Jörgensen (1923)

REPORT

ON THE

DANISH OCEANOGRAPHICAL EXPEDITIONS 1908-1910

TO THE

MEDITERRANEAN AND ADJACENT SEAS

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REPORT ON THE DANISH OCEANOGRAPHICAL EXPEDITIONS 1908—10
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Mediterranean Dinophysiaceae.

By

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I. INTRODUCTION.

While working upon the Ceratia material from the "Thor", (This Report, vol II, J 1) I also noted throughout the Dinophysiaceae occurring in the samples, as items for a later, more extensive work, but without actually contemplating a special account of the Mediterranean species. It seemed to me, however, that it might be of interest to publish the most important part of my notes now, as they may presumably be regarded as more or less complete as far as concerns the contents and occurrence of species. The principle failings are, a still incomplete knowledge of the distribution of the species in the oceans generally, and also the fact that circumstances did not permit revision of plankton samples during the compilation of the work.

II. THE SPECIES FOUND IN THE MATERIAL OF THE THOR.

DINOPHYSIACEAE Pavill.

Pavillard 1916 (p. 44).

Like Pavillard (l. c) and Kofoid a. Michener (1911 p. 268) I look upon this group of the *Peridiniales* Schütt as a separate family (*Dinophysidae* Kof. a. Michen.). The genera in question show so many characteristic features as to general constitution, fission and evolution, that they on the one hand keep closely together, and on the other are very well separated from the rest of the family of Peridiniaceae, to which they have been referred as a subfamily. In fact, no genus transitional between these two families is as yet known (to me).

PSEUDOPHALACROMA n. gen.

The least differentiated forms of the family are found in the earlier genus *Phalacroma* Stein, which comprises a number of species, agreeing on the whole very well in morphological respects, e. g. in the shape of the body. An exception is formed by the *Phalacroma nasutum* Stein, which is so different from the other species that I think it deserves the rank of a separate genus. I have only seen very few specimens and have partly confounded it with forms of *Phalacroma rotundatum*, so that I am not at present able to give an accurate description or figure of it, or quite reliable details of its distribution. Its chief characteristics, at the same time those of the proposed new genus, are the prolongation of the "longitudinal furrow" beyond the girdle for a considerable distance (about $^2/_3$ that from the girdle to the apex), where it shows a dilated rounded end, protected by a raised edge, which altogether calls to mind the apical pore in the *Peridiniaceae*. Also, the ventral "fin" along the left side of the longitudinal furrow, other-

wise so conspicuously developed and so constantly provided with three ribs uniformly appearing in all species at about the same levels, is here but little developed and seems to be destitute of ribs. Otherwise the genus corresponds to Phalacroma.

In establishing this new genus provisionally I hope to draw attention to the remarkable species in question, which might well deserve a thorough examination, where it occurs more frequently. It may perhaps be reduced to a subgenus, as I have seen traces of a similar prolongation — but only a very short one — to a pore-like end above the girdle also in rare cases in species of *Phalacroma*.

PSEUDOPHALACROMA NASUTUM (Stein) (Fig. 1).

Phalacroma nasutum Stein 1883 pl. 18 figs. 1—6.

Body in side view roundish, in shape like a broad *Phalacroma rotundatum* (Clap. et Lachm.) with a low and small epitheca and narrow ventral lists, scarcely reaching half way down the hypotheca. In ventral view elliptical with almost rounded ends. Structure of theca rather coarse, crowded, pit-like areoles.

Fig. 1. *Pseudophalacroma nasutum* (Stein), from the right side, 400/1. St. 66. The structure is only shown on a small portion of the theca. (So also usually in the following figures.)

The peculiar thick "megacytical" stages, described by Pavillard (1916 pp. 45—52) seem to be common in this species. One such, from the Black Sea, had the following dimensions: length 49 μ, dorso-ventral diameter 44 μ, transdiameter 37 μ; epitheca (6 μ high) and ventral lists very little prominent.

This species on the whole looks like some cyste-like stage of *Phalacroma rotundatum*. Besides the mentioned occurrence in the Black Sea (st. 172, 17—50 m., singly) it was caught at st. 209, 945 m. wire (in the Catalonian Sea), a very heavy-structured individual, and during the winter-cruise at st. 66 in Bay of Cadiz. According to my notes it was most probably also found singly at sts. 26 and 31 in the Tyrrhenian Sea in winter, and at sts. 189, 945 m. wire, 194, surface and 1145 m. wire, 205, 206, 223, 1950 m. wire, 224 and 226 (i. e. near the Straits of Messina, in the Balearic, the Catalonian and the Alboran Seas in August).

Entz (1902) mentions it from the Adriatic (Quarnero, May). Oherwise it seems to have been overlooked.

Outside the Mediterranean I have seen it from the Tortugas (Florida Current), in July, from about midway between Ireland and Nova Scotia in April, and off the Norwegian Coast near Bergen (December 1901, 5—8 m. below the surface).

PHALACROMA Stein.

This genus, in morphological respects the least differentiated of the family, has proved to offer considerable difficulty as to the distinguishing of the species. As already remarked by Pavillard (1916), the occurrence of most of the species in the Mediterranean is merely sporadical, which also renders a thorough treatment of the genus in a systematical respect somewhat difficult. The following list and remarks are therefore only to be considered as a preliminary report, based upon my notes and slides, prepared during my examination of the Ceratia.

Sectio I. PARADINOPHYSIS n. sect.

Theca in side-view roundish, in ventral view more or less broadly elliptical; epitheca convex, ± prominent over the plane of the girdle, which does not break the evenly rounded contour. Structure of theca finely areolate, sometimes almost indistinct, usually finely pitted, rarely coarse. Longitudinal (left) fin at the lower end angular or acutely protracted. Colour usually hyaline or pale rose; (yellow) chromatophores rarely present.

Girdle lists, answering to their position near the apical pole, often somewhat obliquely set; the upper one not infrequently somewhat better developed than the lower, without distinct ribs.

More or less small species, occupying an intermediate position between the genera Phalacroma and Dinophysis.

The separation of the genus *Phalacroma* Stein from *Dinophysis* Ehrenberg seems to me to be somewhat arbitrary. Both genera are, however, natural ones, showing parallel forms; only there are intermediate connecting links, species which may equally well be referred to either of the two genera. Such a connecting link is formed by the "*Dinophysis rotundata*"-group — which does not coincide with my section *Paradinophysis*, proposed above. I think, however, that group of species will find their most natural position in the genus *Phalacroma*, where KOFOID has placed them.

As the main distinguishing features between the two genera in question — in the absense of any definite difference in structure of theca — I consider the more or less pronounced differentiation of the upper girdle list (in size, structure and direction) in *Dinophysis*, and the more or less conspicuous compression of the body in that genus, in contradistinction to the almost uniform development of both lists and the usually much thicker body in *Phalacroma*. Chromatophores are often wanting in the latter genus, whilst they are generally present in the former.

1. PHALACROMA ROTUNDATUM (Clap. et Lachm.) Kofoid a. Michener (Fig. 2 p. 7).

Kofoid a. Michener 1911 p. 290.

By the above name I designate a variable species, or perhaps a group of species, usually referred to the genus *Dinophysis*, but in many respects differing considerably from the other species of that genus. They are less strikingly compressed, have a more regularly rounded shape and usually a much finer structure, and are especially characterized by wanting a funnel-like upper girdle list, both lists being low and almost equally developed, but more or less distinctly oblique, not perpendicular to the surface as usual in *Phalacroma*. When alive these forms are seen to be rose-coloured or hyaline, not (or very seldom) provided with yellow chromatophores.

The forms in question vary in size, structure and somewhat in shape. I think we may at once exclude the very small ones and refer them to one or more separate species (see below). The true *Dinophysis rotundata* of CLAPARÈDE is stated to have a coarse structure, in contradistinction to *D. laevis*, where no structure was seen (by CLAPARÈDE). Without being able to decide this question finally at present I shall follow my earlier impression (see JÖRGENSEN 1899 p. 32), when I proposed to reduce this *D. laevis* to a variety of *D. rotundata*. As to the variation in shape there exist forms with a relatively large convex epitheca, and others with a much smaller, less conspicuous one. The form var. *laevis* should answer to the latter case, which is true, both in regard to the northern and to the Mediterranean specimens; I have not, however, the impression that there also is a special northern form with a very coarse structure and at the same time a large epitheca, answering to the true *D. rotundata* Clap. I hope, however, soon to be able to give a more detailed account on the whole family.

The *Phalacroma Rudgei* Murray and Whitting (1899 p. 331, pl. 31 figs. 6 a, b) is perhaps only a thick, "megacytical" stage of *Phalacroma rotundatum* var. *laevis*. It was only found once by the authors near the Azores, and is otherwise mentioned from the North Sea, where *Phalacroma rotundatum* is frequent. The detection of these megacytical stages by PAVILLARD removes the necessity of distinguishing between thick and thin forms of the same species.

In the collections of the "Thor" *Phalacroma rotundatum* var. *laevis* proved to be distributed all the way from the Bay of Biscay in June (1910) to the Southern Levant — where it only seemed to be present below the surface — and back again to off Lisbon in September. It also occurred in the region of the fresher water from the Black Sea, from st. 167 before the Dardanelles almost everywhere (in small numbers) to the st. 172 in the Black Sea, 17—50 m. The form occurring here agrees on the whole rather

well with the northern form. This was also the case with that from the Bay of Biscay, while in the Mediterranean proper beside this form another was frequent, which differs in having the "longitudinal fin" broader and more acutely protracted at the lower end, which was supported by a stronger and often club-shaped spine. The structure of the theca always was visible, but more or less fine, consisting of small and often rather pale, pit-like areoles.

The species was in all caught at 15 among 37 Mediterranean stations in winter, as far as the Bay of Aegina (from the Straits of Gibraltar and the Bay of Cadiz) and at 30 of 102 stations in summer. Where deep water samples were taken the species was present at more than half the number of stations, partly both in the surface and beneath, partly only in deeper layers. In greater numbers I have only seen it in a sample from off Naples in January.

Megacytical stages were relatively frequent and often seen combined with fission (sts. 31, 33, 58; 116, 139, 134, 199, 216, 234, 246, i. e. in winter in the Tyrrhenian and the Alboran Seas, in summer in the Balearic and the Tyrrhenian, and off Lisbon and Brittany).

The species has been previously reported from Naples by ENTZ (1884, "*Dinophysis laevis*"), KLEBS 1884 (*D. rotund.*), DADAY 1888 ("*D. rot. laevis*") and SCHRÖDER 1900 (also *Phalacroma Rudgei* and *vastum* (?)), from the Adria by ENTZ (1902), SCHRÖDER 1911 (scarce, also present in the brackish region on the Dalmatian Coast) and SCHILLER (1912), and by PAVILLARD 1909 (var. *laevis*) and 1916 from the Golfe du Lion, where he finds it rather rare in spring and in summer, in February 1912, however, abundant, with different megacytical fission-stages.

