THE ARMOURED DINOFLAGELLATA: II. PROROCENTRIDAE AND DINOPHYSIDAE (C)— *ORNITHOCERCUS, HISTIONEIS, AMPHISOLENIA* AND OTHERS

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With 19 Text-figures

Genus *Ornithocercus* STEIN

Ornithocercus STEIN, 1883: BÜTSCHLI, 1885: SCHÜTT, 1893, 1895, 1896: DELAGE & HÉROUARD, 1896: KOFOID & SKOGSBERG, 1928: SCHILLER, 1928, 1931: LINDEMANN, 1928.

The literature of the present genus shows that the specific demarcation in *Ornithocercus* is much more difficult than in *Dinophysis* and in a tangle almost beyond the possibility of unravelling as stated by KOFOID & SKOGSBERG (1928, p. 511). This is mainly due to extraordinary variability in size, shape and structural differentiation of the left sulcal list or the posterior sail. Before going further, the present author intends to give briefly the general account of the genus basing mainly on his own morphological analyses.

There has never been given any information about the number and arrangement of the thecal plates in diagnosing species, whereas undue stress has generally been put upon size, shape and structural differentiation of the cingular lists and particularly of the left sulcal list. Of these features, the last is most variable, not only in size and shape but also in the structure itself. This is pronounced particularly in regard to its middle portion standing along the entire length of the posterior moiety of the paired ventral hypothecal plates, in other words the portion demarcated on the ventral by the fission rib and on the posterior or dorsal by the third rib of the left sulcal list. The broad anterior cingular list anteriorly convexed and distally flared, the posterior cingular list much broader and sigmoid, the cingular wall broadened dorsally, and the midbody which may be somewhat compressed laterally but scarcely elongated anteroposteriorly, have been the characteristics defining the genus. This is as well characterized distinctly by the extraordinarily elongated paired ventral hypothecal plates which are arranged dorsoventrally and extending at least to the antapex, often further dorsally beyond it.

KOFOID & SKOGSBERG's (1928) figures are very beautiful, but the morphological

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analyses made by these authors are generally far from complete. For example, they are absurdly describing that "we are not able to decide whether or not the posterior" portion of the posterior cingular list "is always open ventrally" (p. 498). In no case the posterior cingular list is closed ventrally. The structural relation between the cingular and the sulcal lists as well as between the left sulcal list and the ventral hypothecal plates is principally the same as in *Dinophysis*. The right sulcal list is usually fairly simple in shape. However, the left sulcal list, consisting of three parts, is much broader in the present genus than in *Dinophysis*; its basal length is incomparably great and its structural differentiation is most complicated. It is to be noticed that the radial ribs of the cingular lists are formed only on the one side opposite the cingular furrow and the radial and irregularly formed ribs of the left sulcal list are found regularly only on its left surface. In other words, in both the cingular and the sulcal lists, the surface protuberant structures such as radial ribs or the meshwork of ridges are built only on the surface opposite the side on which flagella are present. In short, such structures are seemingly designated to weaken the water current arisen by active movement of the transverse and the trailing flagella.

As to the shape of the epitheca and the anterior cingular list, *Ornithocercus splendidus* has usually been explained in textbooks as an example; in this species the lateral dimension is about 1.4 times greater than the dorsoventral dimension. As far as analysed by the present author, this is rather an exceptional example. Ordinarily, the dorsoventral dimension is a little greater than the lateral dimension as illustrated in Fig. 34 *e*. The actual breadth of the list, however, is seen clearly in Fig. 34 *d* which represents the apical view of an isolated epitheca slightly pressed anteroposteriorly for the purpose to see the actual transition of the list-breadth from its left ventral to the right ventral end around the dorsal. Basing on these observations, it is suggestible that the water passes down to the sulcus most easily through the midventral narrowest portion of the list.

The number and arrangement of the thecal plates are fairly constant throughout the species of the genus, as in the case of *Dinophysis*. One or both moieties of the paired ventral hypothecal plates are given in some of the figures presented in this paper in an intact state in ventral, antapical, or side views. When one compares Fig. 33 *b* with either of Fig. 34 *c* and *e*, he will learn that structure of the paired ventral hypothecal plates, wholly neglected so far, is to be highly estimated, because it affords some distinct specific characteristic worthy of due consideration.

Some morphological features, superficially distinct but taxonomically insignificant, have often been unduely stressed or misinterpreted. In the result this has brought forth much confusion in synonymy, specific demarcation, and specific identification on one hand and suppressed the volition of some planktologists to learn more the finer and more detailed and accurate morphological features of some armoured dinoflagellates on the other hand. Now, it is generally ascertained that most distinct morphological variations in *Ornithocercus* are confined in the main in the posterior half of the left sulcal list, more strictly speaking, in the portion standing along the posterior moiety of the paired ventral hypothecal plates as revealed for the first time in this paper. Morphological features and their variations must not be discussed sweepingly. When these are discussed or considered, different thecal positions are to be treated with different weights duely estimated according to respective positions. The present author's works, presented previously and prepared for future publication, are morphological rather than taxonomical. In consequence, the present author fears if some of his taxonomical points of view might be accused of being arbitrary, and expects that those points will be emended by forthcoming investigators.

Ornithocercus splendidus SCHÜTT

(Fig. 27 a-c)

Ornithocercus splendidus SCHÜTT, 1893, p. 272, Fig. 82; 1899, p. 10, Fig. 1 B: STEUER, 1910, p. 197, Fig. 107; 1911, p. 103, Fig. 83: LINDEMANN, 1928, p. 75, Fig. 61: KOFOID & SKOGSBERG, 1928, p. 521, Figs. 77, 85_3, Pl. 16, Figs. 2, 4, Fig. 3: SCHILLER, 1931, p. 196, Fig. 189 (after KOF. & SKOGSBG. and MURRAY & WHITTING).

Syn.: *Ornithocercus splendens* SCHÜTT, 1896, p. 10, Fig. 13 B.
Ornithocercus magnificus, DOFLEIN, 1929, p. 481 B (not A): DOFLEIN & REICHENOW, 1952, p. 454, Fig. 426_8.

The present species is so well noted owing to its extraordinarily broader cingular parachute, but not as yet minutely explored morphologically. In lateral outline, the body appears to protrude anteriorly much beyond the bases of the cingular lists. But as seen in Fig. 27 *c* representing the leftside of a disjoined right valve, the epitheca is nearly flattened as a whole and the cingulum does not broaden distinctly dorsalwards. The left sulcal list appears to remain in a fairly primitive stage of differentiation as it has only feebly formed radial ribs, although the ventral hypothecal plates extend to the posteromedian point of the hypotheca. The posterior sail or the posterior half of the left sulcal list is not stretched posteriorly straight, but slightly bent towards the right as seen in dorsoventral view.

Length of body, 40–48 μ. Greatest dorsoventral dimension of body, 45–62 μ.

Distribution: Sagami Bay. It is recorded commonly from the tropical, subtropical and warm temperate waters.

Ornithocercus heteroporus KOFOID

(Fig. 28 a-b)

Ornithocercus heteroporus KOFOID, 1909, p. 207, Pl. 12, Fig. 70: JÖRGENSEN, 1923, p. 38, Fig. 54: KOFOID & SKOGSBERG, 1928, p. 517, Fig. 75, Pl. 18, Figs. 1, 3: SCHILLER, 1931, p. 195, Fig. 178: WOOD, 1953, Fig. 58 a-c.

Syn.: *Ornithocercus triclavatus* WOOD, 1953, p. 210, Fig. 65.
Ornithocercus biclavatus WOOD, 1953, p. 211, Fig. 66.

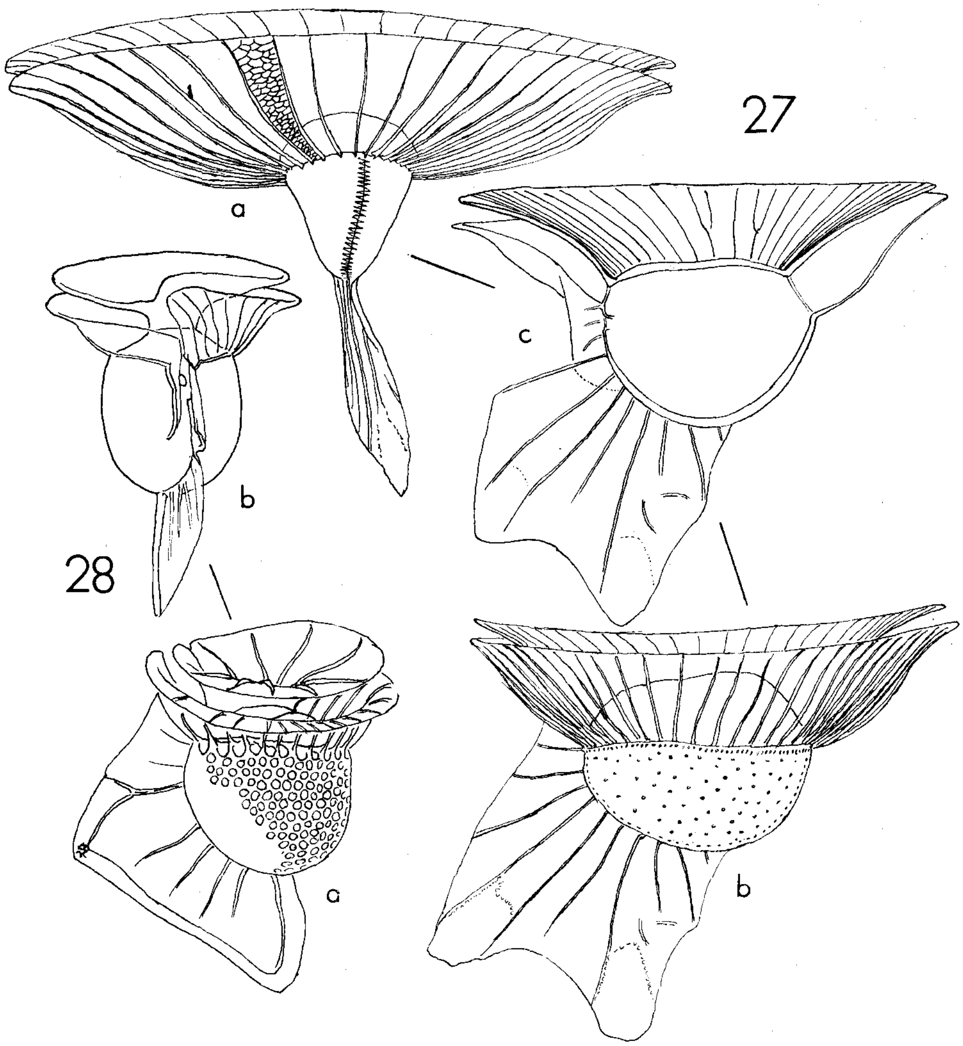


Fig. 27. *Ornithocercus splendidus* Schütt. *a*, Dorsal view of a rather large specimen. *b*, Left side-view of a rather small specimen. *c*, Left side-view of an isolated right valve.
Fig. 28. *Ornithocercus heteroporus* Kofoid. *a*, *b*, Left side-view and ventral view of different specimens.

This is a fairly small species characterized by somewhat spheroidal body. The maximal dorso-ventral dimension is 0.8 as large as the body length at the level of the fission rib and the lateral aspect of the body assumes roughly an equilateral. The left sulcal list is triangular in lateral outline, forming distally a more or less acutely pointed lobe. The fission rib is forked distally, sending out a somewhat longer postero-dorsal branch which ends in the ventral lobe of the list. The third rib stands at or just dorsal to the midposterior point of hypotheca and issues distally a submarginal rib which is often extended to the distal end of the fission rib. Between these two main ribs are arranged several radial ribs at nearly uniform intervals. The spiral tract figured by the distal free margins of the cingular lists, which can be seen more or less distinctly in the majority of species of this genus, is clearly shown in Fig. 28 *b*.

Dimension: Length, 62–65 μ. Greatest dorsoventral dimension, 52–59 μ.

Distribution: Mutsu Bay, Sagami Bay. The tropical, subtropical and warm temperate waters.

Ornithocercus heteroporoides n. sp.

(Fig. 29 a-c)

The present new species resembles closely the preceding species, but the body is a little larger than in the preceding species. Although the hypotheca has the greatest dorsoventral dimension also at the level of the fission rib, it bulges more strongly on the ventral than on the dorsal side so that in lateral outline the hypotheca is roughly symmetrical in the dorsoventral direction. The total length of the hypothecal ventral plates is larger than in the preceding species and the total span of the plates occupies more than the ventral half of the circumference of the hypotheca. In consequence, the sail is much larger and stretched further dorsally beyond the midposterior point of the hypotheca. The posterior moiety of the ventral hypothecal plates is about three times as long as the other moiety in the preceding species, while in the present new species it is about 2.5 times the anterior moiety. Thus, the present species differs from the preceding species not only in the total length but also in the relative length of respective moieties of the ventral hypothecal plates. When Fig. 29 *c* is compared with Fig. 28 *b*, it may be seen that the hypotheca bulges laterally a little more strongly in this new species than in the preceding species. The sail is roughly oblique quadrangular and with the very short third rib near the dorsal end of the sail. The fission rib is running slightly aslant across approximately the middle of the ventral part of the sail. These two ribs are connected completely or incompletely by the submarginal rib which is furnished with a so-called brush or more correctly a narrow zone marked by closely crowded minute areolae near the distal end of each of the two angulated lobes formed between the two ribs. The luxuriant radial ribs found between the two main ribs vary in number, arrangement and minute structures.

Dimension: Length of body, 50–65 μ. Greatest dorsoventral dimension, ca. 60 μ. Greatest lateral dimension, 44–55 μ.

Locality: Sagami Bay.

Ornithocercus galea (POUCHET)

(Fig. 30 a-c)

Syn.: *Dinophysis galea* POUCHET, 1883, partim, p. 426, Fig. 6 (the most righthanded).

