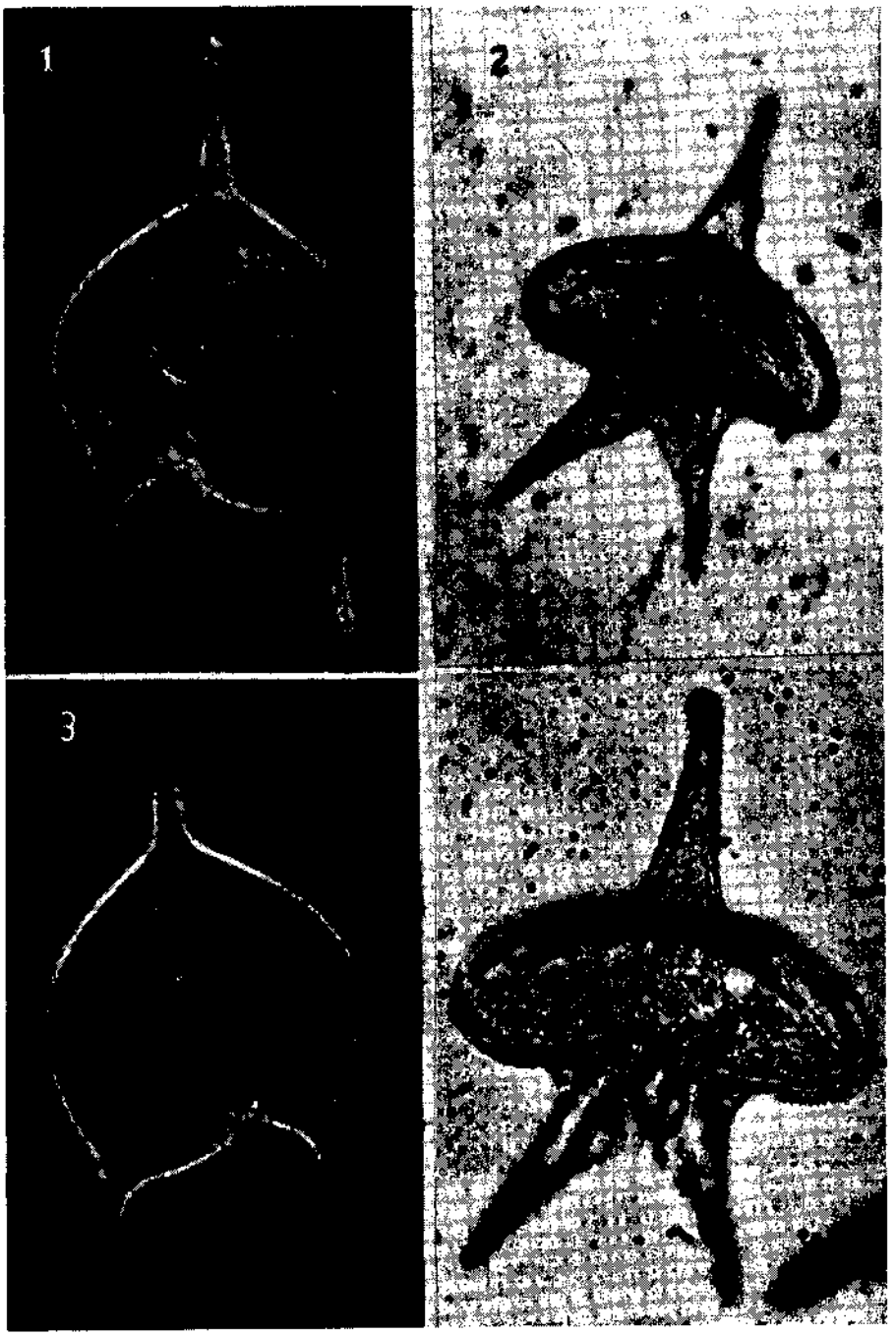


R. Subrahmanyan On PERIDINIACEAE Schütt emend Lindemann.

PLATE LXXIX

Figs. 1 & 3. *Peridinium oceanicum* Vanhöffen. Photomicrographs under dark ground illumination, two views.

Figs. 2 & 4. *Peridinium elegans* f. *granulata* (Karsten) Schiller. Photomicrographs, dorsal and ventral views respectively.



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ERRATA

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2	24 :	*read*	Lemmermann *for* Lemmerman
3	1 :	...	*Diplopsalopsis* for *Displopsalopsis*
4	26 :	...	Lebour *for* Labour
8	31 :	...	saprophytic *for* satrophytic
8	33 :	...	Baltic Sea *for* Belt Sea
10	8 :	...	*H. pacifica* Kofoid for *H. pacifica*
10	32-33 :	...	Lœblich and Lœblich, 1966 *for* Lœblich *et al*, 1963
11	25 :	...	are *for* arc
12	14 :	...	embedded *for* enbedded
12	37 :	...	flagellar *for* flageller
13	4 :	...	flagellar *for* flageller
14	26 :	...	Meunier (1909) *for* Meunier
17	12 :	...	nutrient-deficient *for* nutrieut-deficient
19	8 :	...	*Archaeperidinium* for *Archaeperidininm*
23	24 :	...	present *for* presents
24	30 :	...	to *for* do
31	17 :	*insert*	" ; pl. XIX, figs. 1-4 " after 10
31	26 :	*read*	processess *for* pocesses
31	28 :	...	Colombo Harbour *for* Colombo
32	21 :	...	52° 08′ *for* 52° 8′
33	2 :	...	10 A — D *for* 10 *a-d*
34	18 :	...	figs. 1-9 *for* figs. 1–12
38	17 :	...	fig. *for* ffg
40	23-24 :	...	different from *for* differen form
42	14 :	...	1904 *for* 1907
46	4 :	...	1909 *for* 1909 *a*
46	34 :	...	Braarud *for* Brarrud
47	18 ;	...	plasma *for* plama
48	1 :	...	*tennuissimum* for *tenuissimum*
49	26 :	*insert*	2 *after* 1 *and* 8 *after* 5
51	14 :	...	" ; pl. LXXVII, figs. 2 & 4" after 10
57	4 :	*read*	spine-like *for* spinelike
57	22 :	...	other *for* other
63	31 :	...	coast *for* cost
65	28 :	...	coarsely *for* coarcely
68	22 :	...	" Pl. XLIII, figs. 1-9, 11-13 ; " for " Pl. XLIII, figs. 1 - 13 "
74	29 ;	...	North Sea *for* North sea