Otherwise this (or these) species may be said to have a very wide distribution in the Northern Atlantic, to the Barent Sea (August) and between Norway and Greenland and the northern coast of Norway, at Karajakfjord (Greenland) and at the New Foundland Bank. In the North Sea it is frequent and penetrates in single specimens to the Gothland Deep in the Baltic. The same or nearly allied species I have also seen from scattered localities in the tropical and subtropical Atlantic, to about 30° S. east of Southern Brazil and west of Southern Africa, as well as from the Arabian Sea and off the south-west point of Australia.

2. PHALACROMA OVATUM (Clap. et Lachm.) (Fig. 3 p. 7).

Dinophysis ovata Claparède et Lachmann (1859 p. 409, pl. XX figs. 14, 15).

There are some small forms, related to the preceding species, generally of much the same shape, but only about half the size. One of these is *Dinophysis ovata* Clap. et Lachm., which occurs in the fjords near Bergen and is a pretty little species, easily recognizable but so small that it passes through the finest of the common plankton nets. I have taken it together with other small organisms by a special net, and know it as an inhabitant of the waters during and after the great "in-flow of diatoms" (see JÖRGENSEN 1905 p. 88). It has a distinct structure of small pit-like areoles and is especially distinguished by a small antapical spine-like projection (or sometimes two). Probably it is identical with *D. apiculata* Meunier (1910, p. 62, pl. III fig. 49) from the Barent Sea.

A similar form occurs rarely in the Mediterranean: sts. 18 (Bay of Aegina, December), 28 (off Naples, January), 94 (Cadiz Bay, June), 126 (Tyrrhenian Sea, July) and 156, 250 m. wire (Levant, July), always singly.

There also exist related small forms with a finer or indistinct structure of theca and destitute of spines at the antapical end. In the Mediterranean such a form proved relatively frequent, but again only occuring singly or in very small numbers: sts. 26 and 31 (Tyrrhenian Sea, January), 189, 945 m. wire, and 194, surface and 1145 m. wire, 205, 206, 209, 945 m. wire, 223, 1950 m. wire, 224 and 226 (near the Straits of Messina, in the Balearic and in the Alboran Sea, August and September).

In this case we have most probably to deal with more than one species, as these forms differ notably in shape, situation of the girdle, structure and evolution of the longitudinal fin. Similar forms

are *Dinophysis rotundata*, Schütt 1895 pl. 1 fig. 5 and *D. semen* Meunier (l. c. p. 61, pl. III figs. 47, 48). Other forms I have seen from the Tortugas (Mexican Gulf) and the Benguela Current.

These small species look partly like species of *Phalacroma*, partly, however, they are much more like the usual species of *Dinophysis* than the true *Phalacroma rotundatum* (incl. *Dinophysis laevis*) and *Ph. ovatum*, having a somewhat funnel-like, but low, upper girdle list, protruding beyond a very low epitheca.

3. PHALACROMA PARVULUM (Schütt) (Fig. 4).

Ph. porodictyum var. parvula Schütt 1895 Pl. 2 fig. 13,c.

Among the many forms closely related to *Ph. rotundatum*, both in shape and size, is the present, which is distinguished by more regular shape, sail broader at the lower part, and distinct "*Porodictyum* structure" of both "pores" and "poroids". Theca in side view almost circular, somewhat longer than

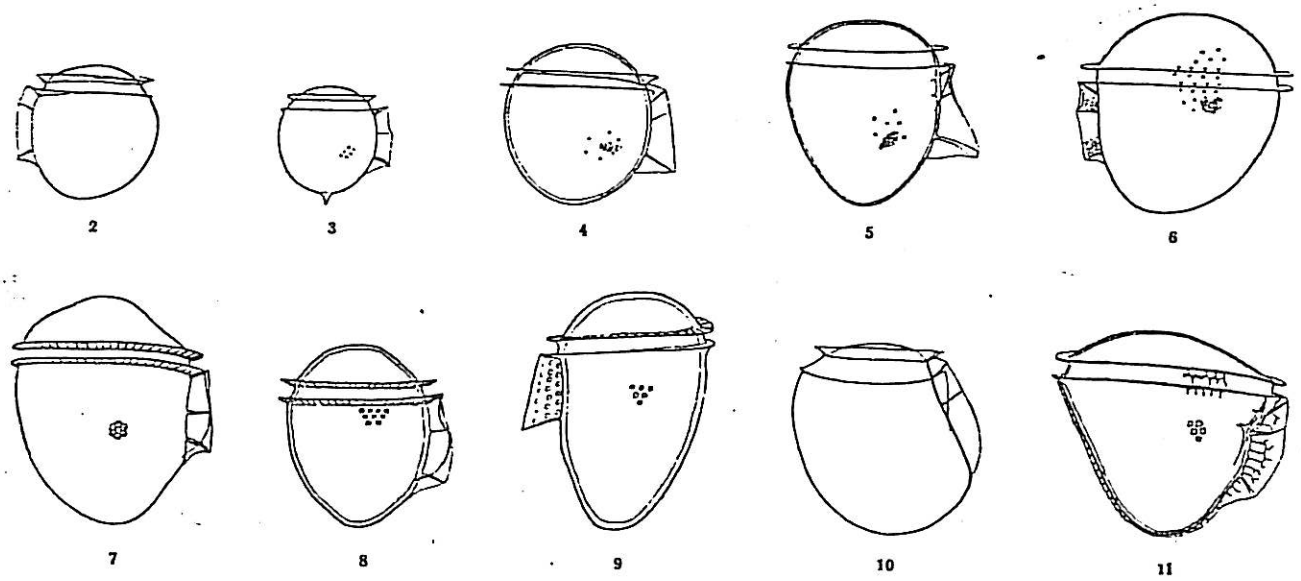


Fig. 2. *Phalacroma rotundatum* (Clap. & Lachm.) Kof., from the left side, 400/1. St. 171. Fig. 3. *Phalacroma ovatum* (Clap. & Lachm.), 400/1. Bergen 19. XII. 1908. Fig. 4. *Phalacroma parvulum* (Schütt), 400/1. St. 189, 945 m. wire. Fig. 5. *Phalacroma operculoides* Schütt, 400/1. St. 145. Fig. 6. *Phalacroma porodictyum* Stein, 400/1. St. 10. Fig. 7. *Phalacroma operculatum* Stein, 400/1. Deutsche Südpol-Expedition 11. VIII. 1903 (South Atlantic), 200 m. Fig. 8. *Phalacroma acutum* (Schütt) Pavill., 400/1. St. 192. Fig. 9. Left half of theca of *Phalacroma elongatum* n. sp., 400/1. St. 132. (Ribs only shown in the upper girdle list). Fig. 10. *Phalacroma stenopterygium* n. sp., 400/1. St. 205. Fig. 11. *Phalacroma cinctum* Schütt, 400/1. Deutsche Südpol-Expedition, 21. IX. 1903 (Atlantic near the equator).

broad, with even contour hardly broken by the girdle; seen from above, the shape is broadly elliptical. Epitheca regularly dome-shaped, 1/6 of total length; girdle lists equally developed, horizontal, low. The left longitudinal furrow list (the "sail") 2/3 the length of the hypotheca, evenly broader towards the lower end, where it is cut off abruptly (transversely) with a somewhat acute outer angle. The lower (third) spine is thin and sharply pointed, pointing obliquely down; the middle (2nd, fission spine) directed outward and upward, and hardly 2/3 as long. Distance between the two lowest spines twice that between the two upper ones. Structure of small areoles and regularly scattered (at same microscope adjustment) dark spots. Dimensions: Length 55—56 μ, breadth 51 μ; length of lowest spine 12 μ; diameter of girdle (*f*) in side view 46—48 μ; breadth of theca seen from above 40 μ (?) all measured from four drawn specimens.

Without wishing here to go further into the nature of "pores" and "poroids" (Schütt) I would merely point out that the former are often difficult to see. Personally, they give me the impression only of being somewhat larger areoles, but they are distributed with a remarkable regularity, and provide what is usually an easily applicable mark of distinction.

Schütt does not state the degree of magnification for the figure referred to, so that I cannot with certainty see whether the dimensions fit my species; from the appearance of the whole figure, however, especially the breadth of the girdle, it would seem likely that this figure was drawn with the same magnification as fig. 13, 1—4, which would give a total length of 47 μ, i. e. somewhat smaller than above noted. The name chosen by Schütt also suggests a smaller form than the usual *Ph. porodictyum*.

I am unable at the moment to give its exact distribution in the Mediterranean, as it is so easily confused with *Ph. rotundata*, and on the other hand — from the structure of theca — with *Ph. porodictyum*. It was found, however, at many places, and appears to be frequent throughout the entire Mediterranean, though always in small numbers, which, however, may be ascribed to its smallness of size, on account of which it would be but incompletely taken by the nets. I have seen specimens from sts. 92 (Bay of Cadiz), 108 and 223 (Alboran Sea), 123 (Ligurian Sea), 126, and 200—80 m. at st. 199 (Tyrrhenian Sea), sts. 140 (Sidra Sea), 186 and 189, 945 m. wire (Ionian Sea), sts. 160 (Levant), 162 and 180 (Ægean) and 246 (w. of Brest). On the winter cruise it was taken at sts. 11 (Ionian Sea), 25 and 31 (Tyrrhenian Sea) and 45 (Balearic Sea). Entz (1902) notes it already from the Adriatic, and Ostenfeld and Schmidt (1901) from the Arabian Sea. Further, I have seen it from the German South Pole Expedition $^{11}/_{8}$ 1903, 200 m. (w. of South Africa) and $^{1}/_{10}$ 1903 (Guinea Current) also, alive, at the Tortugas, in the Mexican Gulf, May 1910 (colour pale rose, without chromatophores).

Sectio II. EUPHALACROMA n. sect.

Medium sized or rather large species, with structure of theca essentially as in the previous section, consisting of small areoles, forming regularly distributed spots (foveæ) or a fine, more or less regular network, often also with regularly distributed "pores". Theca in profile more or less narrowing downwards, from the ventral side, more or less wedge-shaped down, with broad, more or less domeshaped epitheca. Left longitudinal furrow list as in previous section, cut off sharply and acutely pointed below, but little if at all decurrent. Girdle lists equally developed and horizontal, with or without distinct ribs.

4. PHALACROMA OPERCULOIDES Schütt (Fig. 5).

Schütt 1895, pl. 2 fig. 11,2, 3, (11,1?).

Under this name, Schütt has figured (l. c.) two apparently different species. Unfortunately, his first figure is uncertain, and seems to represent the same species which he notes, lower down on the same plate, as *Phalacroma porodictyum* var. *parvulum*, while the second figure shows a characteristic species closely related to the foregoing, and possibly merging into the same. The shape of the body, however, is different — wedge-shaped as in most *Phalacroma* species — the epitheca, lower and broader, left longitudinal furrow list more drawn out below (broader), 3rd spine usually powerfully developed distally and the upper part of the longitudinal furrow list more or less bent over (rendering it often markedly narrower above than below). The dimensions somewhat larger, but otherwise proportionately about the same; total length 60—66 μ. Schütt presumably took them as distinct species chiefly on account of the structure, as he shows (fig. 11,1) this species without "pores", but I have found specimens, exactly corresponding to fig. 11,2, with the same structure as the foregoing species, with distinct pores. These are here pale, and often difficult to see except in empty thecae; with such, I was able clearly to discern that they are large, regularly distributed areoles.