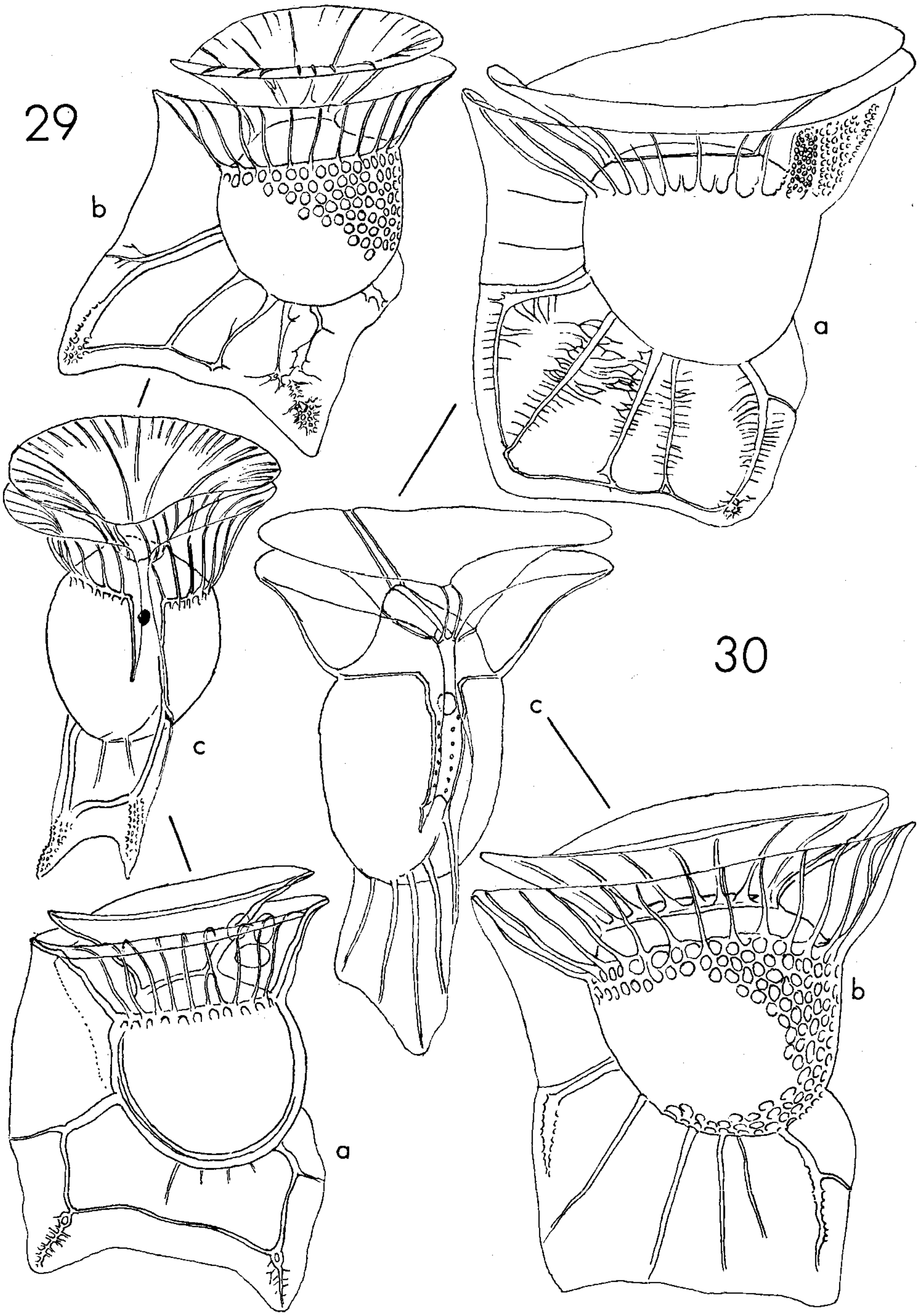


Fig. 29. *Ornithocercus heteroporoides* n. sp. *a*, *b*, Left side-view of two different specimens. *c*, Ventral view of the specimen *a*.
Fig. 30. *Ornithocercus galea* (Pouchet) *a*, *b*, Left side-view of two different specimens. *c*, Ventral view of another specimen.

Ornithocercus quadratus, SCHÜTT, 1900, partim, Figs. 3, 5, 6: KOFOID & SKOGSBERG, 1928, partim, p. 561, Fig. 86_{12-14}, 87_{1-20}: JÖRGENSEN, 1923, partim, p. 304, Fig. 195 a, b, d: SCHILLER, 1931, partim, p. 204, Fig. 195 a-d.

POUCHET (1883) reported four different forms under the name *Dinophysis galea*, of the figures given by him the most righthand one agrees with the present form. KOFOID & SKOGSBERG (1928) scraped together nearly all of forms with rectangular or quadrangular sail under *Ornithocercus quadratus* which was then subdivided into more than five forms, describing that "Whether or not our decision to treat this multitude of forms as a single species is correct cannot be decided at the present time" (p. 562). JÖRGENSEN and SCHILLER also seemed to be annoyed at the same puzzle. And the same is the case with the present author. However, establishing the peculiarity of the shape of the posterior ventral hypothecal plate in the typical *Ornithocercus quadratus* (Fig. 33 *b*), the present author is inclined to the venture of regarding the present form as identical with POUCHET's *Ornithocercus galea*, though his figure is very incomplete.

This species is characterized by the quadrangular sail which is relatively small, posteriorly decreasing the breadth in its anterior half, and provided with somewhat irregularly arranged radial ribs along the posterior margin of the body. The ribs are often furnished with finer side-ribs issued perpendicularly and connected distally to the submarginal rib as illustrated in Fig. 30 *a*.

The dorsoventral dimension of the epitheca is about 0.7 of that at the anterior end of the hypotheca. The dorsoventral difference of the cingulum width is not so prominent as in *Ornithocercus quadratus* (compare Fig. 30 *a*, *b* with Fig. 33 *a*). The hypotheca is a little broader than long in lateral outline. The sulcus terminates posteriorly at, a little posterior to, or slightly in front of the fission rib.

Dimension: Length of body, 46–52 μ. Greatest dorsoventral dimension, 50–53 μ.

Locality: Suruga Bay and Sagami Bay. Exact distribution is unknown.

Ornithocercus skogsbergi n. sp.

(Fig. 31 a-k)

Syn.: *Ornithocercus magnificus*, SCHÜTT, 1899, Pl. 6, Fig. 12: WOOD, 1953, p. 208, Fig. 60_{1-4}.
Ornithocercus thurni, KOFOID & SKOGSBERG, 1928, partim, p. 529, Fig. 81_{7-11}.
Ornithocercus sp., KOFOID & SKOGSBERG, 1928, p. 581, Fig. 1, 3.
Ornithocercus steini, SCHÜTT, 1900, partim, p. 245, Fig. 6.

The body is rather small, its lateral outline is somewhat pear-shaped, the length and the maximal dorsoventral dimension are subequal, and the cingular lists do not flare distally so strongly. The posterior sail usually has three but rarely four lobes. Radial ribs are rather few, four to six; the axes of the fission rib and the third rib cross each other in an angle of 120–130°, 160° at the maximum.

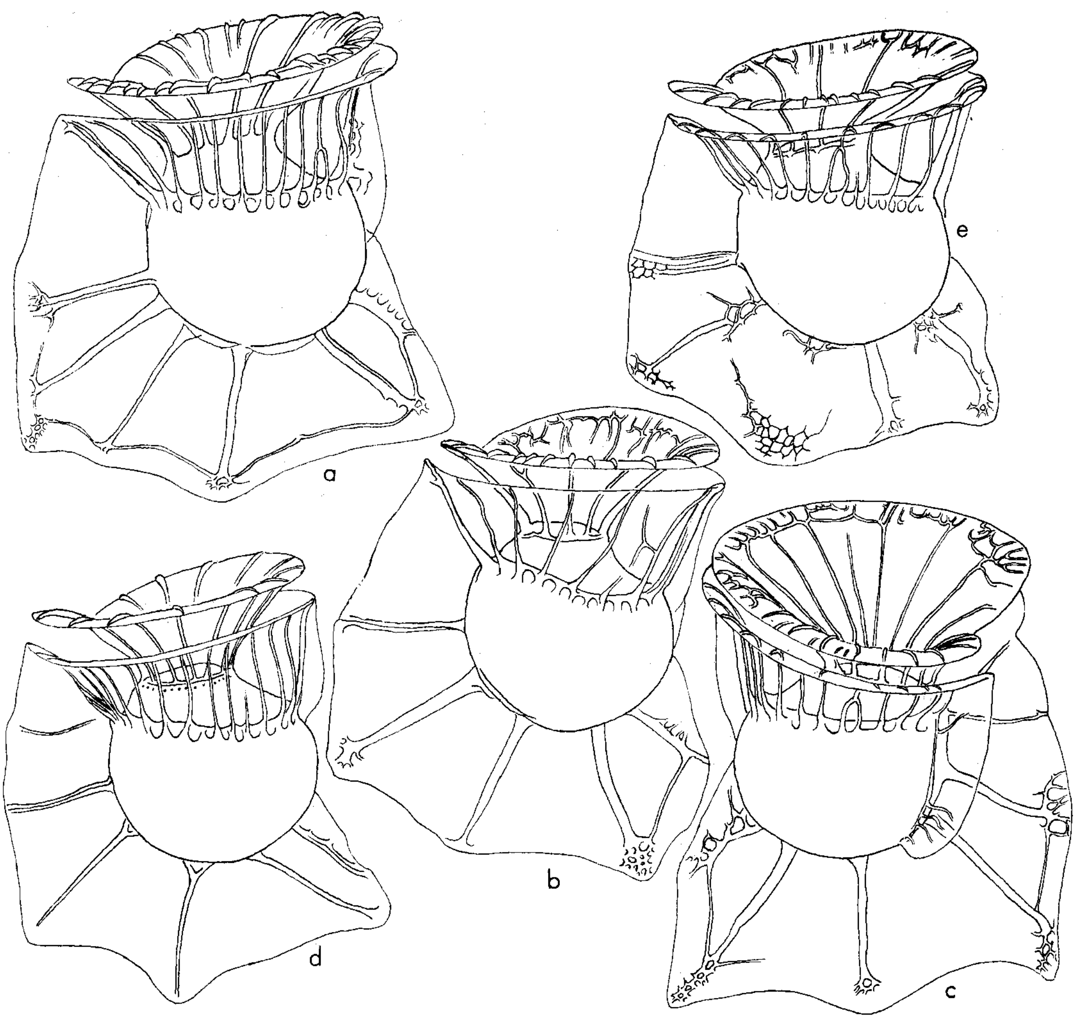


Fig. 31–1. *Ornithocercus skogsbergi* n. sp. *a-e*, Lateral outline of five different specimens, each with differently formed left sulcal list.

Some of Kofoid & Skogsberg's aberrant forms of *Ornithocercus thurni* cannot be distinguished from some of the "specimens of questionable specific allocation" (p. 581) and seem to correspond to Schütt's (1900). Judging from these, the present species seems to be a highly variable species in regard to the shape of the sail. In Fig. 31 *e*, basal and marginal meshes are built in compensation for a rib extending to the tip of the posteromedian lobe. Also in Fig. *g* of Kofoid & Skogsberg, the basal major portion of the posteromedian rib is not presented.

In other respects, the present group of specimens, so far as illustrated here, manifests no abnormality but high variability in shape, size and structural differentiation of the left sulcal list bordering the fission rib (Fig. 31 *c*, *h*); the ventral area

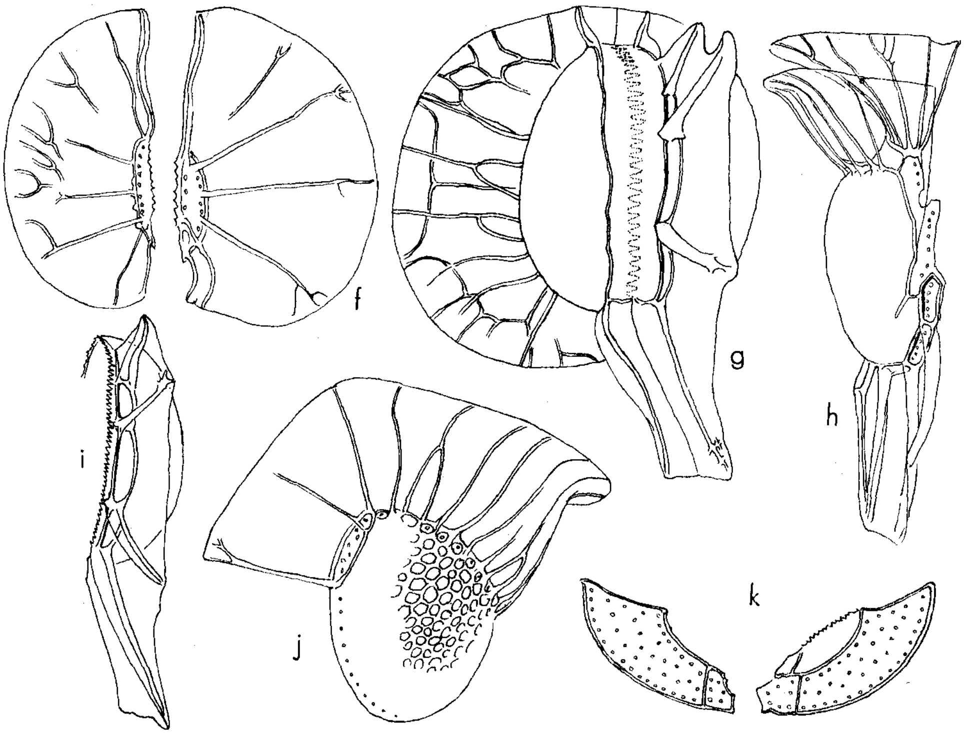


Fig. 31-2. *Ornithocercus skogsbergi* n. sp. *f*, Apical view of isolated epithecae and anterior cingular lists. At the ventromedian corner of respective epithecae, a larger left and a smaller right ventral epithecal plates are seen, each furnished with its own narrow list extending ventrally and demarcated laterally by a rib from the list of the dorsolateral larger epithecal plate. *g*, Oblique antapical view of the body with a broadly grown megacytic zone. The left sulcal list, supported by radial ribs and standing basally along the left side of the zone, comes to cross transversely the zone at the fission rib which is split into a pair of thinner ribs separated laterally by the breadth of the zone. *h*, Ventral view of the isolated right valve of a specimen with the least developed megacytic zone. *i*, Antapical view of a right valve with a weakly formed megacytic zone which can be distinguished as a very narrow belt with the serrated edge along the median of the posterior ventral hypothecal plate and sectioned from the valve by the bases of radial ribs of the left sulcal list. *j*, Ventroposterior view of the isolated left half of the hypotheca, in the anteroventral of which is distinguishable the anterior ventral hypothecal plate and its list. *k*, Isolated lateral sulcal walls, each consisting of a ventral smaller and a dorsal larger plates. The left two epithecal plates are shown in close contact with the left half of the cingular wall.

extends a little beyond the fission rib (Fig. 31 *h*). The posterior moiety of the ventral hypothecal plate is three-times as long as the anterior moiety. In the epitheca, the left ventral of the paired plates is much larger than the other (Fig. 31 *f*, *k*). In Fig. 31 *g* is shown the megacytic zone built between the paired elements of the fission rib formed at the junction between the posterior ventral hypothecal plate and the right dorsal hypothecal plate.

Dimension: Length of body, 42–48 μ. Greatest dorsoventral dimension, 44–49 μ.

Distribution: Sagami Bay. Subtropic warm temperate waters of both the Atlantic and the Pacific.

Ornithocerus magnificus STEIN, s. str. SCHÜTT

(Fig. 32 a-d)

Ornithocercus magnificus STEIN, 1883, partim, Pl. 23, Figs. 1, 2: SCHÜTT, 1900, Fig. 8, 10: JÖRGENSEN, 1923, p. 35, Fig. 48: KOFOID & SKOGSBERG, 1928, p. 529, Fig. 79_{1-9}: LINDEMANN, 1928, Fig. 60 (figure on the right): SCHILLER, 1931, p. 301, Fig. 190 a, b (after KOFOID & SKOGSBERG): WOOD, 1953, p. 203, Fig. 60 a-b.

