REPORT OF THE BIOLOGICAL SURVEY OF MUTSU BAY*

30. NOTES ON THE PROTOZOAN FAUNA OF MUTSU BAY

III. SUBGENUS *PROTOPERIDINIUM*: GENUS *PERIDINIUM*

By

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(With fifty figures)

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PREFACE

Present paper is intended to describe a part of my investigation on *Protoperidinium*, a subgenus of *Peridinium* of Mutsu Bay, including three groups and seven species. The materials upon which this paper is written are those collected by Dr. S. KOKUBO during January—April, 1925–1927.

Sincere gratitude is here expressed to the SAITO Hoon-kai for publishing this paper. And I shall like to express here my hearty thanks to Prof. S. HATAI and also Prof. S. HOZAWA for their warmheated help extended to me to arrange this manuscript for publication, to Assistant Prof. S. KOKUBO for collecting and leaving the materials to me, and to Dr. T. KABURAKI, Professor of Tokyo Imperial University for the privilege of using a room in the Institute where the present paper is written. My

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hearty thanks also should be offered to late Dr. K. OKAMURA for his kindness in placing all his literatures of Dinoflagellata at my disposal.

Subgenus *Protoperidinium* BERGH

Early investigators divided the genus into two groups, *Protoperidinium* and *Euperidinium*, and to the former was given the following definition by PAULSEN (1908 p. 41). "Querfurche rechts drehend. Keine hohle Antapical Hörner, sondern oft solid Stacheln vorhanden." But later workers all followed JÖRGENSEN's system which emphasized the mode of the combinations of the ventral and the dorsal plate patterns of the epitheca. Recognizing the existence of close relations between the general features of the ventral area and its plate pattern on the one hand, and the type of the hypotheca other than the ventral area on the other hand, and finding some diversities in the type of the ventral area and constancy in the structural relations of this area, I feel constrained to readopt here a part of the oldest system somewhat in a modified style in subdividing the genus. And the subgenus *Protoperidinium* may be defined as followings according to my observation.

The body is globular, pyriform or rhombic with or without faint antapical indentation. The hypotheca is hemispherical without antapical horn. The girdle is circular or ascending. The antapical spine is wholly absent in some of the globular or lenticular species, but in anothers, one or generally two are found in the posterior region immediately by or at a little distance from the posterior end of the ventral area, rising directly from the body wall without forming distinct basal hollow horn or protuberance of the wall. The slightly subsided ventral area is narrow and elongated posteriorly, without forming deep groove as a whole. It consists of four plates and the ventral or longitudinal furrow s. str. is restricted in the region occupied by the left and the anterior plates and further extends posteriorly, in some cases, into the posterior plate. The posterior plate is small and does not expands laterally beyond the median plates and anteriorly not beyond the postmargin of the left plate. The left side list of the ventral area and the flagellar fin are the two ventral projections of the hypotheca, forming a sheath for the basal parts of the flagella. The left antapical spine stands always immediately outside the left anterior end of the posterior plate, while the right at outside the right posterior corner of the plate or at a little distance from there on the right antapical plate. These spines are either wingless or buttressed by wings, and in some cases, connected directly or indirectly with the side list of the ventral area.

In this subgenus will be included JÖRGENSEN's or PAULSEN's (1931) following sections, Humilia, Pyriformia and a part of Tabulata and Pellucida. And the species of this subgenus may be grouped in the following six groups or sections according to the structural relations of the ventral area and its appendages such as spines and fins.

I. Group Globula.
II. Group Monacantha.
III. Group Humilia.
IV. Group Rosea.
V. Group Pyriformia.
VI. Group Pellucida.

And in this paper three of the six, Monacantha, Humilia and Pyriformia, are considered. The two groups, Globula and Pellucida, shall be described in a later paper. The Rosea group is distinguished arbitrarily for some doubtful species with characteristic ascending girdle and removed antapical spine, and whether it is to be regarded as a compact and distinct group or to be included in the Humilia, future investigations will reveal.

I. GROUP MONACANTHA

This group is characterized by the possession of a single antapical spine at a short distance from the ventral area and the distinct right handed girdle.

The body is flattened from above downwards in lense- or cake-shaped and contracted distally to a minute apical horn. The girdle forms a distinctly ascending spiral. The ventral area has a relatively narrow left side list with or without ribs. And this is the sole process in the hypotheca, except the minute right antapical spine which lies at a short distance from the ventral area on the right antapical plate. The left antapical spine is absent.

The ventral plate pattern of epitheca is "meta" and the first apical plate is very oblique, much reducing the first precingular to a minute plate. The middle intercalary plate 2a is quadrangular.

To this group is to be included two species as valid, *P. monacantha* BROCH (=*P. complanatum* MEUNIER, not KARSTEN) and *P. subcurvipes* LEBOUR. They are reported from the north atlantic and the arctic seas. And the following four doubtful species and one subspecies also have some relations with this group.

Peridinium cerasus PAULSEN (PAULSEN 1908, p. 43, Fig. 52; 1911, p. 307, Fig. 5: PETERS 1928, p. 45–47, Fig. 12 a–d: ? KISSELEV 1928, p. 39, Fig. 4, non LEBOUR 1925).

P. finlandicum PAULSEN (PAULSEN 1908, 2, p. 51, Fig. 65).

P. roseum PAULSEN (PAULSEN 1908, p. 44, Fig. 53).

P. turgidum MEUNIER (SABELINA 1930, Fig. 4 f).

P. turgidum v. *kariarum* SABELINA (1930, Fig. 4 a–e).

These may be the species to be included in the group Rosea. But our grouping of these species and their inclusion in the Monacantha group is an arbitrary assignment, based primarily on the presence of the separated right antapical spine coupled with distinct ascending girdle, straight extension of the anterior part of the ventral area and narrowing of its posterior end. These species show some transitional features between the two groups, Monacantha and Humilia.

This group is most closely related to the group Humilia, but can be distinguished from it by its smaller posterior plate, lesser degree of the girdle displacement coupled with broad postcingular row of plates, and the presence of the removed single spine.

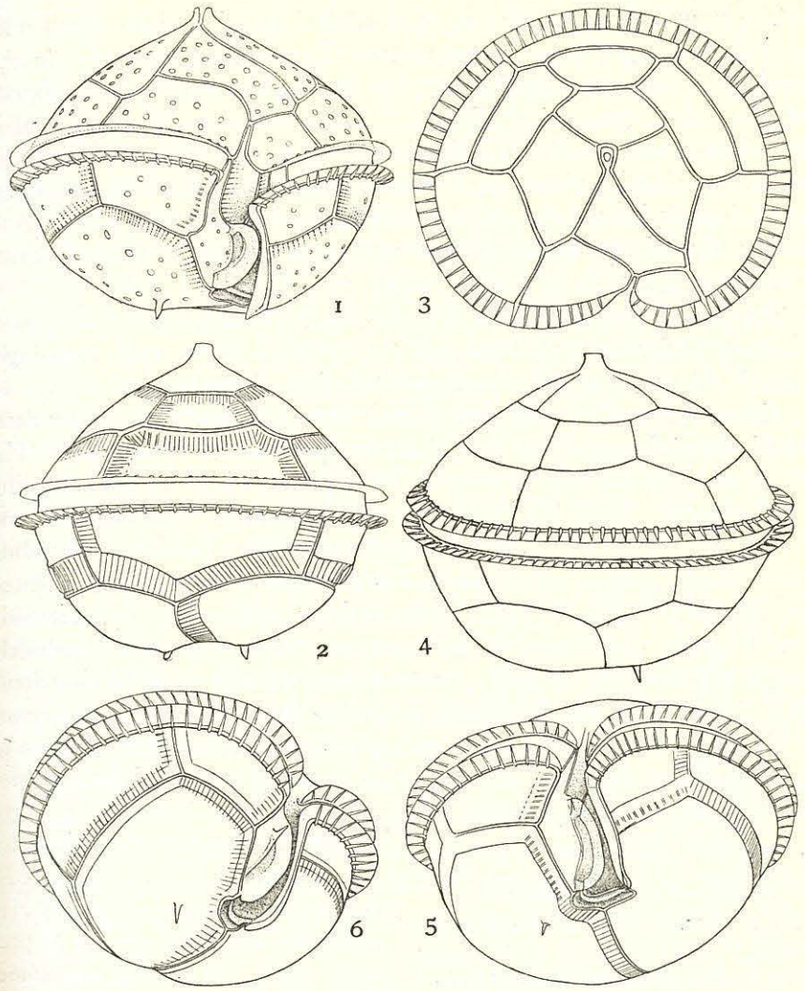
1. P. subcurvipes LEBOUR (?)