All things considered, then, this last species is perhaps only a more or less accidental form of the first, in which case the name *Ph. parvulum* becomes superfluous. I shall, however, here provisionally retain the latter, in order to draw attention to the great similarity of the form in question to "*Dinophysis rotundata*", under which name it doubtless often occurs in plankton lists from the warmer seas. The form *Ph. operculoides* — Fig. 11,2 in Schütt, has as a rule been easily distinguished from the foregoing. *Ph.*

parvulum. The only "definite" difference, however, which I have been able to see as compared with the latter, is that the distance between 2nd and 3rd spines in the longitudinal furrow list is far less than twice the distance between 1st and 2nd.

It was fairly common in the "Thor" material, but occurred for the most part singly or in very small numbers in the samples from the summer cruise, st. 145 to st. 211: sts. 145, 147, 148 (Sidra Sea, July); 152, surface and 950 m. wire (Ionian Sea, July); 156, surface, 250 m. w., 158, 160 (Levant); 161, 163, 181, 182, 545 m. w., 183 (Ægean, August); 186, 245 m. w., 1145 m. w., 187, 945 m. w., 190, 192 surface and 545 m. w. (Ionian Sea, August); 194, surface, 199, 945 m. w., 200 (Tyrrhenian Sea, August); 209, 945 m. w., 210, 211 (Catalonian Sea, August). It was thus most frequent in the inner parts of the Mediterranean, here also in the Ægean, and in the Ionian Sea, at times several individuals together; after st. 211 I have not seen it. I do not venture to state anything definite as to its occurrence from st. 11 to st. 143.

PAVILLARD (1916) has already noted the species from the Mediterranean: Golfe du Lion, Sept., very rare.

5. PHALACROMA PORODICTYUM Stein (Fig. 6 p. 7).

Stein 1883, pl. 18 figs. 11—14, Schütt 1895 pl. 2, fig. 13, 1—5.

This species is larger than the two previous ones, in shape an intermediate form between the two, most like *Ph. operculoides*, but of characteristically oblique shape, with more or less ventral dislocation of the antapical pole. Epitheca highly domed and broad, approximately as in *Ph. parvulum*, hypotheca wedge-shaped, narrowing downward in profile and ventrally. The girdle lists are almost quite horizontal and equally developed, without or with faintly indicated transverse ribs. Left longitudinal furrow list short — 0.6 of the length of the hypotheca — and rather narrow, often somewhat bent over in the upper part, lower part not or but little broader, and here cut off obliquely (a little decurrent) with slightly acute or obtuse outer corner. Lower longitudinal furrow spine about same length as the middle one, moderately powerful development. Structure as in the two foregoing species. Colour, diffused rose.

Ph. porodictyum was already noted from the Mediterranean by DADAY (1888) from Naples, and later by SCHRÖDER (1900) from the same locality, by ENTZ (1902) from the northern Adriatic, by PAVILLARD (1905) from the Étang du Thau (Decbr., very rare) and by SCHRÖDER (1906) from the "Ionian Sea" and (1911) northern Adriatic. PAVILLARD (1916) remarks that it is found throughout the year ("pérennant") in the Golfe du Lion, but is very rare.

On the winter cruise of the "Thor" it was found at sts. 10, 11, 26 and 39, and — according to my notes — probably also at sts. 16, 31 and 33, i. e. certainly in the Ionian and Tyrrhenian Seas, generally in very small numbers, at st. 31 and 33 somewhat more numerous. On the summer cruise it was taken in the Bay of Cadiz (sts. 91, 92, 95, June, and st. 231 Sept.) and of frequent occurrence generally, albeit in small numbers, throughout the entire Mediterranean as far as st. 161 (s. w. coast of Asia Minor) and st. 182, 545 m. w. (near Euboea) in August.

6. PHALACROMA OPERCULATUM Stein (p. p.) (Fig. 7 p. 7).

Stein 1883 pl. XVIII fig. 8 (not fig. 7).

STEIN has figured two distinct forms under this name, fig. 7 and fig. 8. His fig. 7 shows a species greatly resembling *Ph. porodictyum* and differing only essentially in its more powerful structure, without the scattered "pores". According to my experience, this is only a form of *Ph. porodictyum* with a heavier structure, the scattered "pores" of which have become indistinct beside the other structure. SCHÜTT (1895 pl. 2 fig. 10) shows the same, with the same characteristically oblique shape as in *Ph. porodictyum* (his fig. 13,s) only without "pores" and with closer set ribs in the girdle lists. His fig. 10,1, however, of *Ph.* "*oper-*

culatum" in fission, shows that the young theca has the scattered pores as in *Ph. porodictyum*. The colour of the cell, too, is the same as in this latter species.

With regard to my alteration of the specific name *operculatum* to denote STEIN's second figure, instead of the first, the text of the corresponding paragraph in the international botanical rules for nomenclature will be best met by considering fig. 7 as the true *Ph. operculatum*, including *Ph. porodictyum*, and giving fig. 8 a new name. As, however, *Ph. porodictyum* is a well characterised species and a well-chosen name, and STEIN has evidently intended *Ph. operculatum* to denote a similar species whose essential difference from the other was uniform structure without "pores", it seems to me that the names might be retained with the slight alteration here suggested (always providing my conception of his fig. 7 proves correct).

My species, then, answers to STEIN's fig. 8, and differs from *Ph. porodictyum* chiefly in being less asymmetrical in structure, with slightly conical epitheca, distinct ribs in the girdle lists, and especially, a heavier structure of coarse, rather small areoles, forming a distinct reticulation with a "pore" in each areole. Dimensions approximately as in *Ph. porodictyum*, but somewhat larger; length of the specimen drawn 82 μ. As in *Ph. porodictyum*, the epitheca is high, and the left longitudinal fin not, or but little, broader below, here somewhat obliquely decurrent and generally obtuse-angled at the outer corner.

I am not certain whether this species is found in the Mediterranean, as my slides only contain forms answering to STEIN's fig. 7, and these proved not to be different from the foregoing species. I have, however, seen specimens from the German South Pole Expedition $^{11}/_{8}$ 1908, 200 m. (w. of South Africa).

Ph. operculatum is already noted from the Mediterranean (Adriatic) by STEIN (1883) and later by several writers. PAVILLAD (1916) records it from the Golfe du Lion (very rare, only in winter). In all these cases, the form concerned is probably one answering to STEIN's fig. 7.

7. PHALACROMA ACUTUM (Schütt) Pavillard (Fig. 8 p. 7).

Pavillard 1916 p. 55, pl. III, fig. 7, Ph. vastum var. acuta Schütt 1895 pl. 3, fig. 17, 1—4.

Related to the foregoing, but smaller, with coarse, but somewhat finer, often less distinctly reticulate structure, and markedly longer longitudinal furrow list, which is often also somewhat broader below. Length 60—65 μ, (SCHÜTT's and PAVILLARD's figs. 70 μ) longitudinal furrow list 0.8 of hypotheca's length. As in the foregoing, powerful ribs in the girdle lists. Theca often peculiarly obtusely pointed below, and of low conical form above, in ventral view, somewhat narrow, wedge-shaped.

This species is remarkably like *Phalacroma minutum* CLEVE (1900 p. 18 pl. 8, figs. 10, 11) and most probably identical therewith, though it appears larger as a rule. I have, however, seen specimens down to as low as 47 μ, and the forms in the Mediterranean seem generally to be smaller than stated by SCHÜTT and PAVILLARD. CLEVE's figure, however, represents an imperfect specimen, so that for the present, I consider it safest to retain the name as above.

It is altogether rare in the Mediterranean, but was taken both on the winter cruise (st. 31, Tyrrhenian Sea and st. 33 Ligurian Sea) and the summer cruise (st. 140, Sidra Sea, sts. 186, 189, 945 m. w., and 192, 545 m. w., Ionian Sea, and st. 206, Balearic Sea). Probably it is considerably more widely distributed than these few data show. I have also seen it from the Atlantic, about halfway between Madeira and Cape St. Vincent, (June 1906). CLEVE's species was found in the Gulf Stream, far to the south-east of Nova Scotia.

The species is already recorded for the Mediterranean by PAVILLARD (1916, Golfe du Lion).

8. PHALACROMA ELONGATUM n. sp. ad. int. (Fig. 9 p. 7).

This is a third species which is very closely related to the foregoing, also to *Ph. minutum* Cl. I have only seen two half-specimens, left half, in which the species showed marked resemblance to

CLEVE's figure of *Ph. minutum* (which likewise shows the left half of the theca). Possibly both, together with *Phalacroma acutum*, belong to one and the same, highly variable species — which would then presumably also include "*Phalacroma sp.*" OKAMURA 1907 (p. 134 pl. V, fig. 42 a—c) but while *Ph. minutum* Cl. represents one of the smallest forms, the present species is a larger one. It differs from the foregoing species chiefly in regard to shape, the rather low, domed epitheca, and the protracted, somewhat asymmetrical short-pointed hypotheca, which is, however, rounded off at the lower end. Girdle lists strongly developed, and with powerful transverse ribs, possibly also some reticulation; the left longitudinal furrow list also appears to have been long (and broad?) and likewise of powerful structure. Structure of theca strong, chiefly as previous species. Length 71—81 μ, breadth 48—50 μ.

This species may be identical with PAVILLARD's *Ph. acutum* which, from the figure, is 69 μ long. The shape in side view — PAVILLARD has only a figure from the dorsal side — is, however, very different from SCHÜTT's form.

St. 132, 600—195 m., s. e. of Sardinia, July.

Sectio III. CUNEUS.

Epitheca low. Cell markedly wedge-shaped, both in profile and in ventral view, greatest breadth and thickness at the girdle. Structure generally strong, more or less thick walled, but not very large reticulations. Colour in a live state (often?) diffused yellowish green. Girdle lists with irregular short ribs (innermost) which can on anastomose develope into an imperfect, coarse reticulation, or the one with short, regular radial transverse ribs. Left longitudinal furrow list longly decurrent at the lower end, arched below at the outer edge, with more or les markedly downward pointing lowest spine, the point of which lies far below the greatest breadth of the list.

9. PHALACROMA STENOPTERYGIUM n. sp. (Fig. 10 p. 7).

Remarkably like *Dinophysis sphærica* in several respects, especially in the left longitudinal furrow list.

Cell in profile irregular in shape, half roundish, half square, on the dorsal side and downward with almost smoothly rounded contour, on the ventral side almost straight or slightly concave, almost abruptly rounded off above; in dorsal view, more or less narrow wedge-shaped. Upper girdle list somewhat more developed than the lower, both without or with distinct short radial transverse ribs innermost by the cell. Epitheca flat, not or very little prominent, in side view considerably narrower than the hypotheca. Left longitudinal fin long and narrow, the lower end generally without supporting spine apparent, and here rounded off, or with a short spine soon disappearing outward. The cell 54—63 μ long, by 53—58 μ broad, (measured as usual perpendicularly to and parallel with the girdle); epitheca in profile 31—34 μ, 0.6 the breadth of the cell. Structure, distinct areoles or finer with scattered "pores".