The present species is characterized by its distinctly three-lobed posterior sail. In typical specimens, there are three radial ribs extending towards the free margin of its median lobe and arranged symmetrically or asymmetrically. According to KOFOD & SKOGSBERG, one or two of the triple may be missing. In lateral view, it is

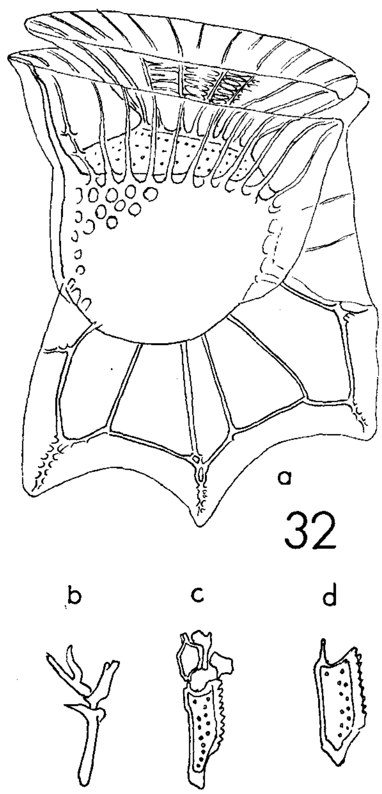


Fig. 32. *Ornithocercus magnificus* STEIN. *a*, Right side-view of a rather small specimen. *b*, *c*, Side-view and ventral view of isolated four sulcal plates. *d*, A ventral view of posterior sulcal plate.

seen clearly that these postero-median triple ribs are lying on the same plane as generally seen in the cases with other species of the genus. The submarginal rib is generally present.

Dimension: Length of body, 43–48 μ. Greatest dorsoventral dimension of body, 41–44 μ.

Distribution: Suruga Bay and Sagami Bay. Widely distributed throughout the tropic, subtropic and warm temperate waters.

Ornithocercus quadratus Schütt

(Fig. 33 a, b)

Ornithocercus quadratus Schütt, 1900, Figs. 2–4: Jörgensen, 1923, p. 37, Fig. 50: Schiller, 1931, partim, p. 204, Fig. 194 a, b.

Syn.: *Ornithocercus assimilis* Jörgensen, 1923, p. 38, Fig. 51.
Ornithocercus quadratus f. *quadratus* Kofoid & Skogsberg, 1928, p. 562, Figs. 85, 86.
?*Ornithocercus quadratus* f. *schütti* Kofoid & Skogsberg, 1928, partim. p. 463, Fig. 86_{8-11}.
?*Ornithocercus quadratus* f. *assimilis*, Kofoid & Skogsberg, 1928, partim, p. 565, Fig. 87_{1-8}.
?*Ornithocercus quadratus* f. *simplex* Kofoid & Skogsberg, 1928, partim, p. 565, Fig. 87_{11-12}.
?*Ornithocercus quadratus* f. *intermedia* Kofoid & Skogsberg, 1928, partim, p. 567, Fig. $87_{15,16}$.
?*Histioneis magnifica* Schröder, 1901, p. 20, Pl. 1, Fig. 15.

There are three diverging ribs in the midposterior region of the sail, which are set closely one another and the median of which is thinner in lateral view than dorsal and ventral neighbours and lying somewhat slantwise as its basal end is deflected towards the right (Fig. 33 *b*). Such a peculiarity has never been ascertained in *Ornithocercus magnificus*. As seen in other species, the posterior ventral hypothecal plate of this species is subdivided in the main (Fig. 31 *g*, *h*, *i*; 34 *c*; 35 *b*) into so many subsections by the base of the radial ribs arranged between the fission rib and the third rib. It is peculiar to see the dorsal and the ventral members of the triple standing across the entire breadth of the posterior ventral hypothecal plate, while the median thinner rib confined basally only at the angulated right corner of a small postero-median pentagonal subsection (Fig. 33 *b*). All the specimens analyzed by the present author invariably exhibited this peculiar structure which had never been described nor illustrated by any authors on any species.

Ornithocercus quadratus has generally been dealt with as a collective species, partly because of a deficiency of morphological analyses and partly of a remarkable variation in the structural differentiation of the sail. It is not certain for the present author whether or not the structural peculiarity of the posterior ventral hypothecal plate is invariably accompanied with the full formation of the median thinner rib. It seems to be more reasonable, for the present author, to put a greater stress upon the peculiarity of the thecal plate than upon the median thinner rib formed on the right side. At any rate, however, the species, *quadratus*, is to be characterized principally by the peculiarity of the shape of the ventral posterior hypothecal plate, but not by shape and size of the sail nor by number and arrangement of the rib on the sail.

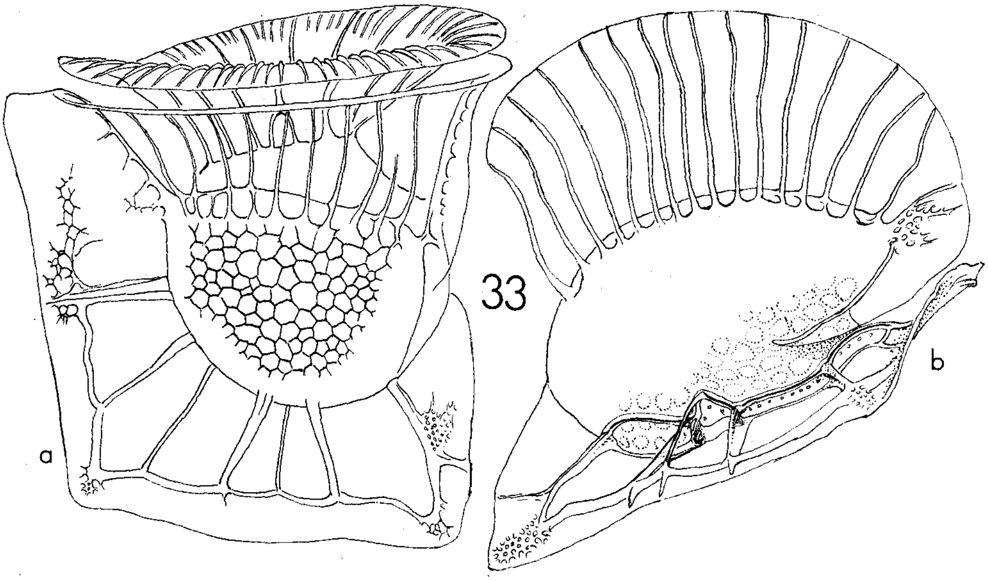


Fig. 33. *Ornithocercus quadratus* SCHÜTT. *a*, Left side-view. *b*, Posterolateral view of a disjoined right half of hypotheca. Though the right posterior cingular and the right sulcal lists are fully illustrated, all of the sulcal plates were lost. The most remarkable is the peculiarity in the shape of the posterior ventral hypothecal plate, subdivided in this case into four subsections, one of which is peculiarly pentagonal in shape. The radial ribs standing on the ventral and dorsal ends of this pentagon are very stout and basally crossing the breadth of the plate, while the other one standing at the lateral corner of the pentagon is much thinner and standing somewhat obliquely. The peculiarity of this plate can be recognized properly only when this figure is compared with Fig. 31 *g-i* or with Fig. 34 *c, e*.

Dimension: Length of body, 56–72 μ. Greatest dorsoventral dimension, 55–72 μ.

Distribution: Sagami Bay. Widely distributed in the tropic, subtropic and warm-temperate waters.

Ornithocercus thurnii (SCHMIDT)

(Fig. 34 a-i)

Ornithocercus thurnii (SCHMIDT) KOFOID & SKOGSBERG, 1928, partim, p. 540, Fig. 81_{8-11}, Pl. 18, Figs. 4–6: SCHILLER, 1931, p. 200, Fig. 191 (after KOF. & SKOGSBG., and MURRAY & WHITTING)

Syn.: ?*Parelion thurni* SCHMIDT, 1888, Pl. 144, Figs. 59–61.

Ornithocercus magnificus STEIN, 1883, partim, Pl. 23, Figs, 4, 5: BÜTSCHLI, 1885, p. 55, Fig. 7: ZACHARIAS, 1906, p. 247, Fig. 7: OKAMURA, 1907, partim, Pl. 4, Fig. 27 a: HJORT, 1911, p. 367, Fig. 4.

Ornithocercus steini JÖRGENSEN, 1923, p. 36, Fig. 49.

Ornithocercus steinii SCHÜTT, 1900, partim, p. 260, Fig. 7.

For a striking variation in the body size and in the shape of the posterior sail, this group of rather large specimens has been differently named by many authors.

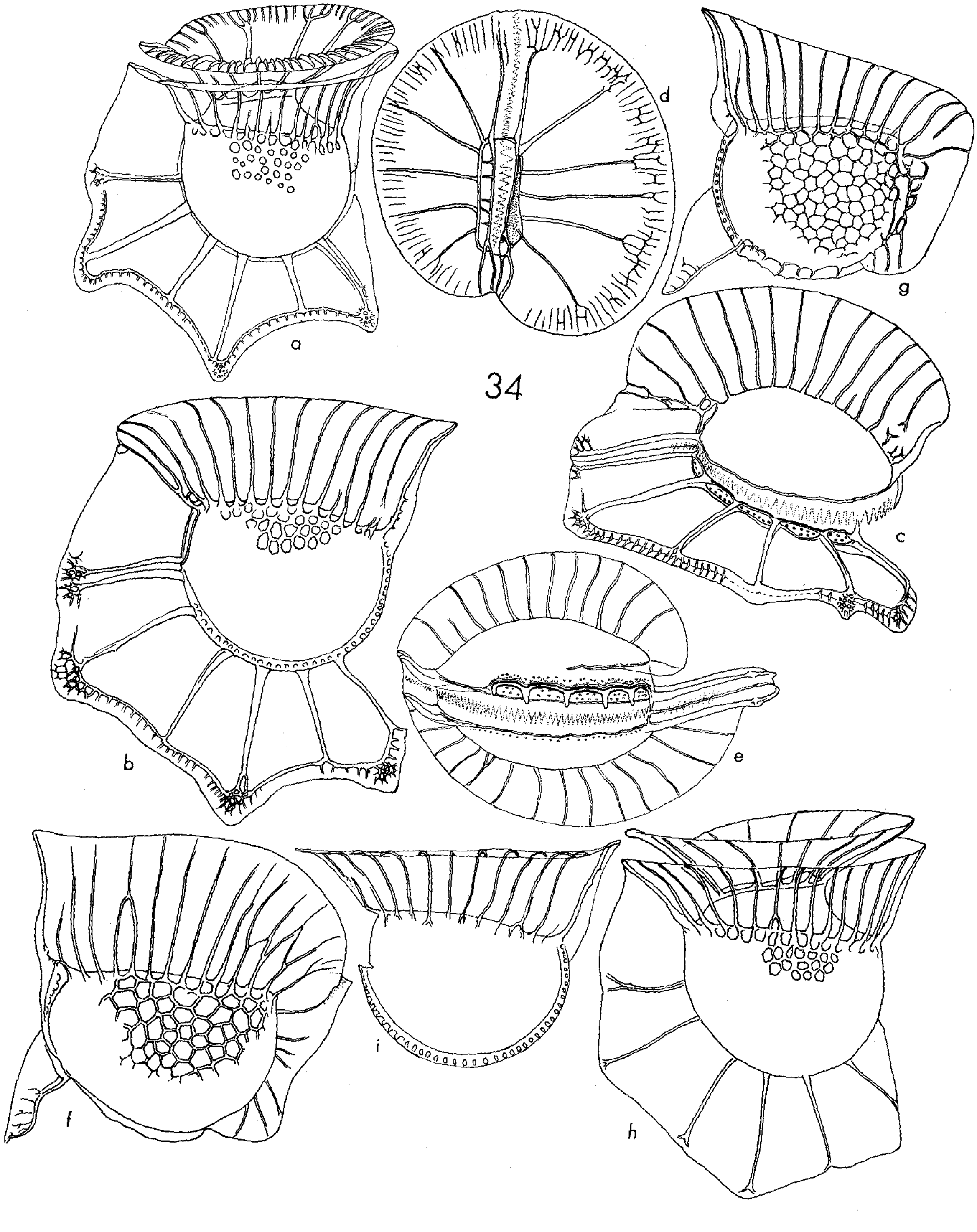
It is still uncertain whether or not this and *Ornithocercus steinii* deserve respectively a distinct specific status. It is true, as was ingeneously expressed by KOFOID & SKOGSBERG (1928, p. 545), that "we are forced to assume that we are dealing with a single systematic unit". And the present author was also led to confirm their conclusion, though tentatively, that the left sulcal list or the sail of this species has "three narrowly to fairly broadly rounded lobes, one in its posteroventral, one in antapical, and one in posterodorsal portions".

Present species, however, served the present author as one of the most suitable material to study the thecal morphology because of its fairly frequent occurrences in Shimoda Bay. Fig. 34 *d* is the apical view of an isolated epitheca with the moderately grown megacytic zone. The median zigzag line represents the fission suture. The distal marginal rim of the anterior cingular list forms in its intact state (Fig. 34 *h*) a somewhat spirally wound tract. In Fig. 34 *d*, the list was made flat to know the exact breadth along its entire circular course. In consequence of this treatment, the epitheca in Fig. 34 *d* is somewhat twisted along its dorsoventral axis.

As elucidated by Fig. 34 *d* and *e*, the increase of breadth of the megacytic zone scarcely bring forth any change in dorsoventral dimension of both the epitheca and the hypotheca, but only the increase in lateral dimension. For similar reason that the megacytic zone is flat in both the epitheca and hypotheca, the body length is kept fairly constant throughout the whole growing stages of the breadth of the sagittal zone. Another peculiarity is that the sagittal growth zone increases regularly its breadth dorsally in the epitheca, whereas in the hypotheca the breadth increase of the zone is confined mainly within the length of the sulcus. It is not cleared how the growth zones are distributed and in what way the zone becomes broader posteriorly within the sulcus.

Regardless of the development of the growth zone, the dorsoventral dimension of the hypotheca is about two times greater than its lateral dimension, whereas the dorsoventral dimension of the epitheca, which is as large as the lateral dimension of the hypotheca, is 6–7 times greater than its lateral one. One can establish in Fig. 34 *d*, a smaller right and a little larger left ventral epithecal plates, each furnished along their ventral margin with a narrow but fairly long list, by which the anterior cingular list is completely closed at its midventral. Even by the growth zone formation, the closed midventral of the cingular list cannot be opened.

Two isolated right dorsal hypothecal plates, derived from different specimens, are illustrated in Fig. 34 *f* and *g*. The former is fairly pressed to be flattened to show the actual breadth of the cingular list, consequently the ventralmost of the cingular list and the anteriormost of the right sulcal list are strongly folded. In the latter, the thecal plate is deformed least. Comparing these two figures, one can see variations not only in number and arrangement of ribs in both the cingular and the right sulcal list but also in some other morphological features. Only in these isolated plates, one can detect a low subsagittal list standing along the posterior margin


a
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34

between the rear end of the right sulcal list and the third conjoined rib of the left sulcal list. This subsagittal list is rather indistinct and cannot be seen in intact specimens, yet it exhibits individual variations in the structural differentiation as seen in figures. Another list-like structure is seen, in Fig. 34 *g*, along the dorsal side of the dorsalmost rib of the cingular list; this can be traced much further posteriorly in Fig. 34 *f*. In this connection, it is to be noticed that two different such lists are illustrated also in Figs. 32 *a* and 35 *a*, in both of which one of the two lists can be traced much further than the other and posteriorly overlapping, though partly, the anterodorsal end of the left sulcal list. In Fig. 34 *e* it is shown that these structures are formed along either side of the megacytic zone. Further posterior extension of these lists is apparently correlated to the growth in breadth of the megacytic zone, though the structural relations between them has not yet been clarified.