(Figs. 1–8)

LEBOUR 1925, p. 133, Fig. 3, Pl. 17.

This species is characterized by its separated antapical spine, its rounded but somewhat flattened body, the small posterior plate and rightwards triangular expansion of the right plate.

The body is slightly flattened in cake-shaped and contracts diatally to a minute but distinctly differentiated apical horn (Figs. 1, 2, 4). And there is a slight ventral median indentation of the body, making the cross section of the body at the girdle a broadly reniform, and further extends posteriorly to the antapex (Fig. 6). The girdle divides the body into two equal parts, forming itself a distinct ascending spiral with terminal arches, and is displaced distally 0.5–1 girdle width. Its side lists are well ribbed and the posterior component extends posteriorly along the median margin of the proximal postcingular plate, forming the left side list of the ventral area (Fig. 1). The antapical spine is short, standing at a distance from the postmargin of the ventral area, springing from the right antapical plate. It is straight in most cases but rarely curved distally to the right.



Peridinium subcurvipes LEBOUR

Fig. 1. Ventral view of body showing general feature of ventral area and surface marking of thecal plate (×600).

Fig. 2. Dorsal view (×600).

Fig. 3. Apical view of epitheca (×600).

Fig. 4. Dorsal view of another specimen showing asymmetrical dorsal plate pattern (×600).

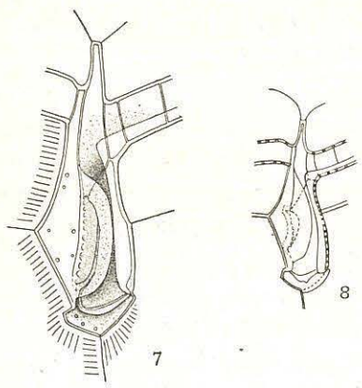
Fig. 5. Oblique antapical view of hypotheca, showing posterior portion of ventral area together with flagellar fin, flagellar trough, longitudinal furrow s. str. (×600).

Fig. 6. Right oblique antapical view of hypotheca, showing posterior median indentation of body (×600).

The ventral plate pattern of epitheca is "meta" and the small mid-dorsal intercalary 2a is quadrangular. There occur two types in the dorsal plate pattern concerning the plate 2a, the one asymmetrical (Fig. 4) and the other symmetrical (Fig. 2). The irregular midventral apical is very oblique with its left half slouches down to the girdle, reducing the the first precingular plate. It does not extend to the girdle but is removed from it by a long anterior extension of the anterior plate. And another three large apicals gather to form a smooth trapezoidal dorsal outer-contour (Fig. 3).

The apical closing platelet is also plainly detected in this species. The postcingular row is narrow and the antapical plates are exceedingly large, forming by far the greater portion of the hypotheca.

The transitional plate is narrow and lies transversely at the proximal end of the girdle, and the first cingular plate is small rectangular. The ventral area is short, not extending to the center of the hypotheca and irregular in contour, expanding rightwards with a bluntly pointed middle part, while its left side runs straight. It tapers anteriorly to a narrow extension, which indents the epitheca, and its posteriormost part is constricted from the rest at the anterior margin of the posterior plate, the constriction being particularly prominent on the right (Fig. 7). The area is, accordingly, narrow and lies slightly oblique in its anterior and broad and meridional in its posterior parts. A slender and somewhat oblique anterior extension of the anterior plate deeply indents the epitheca, intervening between the two terminal precingular plates, and thus removing the ventral apical plate from the girdle (Figs. 1, 7 and 8). The elongated and irregularly triangular right plate, widest and bluntly pointed at the postcingular-antapical suture, extends anteriorly to the epitheca, and on its posterior left margin bears a broad hemicircular flagellar fin, which has a crowded line of minute ribs along its base.



Peridinium subcurvipes LEBOUR

Fig. 7. Ventral view of ventral area (×1500).

Fig. 8. Ventral view of somewhat modified ventral area of another specimen with elongated flagellar fin and well ribbed left side list. The ribs are illustrated only basally (×600).

The broad and somewhat straightened postmargin of the small and irregular left plate protrudes over the anterior margin of the posterior plate, forming a narrow list or lip (Figs. 1, 5–8). The flagellar pore is elongated reniform, lying somewhat obliquely and the short and distinct flagellar trough lies immediately inside the posterior right-hand constriction of the ventral area. The longitudinal furrow s. str. is restricted in the region occupied by the three components of the ventral area excluding the right plate (Fig. 7). Together with the broad flagellar fin, the left side list, which is restricted basally only along the left margin of the left plate, guard the longitudinal furrow, and this, together with the absence of any other wing or list in or outside the ventral area and the restriction of the furrow, suggest a probable functional differentiation of the right plate from the other three, concerning water current caused by the flagella. The left side list is hyaline in most cases, but rarely provided with distinct ribs of regular intervals as those of the cingular list, and in the latter case the flagellar fin extends further anteriorly to the hight corresponding to the distal end of the posterior cingular list (Fig. 8).

The thecal plate is hyaline and has sparingly scattered, circular minute thickenings, each with a minute central pore (Fig. 1). The seemingly differentiated right plate is also porulated very sparingly along its outer and inner margins (Fig. 7), and there are three or four pores to be seen on the posterior plate. And I have found, on the other hand, a few specimens with fine meshes on the thecal plate.

Dimensions: Body length including the apex 56–60 μ, transverse diameter 62–73 μ, dorso-ventral diameter 50–55 μ, width of girdle 5–5.5 μ.

The antapical spine of LEBOUR's species seems to be less removed and more evidently curved than that of our species. But this may be an individual or local variation.

II. GROUP HUMILIA

Section Humilia JÖRGENSEN

Based mainly upon the combination of ventral and dorsal plate patterns of epitheca, JÖRGENSEN (1912) grouped those *P. ovatum*, *P. roseum*, *P. decipiens* and others under his sixth section Humilia. But recently PAULSEN (1931) removed *P. ovatum* from the section to the Pyriformia. This difference of interpretation between them is probably due to a lack of accurate knowledge on the skeletal morphology of the

genus *Peridinium* at that time, to establish a sharp distinction between this and the other groups.

A revision of old literatures, together with the data obtained from our own observation on the winter plankton of Asamushi, necessitated me to rearrange the definition of the group Humilia as following.

The globular or slightly compressed body has a distinct apical horn and two antapical spines, the latter is wingless in some cases, but often buttressed with single, or rarely two wings. The ventral plate pattern of epitheca is "meta" and the middorsal intercalary 2a is quardrangular or rarely pentagonal. The postcingular row of plate is very narrow, its width being nearly comparable with that of the girdle, and the antapicals are of extremely large plates, forming by far the greater portion of the epitheca. The girdle forms a distinctly ascending spiral, displaced distally about a height of the distal postcingular plate. The ventral area is relatively short, not extending to the center of the epitheca and slightly broadening posteriorly. Its narrower anterior part lies obliquely, while its broader posterior half extends straight in meridional direction. The short antapical spines stand just outside the posterior plate and the inter-antapical suture extends dorsally from the posterior median point of the ventral area. The left side list of the ventral area is restricted basally, in most cases, only along the left margin of the left plate so as to leave the postmargin of the posterior plate free from the list-formation, and the left antapical spine is not connected with the list in any way. The right side list of the area is narrow and indistinct. The longitudinal furrow s. str. is restricted within the left half of the area, not expanding into the right plate.

This group is distinguished from Humilia by its distinct girdle displacement, the anterior oblique extension of the ventral area, the posterior expansion of the ventral area and by the subterminal ending of the left side list, which has no connection to the left antapical spine. *P. roseum* PAULSEN and its allied species seems to be closely related to this group in the structural relation of their ventral area and the distinctly ascending girdle, but differ in their removed right antapical spine, which suggests some closer relations with the preceding group. The monacantha group is the other one to be distinguished from this by its removed single antapical spine when the *roseum*-group were separated from it by further minute examination of their skeletal morphology. The globula group, which is also closely related in some other points, is distinguished from this by its smaller posterior plate, distinctly ascending and overhanging

girdle, and the absence of the antapical spine. Among the subgenus *Protoperidinium*, the group Pellucida has the most highly organized wing-system, guarding the ventral area, and this is the main feature that distinguishes it from the group Humilia.