Despite the great resemblance to the *Dinophysis* species, I have ascribed it to the genus *Phalacroma*, chiefly on account of the wedge-shaped cell and also because the lower girdle list can apparently have the same short radial ribs as the upper. It seems to be related to *Dinophysis expulsa* Kof. & Michener.

From the winter cruise of the "Thor" I have only seen it in samples from sts. 26 and 31 (Tyrrhenian Sea). On the summer cruise it was present at the following stations: 184,945 m. w. (?), 186 (in salpæ), 189, 945 m. w., 194, 0 m. and 1145 m. w., 204, 0 m., 205, 206, 0 m., 209, 945 m. w., 223, 224 and 226, i e. scattered throughout the whole of the Mediterranean to the Bay of Corinth, often in deep water samples.

10. PHALACROMA CUNEUS Schütt. (Fig. 11 p. 7).

Schütt 1895, pl. 3 fig. 14. Ph. Blackmani Murray & Whitting 1899 p. 330, pl. 31 fig. 4, a, b.

About as long (high) as broad in dorso-ventral direction, 72—88 μ, somewhat narrower in lateral direction, (perpendicularly to the median plane), seen from above broad oval. Especially the one girdle

list often with short, regularly set radial ribs. Left longitudinal fin rather broad, often with irregularly developed reticulation, more or less protracted downwards, rarely almost abrupt at the lower end, about $^3/_4$ the length of the hypotheca. The reticulation thin-walled, or somewhat thick-walled, on the epitheca generally with somewhat larger mesh than on the sides of the hypotheca.

An easily distinguishable species, widely distributed in the Atlantic. On the winter cruise of the "Thor" it was found at only 6 stations (Port Alice, 16, 18, 23, 24, 45) from the Bay of Ægina to Galita, only in single specimens. On the summer cruise it was found to be distributed from the south-west coast of Portugal (st. 234, 100—25 m.) to st. 182, 545 m., in the Ægean, now also rare and almost invariably in single specimens, generally only below the surface, but here present at lesser depths at nearly all stations where deep water samples were taken (sts. 126, 200—100 m., 275 m. w., 129, 80—0 m., 600—0 m., 1100—0 m., 134, 125—75 m., 152, 250 m. w., 156, 250 m. w., 182, 545 m. w., 186, 245 m. w., 187, 190—100 m., 945 m. w., 194, 1145 m. w., 199, 200—80 m., 945 m. w., 204, 945 m. w., 206, 1945 m. w., 209, 80—30 m., 100—85 m., 1945 m. w., 223, 1950 m. w., 234, 100—25 m.) whereas at the surface, it was only observed at four stations, (sts. 92, 183, 194 and 202). Sts. 199, 200—80 m., 209, 80—33 m., 129, 80—0 m. and 134, 125—75 m., in the central parts of the Mediterranean, were the only stations where several individuals were observed; otherwise, it was always but very sparsely present.

The species immigrates in all probability from the Atlantic, but presumably only to a slight extent. This immigration could not be directly traced at the time when the "Thor" samples were taken, — no immigration in January or September, and only insignificant traces in June — but may perhaps take place in the late autumn months. In the central Mediterranean, the species seems able to keep alive for some time in deeper water.

The species was already recorded from the Mediterranean by Schröder (from Naples) 1900 and later by Schröder (1906) ("Ionian Sea") and by Pavillard (1909 and 1916) from the Golfe du Lion ("all the year, but rare").

11. PHALACROMA STRIATUM Kofoid (Fig. 12 p. 13).

Kofoid 1907 a p. 195, pl. 12, fig. 73.

Resembles a large form of the foregoing, but with the hypotheca oblique and more broadly rounded below; is also particularly distinguishable by a very long and at the same time broad left longitudinal fin, the broad part of which reaches almost to the antapex, where it is shortly decurrent. The girdle lists often entirely covered with coarse reticulations. The lowest spine in the sail weak and directed downward or even at times somewhat rearward. The reticulation often faint and thin-walled; sail with more or less distinct structure of incomplete areoles, which often present the impression of irregular radial striations. Length of cell (height) almost equal to breadth in dorso-ventral direction, or somewhat greater; the latter 102—136 μ.

Very rare. Only observed at st. 187 in the Ionian Sea, singly in the sample from 190—100 m., and in the sample with 945 m. w. and at st. 126, 275 m. w. Kofoid found it in samples from the Pacific, n. e. and far to the s. w. of Galapagos. I have also seen it from the Guinea Current (German South Pole Exped. $^1/_{10}$ 1903, 200 m.).

Undoubtedly one of the tropical species which come in at times from the Atlantic through the Straits of Gibraltar, and are as a rule only found later on in deeper water in the inner parts of the Mediterranean, where they seem to be able to exist for a more or less considerable time.

Sectio IV. ARGUS.

Structure of theca reticulate, in large, thin-walled polygonal meshes, each with a pore in the centre. Cell almost elliptical in shape, somewhat wedge-shaped both in profile and in ventral view. Left longitudinal furrow list (fin, sail) essentially as in Sectio 3, with more or less indistinct lowest spine, the point of which lies far below the greatest breadth of the list. Girdle lists without regular radial ribs.

12. PHALACROMA ARGUS Stein (Fig. 13).

Stein 1883 pl. 18, figs. 15—17. Schütt 1895 pl. 3 figs. 15, 1—3.

The cell in profile somewhat asymmetrical elliptic (in relation to the girdle, which hardly breaks the contour). Epitheca almost evenly and highly domed, hypotheca obliquely oval, the ratio of their heights, reckoned vertically to the girdle, about 0.29. Girdle lists almost horizontal, parallel and strongly developed (breadth often somewhat exceeding that of the girdle) without transverse ribs; in specimens of more powerful structure, close into the cell, with irregular, coarse and short radial beams, finally anastomosing into an incomplete, wide-meshed reticulation. Left fin comparatively narrow, the upper part more or less markedly bent over, broadening evenly toward the lower end, and then rounding off in a curve to an

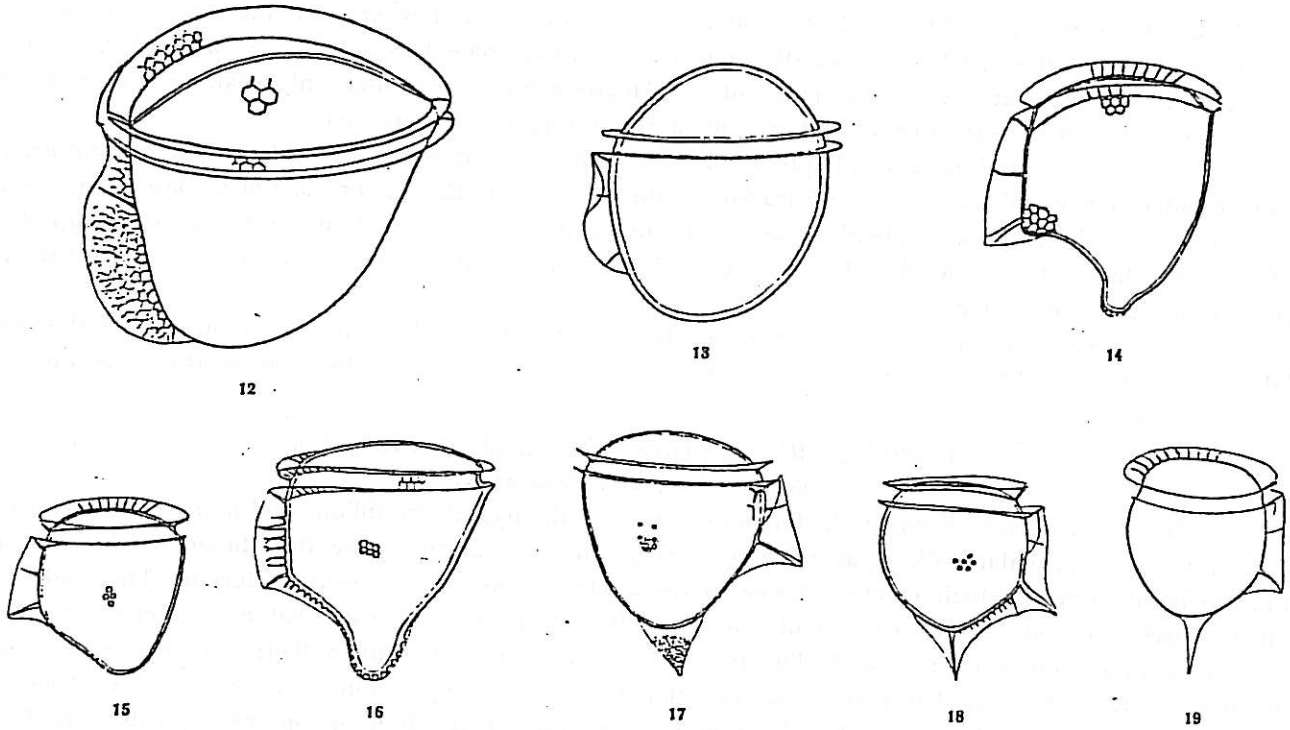


Fig. 12. *Phalacroma striatum* Kof., oblique side view, 400/1. Deutsche Südpol-Expedition, 1. X.-1903 (Guinea Current). Fig. 13. *Phalacroma argus* Stein, 400/1. St. 10. Structure of theca not shown. Fig. 14. *Phalacroma rapa* Stein, oblique side view, 400/1. St. 66 (Cadiz Bay). Fig. 15. *Phalacroma dolichopterygium* Murr. & Whitt.?, 400/1. Tortugas 4. VI. 1910. Fig. 16. *Phalacroma favus* Kof. & Michen.?, 400/1. St. 10. Fig. 17. *Phalacroma doryphorum* Stein, 400/1. St. 11. Fig. 18. *Phalacroma circumsutum* Karst., 400/1. St. 156, 950 m. wire. Fig. 19. *Phalacroma pugiunculus* n. sp. ad int., oblique side view, 400/1. St. 132.

obliquely decurrent lower part, without any angle at the outer corner. Structure of distinct pores, roughly distant one from another as the "pores" in *Ph. porodictyum* (but one in each mesh).

This easily distinguishable species was found on the winter cruise of the "Thor" throughout the whole of the Mediterranean (at 14 out of 37 stations), everywhere in single specimens, most rare in the Tyrrhenian Sea, in the Bay of Cadiz with "megacytic" cells. In the course of the summer cruise, it was found at 34 out of 102 stations in the Mediterranean, likewise in small numbers, or for the most part singly, again sparsely in the Tyrrhenian Sea, where it even appeared to be lacking in June, in the eastern Mediterranean almost exclusively in deep water. Megacytes in the Balearic and Catalonian Seas.