The left dorsal hypothecal plate is, on the contrary, much simpler in its structure as illustrated in Fig. 34 *i*, in which the anterior ventral hypothecal plate is lost, leaving a corresponding broad but shallow dent at the anteroventral portion of the thecal plate.

Surface observation of the structural differentiation seen along the contact faces between the two thecal valves was already made in regard to *Dinophysis*. Differing from that case, here are illustrated optical sections of the contact faces in Fig. 34 *b*, *g* and *i*; especially Fig. 34 *g* was drawn as accurately as possible. Slowly adjusting the focus of the microscope, one can see along the serrated margin a row of brighter or darker rings respectively with subequal diameters and arranged regularly. By lowering or raising the focal plain, it is seen that the diameter of rings becomes larger and then fairly abruptly invisible, and next there emerge new rings of a different brightness, one at each interval between any two former adjoining rings; they become

Fig. 34. *Ornithocercus thurnii* (SCHMIDT). *a*, Lateral view of a rather small specimen. *b*, *c*, Left side-view and oblique antapical view of the same left half of the hypotheca keeping a close contact with the posterior ventral hypothecal plate, with a well formed megacytic zone between. The fission rib in this species is doubled, this is noticed in Fig. 33 *b*, and 34 *a-c*. It is noteworthy that the submarginal ribs of the list are formed on only one-side surface of the list. *d*, Apical view of an isolated epitheca with the anterior cingular list, rather strongly flattened anteroposteriorly. Partly due to the pressure and partly because of the spirally descending tract of the cingular free margin, the epitheca itself is twisted along its dorsoventral axis. Thus the seeming unequality in size and shape of the two epithecal halves is brought forth. *e*, The posterior half of the ventral hypothecal plates is clearly illustrated, bearing along its lateral margin the basement of the left sulcal list; the radial ribs of the list are extending from the basement medianwards across the entire breadth of the plate to the sagittal fission suture. *f* and *g* represent respectively the right dorsal hypothecal plates derived from different specimens. In *f* the specimen is compressed laterally to see the actual breadth of the posterior cingular list, thus the anterior cingular list and the right sulcal list are partly folded in a zigzag fashion. In *g*, the specimen is in a natural state. *h*, Side-view of a specimen without submarginal ribs on the left sulcal list. It is to be noted that a narrow parasagittal list can be seen in both of *f* and *g*, between the right sulcal list and the dorsalmost portion of the left sulcal list. This structure is so delicate that it can hardly be seen in the lateral view of intact body: it shows slight individual variations in width and structural differentiation. *i*, Lateral view of the left dorsal hypothecal plate, isolated from other portions. A broad but shallow notch along the anteroventral margin corresponds to the disjoined anterior ventral hypothecal plate.

again smaller and finally fade away. These two sorts of rings may represent respectively the alternately arranged dents and serrae. In favourable conditions one can distinguish on either or both sides of the linearly arranged rings an optical cross section image of an extremely thin lamella. The above-mentioned observations well agree with what described on *Dinophysis cuneus* (Fig. 24 *e-h*).

The zigzag feature of the sagittal suture could be established fairly clearly not only in the thecal wall encrusting the protoplasmic mass but also in grown zones of the cingular and the sulcal lists. In both of Fig. 34 *c* and *e*, moieties of the fission ribs are separated laterally from each other by the breadth of the growth zone, but are connected by a newly built, transversely stretched strip of the list, along the middle of which is seen a zigzag fission suture.

As visually illustrated in Fig. 34 *e*, the posterior major portion of the left sulcal list is seen standing along the lateral margin of the posterior ventral hypothecal plate, whereas bases of the radial ribs of that part of the list are strongly flattened dorsoventrally and standing across the entire breadth of the plate, protruding out from the list surface towards the sagittal suture. Just similarly, the submarginal rib of the list is built on the median surface of the list (Fig. 34 *c*).

Dimension: Length of body, 48–56 μ. Greatest dorsoventral dimension, 46–58 μ.

Distribution: Sagami Bay. Widely distributed in the tropical, subtropical and warm temperate waters.

Ornithocercus steini SCHÜTT

(Fig. 35 a-c)

Ornithocercus steini SCHÜTT, 1900, partim, Figs. 5, 6: JÖRGENSEN, 1923, p. 32, Fig. 49: DANGEARD, 1927, p. 383, Fig. 45 a: KOFOID & SKOGSBERG, 1928, p. 551, Fig. $93_{1-8,\,10-12(?9)}$, Pl. 16, Fig. 1: WOOD, 1953, p. 203, Fig. 62: GAARDER, 1954, p. 35, Fig. 41.

Syn.: *Ornithocercus steinii*, SCHILLER, 1931, p. 202, Fig. 192 (after KOF. & SKOGSBG.)
Ornithocercus serratus KOFOID, 1907, p. 207, Fig. 95: JÖRGENSEN, 1923, p. 38, Fig. 52.
Ornithocercus spp., KOFOID & SKOGSBERG, 1928, p. 581, Fig. $92_{4-6,\,8}$.
Ornithocercus magnificus STEIN, 1883, partim, Pl. 23, Fig. 2.

This is one of the least definable species. KOFOID & SKOGSBERG (1928) assigned to this species somewhat large forms with the broad left sulcal list supported by radial ribs more or less angulated at the distal end. It is to be remembered in this respect that in many larger species of *Ornithocercus*, not only the number, arrangement, branching, distribution and the shape of ribs of the list but also the shape and size of the list itself are often highly variable. A form which KOFOID & SKOGSBERG (1928) assigned to this species has a broad but nearly rounded list (Fig. 83_{10}). GAARDER's (1954) form has also a rounded list. Then the specimen shown in Fig. 35 *c* can be assigned neither to *Ornithocercus thurni* nor to *Ornithocercus steini* so long as the taxonomic stress is put upon the shape of the left sulcal list, although it seems

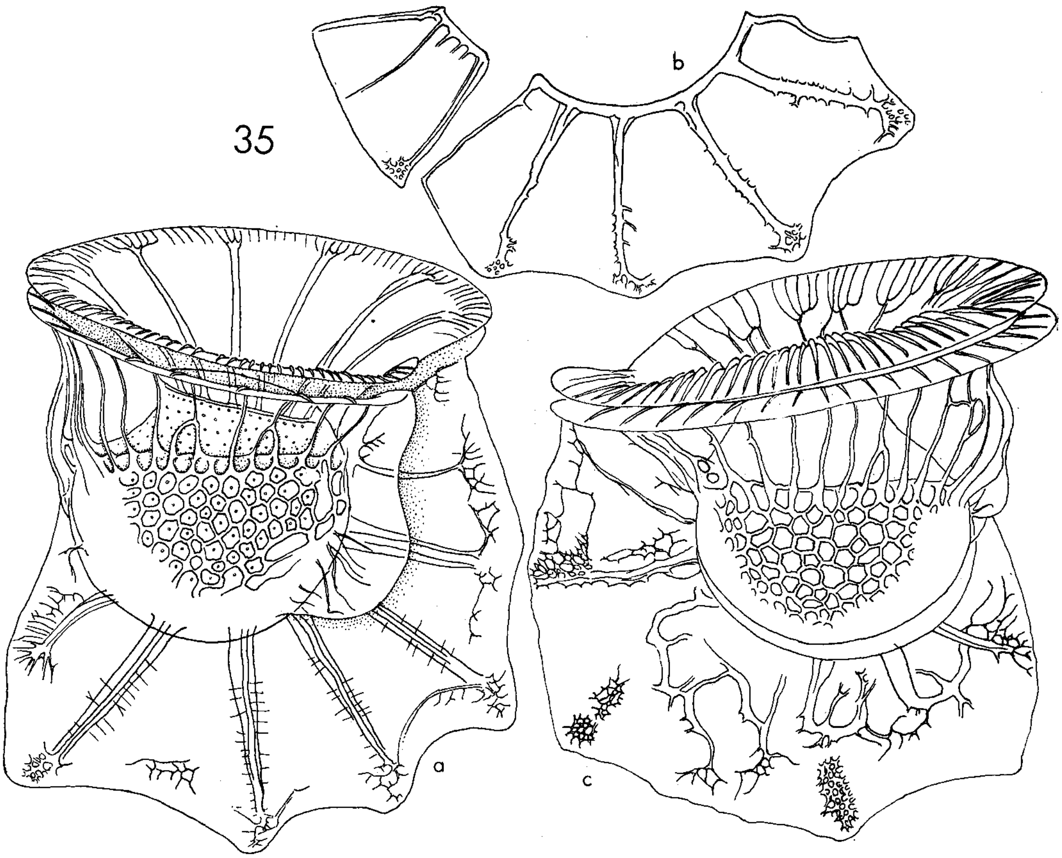


Fig. 35. *Ornithocercus steini* SCHUTT. *a*, Side view. *b*, Lateral view of the two ventral hypothecal plates and their lists, isolated from the other specimen. *c*, An aberrant form of *O. steini*.

very reasonable not to distinguish this from the specimen shown in Fig. 35 *a* when other morphological features are taken into account. For these facts and considerations, this specimen may be dealt tentatively as *Ornithocercus steini*. In Fig. 35 *b* is given the left side-view of the isolated paired ventral hypothecal plates together with their lists.

Dimension: Body length is subequal with the greatest dorsoventral dimension, ca. 70 μ respectively.

Distribution: Sagami Bay. Widely distributed in the tropic, subtropic and warm temperate waters.

Ornithocercus francescae (MURRAY & WHITTING) BALECH

(Fig. 36 a, b)

Ornithocercus francescae, BALECH, 1962, p. 136, Pl. 18, Fig. 259.

Syn.: *Histioneis francescae* Murray & Whitting, 1899, p. 333, Pl. 32, Fig. 3.
Parahistioneis francescae, Kofoid & Skogsberg, 1928, p. 495, 511, 590, 592: Schiller, 1931, p. 210, Fig. 198 (after Murray & Whitting).
Ornithocercus carolinae Kofoid, 1907, p. 205, Pl. 15, Fig. 92: Mangin, 1915, p. 75, Fig. 17_6: Jörgensen, 1923, p. 38, Fig. 53: Kofoid & Skogsberg, p. 572, Fig. 89_{1-7}, Pl. 17, Figs. 1, 6: Wood, 1953, p. 210, Fig. 64: Balech, 1962, p. 135, Fig. 260.

Although Kofoid & Skogsberg (1928, p. 576) described that "According to Murray and Whitting's (1899, Pl. 32, Fig. 3) figures, the type of *Histioneis francescae* differs from our atypical members of *Ornithocercus carolinae* mainly in having the entire posterior cingular list finely and evenly reticulated, while in our specimens this list is ribbed. A reinvestigation of the relationship between these two species is necessary", there must be some misunderstanding on the side of Kofoid & Skogsberg, because the specimen treated in this paper which is indistinguishable from both of the above-mentioned species in general morphological features, has the posterior cingular list finely and evenly reticulated superficially but essentially ribbed regularly. In short, the present author confirmed regularly arranged ribs through the densely areolated outer surface of the list in his specimen. In this regard, it is to be noted that the present specimen has the fairly well-formed megacytic zone and well-thickened thecal walls, presumably just like the specimen figured by Murray & Whitting.

It can be concluded, then, Kofoid's (1907), Jörgensen's (1923) and Kofoid

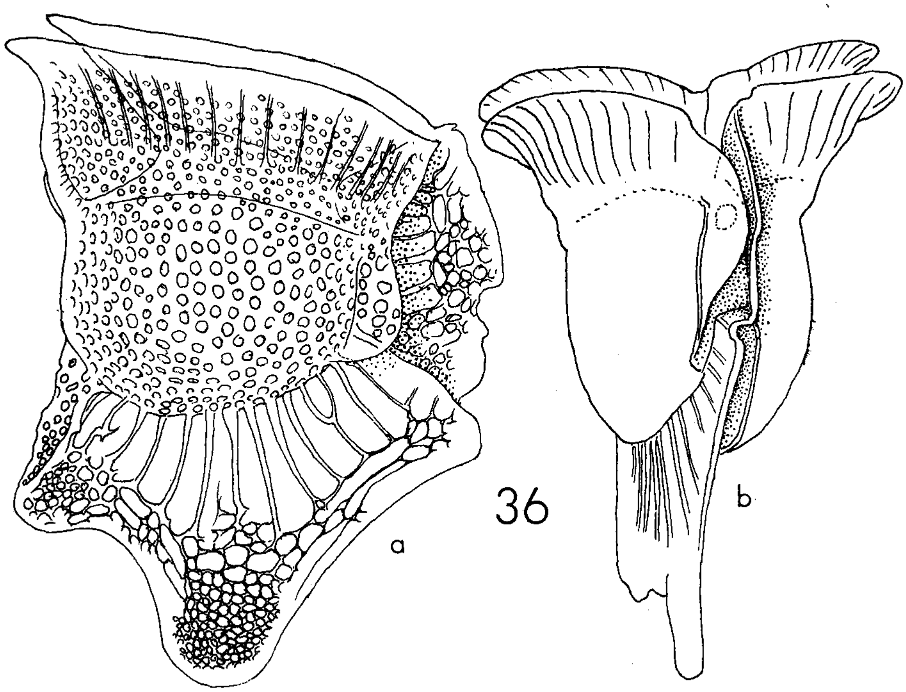


Fig. 36. *Ornithocercus francescae* (Murray & Whitting) Balech. *a*, Left side-view. *b*, Ventral view.

& SKOGSBERG's (1928) figures represent the younger and thin-walled forms, whereas MURRAY & WHITTING's (1898) and the present ones are well grown and thick-walled specimens of the same species.

Dimension: Total length of body, 48 μ.

Distribution: Sagami Bay. Widely distributed in the tropic and subtropic regions of the Mediterranean, Pacific and the Atlantic.

Genus *Parahistioneis* KOFOID & SKOGSBERG

KOFOID & SKOGSBERG 1928: SCHILLER, 1931.

KOFOID & SKOGSBERG (1928) established the genus *Parahistioneis*, to which were assigned nine species of *Histioneis* besides one new species; later SCHILLER (1931) and BOHM (1931) reported four new species of this genus. KOFOID & SKOGSBERG distinguished *Parahistioneis* from *Histioneis* mainly by the absence of the submarginal cross-rib of the posterior cingular list in the former. In this respect, it is to be noted that *Histioneis dentata* MURRAY & WHITTING was assigned by KOFOID & SKOGSBERG to *Parahistioneis* but was reassigned by SCHILLER (1931) to *Histioneis*, presumably because of MURRAY & WHITTING's original figures reproduced by SCHILLER (1931, p. 253, Fig. 249 a, b), in which the cross-rib is clearly illustrated. No one has ever described about the plate pattern of this genus. Review of the literature, however, seems to lead us to conclude that the paired ventral hypothecal plates are longitudinally arranged, extending to or nearly to the midposterior point of the hypotheca with the exception of *Parahistioneis mediterranea* SCHILLER, in which the fission rib is not illustrated and that the anterior moiety of the paired plates clearly illustrated by KOFOID & SKOGSBERG on *Parahistioneis diomedeae* (Pl. 19, Fig. 4), *P. paraformis* (Pl. 19, Fig. 6) and also on *P. reticulata* (Pl. 19, Fig. 10) is just as in the cases with members of *Ornithocercus*.