This group includes following species as valid.

P. cerasus PAULSEN (LEBOUR 1925, not PAULSEN's species).

P. ovatum (POUCHET) SCHÜTT (PAULSEN 1908, p. 44, Fig. 54; DANGEARD 1927, p. 4, Fig. 3; PETERS 1928, p. 40–41, Fig. 10 a–b).

P. quanerense (STEIN) SCHRÖDER (BERGH 1910, p. 184, Fig. 3_{I}; BROCH 1910, p. 184, Fig. 3_{I}, not $_{II}$ and $_{III}$; PAULSEN 1931, p. 31, Fig. 32_{B-D}).

P. roseum PAULSEN (MARUKAWA 1921 b, Fig. 81, Pl. 8, not PAULSEN's original species).

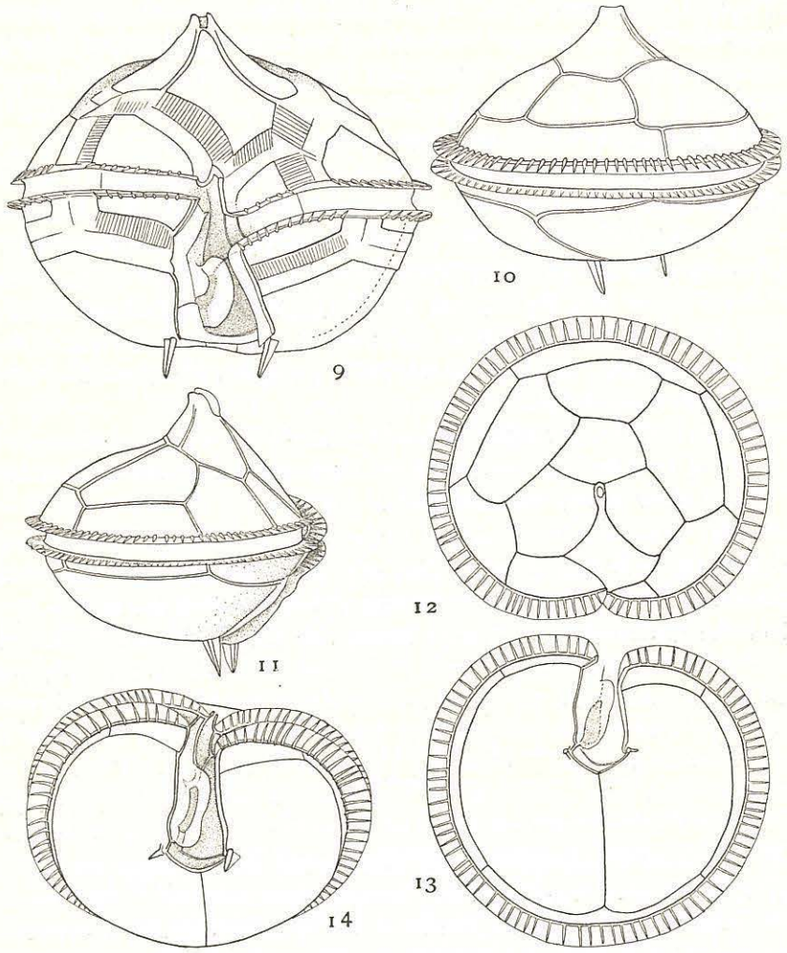
P. ovatum LEBOUR (1925) is closely related with *P. lenticulatum* F. F. and may be distinguished from PAULSEN's or DANGEARD's species by their nearly circular girdle.

To this group may be added *P. decipiens* JÖRGENSEN if PAULSEN's Fig. 63 b be accurately drawn. This suggestion is based upon its distinct displacement of the girdle and the typical relation between the proximal end of the girdle and the distal postcingular plate, associated with the flattening of the body.

2. **P. marukawai**, n. sp.
(Figs. 9–16)

P. roseum PAULSEN (MARUKAWA 1921 b, not PAULSEN's).

The body of this species is slightly flattened downwards from apex to antapex in cake- or lense-shaped and its apex and antapical spines are displaced ventrally. But the displacement of the apex of smaller specimen is not so much as that of the larger one. The body of full grown specimen may be more rounded than that of the smaller narrow sutured one, probably due to the strong development of the sutures in the epitheca, which rises above the thecal surface (Fig. 7). But the flattening of the narrow sutured specimen is also variable in some extent. The transverse section of the body at the girdle takes a broad reniform due to a ventral median indentation, and the largest transverse diameter lies in its ventral half in connection with the ventral displacement of the apex and also of the antapex where the antapical spines stand (Figs. 12, 13). The slightly excavated girdle forms a ascending spiral, displaced distally 1–2 girdle



P. marukawai, n. sp.

Fig. 9. Ventral view of a wide sutured specimen showing bulged dorsal portion of epitheca caused by growth, ventral area and antapical spines with lateral fin (×600).

Fig. 10. Dorsal view of another narrow sutured specimen showing normal outline of body and asymmetrical antapical spines (×600).

Fig. 11. Side view of the same specimen with ventral displacement of apex and antapical spines. Both right and left side lists of ventral area are also illustrated. (×600).

Fig. 12. Apical view of epitheca (×600).

Fig. 13. Antapical view of hypotheca showing plate pattern, distribution of ribs in the cingular list and relation of left side list to left antapical spine (×600).

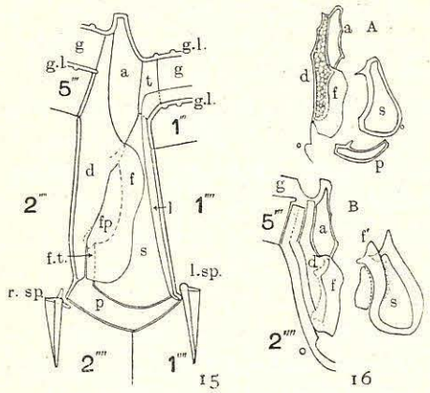
Fig. 14. Postero-ventral view of hypotheca of another specimen showing typical ventral area (×600).

width, which corresponds to the height of the distal postcingular plate, and is guarded with well ribbed lists. The median margin of the distal postcingular plate, accordingly, lies opposite to the proximal end of the girdle, with the anterior part of the ventral area between them. The short ventral area is somewhat oblique in its anterior part, while its posterior broader half lies straight, not etxending to the center of the hypotheca (Fig. 9). Two slender spines stand at outside the postero-lateral corners of the ventral area, each with three side fins in most cases, but not rarely one or two of them are extremely narrow or wholly absent.

The ventral plate pattern of epitheca is " meta " and the middorsal intercalary plate 2a, which is trapeziformed or somewhat rounded, is quadrangular and lies either just in the median or slightly displaced to one side, right or left. The slouch in the left half of the ventral apical plate as that of *P. subcurvipes*, is also distinct in this species. Surrounded with two larger lateral and one smaller middle intercalary plates, the dorsal and lateral outer contour of the apical series of plate assumes a trapeziform in apical view (Fig. 12). The dorsal precingular 4″ is a large, transversely elongated plate and the proximal triangular 1″ is the smallest in the series, whose median margin is oblique in accordance with the oblique extension of the anterior plate. The postcingular row consists of extremely narrow plates, and its subterminal components of younger specimen attain in their height only 0.3–1 width of the cingular plate, while the other three have a little larger breadth. The antapicals are extremely large, forming by far the greater portion of the hypotheca. The inter-antapical suture runs straight in dorso-ventral direction, coming in contact with the posterior median point of the ventral area (Fig. 13).