There was an immigration from the Atlantic in January and February, less in June, none in September. Appears to immigrate in winter, January to April; in the summer only a little during the earlier months. Was not found north of Cadiz. The species is already recorded for the Mediterranean by

Entz, 1902, from the northern Adriatic, and later by Pavillard from the Golfe du Lion, 1909 and 1916, (all the year round, most numerous in winter).

Also known from many places in the warmer Atlantic, including the Florida Current.

Sectio V. PODOPHALACROMA.

The cell, in ventral view, wedge-shaped, in profile irregularly so, more or less distinctly protracted downward into a broad rounded prolongation. Left longitudinal furrow list as in Sections I and II, structure as in Section III. In a living state, usually (?) coloured a diffuse yellowish green (?).

13. PHALACROMA RAPA Stein (Fig. 14 p. 13).

Stein 1883 pl. 19, figs. 5—8.

A comparatively large species. The epitheca flat, in profile hardly projecting beyond the girdle, seen from above, a broad oval. The hypotheca in profile with lateral contours almost parallel above, or converging downward, obliquely drawn out below at the back into a short rounded prolongation, on the ventral side abruptly ending in a broad obtuse angle. The girdle lists strongly developed, parallel and equally developed, directed slightly upward, with strong radial ribs. Left longitudinal fin about 0.6 of the length of the hypotheca, broad and often with some structure, in the lower part, broader, and almost transversely cut off to slightly decurrent, with slightly acute or almost rectangular outer corner, and long and powerful, obliquely down-pointing supporting spine. Structure coarse and very distinct, in large meshes with strong, but not thick walls, and distinct pore, one in each mesh. Length (height) of the cell 72—85 μ, breadth (greatest at the girdle) 60—64 μ. In a living state, diffused yellowish-green. (?)

An easily recognisable species, widely distributed throughout the Atlantic, according to Cleve (1901 a) from Lat. 20° S. to Lat. 42° N., Long. 1° E. to Long. 74° W. In the winter cruise of the "Thor" it was found scattered and very sparsely in the northern Ionian Sea (sts. 12 and 16) at st. 14 in the Adriatic, off Naples (sts. 25, 26, 28) in the Ligurian Sea (sts. 33 and 35), off the east coast of Sardinia (sts. 38 and 39), east of the Straits of Gibraltar (st. 60) and in the Bay of Cadiz (sts. 62 and 66), here, at one station (66) somewhat more numerous. On the summer cruise, it occurred from st. 89 off the south coast of Portugal sometimes numerous at the deeper outer stations (89, 91, 92) — here as the dominant species among the *Dinophysiaceæ* — sparsely at the inner stations (94—96) and later at most stations (54 out of 102) throughout the entire Mediterranean, as a rule singly or in small numbers. In the Sidra Sea it seemed to be lacking and was altogether most frequent and most numerous in the western part of the Mediterranean, west of the Tyrrhenian Sea, here, at stations along the coast of Africa and across to the south-eastern corner of Spain, on the way back, very numerous and dominant in September, but sparsely occurrent in June. Outside the Mediterranean, it was found on the return journey in the Bay of Cadiz at both stations, — also in deep water at st. 231 — in deep water at st. 234 off the south-west coast of Portugal and at sts. 237 and 238 (farther north), likewise at st. 243 (far to the south-west of Brittany), everywhere sparsely.

There appears to be an immigration of the species all the year round from the Atlantic. In the winter (December and January) it does not seem to survive the transition to Mediterranean water. In June, there seems to be an immigration with positive result, — albeit with a marked decrease in numbers on passing into the Alboran Sea — while the immigration in August appears to be excellently successful, with a striking increase in the number of individuals in the eastern part of the Alboran Sea and in the western waters of the Balearic Sea. Fission stages were observed.

Occurs at the Azores and in the Florida Current, and was noted from the Mediterranean already by Schröder (1900, from Naples) and later by Cleve (1903), Entz 1902, Zacharias (1906) and Pavillard (1915 and 1916, fairly frequent in the Golfe du Lion).

14. PHALACROMA DOLICHOPTERYGIUM Murray & Whitt.? (Fig. 15 p. 13).

Murray & Whitting 1899 p. 330, pl. 31, figs. 8, a, b. Ph. mitra Pavillard 1916 p. 53, fig. 13 B, p. 54 figs. 14 A—C, hardly Schütt 1895 pl. 4 figs. 18, 1—4.

Resembles the foregoing in shape, but is much smaller, with less coarse structure, not distinctly protracted — or off-set — antapical prolongation and the left longitudinal furrow list less broad below (though this is broader below than above). Epitheca somewhat domed, thus projecting slightly above the girdle in profile; dorsal contour of the hypotheca generally shows a smooth curve in the lower part, or but faintly off-set prolongation, this last, moreover, much broader in proportion than in *Ph. rapa*. Ventral side contour of the hypotheca is also less sharply (or angularly) truncated than in this last species. The cell seen from the dorsal side mainly as in *Ph. rapa*, but as a rule somewhat more compressed, and proportionately broader in side view. Length 60—68 μ, breadth 51—55 μ.

Ph. mitra Schütt seems, from the figure mentioned, to be *Ph. rapa*, but does not exhibit, in profile, the set-off lower prolongation. *Ph. mitra* (Murr. & Whitt. 1899 pl. 31 fig. 7) is doubtless *Ph. rapa*; it is stated in the text that they did not find Schütt's figure satisfactory, and therefore give a new one. Their *Ph. dolichopterygium* derives its name from the very long "wing" extending right to the antapex, but answers otherwise well enough to the species I indicate by the above name. They mention that it resembles *Ph. "mitra"* (i. e. *rapa*). PAVILLARD's species is doubtless the same as mine here (above) and it is in order to avoid a new name that I endeavour to use Murray and Whitting's (with essential correction for the "wing", which is roughly as in the foregoing species). The figure quoted by PAVILLARD as from OKAMURA looks to me as if it might be *Ph. rapa* (though the dorsal contour is not the same) while his fig. 42 is perhaps PAVILLARD's *Ph. mitra* (or perhaps *Ph. acutum*). The size of the figures and the structure seem to me safer distinguishing marks (than the dorsal contour and the antapical prolongation) in view of the obliquity of the cell, which may easily give rise to divergence in the drawings. I have indeed never seen anything quite corresponding to the long wing in MURRAY and WHITTING's figure.

This species was found both on the winter cruise and the summer cruise of the "Thor", always singly or in small numbers. I cannot at the moment give any exact statement of its distribution, but have noted it on the winter cruise from st. 66 in the Bay of Cadiz, (several specimens), st. 55 off the south-east coast of Spain, and also from the northern Balearic Sea, the Ligurian Sea and the Tyrrhenian Sea. On the summer cruise, it was found scattered and sparsely, from the south-west coast of Portugal (at any rate in September) right in to the northern Ægean (st. 167) and even at st. 170 in the Sea of Marmora, 80—20 m., i. e. in the layer containing inflowing salt water from the Ægean. This species was also found in the Sidra Sea, at st. 145.

Outside the Mediterranean, I have seen it at the Tortugas, and in a sample from the Persian Gulf (more like Murray and Whitting's figure than usual). CLEVE (1901 b and 1902) notes *Ph. dolichopterygium* from the Azores (in June), the southern Atlantic and the Indian Ocean.

15. PHALACROMA FAVUS Kof. a. Michener (?) (Fig. 16 p. 13).

Kofoid a. Michener 1911 p. 289. Ph. simulans Jørg. mscr.

In appearance, an intermediate form between *Ph. rapa* and *Ph. Hindmarchii* Murray & Whitting. Epitheca low-domed. Hypotheca in the upper half in profile with almost straight converging lateral contours, below the middle, abruptly narrowed to a short rounded antapical prolongation, in shape and direction as in *Ph. rapa*, but situated almost in the middle, or somewhat nearer the dorsal side. Girdle lists as in *Ph. rapa*, Left longitudinal fin not or but little broader below, with distinct, but not particularly thickened lower supporting spine, pointing obliquely down, from here, longly and narrowly decurrent nearly to the base of the antapical prolongation. Structure rather coarse, somewhat finer than in *Ph. rapa*, but far coarser than in *Ph. Hindmarchii*. Two forms, a larger with length and breadth 81—83 $\mu \times$ 68—71 μ, and a smaller, 54—62 $\times$ 54 μ.

I have not noticed that the species I have noted from the cruise of the Thor as *Ph. Hindmarchii* really differed essentially from that species. The few slides and figures I at present possess all exhibit the form here described, certainly, in two different sizes, but otherwise entirely alike in all essential characters. These are first and foremost, the development of left longitudinal fin which in the present species is but little broader at the lower supporting spine — this is not strikingly thickened distally — and from here longly decurrent, whereas in *Ph. Hindmarchii* it is drawn out into a much broader shape, with a club-shaped thickening of the supporting spine, and cut off almost transversely at the end, consequently much shorter. The outer corner, at the end of the spine referred to, is therefore, in *Ph. Hindmarchii*, acute-angled, (but the "point" itself blunt) or almost rectangular, whereas in *Ph. favus*, it is obtuse-angled. Furthermore, the lateral contours of the hypotheca in *Phalacroma Hindmarchii* in profile are convex and distinctly arched, whereas in *Ph. favus* they are straight and convergent. The antapical prolongation in *Ph. Hindmarchii* almost symmetrical — like the cell generally — whereas in *Ph. favus* it is more or less asymmetrical, with a somewhat ventral trend, much sharper set off from the ventral than from the dorsal contour. The structure in *Ph. Hindmarchii* also much finer, and the epitheca higher domed.

On the other hand, this species shows a close relationship to *Ph. rapa*, and this, moreover, to such a degree that there might be some grounds for regarding it as a variety of that species. It is particularly the longly decurrent left longitudinal fin, in connection with the medially placed end prolongation — giving a marked similarity of habitus to *Ph. Hindmarchii* — which makes me consider it necessary to note it as a distinct species.

This species has no resemblance to MURRAY and WHITTING's figure referred to beyond the longly decurrent "sail". It seems, on the other hand, to be identical with the *Ph. favus* described by Kofoid and Michener; I have not, however, seen any figure of this latter species.

The certain specimens are from the winter cruise of the "Thor" st. 10 (Ionian Sea) and summer cruise st. 66 (Bay of Cadiz), here the smaller form, also with "megacyte".

PAVILLARD quotes (1916 p. 53) *Ph. Hindmarchii* as very rare from the Golfe du Lion, in winter samples. As no figure or description of appearance accompanies the statement, I cannot see whether this also is the above described *Ph. favus*. I have not noted either of the species at other stations than the two just mentioned.

Sectio VI. UROPHALACROMA.

Hypotheca furnished with a solid (not hollow) terminal spine, generally with ventral and dorsal lists. Cell in ventral view distinctly wedge-shaped, in side view, often less distinctly so, and always broadly rounded off below. The spine belongs only to the right half of the theca, (whereas the lower prolongation in the foregoing section is divided by the plane of fission). Structure fine, of small "poroids", with or without "pores".