Genus *Histioneis* STEIN

Histioneis STEIN, 1883: BÜTSCHLI, 1885: SCHÜTT, 1896: DELAGE & HÉROUARD, 1896: KOFOID & SKOGSBERG, 1928: LINDEMANN, 1928: SCHILLER, 1831.

This genus is characterized by somewhat anteroposteriorly flattened body, the stalked and distally flared anterior cingular list, and the erected posterior cingular list furnished with laterally lying cross-ribs. About forty species have been assigned to this genus. It is not certain, however, how many species of them are really valid. This is partly due to their rare occurrences and to minuteness and transparency of the body, but largely due to lack of exact knowledge about the detailed morphological features of the body, particularly of the cingular and the sulcal lists, and also about the extent, degree and the direction of variations found in these structures. When such detailed morphological features and their variations are unveiled to some extent, number of valid species will be decreased considerably. In any case, however, in many of reported species the second (fission) rib is illustrated as being of double structure, by means of which one can suggest with least uncertainty the relative or total length of two ventral hypothecal plates, their anteroposterior arrangement, and in addition the development of the sagittal growth zone of a considerably breadth which in turn suggests a fairly low rate of productivity presumably in association with the high oceanic habitat of those species.

Histioneis hippoperoides Kofoid & Michener

(Fig. 37 a-c)

Histioneis hippoperoides Kofoid & Michener, 1911, p. 296: Kofoid & Skogsberg, 1928, p. 701, Fig. 96_5, Pl. 23, Fig. 1, 3: Schiller, 1931, p. 251, Fig. 247: Wood, 1953, p. 214, Fig. 70 *d*.

A single specimen of this species was collected from the mouth of Shimoda Bay by a surface haul made at a time of rising tide when the offshore water was coming into the Bay. So far as learned from its lateral outline (Fig. 37 *a*, *b*), it is closely related to some of *Histioneis milneri*, *H. helenae* and *H. hippoperoides*, all of which are known fairly incompletely as to their detailed morphological features. The first two species seem, however, to differ from the present specimen in lack of a pair of strongly bulged lateral pouches formed by the posterior cingular list. The present specimen is then to be assigned to the last of the three, *Histioneis hippoperoides*, which, according to Kofoid & Skogsberg (1928, Pl. 23, Fig. 1), has well bulged pouches. In addition, the present form agrees with that species in having a reticulated small region limited to the right posteroventral corner of the posterior cingular list, though the meshes of the region in the present specimen are not so fairly regular as in Kofoid & Skogsberg's, but somewhat radially elongated.

Kofoid & Skogsberg's descriptions about the reticulation formed in the distal half of the cingular lists and in the anterior half of the left sulcal list differ somewhat from the features found on the present specimen; this disagreement is in all probability due to individual variations. One point to be noted here is that every partition sectioned by meshes on the left sulcal list is so distinctly convexed towards the left in the present specimen that the mesh work of the sulcal list cannot be recognized in the ventral view of the body.

Dimension: Length of body 27 μ. Greatest dorsoventral length of body, 38 μ. Total length, 94 μ.

Distribution: Sagami Bay. One specimen was recorded, according to Kofoid & Skogsberg, from the east tropic Pacific, off the Pacific coast of middle Mexico, at 18°50′N., 104°50′W.

Histioneis pietschmani Böhm

(Fig. 38 a-b)

Histioneis pietschmani Böhm, 1931, p. 247, Fig. 241: Schiller, 1931, p. 247, Fig. 241: Balech, 1962, p. 137, Pl. 17, Figs. 256–257.

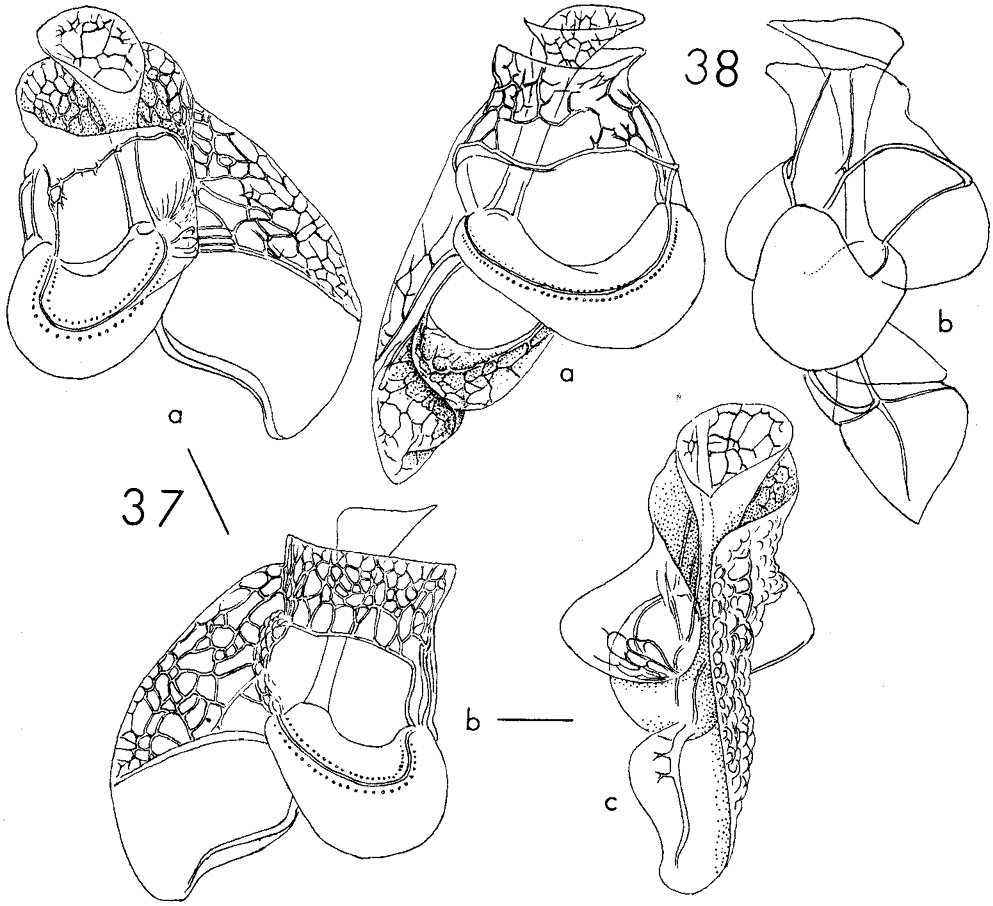


Fig. 37. *Histioneis hippoperoides* KOFOID & MICHENER. *a*, Right side-view. *b*, Left side-view. *c*, Ventral view.
Fig. 38. *Histioneis pietschmani* BÖHM. *a*, Left side-view. *b*, Oblique dorsal view.

The body is banana-like with its thicker dorsal half bending anteriorly much further beyond the level of the epitheca, and a little less than its anterior half is covered with the cingular wall. The anterior cingular list forms a long-stalked and distally flared trumpet shaped free margin which is notched on the ventral. The posterior cingular list forms laterally on each side in its basal half below the cross-rib a broad rounded pouch, the greatest lateral diameter of which is about two times greater than that of the body (Fig. 38 *b*). This postcingular list decreases the diameter distally to form a slight but distinct constriction in a short distance to the free margin, towards which the list flares. The distal half of the postcingular, anterior to the cross-rib, is irregularly reticulated. The fission rib of the left sulcal list, usually paired owing to the grown megacytic zone, extends nearly posteriorly and the third rib of the left sulcal list stands just at the middle of the ventro-dorsal outline of the hypotheca. This portion of the left sulcal list lying between the fission and the third ribs is fairly broad, extending somewhat postero-ventrally, and in lateral outline its distal end is acutely pointed. These two ribs are connected with each other by a posteriorly arched cross rib, along the entire length of which is formed a horizontal shelf-like fin which splits at the dorsal end into an anterior and a posterior wing to form a rhombic fin perpendicularly fringing the dorsal margin of the posteriorly extended sail (Fig. 38 *a*). This posterior part of the left sulcal list is irregularly reticulated except the portion encircled by the arched cross-rib and the midbody. This clear part is a little less than the anterior half of the sail.

Dimension: Length of body, 18 μ. Greatest dorsoventral length of body, 95 μ. Total length, 105 μ.

Distribution: Suruga Bay and Sagami Bay. The Indian Ocean (BÖHM). From three stations in the sea lying between Borneo and the Sunda Islands (04°05'S, 113°13'W; 02°N. 115°52'W; 10°02'N, 118°58'W.) by BALECH (1962).

Histioneis mitchellana MURRAY & WHITTING

(Fig. 39 a-c)

Histioneis mitchellana, KOFOID & SKOGSBERG, 1928, p. 690, Fig. 96 A, Pl. 21, Fig. 2: SCHILLER, 1931, p. 245, Fig. 239 (after MURRAY & WHITTING).

Syn.: *Histioneis pulchra* KOFOID, 1907, p. 205, Pl. 16, Fig. 99: KOFOID & SKOGSBERG, 1928, p. 686, Fig. 96_2, Pl. 21, Figs. 4, 7, Pl. 23, Fig. 2: SCHILLER, 1931, p. 243, Fig. 237 (after KOF. & SKOGSBG.)

A single specimen of this species was found in the plankton sample taken by a surface haul in the mouth of Shimoda Bay at a rising tide. *Histioneis hippoperoides*, *H. pietschmani* and this species occurred in samples collected from the same mouth region of the bay and only at the time of the rising tide, though on different days.

The present specimen is partly related to *H. mitchellana*, but partly to *H. pulchra*, too. KOFOID's and his collaborator's figures of *H. pulchra* apparently represent the same specimen. While KOFOID (1907) stated that he found this species at three stations and KOFOID & SKOGSBERG (1928) reported the species at twenty stations, measurements of body dimensions were made on two specimens only. KOFOID (1907) distinguished *H. mitchellana* from *H. pulchra* only by the "fine, delicate, and more or less regular" reticulation on the cingular and the sulcal lists of the former. According to KOFOID and his collaborator, the midbody of *H. pulchra* is rather less elongated dorsally but more strongly recurved anteriorly in its distal half, while in *H. mitchellana* the body is a little more elongated, slanting down posterodorsally along its ventral, but recurved anteriorly much less distinctly at its distal end. The present West Pacific specimen is akin to *H. mitchellana* in its body shape extending fairly well horizontally in the ventral half and recurving anteriorly in its dorsalmost portion, being raised distally further beyond the epitheca. In short, the presnt specimen

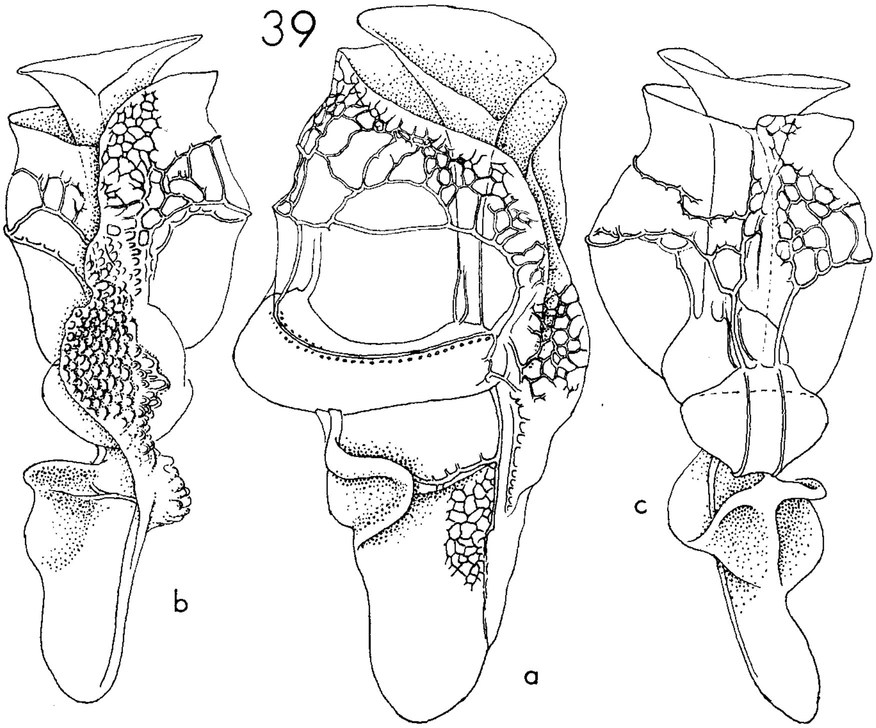


Fig. 39. *Histioneis mitchellana* MURRAY & WHITTING. *a*, Right side-view. *b*, Ventral view. *c*, Dorsal view.

is intermediate not only in the shape of the midbody but also in that of the posterior sail between the two species, and leads us to suggest their taxonomic unity.

Histioneis cymbalaria, H. pulchra, H. mitchellana and *H. schilleri* agree with one another in having a broad and fairly elongated posterior sail, standing basally along the entire length of the posterior or dorsal hypothecal plate and divided by a dorsoventral rib into the anterior meshless portion and the posterior well reticulated portion, just as in *H. pietschmanni* which differs from all of the above cited ones in its posteroventrally extended posterior sail. The last of the five species cited above differs greatly from the other four in the shape of the sail, acutely angulated posteriorly, and in addition in the shape of the ventral sail standing along the anterior ventral hypothecal plate and having a broad and peculiarly pointed ventral lobe. KOFOID & SKOGSBERG (1928) regarded *H. cymbalaria* STEIN (1883) as a valid species basing on an old literature only, in which any accuracy in detailed morphology cannot be expected because no further morphological observation of this has ever been presented since STEIN. So far as judged on literature, this species seems to lack the bilaterally expanding list neither along the arched dorsoventral rib nor along the dorsal side of the posterior sail. Although the detailed structure of the posterior sail had not generally been taken into account in the majority of old papers, it is worthy to note that MURRAY & WHITTING's original figures, cited by SCHILLER (1931), exhibited the lateral and dorsoventral outlines of *H. mitchellana,* in which are clearly illustrated the existence of both a broader dorsoventral and a little smaller bilaterally expanding structures of the posterior sail, although their mutual relations are yet obscured. This peculiar structural relation of the sail had seemingly been overlooked till KOFOID (1907) figured *H. pulchra* in which was shown a structure suggestive of the bilateral extension. Under the same specific name of *H. mitchellana,* KOFOID & SKOGSBERG (1928) presented two quite different forms, one (Fig. 96–4, p. 620) corresponding to *H. pulchra* (Fig. 96–2, Pl. 21, fig. 7) and the other corresponding to MURRAY & WHITTING's figure of the lateral outline of *H. mitchellana* illustrating none about the bilaterally expanding sail. Independently of them, BALECH (1962) described and figured *H. pietschmanni* which is provided with both the dorsoventral and bilaterally expanding portions of the posterior sail.

Thus reviewing literature, we have come to learn the taxonomical importance to know whether or not the bilaterally expanded lists are absent and also to know how the dorsoventral list and the bilaterally expanded list are structurally related with each other. As discussed above, only *H. pulchra* and *H. mitchellana* are the species worthy to be considered here for the purpose to study the specific status of the present specimen.