The girdle consists of three plates, whose terminal components correspond in their length with the basal length of the corresponding terminal precingular plate. The ventral area grows broader posteriorly untill it ends abruptly in a shallow V-form (Fig. 13). The anterior extension of the small and elongated anterior plate slightly indents the epitheca. The slender right plate extends anteriorly to the epitheca and bears a broad flagellar fin along its posterior median margin. The left plate expands posteriorly, forcing the flagellar pore to take a oblique position in the right half of the ventral area (Fig. 15). Consequently, the minute flagellar trough lies at the posterior right corner of the area in the vicinity of the right antapical spine. The actual length of the trough lying outside the pore can be surmised plainly by a truncated postero-

median margin of the isolated left plate (Fig. 16, A). In old well grown specimen, there may be a very narrow secondary list, springing from the left edge of the pore and lying beneath the primary flagellar fin (Fig. 16 f′). The slightly curved and narrow posterior plate lies transversely at the postmargin of the ventral area. The short antapical spines are of subequal length, standing just outside the posterior plate and rising from the ventral marginal part of the antapical plates. They bear respectively two or three side fins, which are wholly absent in some or only poorly developed in others. In most cases, the left spine has a narrow side fin and sometimes a additional smaller one upon its right inner side. And the latter fin is not related in any way with the left side list of the ventral area. The right spine has three fins, radiating from the shaft of the spine, each in ventral, lateral and median direction. And these spines extend in side view parallel to the body axis or inclines to ventral, not diverging distally. The longitudinal furrow s. str. is restricted in the left half of the area, represented by the anterior, left and posterior plates. The posterior plate forms a minute transverse faint groove, lying along the posterior margin of the ventral area in direct communication with the flagellar trough, and a ridge or a extremely narrow list marks it from the left plate (Fig. 14). The obliquely extending flagellar fin stands not only along the right edge of the flagellar pore but also of the flagellar trough, and in many cases, it extends further anteriorly to the height corresponding to the proximal end of the posterior cingular list. The left side list extends posteriorly to the posterior end of the left plate.



P. marukawai, n. sp.

Fig. 15. Schematized ventral area. a—anterior plate, s—left plate, d—right plate, p—posterior plate, t—transitional plate, l—left side list, f—flagellar fin, fp.—flagellar pore, f. t.—flagellar trough, l. sp.—left antapical spine, r. sp.—right antapical spine, 1‴, 5‴—postcingular plates, 1⁗, 2⁗—antapical plates, g.—girdle, g. l.—cingular list.

Fig. 16. Dissociated components of ventral area (×600) of narrow sutured specimen (A) and broad sutured specimen (B). f′—secondary flagellar fin standing along left margin of flagellar pore. Small rings indicate position of spine.

Together with the longitudinal furrow s. str., these two fins form a sheath-like channel to accommodate the basal part of the flagella. The right side list is indistinct and interrupted at the postcingular-antapical suture or sometimes restricted only in its anterior portion standing along the median margin of the distal postcingular plate.

The thecal wall is covered with fine meshes with or without minute spines at the nodes. And this texture is also found in the elongated right plate while the other three components are free from the marking (Fig. 16 A).

Dimensions: Body length 53–72 μ, transverse diameter 56–85 μ, dorso-ventral diameter 52–75 μ, width of girdle 4.5–6 μ.

This species is most closely related to *P. ovatum* (POUCHET) SCHÜTT. The body contour of present species seems to be related to that of those species figured by GRAN (1902), PAULSEN (1908, p. 44, Fig. 54), LEBOUR (1925) DANGEARD (1927) and PETERS (1928). And this seems to be true also concerning the structural relations of their ventral area. DANGEARD's species differs from mine in its small and abruptly differentiated apical horn and more distinct dorso-ventral flattening of the body. But all these PAULSEN's, LEBOUR's and also DANGEARD's species are distinguished from present species by their plate pattern not only of epitheca but also of hypotheca, with a exception of DANGEARD's Fig. 3 d, which shows some closer resemblance with my species. The plate pattern of epitheca of *P. lenticulatum* F. F. (1908, p. 217, Figs. 4, 5, Pl. 15) is nearly the same with that of my species. And I am in different opinion to PAULSEN (1911) who identified this with *P. ovatum*. But above all, our species is distinguished from all these species mentioned above by its very narrow postcingular row of plates.

It seems to me most probable that *P. roseum* illustrated by MARUKAWA et YONEDA (MARUKAWA 1921 b, Fig. 81 c–g, Pl. 8), to which this is most closely related, can be distinguished from my species by its rotund body and removed antapical spines. Strictly speaking, he might have confused two different species because of the fact that Fig. 81 c–d (ventral view) has somewhat removed spines while Fig. 81 g suggests the same structural relation with my species concerning the spine and the ventral area, or if not so, he might have figured incorrectly either of them.

P. granii OSTENFELD (PETERS, but not those of PAULSEN and others) is the other one to be considered here, to which my species is closely similar in body form and plate pattern of epitheca, but is to be distinguished by its widely excavated ventral area and also widely divergent

antapical spines standing upon the top of low horn-like protuberances.

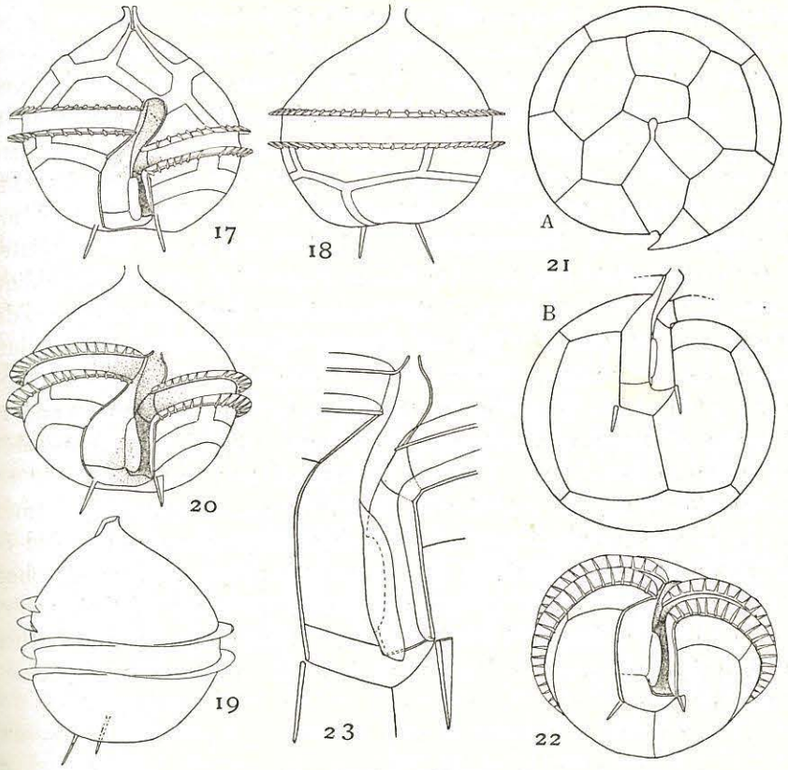
3. P. ventralis, n. sp.
(Figs. 17–23)

This pear-shaped species is characterized by its small size, distinct ascending girdle and two delicate antapical spines. The minute apical horn is distinctly differentiated and flares a little at the aperture. The hemispherical hypotheca has slight antapical flattening.

The ventral plate pattern of epitheca is "meta" and the middorsal intercalary 2a is quadrangular, and the other two are in nearly bilateral balanced position. The postcingular row of plate is narrow and the antapicals are very large, but not so much as that of the preceding species. The left 1'''' is smaller than the right 2''''. The interrelations between the minute precingular 1'', the postcingular 5''', the girdle, the interantapical suture and the ventral area are the same, in the main, with those of the preceding species. The girdle forms a complete ascending spiral, displaced distally 1.5 girdle width.

The ventral area is also similar in its structural relation to that of the preceding. It is short, not extending to the center of the hypotheca. The median margins of both the first precingular and the distal postcingular are very oblique in connection with the slantwise extension of the anterior narrower part of the ventral area, and the posterior broader half of the area extends straight in meridional direction. The left side list of the ventral area is narrow and restricted only along the left margin of the left plate. The flagellar fin is narrow and small, standing along the posterior left margin of the right plate and extending anteriorly to the height corresponding to the proximal end of the posterior girdle list. There is a another list, very narrow and indistinct, standing along the right margin of the ventral area, which is interrupted at the postcingular-antapical suture (Figs. 17, 20). The flagellar pore lies in the left posterior part of the area in consequence of striking development of the right plate. The slender anterior plate indents the epitheca with its narrow anterior extension. And the small and narrow left plate lies posterior to the minute pentagonal transitional plate, which expands markedly into the ventral area. The large right plate tapers anteriorly to a narrow extension which extends to the epitheca. This unbalanced posterior broadening of the right plate naturally displaces the flagellar pore to the left. The posterior plate consists of broader right and narrower left portions, whose

pointed left end lies at the base of the left antapical spine. The right antapical spine stands outside the right posterior corner of the posterior plate (Fig. 22). These two spines extend ventro-posteriorly and diverge distally. And they are generally wingless, but rarely the left has a narrow and indistinct lateral fin, and is not connected in any way with the left side list of the ventral area. The longitudinal furrow s. str. is



P. ventralis, n. sp.

Fig. 17. Ventral view of a specimen with narrow ventral area (×600).
Fig. 18. Dorsal view of another specimen (×600).
Fig. 19. Side view of the same (×600).
Fig. 20. Ventral view of a different wide stured specimen with extremely broad ventral area (×600).
Fig. 21. Schematized plate patterns of epitheca (A) and of hypotheca (B).
Fig. 22. Ventro-antapical view of hypotheca of the first specimen (×600).
Fig. 23. Schematized ventral area.

restricted in the left narrow region, occupied by the left plate and a part of the posterior and anterior plates (Figs. 17, 20).