16. PHALACROMA DORYPHORUM Stein (Fig. 17 p. 13).

Stein 1883 pl. 19, figs. 1—4.

A very characteristic and easily recognisable species. Epitheca low-domed, hypotheca oval wedge-shaped in side view, with medium long left longitudinal fin, broader at the lower end, here cut off almost transversely and very shortly decurrent, with slightly acute-angled outer corner and powerful, often distally thickened lower supporting spine. Apical spine more or less powerfully developed, in profile triangular of thin, broad sail lists (and more or less thick middle rib). The cell in profile is usually somewhat asymmetrical, with the antapical pole and the terminal spine displaced toward the ventral side. The cell wedge-shaped, compressed from the sides, seen from above an elliptical oval. Structure as in *Ph. porodictyum* with fine areoles and scattered "pores" (at a higher adjustment of the microscope), the areoles of unequal

size. The medial spine — the fission spine — generally very thin and very slightly conspicuous. Girdle lists equally developed, directed slightly upward, without transverse ribs. About 68 μ long, and 62 broad.

On the winter cruise of the "Thor" it was present at nearly all stations, generally in small numbers or singly, off Naples and the northern point of Corsica (sts. 26, 29 and 33) numerous, off the south-east side of Sardinia (sts. 40 and 42) and in the Bay of Cadiz, (st. 66), also in some quantity. On the summer cruise it was found from the Bay of Cadiz (rare in June) throughout the whole of the Mediterranean to st. 167, in the northern Ægean, in varying frequency. In the western part, the Alboran Sea and off the adjacent parts of the north coast of Africa, it was rare and sparsely met with, both in June and on the return voyage in September, otherwise occurring at nearly all stations, here and there numerous (the most numerously represented species of the Dinophysiaceae at sts. 115, 118, 123 (off Genoa, where it was numerous in July), 129, 0—80 m. and 0—1100 m, 134, 0—75 m. and 210 (Catalonian Sea, here very numerous). In the middle part of the Mediterranean it was constantly present below the surface; on the forward voyage it was found in the Tyrrhenian Sea exclusively below the surface and at all stations where such samples were taken. It was indeed found at all stations in the Mediterranean where deep water samples were taken. On the homeward voyage, in September, it was found at one station in the Bay of Cadiz, and the last time at st. 234 off the south-west coast of Portugal, here only below the surface, 100—25 m., sparsely.

The species must thus undoubtedly be indigenous to the Mediterranean, and seems to be numerous all the year round at certain places in the middle portion. There is also no doubt an occasional immigration from the Atlantic through the straits of Gibraltar, but this does not seem to play any great part. Fission stages were observed, at any rate at sts. 92, 109 and 119.

Recorded from the Mediterranean already by POUCHET 1883 (and SCHRÖDER 1900). According to PAVILLARD, 1916, the most frequently occurring *Phalacroma* species, in the Golfe du Lion, where it is found all the year round.

Outside the Mediterranean, the species is widely distributed in the Atlantic; according to CLEVE, 1901 a, from 12° S to 57° N, and 9° W to 74° W. It is also found at the Azores and in the Florida Current.

17. PHALACROMA CIRCUMSUTUM Karst. (Fig. 18 p. 13).

Karsten 1907, pl. LIII fig. 8.

Very like the foregoing, and perhaps not altogether distinct from it in all its forms. The most essential difference is that the antapical spine and the lower supporting spine in the left longitudinal fin are joined by a more or less broad sail list. Also, the epitheca seems as a rule (in *Ph. circumsutum*) to be lower, the girdle lists often broader, and with an indication of transverse ribs close in the cell, which also is more laterally compressed. The structure of the theca may also be as in *Ph. doryphorum*, but seems often to be coarser, and without distinct scattered "pores".

Besides a larger form, answering to KARSTEN's figure, with protracted lower end of left longitudinal fin (at the supporting spine) and large, somewhat ventrally directed terminal spine, there occurred in the "Thor" material also a smaller and divergent form, with downward trending terminal spine, and slightly prominent corner of left longitudinal fin, shape of cell in profile broader in proportion, and epitheca higher.

Very rare in the "Thor" material, and only observed in samples from the summer cruise at sts. 156, 950 m. w. (Levant), 187, 945 m. w. (the smaller form) and 189, 945 m. w. (Ionian Sea), 194, 1145 m. w. (Tyrrhenian Sea), 206, 1945 m. w. (Balearic Sea) and 209, 1945 m. w. and 210 (the smaller form) in the Catalonian Sea. Found, then, only in one surface sample.

KARSTEN found the species in the Indian Ocean. I have also seen it in three samples from the German South-Pole Expedition, ($^{18}/_{9}$ 1903, $^{21}/_{9}$ 1903, 400 m. and $^{1}/_{10}$ 1903, 200 m., in and near the Guinea Current).

18. PHALACROMA PUGIUNCULUS n. sp. ad int. (Fig. 19 p. 13).

? Ph. pulchrum Kofoid a. Michener 1911 p. 291.

A smaller species with long, narrow terminal spine without (distinct) sail edges. The epitheca low-domed, the upper part somewhat flattened from above. Hypotheca in profile about symmetrical, $^2/_3$ of a circle, somewhat ovally extended downward. Left longitudinal fin long, somewhat broader below, and cut off almost transversely with acute outer corner and here almost a right angle with curving, down-turned, rather thin supporting spine. Girdle lists broad (especially the upper) and curved outward, with distinct but somewhat irregular radial stripes. Structure rather fine, of small areoles. Length and breadth 49—53 μ, by 43—48 μ.

Answers fairly well to the description of *Ph. pulchrum*, but differs in the transverse striation of the girdle lists.

Very rare, only observed in two summer samples, st. 132, 600—195 m., and st. 194 (southern Tyrrhenian Sea).

DINOPHYSIS Ehrb.

In contradistinction to *Phalacroma*, this genus, in its typical forms, includes more or less markedly compressed, not wedge-shaped species, with small or almost rudimentary epitheca and obliquely set girdle lists, which are more or less conspicuously dissimilar, the upper one being developed to a funnel, and often having a different structure (generally of radial ribs) from the lower. The section *Paradinophysis* of the genus *Phalacroma* connects the two genera, including as it does a continuous series of forms from those of the *Phalacroma* type — though not wedge-shaped — to those of the *Dinophysis* type, which latter have, on that account alone, been ascribed to *Phalacroma* as it would be unnatural to separate them from the others.

Both genera show a certain parallel development.

Sectio I. ACUTÆ Pavill. (emend.).

Theca in ventral view more or less narrowly elliptical to almost (broadly) linear, in profile irregularly pentagonal-ovate, somewhat tapering below, or rounded. "Funnel" (upper girdle list) without distinct radial ribs, left longitudinal fin long, about $^3/_4$ the length of the hypotheca.

1. DINOPHYSIS ACUTA Ehrenberg, Jörg. (Fig. 20 p. 20).

This species, which is very frequent in northern waters, was early recorded from the Mediterranean (Entz 1884, Daday 1888 etc.). As however there are two closely related species (see the two following) it was not until these were separated out by Pavillard (1909 and 1916) that we could take it for granted that records actually referred to the above species.

With regard to the name, it is no doubt most likely that Ehrenberg's original name was based on *Dinophysis norvegica* (from Kiel).

On the winter cruise of the "Thor" it was taken at 9 stations (11, 14, 23, 24, 25, 26, 28, 45, 53) from the Ionian Sea to the eastern part of the Alboran Sea, everywhere singly or very sparsely, most frequent off Naples. In the summer cruise it was found off the coast of Portugal in June (sts. 84, 85, 87) in September, several specimens off Lisbon and especially in the deep water outside (sts. 234, 235, 237), in June in the Bay of Cadiz (sts. 89, 92, Cadiz, — numerous, — 95) but not there in September, in the Straits of Gibraltar in June (st. 98) but lacking altogether in the Atlantic Current and indeed from Gibraltar to the coast of Tunis in July and from the Catalonian Sea to the Straits of Gibraltar in September. As regards the Western Mediterranean, on the inward voyage in July it is noted from 3 stations at the sur-

face (119, 120, 123) and from 3 stations only from deep water (sts. 126, 275 m. w., 132, 195—600 m., south east of Sardinia, and 134, 185—350 m. in the south eastern part of the Balearic Sea), on the return voyage in August, from several stations, three in the Tyrrhenian Sea (sts. 194, 0 m., 1145 m. w., 195, 199, 945 m. w., one in the Balearic Sea (st. 206, 1945 m. w.) and three in the Catalonian Sea (sts. 209, 33—80 m., 200—1000 m., 945 m. w., 1945 m. w., 210, 211) here numerous in deep water (945 m. w.) at st. 209, otherwise everywhere in small numbers. In the Eastern Mediterranean, it seemed to be lacking altogether in the southern part, and to be very rare generally, save in deep water between Greece and Sicily, where it was fonnd at all stations where samples were taken from deep water (sts. 161, 194, 945 m. w., 186, 1145 m. w., 187, 0—25 m., 945 m. w., 189, 945 m. w., everywhere single or few). On the other hand, it seems to be extremely numerous in the Black Sea, where, at st. 172, between 50 and 200 m., it occurred in quantities together with *Ceratium tripos* and *C. furca* (salinity about 20 ‰, temp. about 8° C.). In the intermediate area between the Black Sea and the Ægean, it was found in the Bosphorus and at Constantinople, also in the Marmora below the surface (sts. 170, 0—20 m., 20—80 m., 85—200 m., 195—1000 m., 175, 350 m. w., 1150 m. w., here many specimens with 350 m. w.). On the return voyage, it was found at Brest and outside (st. 246).

Outside the Mediterranean, it is widely distributed in the north-European waters (especially in the North Sea and Norwegian Sea), in the Atlantic from the most eastern parts at least to about 40° W, and south to abt. 48° N. (in April) or perhaps more southerly, along the coast of Portugal, as stated above from the "Thor" cruises in June right down to the Bay of Cadiz in September at any rate to south of Lisbon.

Immigration from the Atlantic does not succeed in June. Nor is there any distinct indication of immigration in September, but the occurrence at sts. 23—28 seems to be due to immigration through the Straits of Gibraltar in late autumn (Nov.?) and the occurrence at st. 45 — at the surface — must probably be ascribed to immigration in January; that at st. 134 — deep water — perhaps to immigration in the spring (May?). On the other hand, there may perhaps be a possibility of occasional emigration from the Black Sea region, and that the species can continue to exist at places with lower salinity or temperature. It appears to thrive in the vicinity of harbours; at Cadiz and Lisbon, for instance, it was numerous, and at Constantinople it was the only Dinophysiaceae species. Schröder (1911) found it below the surface off the coast of Dalmatia. It is perhaps altogether somewhat widely distributed throughout the middle and inner parts of the Mediterranean, in deeper water; the form there found is generally very thick-walled and of powerful structure (see fig. 20) and differs considerably in appearance from the northern form, though it cannot be reckoned as a distinct species. This seems to suggest that the species keeps alive for a long time in the Mediterranean, and should perhaps be regarded as indigenous (naturalised) there. (See also remarks to the three following species).