So far as the present author's carefully carried morphological analyses revealed, the structural peculiarity of the posterior sail in the present specimen is shown in detail in Fig. 39. Its sail is more closely related, as a whole, to that of *H. mitchellana* MURRAY & WHITTING (1899) than that of *H. pulchra* KOFOID. But, in regard to the structural peculiarity seen along the dorsal margin of the sail, the present specimen seems to correspond to KOFOID's (1907) or KOFOID & SKOGSBERG's (1928) *H. pulchra,* and, in addition, to one of the latter authors' *H. mitchellana* (Fig. 96–4). The bilaterally extended longitudinal list in the present specimen arises from the base of the third rib and is deeply folded along the dorsal-most portion of the cross rib, along which is formed another horizontally expanded list. The longitudinal list, recurves dorsally and then extends further posteriorly along the dorsal margin of the main dorsoventral sail. In other words, the horizontal list built along the cross rib split anteroposteriorly in its dorsal half or dorsal one-third to form the bilaterally expanded longitudinal list. The same peculiarity was ascertained also in *H. pietschmani,* but not illustrated in the other form of KOFOID & SKOGSBERG's *H. mitchellana.* Judging from MURRAY & WHITTING's drawing of *H. mitchellana* dorsoventrally viewed, the authors' form has in all probability a similarly shaped bilaterally expanded longitudinal list. So far as the present author believes, carefully made figures based on exact and detailed morphological analyses may be more eloquent than routine descriptions. It is interesting to note that one of KOFOID & SKOGSBERG's two figures of *H. mitchellana* (Pl. 21, Fig. 2) resembles so closely the lateral aspect of the same species presented by MURRAY and WHITTING.

Basing on these considerations, the present author is inclined to regard, at the present level of our knowledge, *H. pulchra* and *H. mitchellana* represent together one and the same species, though some uncertainty is still left about the variability in extent of the lateral pouches built by the posterior cingular list.

Dimension: Length of body, 12–20 μ according to different points of the body. Greatest dorsoventral dimension, 53 μ. Total length, 140 μ.

Distribution: A single specimen from Sagami Bay. MURRAY and WHITTING found this species from the Atlantic Ocean and the Caribbean Sea, between lat. 15° 50′ N. and 34° 30′ N., and between long. 30°W. and 70°W.; SCHRÖDER recorded this from the Indian Ocean (according to KOFOID & SKOGSBERG: 1928, pp. 693–694). KOFOID & SKOGSBERG (1928) reported the occurrences of this species in the East Pacific covering the region including the Paumotu Archipelago, Easter Island Eddy, the South Equatorial Current and the Mexican Current. The specimens were found in samples usually from 300 fathoms, but not a single specimen from the very surface as in Shimoda Bay.

Genus *Citharistes* STEIN

Citharistes STEIN, 1883: BÜTSCHLI, 1885: SCHÜTT, 1896: DELAGE & HÉROUARD, 1896: KOFOID & SKOGSBERG, 1928: LINDEMANN, 1928.

This is a unique genus comprising two species. The body is horseshoe-shaped; the ventral half of the gody is elongate and fairly straight, while the dorsal half of the hypotheca is broadly and posteroventrally indented. The small but distally flared anterior cingular list lies around the small and weakly rounded anterior end of the body, whereas the posterior cingular list lies basally somewhat close to the anterior cingular list in the ventral minor region, but it moves posteriorly or posteroventrally along the entire length of the large dorsal depression of the hypotheca. This dorsal portion of the posterior cingular list extends anteriorly to the level just corresponding to the free margin of its ventral portion, thus forming a canal along the anterodorsal region of the epitheca and the so-called large phaeosomal chamber between the epitheca and the large dorsal depression of the hypotheca. This peculiar structure is correlated with the dorsoposterior elongation of the cingular portion without any length reduction of the ventral half of the hypotheca. Presumably the primitive stage of this feature is conceivable in *Histioneis highlei* MURRAY & WHITTING, in which the epitheca lies deep in the bottom of the high collar-shaped cingular sulcus. In contradiction to some authors' imagination, the present genus seems to show some closer relationship to *Histiophysis* rather than to *Dinophysis*, not only in the shape and size of the anterior cingular list but also in the lateral outline of the body and in total and relative length of the longitudinally arranged ventral paired hypothecal plates, which can be estimated from the sites of the second and third ribs of the left sulcal list shown in figures appeared in the literature (refer to Diagram 1).

In contradiction to the *Dinophysis—Citharites* group, the following five genera, *Metaphalacroma, Heteroschisma, Oxyphysis, Amphisolenia* and *Triposolenia* form together, as far as the present author believes, a quite different evolutionary stem. In addition to the four sulcal plates, the paired sets of ventral epithecal and hypothecal plates, at least of the hypothecal ones, were ascertained in all genera by the present author's morphological analyses or by his reviewing literature. The arrangement of the four sulcal plates is constant throughout these genera, while the ventral hypothecal plates exhibit two types of arrangement. As given before, the differentiation of "a postcingular plate" in the left ventral of the hypotheca in a few special cases has been overestimated by some authors as being of utmost importance in the taxonomy of this group of dinoflagellates. In this respect, it is to be noticed that the so-called postcingular plate has neither direct contact with the sulcus nor any essential influence to bring forth some variation or deformation of the shape of the sulcus and the cingulum or to induce the disarrangement of the ventral hypothecal plates. In consequence, the emergence of the postcingular plate is distinct and noteworthy, but it is of secondary importance in the taxonomy of Dinophysidae.

Genus *Metaphalacroma* TAI & SKOGSBERG

Metaphalacroma TAI & SKOGSBERG, 1934, p. 457.
Syn.: *Pseudophalacroma,* TAI & SKOGSBERG, 1934 (not JÖRGENSEN 1923).

JÖRGENSEN (1923) established a new genus *Pseudophalacroma* for *Phalacroma nasutum,* basing in all probability on his misinterpretation that the sulcus in that species is prolonged anteriorly beyond the girdle for a considerable distance (about 2/3 of the distance from the girdle to the apex), and there it forms a dilated round end, protected by a raised edge. In no case, however, in Dinophysidae, the sulcus is prolonged anteriorly beyond the anterior cingular list which is closed invariably on the midventral. In the majority of small or medium-sized specimens of *Dinophysis,* a ventral minor portion of the epitheca in lateral outline is tilting down ventrally and more or less distinctly differentiated from the remaining major dorsal portion; not infrequently this tilting portion is furnished along its left side with an indistinct list (Fig. 5 *g*).. The present author could ascertain that this structure is nothing but a portion covered by the paired ventral epithecal plates separated from the cingulum by the anterior cingular list. TAI & SKOGSBERG (1934) described and figured under the name of *Pseudophalacroma nasutum* a species apparently different from either JÖRGENSEN's or STEIN's. A new genus *Metaphalacroma* was established by the same authors for a quite different species which is characterized by a small subtriangular anterior ventral hypothecal plate lying along the postcingular ridge and the other posterior ventral hypothecal plate extending along the entire length of the sulcus, between the cingulum anteriorly and the rear end of the sulcus posteriorly but never beyond it. And just the similar structure can be seen on TAI & SKOGSBERG's *Pseudophalacroma nasutum* which has the ventrally closed anterior cingular list, as shown clearly in their illustrations Fig. 13 *i* and *j*. These two species reported by TAI & SKOGSBERG (1934) agree with each other in the structural relationship between the sulcus and the two ventral hypothecal plates which show rather a lateral arrangement as schematically illustrated in Diagram 2 C. In these respects, these two species cannot be assigned to *Dinophysis* on one hand, and JÖRGENSEN's characterization of the genus *Pseudophalacroma* is unacceptable on the other hand. Consequently, then, the present author is led to conclude that these two species are to be most reasonably unified under the generic name *Metaphalacroma.*

Genus *Heteroschisma* Kofoid & Skogsberg

Heteroschisma Kofoid & Skogsberg, 1928: Schiller, 1931.

Kofoid & Skogsberg (1928) established this genus for two new species, *aequale* and *inaequale*, basing respectively on a single extremely megacytic specimen and on a moderately megacytic one. The authors characterized this genus "by a triangular postcingular plate, occupying the ventroanterior corner of its left hypotheca" (p. 37, somewhat emended). In these specimens, the megacytic zone on the ventral of the body runs anteriorly along the entire length of but outside the sulcus, seemingly without entering into the sulcus, and finally crossing the cingulum. In regard to *Heteroschisma inaequale*, the authors described that "In the entire triangular field about sixteen meshes are to be found." Judging from Pl. 1, Fig. 2, within the so-called triangular field one can distinguish fifteen subequal smaller meshes and a much larger triangular one occupying the anteroventral corner of the field. The morphological as well as the taxonomic significance of this larger mesh has been overlooked, but really it can be nothing but the anterolateral moiety of the ventral hypothecal plates. In the ventral view of *Heteroschisma aequale* (Pl. 1, Fig. 7) is shown a minute, triangular pocket-like structure, superficially looking like a wavy folding of the posterior cingular list, just on the anteroventral corner of the so-called triangular postcingular plate. When one compares this structure with the larger mesh referred to just above in regard to *Heteroschisma inaequale* and also with the small triangular sinistral moiety of the paired ventral hypothecal plates illustrated on *Metaphalacroma skogsbergi* (Fig. 11 *j*) and (*Pseudophalacroma*) *nasutum* (Tai & Skogsberg: 1928, Fig. 12 *j* and *k*), he will undoubtedly be led to conclude that the peculiar triangular structure, illustrated by Kofoid & Skogsberg on both of the two species of this genus, represents in reality the anterolateral moiety of the paired ventral hypothecal plates.

If one examines Diagram 2 B and C, he will naturally understand that these two are only the forms in which the megacytic zone, however broad it may be, comes to pass directly along the entire left outside margin of the sulcus and then across the cingulum, affecting least the structural relations within the sulcus and separating the smaller antero-lateral moiety of the ventral hypothecal plates towards the left, but keeping the direct connection with the left thecal valve. As to the postcingular plate see *Proheteroschisma* (B, p. 77).

Genus *Oxyphysis* Kofoid

Oxyphysis Kofoid, 1926, p. 205, Pl. 18, Figs. 1–4: Schiller, 1931, p. 191, Fig. 186 c, d (after Kofoid). Tai & Skogsberg, 1934.

Kofoid (1926) figured two ribs standing close to each other in the anteriormost portion of the left sulcal list of *Oxyphysis oxytoxoides* which seem to suggest the longitudinal arrangement of the two ventral hypothecal plates. The third rib is not figured by him; judging from the site of the posterior termination of the left sulcal list in conformity to the sulcus which agrees in general feature with the posterior sulcal plate of *Amphisolenia*, this seems to prove the real absence of that rib. According to Tai & Skogsberg (1934, p. 475, Fig. 14 *o*), however, the two ribs are figured to stand at the left-ventral end of the posterior cingular list and on either side of a small triangular plate which is separated from the sulcus by an elongated median ventral hypothecal plate. In respect to this arrangement, the present genus agrees with *Metaphalacroma* and *Pseudophalacroma* of the same authors and also with *Heteroschisma* KOFOID & SKOGSBERG (1928). This genus is, then, closely related on one hand to *Metaphalacroma* in the structure of the paired ventral hypothecal plates and on the other hand to *Amphisolenia* in the body shape axially elongated and in the structural relation between the posterior sulcal plate and the right ventral hypothecal plate. The present genus is unique in having the strongly elongated left ventral epithecal plate among all the species and genera of Family Dinophysidae.

Genus *Amphisolenia* STEIN

Amphisolenia STEIN, 1883; BÜTSCHLI, 1889; SCHÜTT, 1896; DELAGE & HÉROUARD, 1896; LINDEMANN, 1928; KOFOID & SKOGSBERG, 1928; SCHILLER, 1931; BALECH, 1962.

The body of this genus is strongly elongated posteriorly, forming in its median or premedian region a slightly swollen midbody and at the anterior end a little larger epitheca and cingulum, both of which are dislocated dorsally in conformity to dorsalward bend of the anteriormost portion of body, the neck, along the ventral side of which lies the narrow and elongated sulcus. The outstanding morphological features of this species are that a shorter left and a slightly longer right ventral hypothecal plate, together with the posterior sulcal plate, are arranged transversely along the posterior end of the sulcal furrow, somewhat expanded leftwards, which extends from the midventral part of the cingulum to the flagellar pore which lies close to the right posterior corner of the sulcal furrow and that the posterior sulcal plate extends further posteriorly from the flagellar pore beyond the rear border of the sulcal furrow and onto the general body surface. A tubule, opening at the flagellar pore ventroanteriorly, leads deep into the body to a large pustule (Diagram 2 D, Fig. 42 *b*).

The fission suture in the ventro-anterior portion of the body enters into the sulcus passing between the laterally arranged two ventral epithecal plates, but posteriorly the suture can be traced to emerge at the posterior end of the sulcus. In the species with bi- or tri-furcated posterior body ends, the fission suture comes to pass the tip of every branched end. It is to be noted in this connection that the three posterior branches of the body in *Amphisolenia thrinax* are arranged bilaterally and perpendicularly to the dorsoventral axis of the epitheca. These clearly indicate that the sutural plane of the body in this genus is more or less twisted distinctly along the body length.

One can distinguish at least three different shapes of the posterior sulcal plate as illustrated in Fig. 42 *d*, *e* and *f*. In all cases, the plate lies somewhat slantwise, with its posterior end deflected towards the left, and extends distally to the fission suture. In the case of *e*, the plate decreases its width posteriorly and is bending fairly abruptly towards the left in its posterior portion, while in *f* the plate is obliquely truncated posteriorly, yet reaching the fission suture distally. Fig. 42 *d* represents a rare type. The plate extends posteriorly further beyond the rear ends of the formed sulcal lists and then expands towards the left to border broadly on the fission suture. The occurrence of these different types of the posterior sulcal plate was ascertained within a single species.

As to some species of the genus *Dinophysis* such as *D. miles*, some one may be liable to think of a closer phylogenetic or taxonomic relationship between it and *Amphisolenia*, if he incorrectly support "the assumption that the degrees of structural resemblances are indications of commensurate degrees of genetic relationship." This resemblance is, however, only an example of parallelism, because *D. miles* has two anteroposteriorly arranged ventral hypothecal plates as clearly indicated by the arrangement of the fission and the third ribs.