Dimensions: Body length 38-41 μ, transverse diameter 40-43 μ, dorso-ventral diameter 37-40 μ, width of girdle 5-6 μ.

This species is very closely related to *P. quarnerense* (BROCH, 1910, p. 184, Fig. 3_{I}, not $_{II}$; DANGEARD 1927, Fig. 9; PAULSEN 1931, Fig. 32). But these illustrated by them are distinguished from mine by their more swollen body and abruptly differentiated apical horn. It seems to me probable that *P. cerasus* illustrated by most of the former investigators do not represent a one and the same species in every cases. And among them BROCH's species is most closely related to this in its plate pattern of epitheca and also in the outline of the ventral area. From *P. cerasus* PAULSEN (1908, p. 52; PETERS 1908, Fig. 12 a-d) and *P. roseum* PAULSEN (1908, p. 44, Fig. 53) are distinguished from this by their removed antapical spines. From *P. marukawai* to which this is most closely related, it is to be distinguished by its body form, smaller size, pronounced oblique extension of the anterior part of the ventral area, and distinctly expanded posterior part of the area coupled with its characteristic posterior plate. Judging from SABELINA's figure 4 a, c, *P. turgidum* MEUNIER (SABELINA 1930, Fig. 4) differs from this in the plate pattern of epitheca and relative size of the terminal postcingular plates, though much resembles each other in body form. And *P. sylvanae* DANG. (1932, fig. IV, a-f) seems to differ from this not only in body form and cingular displacement but also in the organization of the hypothecal appendages. Detailed description or figures of all these species mentioned above have not been given in reference to their skeletal morphology especially of their ventral area. And this makes the identification very difficult. Accepting all these published figures correct and yet I am inclined to regard my species a different one.

III. GROUP PYRIFORMIA

JÖRGENSEN grouped *P. steini* and its allied species under his fourth section Pyriformia. And recently PAULSEN (1931), following JÖRGENSEN's system, placed it in his fifth section and cited seventeen species as valid. And present group intended to define in this paper, includes a part of PAULSEN's section with following modifications.

The globular or pear-shaped body has a circular and rarely oval cross section. The apical horn exists in most cases. The girdle is circular or

slightly ascending and is guarded with broad hyaline or well ribbed lists. The hemispherical hypotheca has two antapical spines at the posterior lateral margin of the ventral area.

This group is characterized especially in the structural relations of the ventral areas and its appendages. The ventral area is straight, extending in meridional direction and slightly indenting the epitheca. It is widest at the postcingular-antapical suture and narrows posteriorly, terminating, in most cases, in bluntly pointed end. The left side list stands along the whole length of the left margin of the left plate. The left antapical spine stands at the left anterior end of the posterior plate, springing from the median margin of the left antapical plate. It is connected, in most cases, directly with the left side list, but rarely it extends independently outside the list without any direct connection. Thus the left side list is divided, in most cases, by the spine into two portions, the one forming the ventral and the other the dorsal wings of the spine. And its ventral wing is connected with the posterior cingular-list through the left side list of the ventral area, and the posterior fin stands slong the sinistro-posterior margin of the posterior plate, ending at the ventral end of the interantapical suture. But rarely these two fins, as stated above, form a continuous wing without any direct connection with the spine. In highly organized species, there is a minute third wing, the side fin of the spine. The right antapical spine stands either immediately outside the right posterior corner of the posterior plate or at a little distance from there on the right antapical plate. The right spine is wingless or buttressed with one or two wings, and in most highly organized species there are three wings radiating from the shaft of the spine respectively in ventral, dorso-median and lateral directions. Generally, they are small and indistinct, but in most highly organized species the ventral one extends anteriorly comming in connection with the distal end of the posterior girdle list in the same way as that of the left spine. The right side list of the ventral area is variable in different species, but it is generally narrow or indistinct as compared with the highly developed left one. There is a narrow fin, in most cases, standings along the median margin of the postcingular plate 5‴, which, in some highly organized ones, is discontinuous with the ventral fin of the right antapical spine. The large flagellar fin stands along the right edge of the flagellar pore with a minute spine in its anterior end. But not rarely, it extends further anteriorly beyond this spine, for a short distance, along the suture between the anterior and the right plates. The flagellar fin of this group is larger and more distinct as compared with that of the pellucida group,

whose side list is the most highly developed and specialized one among the genus *Peridinium*.

The ventral plate pattern of the epitheca is "meta", and the mid-dorsal intercalary is pentagonal or rarely quadrangular. The three anterior intercalary plates are slightly displaced, as a whole, to the left. The postcingular row of plates is not narrow, and its two terminal plates, I‴ and 5‴, extend posteriorly nearly to or further than the midway between the girdle and the posterior end of the ventral area. The length of the terminal cingular plates corresponds to the basal length of the corresponding terminal pre- or postcingular plates. The transitional plate is small and narrow.

Among the four components of the ventral area, the largest right plate extends anteriorly to the epitheca and narrows posteriorly, terminating in more or less pointed end. The left plate, on the contrary, broadens posteriorly and its postmargin does not bear a distinct lip. Connected with the asymmetry in the posterior halves of these median two plates, the flagellar pore lies obliquely. The posterior plate is small, and its transverse diameter is much smaller than that of the median part of the ventral area. This plate can be divided into a narrow and longer left, and a wide and shorter right portions, and the inter-antapical suture extends posteriorly, in most cases, from the median point of its postmargin. Rarely, the posterior plate is quadrangular with the inter-antapical suture springing from its left posterior corner. This latter type of the posterior plate seems to designate a transitional form between this and the pellucida group.

Two forms can be detected in the texture of the thecal wall. The thecal wall of *P. steini* is covered with sparsely scattered minute pores, while that of *P. subpyriforme* with fine meshes. In the latter case, the right plate, which is the sole protuberant one among the quadruplet, has the same texture with that of the body plate, and the other three are free from the marking. This seems to be related with differentiation of the longitudinal furrow s. str.

The Humilia and the Pellucida groups are the most closely related ones to this. But present group is distinguished from the former by its circular girdle, smaller posterior plate, the asymmetrical development of the posterior part of the middle two plates of the ventral area, and the direct connection of the left antapical spine with the left side list of the ventral area or the further posterior extension of the list. From the Pellucida group, this is also distinguished by its smaller posterior plate, absence of

a minute wing connecting the side list of the ventral area with the left antapical spine, absence of a minute pore at the anterior median corner of the first postcingular plate, which we found in all the species of the group and shall be described in a later paper.

From my investigation on the ventral area of some of this group and a critical review of literatures and published figures, following species may be recognized to be included in this group.

Peridinium heteracanthum DANGEARD (1927, p. 7, Fig. 35).
P. longicollum PAVILARD (PAULSEN 1931, p. 63, Fig. 35).
P. michaelis EHBG. (SCHÜTT 1895, Pl. 14, Fig. 16).
P. oviforme DANGEAD (1927, p. 4, Fig. 2; PAULSEN 1931, p. 62, Fig. 34; DANG. 1932, Fig. 4 a–c).
P. steini JÖRGENSEN (PAULSEN 1908, p. 47, Fig. 58; KOFOID 1909, Figs. 1–7, Pl. 2; BROCH 1910, p. 185, Fig. 4; DANG. 1932, Fig. V c; LEBOUR 1925, Pl. 14, Fig. 4 a–d).
P. steini v. *africanum* DANG. (1927, p. 2, Fig. 1_{D-F}).
P. sylvanae DANG. (1927, p. 2, Fig. 1_{A-C}).
P. variegatum PETERS (1928, Fig. 9 a–g).