According to Pavillard (1916) in Golfe du Lion in spring and summer, sometimes numerous.

I have not seen it from the coast of America; the specimen noted by Cleve (1901 a) from the Florida Current, was probably the following species.

2. DINOPHYSIS INTERMEDIA Pavill. (Fig. 21 p. 20).

Pavillard 1916, p. 58, pl. III, fig. 4. D. atlantica Ehrb.? 1854.

Closely related to the foregoing, but differing in evenly curved dorsal contour rounded off below (in profile), somewhat narrower funnel base, generally somewhat less coarse structure with areoles of about equal size — in the foregoing species, they grow smaller in the circumference — and especially with a more compressed cell, with almost parallel lateral contours in dorsal view. In *Dinophysis acuta*, the cell, seen from the dorsal side, is generally narrowly elliptical, with convex lateral contours. Length and breadth (of cell, excl. funnel) reckoned vertically and parallel to girdle, about 64 μ by 49, as a rule somewhat shorter than the foregoing species.

On the winter cruise of the "Thor" this species seems to be lacking; only noted from st. 53 (singly). On the summer cruise, it was found at some few and scattered stations from the Straits of Gibraltar to the Ligurian Sea, the Bay of Corinth and the Levant; a couple of specimens also at st. 172 (Black Sea) 17—50 m, together with the foregoing species. In June, it was present at almost all stations in the Bay of Cadiz, for the most part singly, at st. 89 several specimens, in the Alboran Sea at 5 out of 10 stations, (sts. 98, 99, 102, 106, 109, generally very few specimens) in the Balearic Sea in June only at one station in the Atlantic Current (st. 113) and at st. 120 to the north, also below the surface, (185—350 m.) at st. 134 in the south-east, in the Ligurian Sea at st. 123 outside Genoa, in the Tyrrhenian Sea at st. 132 off the south-east corner of Sardinia and in deep water at st. 126 (275 m. w.) and 129 (0—600 m., and 0—1100 m.), in the Ionian Sea at st. 185 and otherwise only in deep water (sts. 152, 250 m. w., 184,

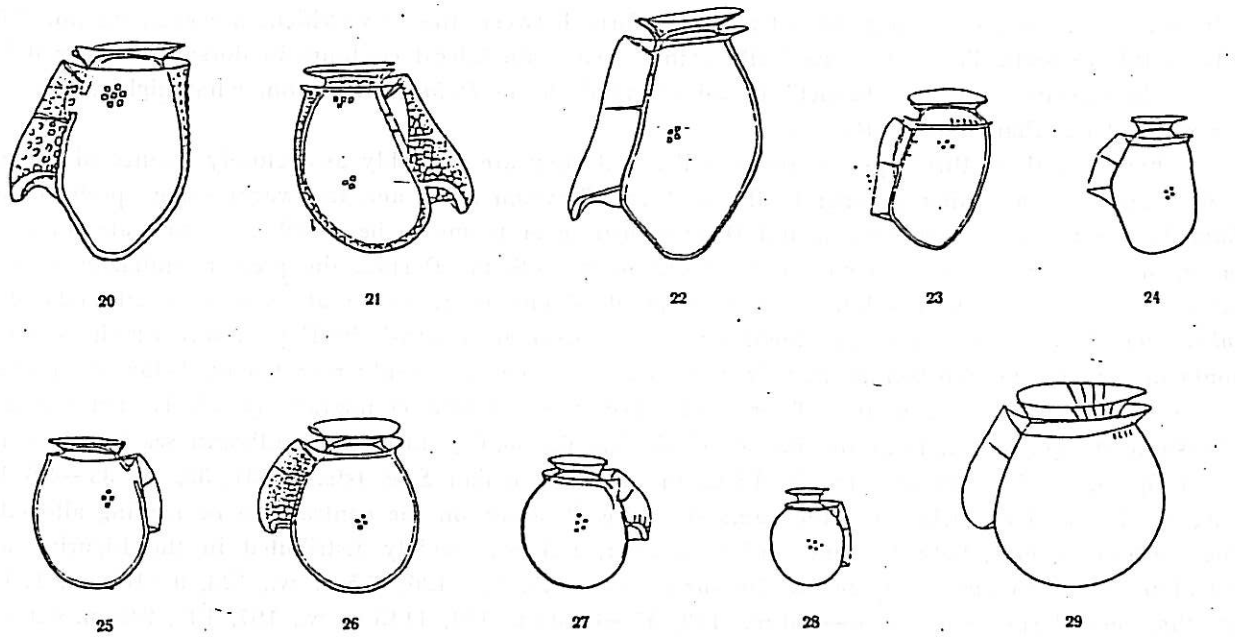


Fig. 20. *Dinophysis acuta* Ehrb., Jørg., *var. sculpta* n. var., $^{400}/_{1}$. St. 186, 1145 m. wire. Fig. 21. *Dinophysis intermedia* Pavill., *f. pachyderma*, $^{400}/_{1}$. St. 184, 945 m. wire. Fig. 22. *Dinophysis Schroederi* Pavill., $^{400}/_{1}$. St. 129. Fig. 23. *Dinophysis dens* Pavill., $^{400}/_{1}$. Cadiz. Fig. 24. *Dinophysis sacculus* Stein, $^{400}/_{1}$. St. 174. Fig. 25. *Dinophysis acuminata* Clap. & Lachm., *forma*, $^{400}/_{1}$. St. 53. Fig. 26. *Dinophysis ovum* Schütt, $^{400}/_{1}$. St. 45. Fig. 27. *Dinophysis lenticula* Pavill., $^{400}/_{1}$. St. 58, among diatoms. Fig. 28. *Dinophysis punctata* n. sp., $^{400}/_{1}$. St. 186, in salpæ. Fig. 29. *Dinophysis sphaerica* Stein, $^{400}/_{1}$. St. 45. (Only a few of the radial ribs of the upper girdle list shown in the figure.)

945 m. w., 186, 1145 m. w.) and in the Levant at st. 156, 250 m. w., 950 m. w. On the return voyage in the Western Mediterranean in August—September, it was present only at st. 202 (south coast of Sardinia) and 228, 1145 m. w. (east of the Straits of Gibraltar) and was further only observed at sts. 234—238 along the west coast of Portugal (234, 0 m., 0—25 m., 25—100 m., 95—200 m., 200—700 m., most specimens at depht 0—25 m.; 235, several specimens, Lisbon, numerous and altogether predominating over other dinophysiaceæ, 237, sparsely, 238 empty thecae).

There is a distinct immigration from the Atlantic in June, probably also in May, (and perhaps in late autumn). Fission stages were found in the Alboran Sea (sts. 99 and 109). Like many other Peridinea species it seems in the middle and eastern Mediterranean chiefly to go over into deeper water (in summer); if it really is present all the year round — as PAVILLARD thinks — it should presumably also be found at deeper levels in winter, which cannot be seen from the "Thor" material.

Outside the Mediterranean, I have seen it from the Florida Current, (off the northern coast of

Florida, temp. 23° C., $^{6}/_{5}$ 1910) and from several places, partly in mixed water, along the northern course of the Gulf Stream, far to the south of Nova Scotia, from 39° to 43° N, and 70°—40° W (temp. 22—18° C., salinity abt. 36.5 $^{0}/_{00}$).

3. DINOPHYSIS SCHROEDERI Pavill. (Fig. 22 p. 20).

Pavillard 1909, p. 284, fig. 5 (p. 283).

Very closely related to the two foregoing species, and particularly, it would seem, to *D. acuta*, from which it is at times hard to distinguish with certainty. It is more prolonged in proportion than either of these species, has in profile a more evenly rounded dorsal contour, than *D. acuta*, but less even than *D. intermedia*, is more broadly rounded below than the former, but less so than the latter, and is also in point of structure of theca an intermediate form between the two (which, however, do not differ greatly in this respect). The cell is markedly compressed, with lateral contours in dorsal view parallel or even slightly concave and the "funnel" in all essentials as in *D. intermedia*, somewhat higher, and narrower at the base, than in *D. acuta*.

Altogether, these three species are so alike that they are probably also closely connected genetically, presumably in a similar manner to the northern *Ceratium tripos* and the warm water species *C. pulchellum*. In other words, *D. intermedia* and *D. Schroederi* seem to me to be possibly warm water forms of *D. acuta*, or vice versa *D. acuta* a cold water form of the others. Despite the greater similarity between *D. acuta* and *D. Schroederi*, this latter seems in point of characters to be at least as nearly related to *D. intermedia*. I have also seen specimens (from the German South-Pole Expedition) which, I think, undoubtedly should be referred to *D. Schroederi*, but had the cell evenly rounded off below (in profile).

On the winter cruise of the "Thor", this species was found comparatively widely distributed in the Western Mediterranean, from the Bay of Cadiz (sts. 62, 66, 68) through the Alboran Sea (off the south coast of Spain, sts. 55—59) and in the Ligurian and Tyrrhenian Seas (sts. 29, 31, 33, 36, 38—42) but lacking off the coast of Africa. On the summer cruise, it seems on the contrary to be lacking altogether at the western stations, both in June and September, but was widely distributed in the Ligurian and Tyrrhenian Seas, sometimes only below the surface (sts. 123, 125, 126, 275 m. w., 128, 0—100 m., 129 at all depths, several specimens at 0—600 m., 132, 57—1090 m., 194, 1145 m. w., 197, 199, 945 m. w.) and in the middle and south-eastern parts of the Balearic Sea (sts. 137, 138, 202, 204; 206, 1945 m. w.) as also near Barcelona (st. 210 and Barcelona). Further, it was found at st. 140 in the western Sidra Sea, in deeper water to the south-east off the African coast (sts. 152 and 156, 250 and 950 m. w.), at st. 158 and in deeper water at two stations in the northern Ægean, (163, 0—80 m. and 182, 545 m. w.). Always in small numbers, most numerous in deep water at st. 129. West of a line Barcelona-Tunis I dit not observe it.

Outside the Mediterranean, I have seen the species from several places in the southern Atlantic, partly near and west of the southernmost part of Africa, (German South-Pole Expedition, $^{11}/_{7}$—$^{11}/_{8}$ 1903) partly east of South America ("Fram" 1911). PAVILLARD found the species in the Golfe du Lion (always rare, found more especially in winter). SCHRÖDER records it from the coast of Dalmatia.

From the "Thor"-material there is no direct sign of immigration from the Atlantic (as with the foregoing species) it seems therefore to be a true Mediterranean species (or form).

4. DINOPHYSIS DENS Pavill. (Fig. 23 p. 20).

Pavillard 1915, 1916, p. 57, pl. III, fig. 1.

I have only seen a few specimens from Cadiz, $^{19}/_{6}$ 1910. PAVILLARD found it in the Golfe du Lion in the spring.

A small form; the specimen drawn has a cell 51 μ long by 36 broad (measured as usual, vertically to and parallel with the girdle).