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77	16 :	...	posterior *for* posterior
78	32 :	*insert*	" ; pl. LIV, figs. 1-11 " *after* 1-7
79	25 :	*read*	differences *for* differencces
80	23 :	...	1855 *for* 1885
80	24 :	...	pl. *for* p *and* pl *for* dl
80	25 :	...	figs. 1-11 *for* 1 11
83	24 :	...	1931 *for* 1930
83	26 :	...	*oceanicum* for *occanicum*
83	31 :	...	LXXVIII *for* LXXVII
85	29 :	...	First sentence in the para to read : " The oceanic forms are slender ; f. *typica*, 200-300 μ long, comparable in build to those forms of oligotrophic waters ; the neritic individuals are shorter, plumber, with thick small horns, 118-170 μ long, comparable in build to those forms of eutrophic waters "
86	8 :	*read*	1909 *for* 1910
87	17 :	...	Colombo Harbour *for* Colombo
91	33 :	...	Silva (1955) 1957 *for* Silva, 1955
92	23 :	*insert*	" Pl. LXI, fig. 7 ; " *in front of* " Pl. LXII ..."
94	31 :	*read*	*mikronyx* for *mikrenyx*
96	9 :	*insert*	" Pl. LXIII, figs. 3 & 4 ; " *in front of* " pl. LXV....."
101	15 :	...	spine *after* with
101	18 :	...	" Pl. LXVII, figs. 6 & 7 ; " *in front of* " pl. LXX..."
105	4 :	...	1919 *after* Playfair
107	17 :	*read*	Lemmermann *for* Lemmermamn
107	29 :	...	1925 *for* 1926
114	3 :	...	1912 *for* 1913
114	18 :	...	1931 *for* 1930
114	23 :	...	1908 *for* 1907
114	26 :	...	1915 *for* 1914
114	36 :	...	1928 *for* 1932
114	37 :	...	*cerasus* for *cerassus*
115	1 :	...	1928 *for* 1938
115	6 :	...	1901 *for* 1900
115	31 :	...	1922 *for* 1926
116	1 :	...	1937 *for* 1927
116	8 :	...	1958 *for* 1957
116	22 :	...	1958 *for* 1957
116	35 :	...	1922 *for* 1926
122	:	*insert*	*in front of Barrows, A. L. 1918 :* " Ballantine, D 1961 ... *Gymnodinium chuckwanti* n. sp. and orher marine dinoflagellates collected in the vicinity of Zanzibar, *J. Protozool.*, 8 : 217-228."

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123	28 :	*read*	western *for* westerh
125	1 :	...	Broch *for* Broach
125	7 :	*insert*	1962 *after* Brunel, J.
130	:	*read*	Gaarder, K. R. 1954 *for* Gaarder, K. R. 1943
131	:	*insert*	*after Gourret*, P. 1883 : " Graham, H. W. 1942 ... Studies in the morphology, taxonomy, and ecology of the Peridiniales. *Sci. Res. Cr VII Carniegie*, Biol. III: i-v + 1-129. "
149	8 :	*read*	text-figs. *for* tex figs.
151	:	*insert*	1966 *after* Taylor, F. J. R.
166	:	...	" Fig. 10. Epithecal tabulation with two intercalary plates. (After Graham, 1942)".
166	8 :	*read*	1942 *for* 1944
116	11 :	...	1942 *for* 1944
190	9 :	*insert*	13 *after* 12
192	8 :	*read*	*heteracanthum* for *heterocanthum*
210	3 :	*insert*	7 *after* 5
210	4 :	...	5 *for* 6
210	4 :	...	7 *before* 8
240	2 :	...	12 *after* 11
260	2 :	...	1-7 *after* figs.
260	7 :	...	11 *after* figs.
276	:	...	" Fig. 13. *Peridinium grande* Kofoid ; ventral view ; (original); x 165."
294	2 :	*read*	figs. *for* figg
304	3 :	...	comb. nov. *for* n. nov.
315	28 :	*insert*	Murray & Whitting *after saecularis*
317	1 :	*read*	*Minuscula bipes* (Paulsen) Lebour for *Minuscula bipes* Lebour
317	13 :	*delete*	1832
317	13 :	*change*	10 *to ilatics 10, delete 11*
320	19 :	*insert*	13 *before* 14
321	17 :	...	Cleve *after* diabolum
325	25 :	...	Pavillard *for* Matzenauer
329	15 :	*insert*	*author's name* Fauré-Fremiet
329	16 :		... ...
329	17 :		... ... Broch
329	18 :		... ...
329	19 :		... ...
330	3 :	*change*	102 *to italics 102*
331	13 :	*insert*	*authors name* Schiller
333	35 :	*read*	Playfair *for* Playfair