Here may be placed, also, following species, but as their morphological details are insufficiently known at present, careful examination of their thecal structure is necessary before precise decision is made as to their actual position.

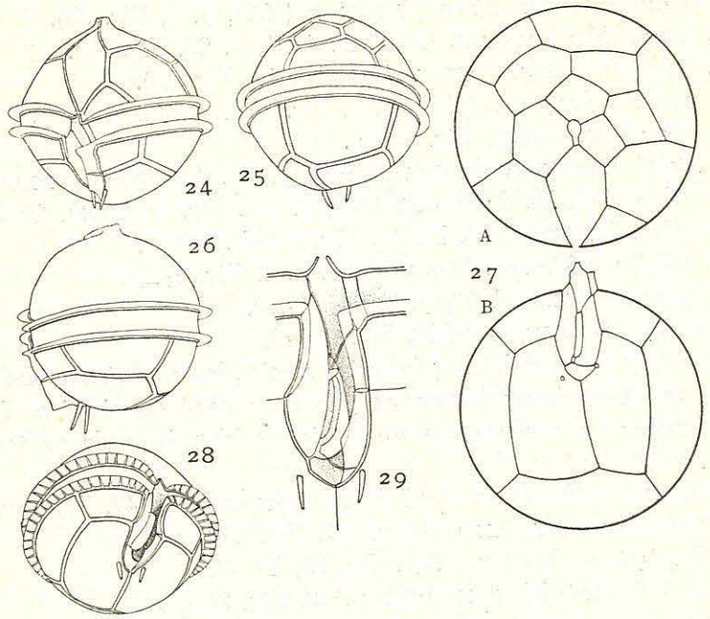
Peridinium pedunclatum SCHÜTT (PAULSEN 1908, p. 47, Fig. 59).
P. latisspinum MANGIN (1922, p. 81, Fig. 24_1).
P. longispinum KOFOID (1907, Fig. 33, Pl. 5).
P. castaneiforme MANGIN (1922, p. 79, Fig. 20_2).
P. breve PAULSEN (1908, p. 46, Figs. 5–6; 1911, p. 309, Fig. 7, non LEBOUR 1925).
P. rectum KOFOID (1907, p. 311, Figs. 48–49).
P. subpyriforme DANG. (1932, Fig. V a–b).

4. **P. solitarium**, n. sp.
(Figs. 24–29)

The body of this minute species is globular with a minute but abruptly differentiated apical horn and somewhat ventrally displaced short antapical spines. The slightly ascending median girdle is guarded with well ribbed lists.

The plate pattern of epitheca is typical for the group Pyriformia.

The ventral plate pattern is "meta" and the ventral apical plate is somewhat elongated pentagonal and the first precingular a small triangular plate. Three anterior intercalaries are displaced as a whole to the left. In consequence of this asymmetry, the left apical is smaller than the right. The postcingular plates are arranged as to increase their height successively from ventral to dorsal, and the middorsal 3‴ is the tallest and



P. solitarium, n. sp.

Fig. 24. Oblique ventral view (×600).
Fig. 25. Postero-dorsal view (×600).
Fig. 26. Side view showing antapical spine and left side list of ventral area (×600).
Fig. 27. Schematized plate patterns of epitheca (A) and of hypotheca (B).
Fig. 28. Oblique antapical view of hypotheca showing well ribbed cingular lists and relation between antapical spine and side list of ventral area (×600).
Fig. 29. Surface view of ventral area (×1500).

largest plate among them, extending posteriorly occupying more than a quater of the dorso-ventral surface length of the hypotheca. The oblique inter-antapical suture separates the smaller left antapical plate from the larger right (Figs. 25–27).

The girdle forms a slightly ascending spiral with its distal displacement by 0.3 its width. The exceedingly narrow transional plate lies transversely at the proximal end of the girdle.

The ventral area is short and narrow, not extending to the center of the hypotheca. It broadens a little at the postcingular-antapical suture and then narrows posteriorly, terminating in bluntly pointed end. The hyaline left side list broadens posteriorly and forms a wide marginal serra before it terminates (Fig. 26). This is not connected in any way with the left antapical spine and bears a short rib at the postcingular-antapical suture. The anterior plate slightly indents the epitheca. Concerning the subequal median plates, the left component slightly broadens posteriorly, while the irregularly spindle-shaped right plate extends anteriorly to the midway between the two distal ends of the girdle lists. The flagellar pore lies slightly oblique between them. The minute posterior plate is bluntly pointed posteriorly. The flagellar fin has a minute subterminal rib at the anterior end of the flagellar pore. The ventral area is slightly depressed as a whole, but its left half forms especially a deeper groove or the longitudinal furrow s. str. (Figs. 28, 29).

The short antapical spines are wingless, and the left one inclines and locates more ventrally than the right, standing just outside the left pointed end of the posterior plate, while the right stands at a distance from the posterior plate, springing from the right antapical plate (Fig. 29).

Dimension: Body length 36 μ, transverse diameter 36 μ, dorso-ventral diameter 35 μ, breadth of the girdle 5.4–6 μ, width of girdle 2–2.5 μ.

This species is distinguished from *P. subpyriforme* DANG. to which it is most closely related, by its smaller size, larger dorsal postcingular plate 2‴ and isolated left antapicall spine. *P. truncus* n. sp. is also closely related to this in size and outline of the body, but is distinguished by its larger ventral area. *P. ventralis* n. sp. is distinguished from this by its narrow postcingular row of plates, more strongly ascending girdle, and oblique elongation of anterior part of the ventral area. From *P. nipponicum* ABÉ it is distinguished by its simpler organization of the ventral area. And from *P. cerasus* it is distinguished at once by its smaller antapical horn and more closely lying antapical spines.

5. P. subpyriforme DANGEARD
(Figs. 30–37)

DANGEARD 1932.

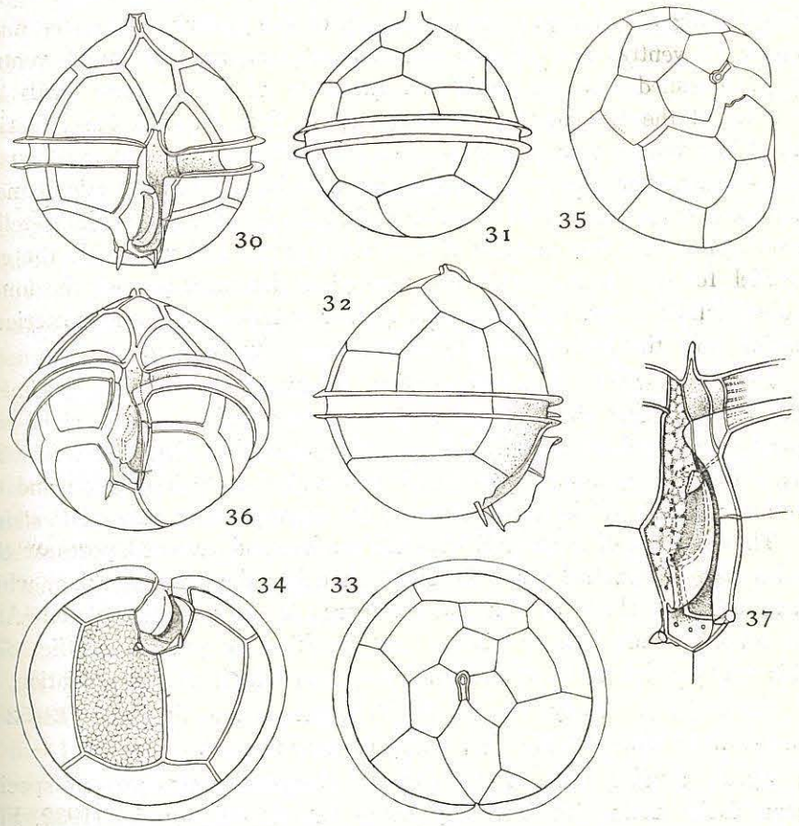
This is a medium sized globular species with a minute apical horn and ventrally displaced short antapical spines. The swollen conical epitheca is slightly larger than the hemispherical hypotheca, and the slightly ascending postmedian girdle has faintly depressed wall and is guarded with hyaline lists.