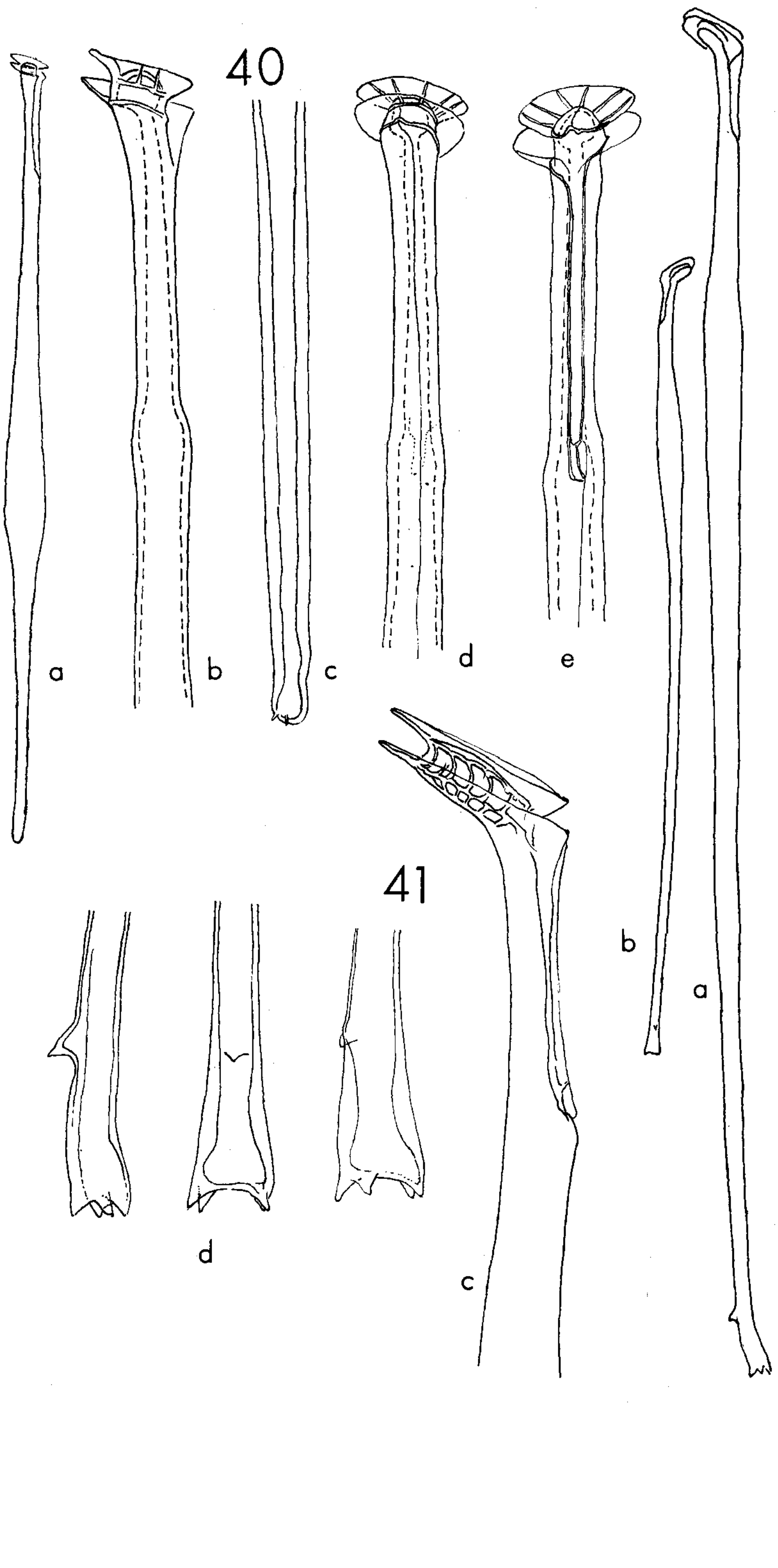
Amphisolenia, together with *Triposolenia*, agrees with other genera of Dinophysidae in having laterally arranged ventral epithecal plates, but they differ from others mainly in that the paired ventral hypothecal plates are laid together with the posterior sulcal plate along the posterior end of the exceedingly elongated sulcal furrow, independently from the cingulum, and laterally arranged. Unfortunately, the present author failed to uncover the plate arrangement within the sulcus; he could establish the plate arrangement only in the anteriormost region of the sulcus, as schematically given in Diagram 2 D, basing on analytical observations shown in Fig. 43 *d* and *f*. The anterior sulcal plate only reaches anteriorly the epitheca, whereas other right and left sulcal plates extend anteriorly only a little beyond the posterior cingular ridge. Here it is to be emphasized again that the posterior sulcal plate lies outside the sulcal furrow, just like the two ventral hypothecal plates. In this connection, it is to be noticed than in *Amphisolenia* and *Triposolenia*, both the entire right sulcal list and the anterior major span of the left sulcal one are nothing but the posterior continuations of the posterior cingular list. This feature differs much from the structure found in other genera.

Amphisolenia microcephalus n. sp.

(Fig. 40 a-e)

The body of this small species is exceedingly short for the genus and fairly straight, with a very slight dorsal bending in the short anteriormost portion of the body, which is roughly as long as the body diameter in that portion. The greatest body dimension is seen at 0.6; the body dimension gradually increases posteriorly from the level of the flagellar pore to this level and further posteriorly the body contracts more sharply, merging into a pedicel and terminating in a rounded end furnished with two solid spinules.

This can be distinguished from *Amphisolenia globifera* mainly by the entire lack of the constricted posterior globular structure and by more posteriorly located midbody. This species, however, may be a closest relative of *Amphisolenia laticincta*,


40
a
b
c
d
e
41
a
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according to KOFOID & SKOGSBERG's description that "The midbody is fusiform and merges gradually into the anterior process but is fairly well set off from the antapical" ..."The antapex is rounded and has a single, minute spinule (in typical specimens probably one on each valve)." But the latter appears to differ from the former in that "The epitheca is oblique and much more convex dorsally than ventrally. The transverse furrow is very broad, somewhat wider than the dorsoventral diameter of the head; it is rather strikingly concave, which gives to the head the shape of an hour-glass, and without cross-ridges." It is not certain whether or not *A. laticincta* is really to be treated as a form distinct from the present new species, because the former was established on only two specimens and the latter on only a single specimen. Moreover, *A. laticincta* was synthesized by hands of several different persons respectively making observation, sketch, drawing and manuscript. On the contrary, all about the present new species were done by one and the same person. It is a matter of question in which process the accuracy can be expected. Taking these into consideration, the present author feels the possibility that these two forms named differently belong to the same single species. But, so far as concerned with published figures, the present author was obliged to distinguish them from each other as two distinct species.

Thus, inevitably the following additional descriptions are presented. The epitheca is 1.1 times deeper than broad and distinctly convex. The cingular wall is least concaved all around the head, and its breadth is about 0.4–0.5 of the lateral dimension of the epitheca throughout its entire length. The thecal wall increases its thickness along the neck towards the posterior cingular ridge, but it is exceedingly thin in the cingulum and also in the epitheca (Fig. 40 *b*, *d*, *e*). The wall is somewhat thicker throughout major length of the pedicel, but it becomes thinner in the antapex (Fig. 40 *b*). Lateral or dorsoventral dimension of the neck is about 7 μ, a little smaller than lateral dimension of the epitheca.

Dimension: Length of body, 450 μ. Length of the neck portion, 45 μ.

Distribution: Sagami Bay.

Amphisolenia rectangulata KOFOID

(Fig. 41 a-d)

Amphisolenia rectangulata KOFOID, 1907, p. 200, Pl. 14, Fig. 83: KOFOID & SKOGSBERG, 1928, p. 378, Fig. 49_5, Pl. 8, fig. 3, 5, 6, 9: SCHILLER, 1931, p. 170, Fig. 156 (after KOF. & SKOGSBG.)

The total length of body is 15–18 times the length of the sulcus and relatively

Fig. 40. *Amphisolenia microcephalus* n. sp. *a*, Lateral outline of the entire body. *b*, Lateral outline of the anterior portion from the epitheca to the premedian part of the midbody. *c*, Posteriormost portion of the body. *d*, *e*, Dorsal and ventral views of the anterior portion of the body. Broken line represents the inner surface of the thecae of that portion.

Fig. 41. *Amphisolenia rectangulata* KOFOID. *a*, *b*, represent respectively the lateral outline of a larger and a smaller specimen. *c*, Right side-view of the anterior portion, including the epitheca, the cingulum and the neck portions. *d*, Posterior end of the body, seen from three different directions, showing the variability of the outline due to the directions of observation.

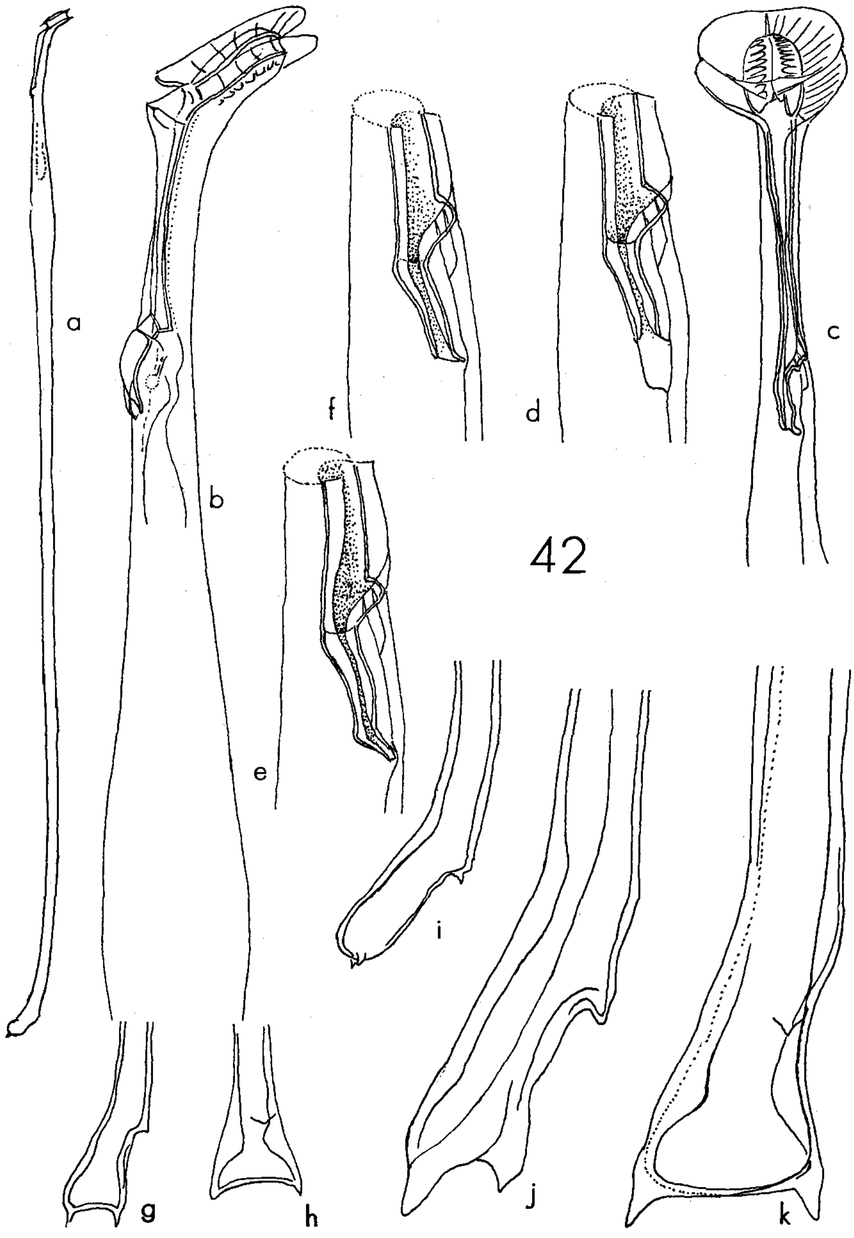

Fig. 42. *Amphisolenia bidentata* Schröder. *a*, General outline of the left side of the body. *b*, Anterior portion of body from the epitheca to the midbody. In this figure are illustrated the total length and the breadth of the left sulcal list with its first and the second (fission) ribs outside the body surface and a small collecting pustule with its outlet canaliculi and a little larger sigmoid canal opening outside to the flagellar pore and leading to a much larger blind pustule. *c*, Ventral view of the epitheca and the neck, at the rear end of which are illustrated the posterior sulcal list and two small ventral hypothecal plates

straight as a whole, though the neck is very slightly bent dorsally (Fig. 41 *c*). In Fig. 41 *d* are shown three different figures of the posterior end of the same body seen from three different sides. Judging from the interrelationship between a heel-like conical subterminal protuberance and the roughly truncated terminal face with much smaller four conical processes, the body axis seems somewhat twisted within this short length.

Dimension: Length, 355–648 μ.

Distribution: Sagami Bay. This was reported from the Mexican Current, the Panamic Area, and the South Equatorial drift in the East Pacific.

Amphisolenia bidentata SCHRÖDER

(Fig. 42 a-k)

Amphisolenia bidentata SCHRÖDER, 1901, p. 20, Pl. 1, Fig. 16 a-c: OKAMURA, 1907, p. 127, Pl. 3, Fig. 15 a-d: KOFOID & MICHENER, 1911, p. 263: JÖRGENSEN, 1923, p. 39, Fig. 56: KOFOID & SKOGSBERG, 1928, p. 409, Fig. 54_{1-4}, 56_1: SCHILLER, 1931, p. 178, Fig. 169 a-e: BALECH, 1962, p. 131.

This species varies greatly in length of the body which is sigmoid and slightly twisted along the body length. In Fig. 42 *b* are shown the right and left sulcal lists, the left sulcal edge (in double lines), depth of the sulcal furrow (in dotted line), the first and the second (fission) ribs of the left sulcal list, and a short tubular structure opening anteriorly to the flagellar pore and leading deep into the body to a large sack pustule through the thin, distinctly undulating canalicule. A small collecting pustule and its leading canal are seen lying just in rear of the flagellar pore. Fig. 42 *c* represents the ventral view of the ventral area and the two ventral hypothecal plates. In Fig. 42 *d*, *e*, *f* are shown three different types of the relationship between the posterior sulcal plate, the ventral fission suture, the two ventral hypothecal plates, and the first and the second ribs of the left sulcal list. For explanation of the relationship, see the paragraph of the general account of the genus. In the five figures from *g* to *k* are illustrated the posterior end of the body seen from various sides and with different magnifications. Here, it is to be noted that the fission suture runs somewhat slantwise across the flattened distal end of the body so as to separate the two of the four distal conical protuberances into respective hypothecal plates.

Dimension: Length, 520–730 μ.

Distribution: Sagami Bay. This species is one of the commonest species of the genus and of the world-wide distribution in the tropical, subtropical and warm-temperate seas.

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arranged laterally on either side of the fission line. *d, e, f*, Three types of the posterior sulcal plates, which invariably extends postero-medianwards to the fission suture. *g, h, i, j* and *k* represent respectively the posterior end of two different specimens under different magnifications. In *j* and *k*, the suture line is represented partly by a solid and partly by a broken line.