The plate pattern of epitheca is typical for the group Pyriformia in most cases. The ventral plate pattern of epitheca is "meta" and the ventral apical is elongated pentagonal. The first precingular plate is much smaller than the distal. Among the three intercalaries, the pentagonal middle plate is the smallest, and displaced to the left wedging in between the precingular 3″ and 4″. But rarely I found specimens with quadrangular intercalary 2 a. The postcingular series is narrow, its breadth not exceeding half the height of the hypotheca, and the proximal 1‴ is smaller than the distal 5‴. The antapicals are subequal, the left being smaller than the right in consequence of the oblique extension of the inter-antapical suture (Figs. 33, 34).

The girdle consists of three plates and its terminal two correspond in length with the basal length of the terminal plates of the pre- or postcingular row. The extremely narrow transitional plate lies transversely at the proximal end of the girdle (Fig. 30).

The small ventral area is short and narrow, not extending to the center of the hypotheca. It is widest at the posterior-antapical suture and again narrows posteriorly. The small anterior plate slightly indents the epitheca with its anterior narrow extension. The irregularly elongated right plate extends anteriorly to the epitheca, and posteriorly narrows to a pointed end. The small J-shaped left plate extends anteriorly to the proximal end of the posterior cingular list, and broadens posteriorly into a rectangular part, which bears along its median margin the narrow and elongated flagellar trough. The flagellar pore is relatively short, lying somewhat obliquely in the center of the area. The trough lies in the right of the area. The irregular minute posterior plate is pointed to the left, terminating at the left antapical spine. The wingless right antapical spine stands at the right posterior corner of the posterior plate, rising from the median margin of the right antapical plate. This is especially apparent in broad sutured specimens (Figs. 36, 37). In specimens such as illustrated

in Fig. 30 or 36, there is broad band or zone of growth lying along the right outer margin of the ventral area, separating the areal plates from the other body ones, and consequently the right antapical spine seems



P. subpyriforme DANGEARD

Fig. 30. Ventral view (×600).
Fig. 31. Dorsal view of another smaller specimen (×600).
Fig. 32. A side view of the larger specimen showing antapical spine and side lists of ventral area (×600).
Fig. 33. Apical view of epitheca (×600).
Fig. 34. Antapical view of hypotheca showing side list of ventral area and marking of thecal wall (×600).
Fig. 35. Oblique apical view of partially dissociated epitheca showing apical closing platelet (×600).
Fig. 36. Postero-ventral view of a different specimen (×600).
Fig. 37. Surface view of ventral area (×1500).

to be removed from the posterior plate. The left antapical spine, provided with ventral and ventro-median wings, stands at the left pointed end of the posterior plate, rising also from the median margin of the left antapical plate. The narrow and triangular posterior fin of this spine stands along the sinistro-posterior margin of the posterior plate, terminating at the ventral end of the inter-antapical suture. Its broad ventral fin is connected with the meridional extension of the posterior girdle list at a rib at the postcingular-antapical suture, thus forming the left side list of the ventral area (Fig. 37). The broad flagellar fin seems to guard both the flagellar pore and the flagellar trough, and bears a minute nail-like spine or process in its anterior end at the anterior end of the flagellar pore. The distal free margins of these flagellar fin and right side list run parallel for the most part, thus canopying the most part of the longitudinal fullow s. str. which extends further anteriorly and also posteriorly leaving only the right plate outside the canal thus formed.

It may be worth to note here that I have often observed specimens with three distinct short ridges, radiating from the base of the right antapical spine, each in ventral, lateral and postmedian direction (Figs. 30, 37). These ridges may correspond apparently in their position and direction to those of the three wings of the corresponding spine of *P. steini*.

The thecal wall is covered with fine meshes and crowded pores at the nodes. In the ventral area, the right plate has the same marking, while there are only three or four minute pores in the posterior plate. And the other two are hyaline without any marking or porulation (Fig. 37). This may be due to their structural and also functional differentiation.

Dimensions: Body length 40–50 μ, transverse diameter 43–52 μ, dorso-ventral diameter 36–45 μ, width of girdle 4–5 μ.

By the slender form of the midventral apical plate, present species seems to be distinguished, if any, from DANGEARD's species (1932, Fig. V a–b). And another point is its swollen epitheca. But, disregarding these points, both these species seem to me to be identical. *P. variegatum* PETERES (1928) is also closely related to this, except its ventral plate pattern (para) of epitheca.

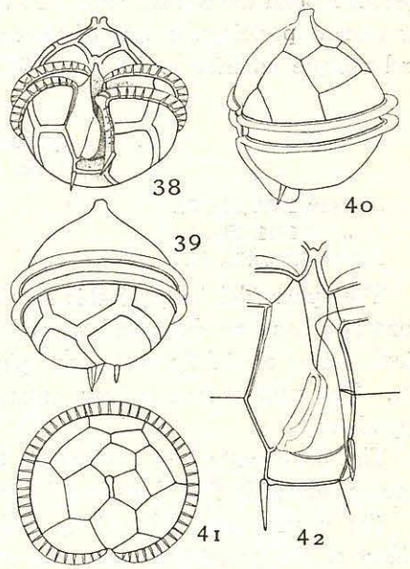
6. **P. truncus**, n. sp.
(Figs. 38–42)

This minute species is characterized by its trochoidal body and relatively large, posteriorly truncated ventral area. The transvere section of the

body is nearly circular with faint ventral flattening. The girdle forms a slightly ascending spiral, displaced distally 0.5 its width and is guarded with well ribbed lists.

The plate pattern of epitheca is typical for the group. The postcingular row is relatively wide and the left antapical plate is smaller than the right.

The relatively large ventral area extends nearly to the center of the hypotheca. It is widest, as in common in the group, at the postcingular-antapical suture and again slightly narrows posteriorly. The minute anterior plate indents the epitheca anteriorly and tapers posteriorly to a pointed end. The left plate extends anteriorly to the midway between the two proximal ends of the cingular edges, and broadens posteriorly. The elongated large pentagonal right plate with bluntly pointed ends, extends anteriorly to the epitheca. And the flagellar pore lies slantwise in the middle of the posterior part of the ventral area and has the very short flagellar trough. The posterior plate is similar to that of the previous species but a little larger, and the ventral end of the inter-antapical suture is displaced to its left posterior corner. The short left antapical spine stands at the left anterior corner of the posterior plate, extending ventro-posteriorly and has its ventral and dorsal wings similar to those of the previous species. The wingless right spine stands at the right posterior corner of the same plate, extending posteriorly. The left side list of the ventral area broadens posteriorly, and we can see, in rare cases, a line of several minute ribs along its basal part, in addition to a stout rib at the postcingular-antapical suture. The right side list is



P. truncus, n. sp.

Fig. 38. Postero-ventral view (×600).
Fig. 39. Oblique dorsal view (×600).
Fig. 40 Oblique side view (×600).
Fig. 41. Apical view of epitheca (×600).
Fig. 42. Ventral view of half schematized ventral area (×1500).

very narrow and restricted only in its anterior part along the median margin of the distal postcingular plate. The small flagellar fin is similar to that of the previous species in its relation to the flagellar pore and the short flagellar trough. The longitudinal furrow s. str. is restricted, as usual, in the left half of the ventral area excluding the right plate (Figs. 38, 42).

Dimensions: Body length 24 μ, transverse diameter 31 μ, dorso-ventral diameter 28 μ, width of girdle 4 μ.

By its large ventral area and its quadrangular posterior plate, this species is distinguished from *P. steini*, *P. solitarium* and *P. subpyriforme*. And from *P. nipponica* it is distinguished by its simpler fin-and-wing-system around the ventral area. *P. ventralis* is distinguished from this by its narrow postcingular row of plates, its more distinct ascending girdle and oblique anterior extension of its ventral area.

7. P. pyriforme Paulsen
(Figs. 43–50)

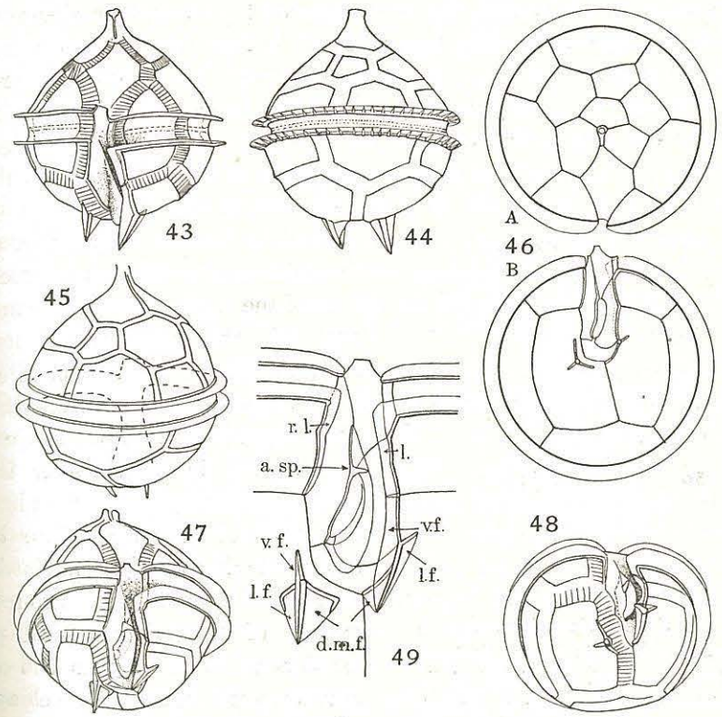
Paulsen 1908, Fig. 57.
,, 1911, Fig. 8.
Peters 1928, Fig. 14.

The spheroidal body of this species tapers anteriorly to a short apical horn and has two short and winged antapical spines. The relatively wide girdle forms a slightly ascending spiral and is guarded with well ribbed list. The ventral area is long, extending posteriorly to the center of the hypotheca.

The plate pattern of epitheca is typical for the group Pyriformia and corresponds with that described by Broch (1910) for *P. steini*.

The ventral area is relatively wide throughout its whole length, but widest at the postcingular-antapical suture (Fig. 50), and its posterior end is bluntly pointed. The irregularly hexagonal, elongated anterior plate slightly indents the epitheca with its anterior truncated end, and tapers posteriorly. The short J-shaped left plate has rounded broad postmargin and extends anteriorly nearly to the proximal end of the posterior cingular list, terminating at the lower end of the narrow transitional plate, which lies transversely at the proximal end of the girdle. The elongated right plate extends anteriorly to the epitheca, and narrows posteriorly to a truncated end. The flagellar pore is reniform, lying obliquely between the middle plates and the short flagellar trough lies, for the most part, within the flagellar pore. The longitudinal furrow s. str. is restricted in

the region similar to that of the other species of this group. The large flagellar fin extends anteriorly, beyond the rib at the anterior end of the pore, standing along the median margin of the right plate, to the level corresponding to the proximal end of the posterior cingular edge. Posterior marginal part of this curved, scoop-shaped flagellar fin turns abruptly to the left to form a narrow folding at the postmargin of the flagellar trough (Fig. 50). This posterior folding is apt to be mistaken for a rib or spine springing from the posterior end of the pore and extending along

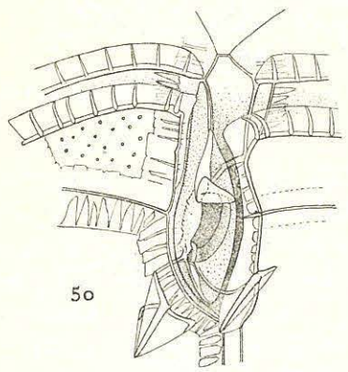


P. pyriforme Paulsen

Fig. 43. Ventral view (×600).
Fig. 44. Dorsal view (×600).
Fig. 45. Dorsal view of another specimen (×600).
Fig. 46. Schematized plate pattern of epitheca (A) and of hypotheca (B).
Fig. 47. Postero-ventral view (×600).
Fig. 48. Oblique polar view of hypotheca (×600).
Fig. 49. Schematized ventral area. r. l.—right side list, v. f.—ventral fin, a. sp.—spine at anterior end of flagellar pore, d. m. f.—postero-median fin, l. f.—lateral fin.

the postmargin of the flagellar fin. The small curved posterior plate lies obliquely behind the two median plates, extending between the two antapical spines.

The relations of the two antapical spines to the posterior plate are the same with the preceding species. The left spine extends slightly oblique in ventro-posterior direction while the right posteriorly. They are provided respectively with three hyaline fins, which extends radially from the shaft of the spine. The ventral and the dorso-median fins of the right spine are decurrent basally parallel with the dextro-posterior margin of the posterior plate, and the other lateral fin extends in dorso-lateral direction. These three fins are subequal both in size and basal length. The dorso-median one has a terminal minute rib or spine standing at a short distance from the ventral end of the inter-antapical suture. The lateral fin has also a similar spine at its distal end. But these terminal spines do not always exist but may be absent in some other cases. The ventral fin extends ventrally for about one-third of the distance between the base of the right spine and the median end of the postcingular-antapical suture. The three fins of the left antapical spine are variable in size and grouped also in a similar manner. The lateral fin of the left is the smallest among them, extending in ventro-lateral direction. The broad triangular dorso-median fin is decurrent basally upon the ventro-median margin of the left antapical plate, terminating at the ventral end of the inter-antapical suture. The elongated triangular largest ventral fin extends anteriorly along the antero-median margin of the same plate, to a rib at the postcingular-antapical suture. Together with the posterior median elongation of the posterior cingular list, this constitutes the left side list of the ventral area. And the rib at the junction is due to their marginal interlocking. The marginal part of the left side list runs parallel with that of the flagellar fin, covering nearly the whole area of the longitudinal furrow s. str. The meridional



P. pyriforme PAULSEN

Fig. 50. Surface view of ventral area showing, in addition to general features of ventral area itself, well ribbed girdle list, striated intercalary zone and distribution of pores of thecal plate (×1500).

posterior elongation of the distal end of the posterior cingular list forms a very narrow right side list, its base terminating at or shortly above the postcingular-antapical suture.

The antapical appendages standing around the ventral area of *P. steini*, and described and elaborately figured by KOFOID, are nearly identical in the main with those of our species. Disregarding the plate pattern of the ventral area, the antapical spine of these two species is provided with three fins grouped in a similar manner, and the right spine is removed, also in both cases, for a short distance from the ventral area. These may be one of the most reliable bases for regarding them very closely related. But the structural relation of the posterior part of their ventral area is wholly different, granting his figures be correctly drawn. The ridge-like structure, which is illustrated in some of his figures, connecting the bases of its two antapical spines and passing around the ventral area, is a character of much higher type such as the group Conica or Pellucida. And it seems to me highly probable that the structure in his figures may be due to his misinterpretation or confusion of more than two species belonging to different groups. This suggestion is based upon my observation which proves the existence of such a structure as his in some of the higher type of the group Pellucida.

The thecal wall is hyaline and covered with corrugated porulation.

Dimensions: Body length, excluding apical horn 38–42 μ, transverse diameter 37–60 μ, dorso-ventral diameter 34–38 μ, width of girdle 5.5–6 μ.

This pacific minute species seems to be most closely related either to *P. steini* or *P. pyriforme* in some points or others. But from *P. steini*, it is distinguished by its shorter antapical spines, rounded midbody and shorter and apparently differentiated apical horn. *P. pyriforme* seems to be variable in its ratio of body length to breadth, as culculated from PAULSEN's and PETERS's figures, ranging from 0.82 to 0.92, and that of our species is 0.95. Our species is, then, more rotund than the atlantic one, and this is especially apparent in the form of epitheca. PAULSEN's (1911) species may be a different one because of its very narrow ventral apical plate, while our species has a broad one. PETERS's (1928) species seems to me not a single species judging from his figures 14 a–c, because of their variable breadth of the ventral apical plate and of their ventral area. Besides these, his species has a exceedingly large right anterior intercalary plate. The posibility arises, then, that when the minute skeletal morphology of these atlantie species is known, it may be necessary to transfer our pacific species to another or to create a new

species to place present species, but at present lack of adequate minute descriptions of those atlantic species preclude a possible identification. *P. variegatum* PETERS has much shorter spines and more flattened body than our species. *P. michaelis*, *P. oviforme* and *P. longicollum*, also, can be distinguished from this by their elongated midbody and longer antapical spines, while on the other hand, present species can be distinguished from *P. heteracanthum* and *P. subpyriforme* by its elongated body.