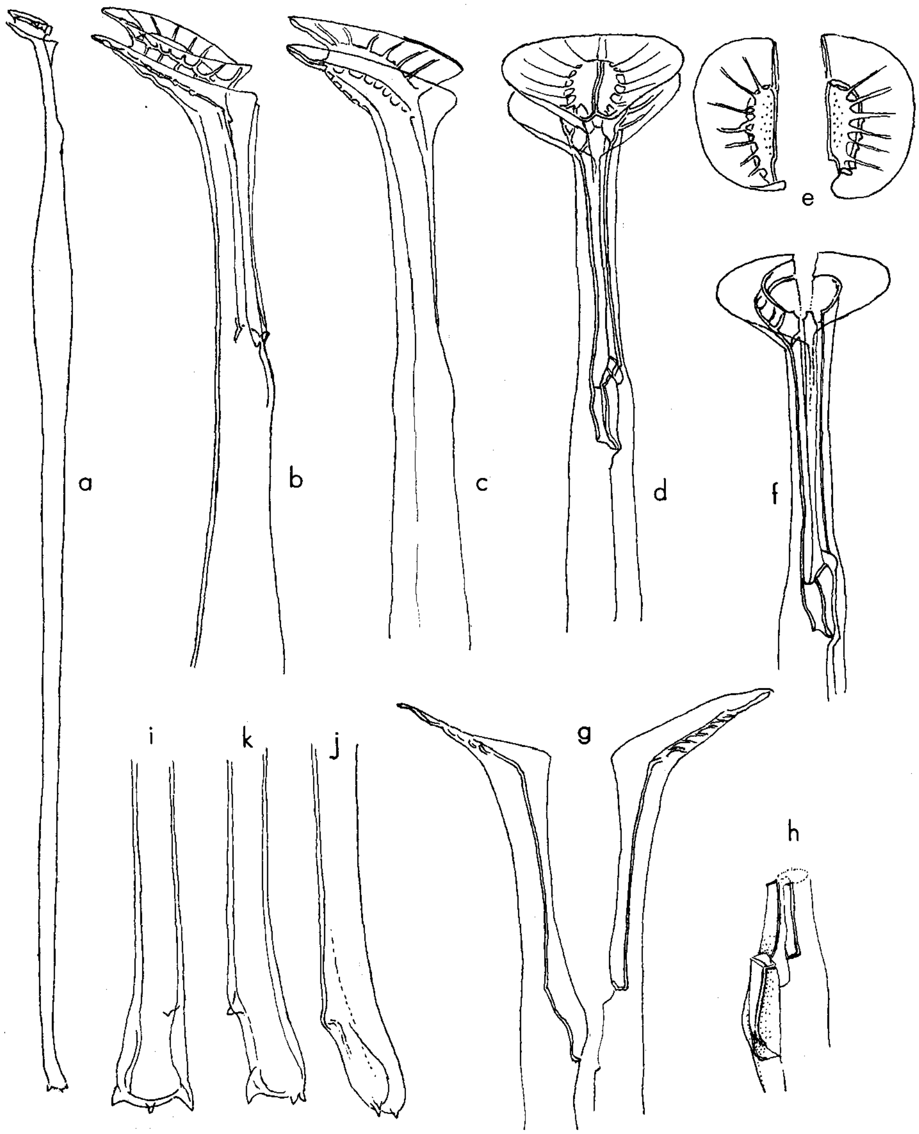

Fig. 43. *Amphisolenia palmata* Stein *a*, General outline of the entire body. *b*, *c*, *d*, Right lateral, oblique dorsal and ventral views of the head and the neck of the same single specimen. In *b* is illustrated the exact shape of the right sulcal list. In *d* are illustrated the posterior extensions of both of the ventral epithecal plates and the anterior extension of the three sulcal plates, the median of which reaches anteriorly the two ventral epithecal plates whereas the laterals attain only slightly beyond the posterior cingular edges; besides the relationship among the posterior sulcal plate, the longer right and the much shorter left ventral hypothecal plates arranged on either side of the ventral fission line, and short first and second (fission) ribs of the left sulcal list standing respectively on either side of the smaller moiety of the paired ventral hypothecal plates. *e*, Apical view of isolated two epithecal plates, both deprived of the ventromedian epithecal plates. It is to be noticed that a small ventral and a much elongated dorsal left cingular plates are seen attaching to the underside of the left epithecal plate. *f*, Ventroapical view of the

Amphisolenia palmata STEIN

(Fig. 43 a-k)

Amphisolenia palmata STEIN, 1883, p. 24, Pl. 21, Figs. 11–15: BÜTSCHLI, 1885, Pl. 55, Fig. 4 b: KOFOID, 1907, p. 315: JÖRGENSEN, 1923, p. 40, Fig. 57: KOFOID & SKOGSBERG, 1928, p. 422, Figs. 54_5, 56_5, Pl. 12, Figs. 4, 7: SCHILLER, 1931, p. 180, Fig. 171 a, b (after KOF. & SKOGSBERG): BALECH, 1962, p. 132.

Fig. 43 *b* and *d* represent respectively the right side-view and the ventral view of the anterior portion of the body. In the former are illustrated the depth and length of the sulcal furrow and the two sulcal lists; and in the latter is shown the anterior sulcal plate extending across the cingulum to the posterior extensions of the two ventral epithecal plates, while the right and the left sulcal plates terminate halfway across the cingulum (refer Fig. *f*). Fig. 43 *e* represents the apical view of the two isolated dorsal epithecal plates, the left of which is underlaid with an extremely minute ventral and a much longer dorsal cingular plate. When a specimen was pressed slightly in dorsoventral direction, the epitheca was detached together with the left half of the cingular wall (Fig. *e*) and the hypotheca was split along the suture (Fig. *f*). By repeating gentle pressure, Fig. *f* and *h* (also refer *d*) lost sight of the left moiety of the ventral hypothecal plates. After further applying of repeated pressure there remained the dorsal hypothecal plates only (Fig. *g*). It was ascertained by such treatments that the posterior cingular list could be traced posteriorly along the rightside of the sulcus to the posterior end of the posterior sulcal plate, whereas along the leftside only to a rib standing at the left of the left ventral hypothecal plate which, together with the longer ventral hypothecal plate, forms posteriorly an irregularly shaped shallow notch, the posterior end of which corresponds in site to the posterior end of the posterior sulcal plate (Fig. *g*). This happened to prove clearly that the first rib of the left sulcal list is moved much far posteriorly from the cingulum.

The three figures Fig. 43 *i-k* represent different aspects of the posterior end of the same single specimen. When the specimen is observed from the least adequate side (*i*), the distal expanded end will appear to be provided with only two distal dents, but by turning the specimen the existence of the third dent will be ascertained (*j* and *k*). The situation represented in Fig. 43 *i* is considered best to ascertain all of the three dents. Apparently for this reason, *Amphisolenia palmata* might have often "been confused with and included under *A. bidentata*," as was stated by JÖRGENSEN

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anterior portion of the body, from which the epitheca shown in *e* was disjoined; partly disjoined longitudinally along the fission suture. The two right cingular plates are left attached, although posteriorly the left smaller ventral hypothecal plate is detached. In *h*, the side view of this specimen is illustrated. *g*, The two larger dorsal hypothecal plates are illustrated in a similarly flattened conditon. From these figures, it is concluded that the posterior right cingular list can be traced posteriorly, as a surface extension of the plate, along the entire length of the sulcus, whereas the left posterior cingular list can be traced posteriorly only to the first rib standing at the anterior end of the left ventral hypothecal plate. *i*, *j*, *k*, The posterior end of the same single specimen, showing three minute spines arranged in an arch.

(1923, p. 40) and supported by KOFOID & SKOGSBERG (1928, p. 426) who granted the opinion as "very plausible but not supported by any published records."

Dimension: Length of the largest specimen found from Sagami Bay, ca. 700 μ.

Distribution: Sagami Bay. This is widely distributed in the tropical, subtropical and warm-temperate waters; recorded from the Atlantic, Pacific, Mediterranean, Red Sea, Indian Ocean, Arabian Sea and the Malay Archipelago.

Amphisolenia thrinax SCHÜTT

(Fig. 44 a-f)

Amphisolenia thrinax, STEUER, 1910, Fig. 105; 1910, Fig. 81: OKAMURA, 1912, p. 327, Fig. 18_2: KOFOID & SKOGSBERG, 1928, p. 439, Figs. 54_{7-9}, 56_8, Pl. 12, Figs. 2, 6: SCHILLER, 1931, p. 183, Fig. 176 (after KOF. & SKOGSBG.): WOOD, 1953, p. 206, Fig. 57 a, b: BALECH, 1962, p. 135, Pl. 18, Fig. 266.

The body of this species has in its posterior one-third two laterally extending branches arranged, together with the stem, on the same plane almost perpendicular to the dorsoventral axis of the anterior portion of the body including the epitheca and the sulcus (Fig. 44 *a* and *b*). Fig. 44 *c* and *d* are the highly magnified representation respectively of *a* and *b*. Just similarly, *e* and *f* represent the highly magnified posterior ends of the stem and two branches respectively of *a* and *b*; the existence of three dents at every distal is to be noted.

Dimension: Length, 897–930 μ.

Distribution: Sagami Bay. This is distributed in the tropic and subtropic waters, being recorded from the east tropic region of the Pacific, the Indian Ocean from off the west coast of Sumatra to the east coast of Africa, and the Atlantic from off the east coast of America to the west coast of Africa. Further localities are the Sargasso Sea, the Gulf of Aden, the Arabian Sea, the Caribbean Sea and the east coastal waters of Japan.

Genus *Triposolenia* KOFOID

Triposolenia KOFOID, 1906; 1907: KOFOID & SKOGSBERG, 1928: SCHILLER, 1931.

Triposolenia agrees in the main most closely with *Amphisolenia* in general structural features, but differing from the latter largely in its triangular bulged midbody and in having two incurved posterior horns.

Triposolenia bicornis KOFOID

(Fig. 45)

Triposolenia bicornis KOFOID, 1906, p. 105, Pl. 15, Figs. 1–2, Pl. 16, Fig. 5: HJORT, 1911, p. 367, Pl. 15, Figs. 1, 2, Pl. 16, Fig. 6: GRAN, 1912 a, p. 936, Fig. 9: 1912 b, Fig. 233: JÖRGENSEN, 1923, p. 41, Fig. 66: SCHILLER, 1931, p. 188, Fig. 182 a-c (after KOF. and SKOGSBG.)

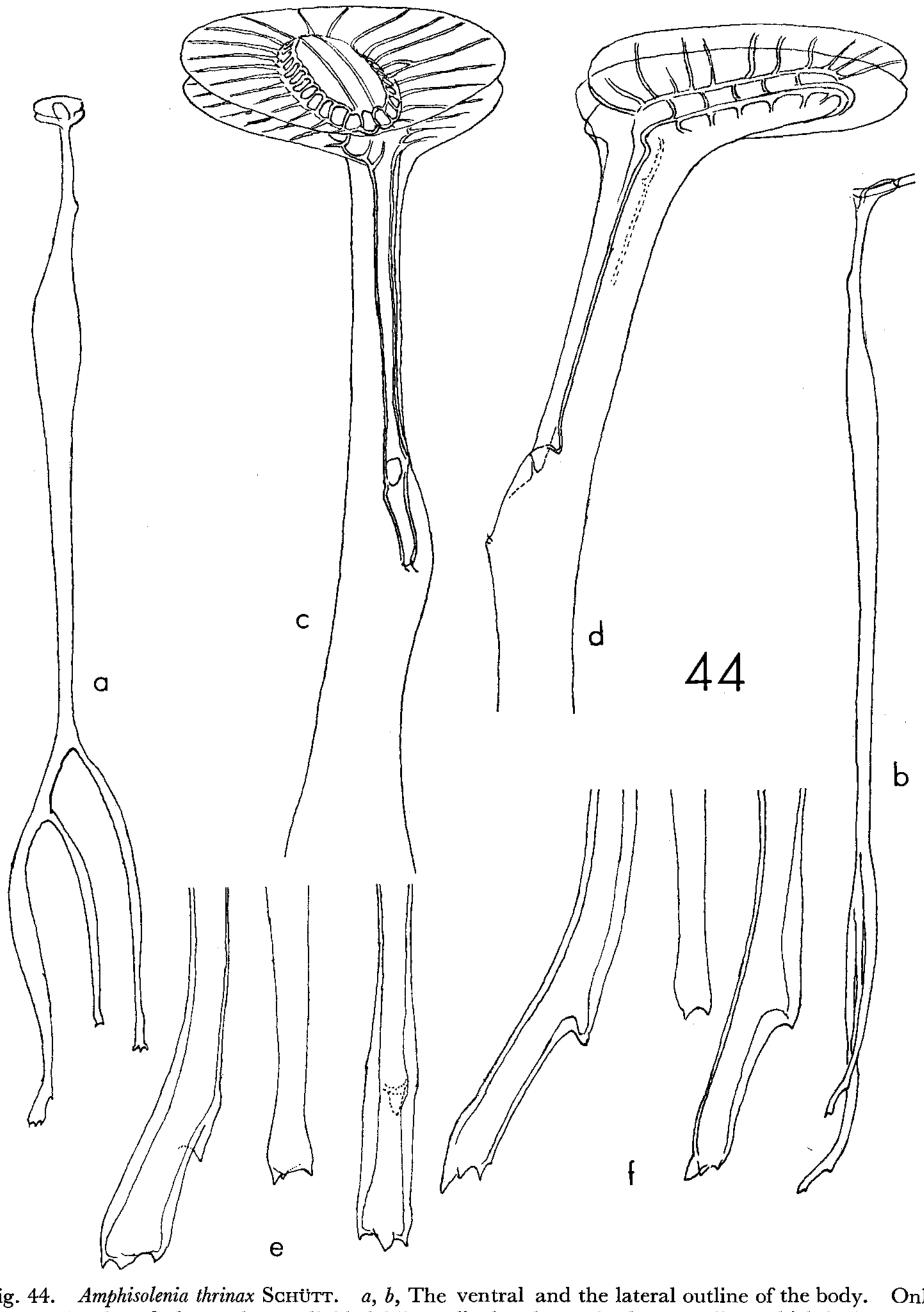

Fig. 44. *Amphisolenia thrinax* SCHÜTT. *a, b,* The ventral and the lateral outline of the body. Only the head and the neck are divided bilaterally by the sagittal suture line, which is, however, twisted posteriorly to cross the distal end of every posterior branch. *c, d,* Right ventral view and left side-view of the anterior portion. *e* and *f* show respectively the posterior end of *a*- and *b*- specimens. In morphology two laterals of the three branches cannot be distinguished from each other, yet KOFOID & SKOGSBERG (1928) called the righthand one the stem and the lefthand one (in figure the righthand one) the branch. This distinction seems quite absurd.

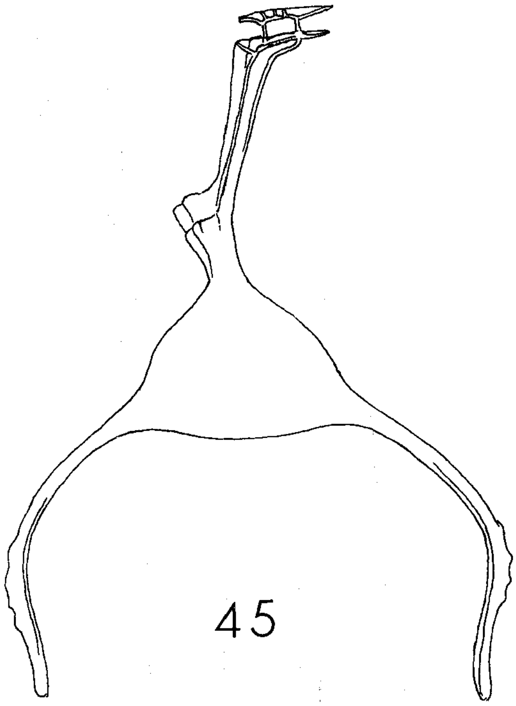

Fig. 45. *Triposolenia bicornis* KOFOID.

Distribution: Sagami Bay. Fairly rare occurrences in Sagami Bay. It is known as a form of the world-wide distribution in the tropic, subtropic and warm-temperate seas.