Being so small, it can naturally easily slip through the net; but not having seen it in the other samples, I should be inclined to think it must be neritic, and possibly a degenerate form (of *Dinophysis acuta*) as *D. diegensis* probably is of *D. caudata*. With it were found (at Cadiz) numerous *D. acuta* apparently in lively fission. I saw several young and small specimens, but do not venture definitely to assert that I saw transition forms to *D. dens*, as I did not realise the possibility of genetic connection until after I had handed over the material.

Sectio II. OVUM Pavill.

Theca in profile generally almost regularly oval or broadly ovate, broadly rounded below, or somewhat square-cut, at times with one or two processes or small spines (but no distinct terminal spine) in ventral view more or less broad with convex sides. Left longitudinal fin comparatively short, abt. 0.6 the length of the hypotheca. Otherwise as previous section.

5. DINOPHYSIS SACCULUS Stein (Fig. 24 p. 20).

Stein 1883, pl. XX, figs. 10—12. D. acuminata var. reniformis Pavillard 1905, p. 59, pl III, fig. 10. D. Pavillardii Schrøder 1906 p. 370. D. sacculus Pavillard 1916 p. 59 pl. II fig. 9.

The cell in profile broadly linear with almost straight, slightly concave or slightly convex dorsal contour and irregularly convex ventral contour, often swelling out a little medially, narrowing upwards, and small epitheca. "Funnel" and lower girdle list very prominent, not very broad; lower breadth of funnel (dorso-ventral diameter of epitheca) small, abt. 0.4 max. breadth of cell. Left longitudinal fin short and medium broad, cut off almost transversely below, with nearly rectangular outer corner and fairly strong but not long supporting spine.

A variable neritic species, length and breadth of cell 48—57 by 26—36 μ. Left longitudinal fin a little over half the length of the hypotheca.

I found it in the "Thor" material only from the Black Sea region, sts. 172, 0—17 m., 51—200 m. (empty), 174 (many specimens) and 175, at surface, singly everywhere save at st. 174 (Marmora).

Pavillard (1905) found it in the Étang du Thau and Golfe du Lion (here all the year round, sometimes numerous, fission stages in July according to Pavillard 1916). Schrøder found it in the northern Adriatic.

The species is noted by Cleve (1901 a) from 40—42° N, 10—9° W, (west coast of Portugal), and 1902 from 24—20° S, 4—0° E. He regards it (1901 a) as neritic.

6. DINOPHYSIS ACUMINATA Clap. & Lachm. (Fig. 25 p. 20).

Claparède & Lachmann 1859 p. 408 pl. 20 fig. 17.

Very like the following, but cell narrower, less egg-shaped with "funnel" lower and broader at the base (broader epitheca). Is often easily recognisable by a small point or process below, near the ventral side, often two or more in succession; I have not seen them in the next species.

Seems very rare in the Mediterranean. In the "Thor" samples I have seen it from sts. 53, 84, 87, Cadiz, 101, 235 and 246, i. e. only from the Alboran Sea (53 and 101) and west of there, where it was found on the return voyage in Septemper right up to beyond Brest (246). Very widely distributed in our northern waters.

7. DINOPHYSIS OVUM Schütt (Fig. 26 p. 20).

Schütt 1895, pl. 1, figs. 6,1-9. Pavillard 1916 p. 58, pl. III.

Somewhat like a small *D. intermedia*, but with shorter (left) longitudinal fin, still smaller epitheca, less straight (slightly convex) ventral contour in lateral view and thick cell, not compressed, (as in *D. intermedium*). Length and breadth of cell: 47—54 μ, 40—47 μ, dorso-ventral diam. of epitheca abt. $^1/_3$ the maximal breadth of the cell. Structure rather coarse.

I found it in the "Thor" material from the winter cruise in samples from sts. 14, 26, 31, 33, 45 and 53, and in the material from the summer cruise from sts. 145, 161, 181, 206, 1945 m. w., Barcelona, 216, and 231; at the surface, always singly or few. It thus occurs rarely and scattered through the whole of the Mediterranean, summer and winter. Probably immigrates from the Atlantic, perhaps in winter.

First recorded from the Mediterranean by PAVILLARD 1905 (from Étang du Thau, where very rare in Decr.) CLEVE (1901 a) records it from 4 places in the Atlantic but it is doubtful whether these really refer to SCHÜTT's species.

8. DINOPHYSIS LENTICULA Pavill. (Fig. 27 p. 20).

Pavillard 1916 p. 59, pl. III, fig. 6.

A small species with more or less thick lenticular cell abt. 40 by 34 μ, or somewhat larger. Structure of rather coarse, pit-like areoles. Left longitudinal fin short and medium broad, often sharply bent over (to the right). Upper girdle list medium high, without distinct transverse ribs, dorso-ventral diameter at base (breadth of epitheca) $^1/_3$ or somewhat less, of maximal breadth of cell.

PAVILLARD found it in the Golfe du Lion, fairly frequent in Febr.-May. I have seen specimens corresponding in size in the "Thor" material from st. 58, (s. coast of Spain February); also noted (doubtful) from st. 187, 945 m. w.

9. DINOPHYSIS PUNCTATA n. sp. ad. int. (Fig. 28 p. 20).

Resembles the foregoing, but is smaller, with longer left longitudinal fin, still smaller epitheca and fine punctate structure. Also much like *D. "sphærica"* STEIN 1883 pl. XX, figs. 9 and 8, with structure as fig. 7, but without (distinctly) striped "funnel". Cell 28 × 23 μ.

I have seen it in material from salpæ, taken at st. 186 (northern Ionian Sea).

There seem altogether to be several quite tiny *Dinophysis* species which cannot be satisfactorily studied in samples taken with the usual plankton nets. This species is mentioned here, partly on account of its agreement with STEIN's figure, and partly because it may perhaps be a form of the foregoing. The *Dinophysis* species seem to have a somewhat large extent of variation.

Sectio III. SPHAERICAE Pavill.

Specially distinguished by radial ribs in the upper girdle list, (which is of medium height and breadth) and by having, in profile, an apparently almost ligulate and rounded lower end of the left longitudinal fin, without distinct supporting spine. Fine areole structure, generally with scattered "pores". Otherwise as previous section.

10. DINOPHYSIS SPHAERICA Stein, Schütt (Fig. 29 p. 20).

Stein 1883 p. p., pl. XX, figs. 3, 4. Schütt 1895, pl. I, fig. 7. Pavillard 1916 p. 60.

The cell in profile characteristically ovate roundish and slightly asymmetrical. Otherwise somewhat resembling *Phalacroma rotundatum*, but is easily distinguished from this by the higher, distinctly striated "funnel", and especially by the lack of the lower, in *Ph. rotundatum* strong, supporting spine, which in *Din. spaerica* is usually indistinct, or only distinct for a short inner portion, not as in *Ph. rotundatum*, running right out to an outer acute corner of the longitudinal fin.

STEIN's figures show the customary acute form of the outer corner of the longitudinal fin, with complete supporting spine, (as in *Phalacroma rotundatum*). It will be found, however, that this left longitudinal fin is markedly curved (to the right). I have seen a specimen, in somewhat slanting position, which showed almost the same appearance as STEIN's fig. 3, so that I think this figure answers to a slightly ventral profile position; the shape of the cell, too, then becomes as in STEIN's figure (less broad). The "funnel" too, suggests the same position of the cell.

Length and breadth of the cell as a rule 57—60 μ, by 55—57 μ, measured vertical to and parallel with the girdle. Structure as in *Phalacroma porodictyum*.

This species was apparently very rare on the winter cruise; I found it only from the two stations 45 (African coast) and 66 (Bay of Cadiz) singly. On the summer cruise, it was found to be widely distributed in the Western Mediterranean, but seemed to be lacking in the Eastern, (possibly one specimen at st. 163 off the coast of Asia-Minor, 0—80 m.; it disappeared during preparation). On the inward voyage, it was first noted at st. 118 in the northern Balearic Sea, and was further found at the following stations: 134, 0—75 m., 196 (?), 199, 945 m. w., 200, 204, at the surface, 205, 206, 0 m., 1945 m. w., 209, 1945 m. w., 210, 215, 216, 217, 218 (numerous), 219, 220, 221, 223, 1950 m. w. (numerous), 224 (numerous), 226, 228, at the surface, Gibraltar, 231, 1145 m. w. It was thus continuously present from st. 215 in the western Balearic Sea all the way to st. 231 in the Bay of Cadiz (not recorded only from sts. 225 and 227) and here at several places more or less numerous, while up to and including st. 204 it occurred only singly or in very small numbers. At five of the stations it was found only in samples from deep water; at st. 206 there were also many specimens, both at the surface and in the deep water sample (1945 m. w.). This distribution suggests that the species immigrates from the Atlantic in summer and multiplies in the Western Mediterranean, where it can sometimes also pass the winter.

It is already recorded from the Mediterranean by Daday, (1888) (Naples) and Entz 1902 (northern Adriatic). Pavillard (1916) finds it rare and sparsely occurring in the Golfe du Lion, but at all seasons. I have seen it from the Guinea Current (1/10 1903, German South-Pole Expedition, 200 m.).

It is easily confused with *Phalacroma stenopterygium*, which has a similar (left) longitudinal fin, only narrower, low upper girdle list with short, incomplete but strong transverse ribs close in to the cell, and, in profile, wedge-shaped cell and somewhat differently shaped hypotheca.

Sectio IV. HOMUNCULUS Pavill.

Theca markedly compressed, with a more or less off-set broad tail-like antapical prolongation, at times also with a similar one more or less developed dorsally. Epitheca little developed, not projecting beyond the strongly developed upper girdle list, which in well-developed specimens is furnished with strong radial ribs. Left longitudinal fin powerfully developed, long, lowest (3rd) supporting spine likewise. Coarse areole structure.

11. DINOPHYSIS CAUDATA Kent (Figs. 30—34 p. 26).

Kent 1882 (p. 460). D. geminatum Pouchet (1883). D. homunculus Stein (1883) p. p. (pl. XXI, figs. 1, 2, 5, 7 not 3, 4, 8).

This common species of warmer seas was at first reported from the Mediterranean by Kent, who described specimens from the Adriatic under the above name, but without figuring them. Shortly afterwards the same species was excellently figured and described by Stein as *D. homunculus* (yet including the two following species), and so the older name was forgotten. The only one who has mentioned it seems to be Grenfell (1887), when describing his supposedly new species *D. semicarinata* (from Jamaica), which however is the present species.

Pouchet (1883) figured a pair of two cells — still cohering dorsally after fission, analogous to the chains of the Ceratia — under the name of *D. geminatum*, which also has the priority as a specific name before that of Stein, and can hardly be abandoned on account of its unfitting special form.

Gourret (1883) described this species from Marseilles under two different names, *D. Allieri* (p. 79, pl. 3 figs. 54, 54 a) and *D. inaequalis* (p. 80, pl. 1 fig. 21). The former figure really is a good one, the latter, however, like so many of his figures on pl. 1, but inadequate and so different from the other that he has deemed it necessary to keep them separate. Unfortunately, the description of this latter "species" also seems to have been made from this bad figure, not from nature, so that the supposedly distinguishing

marks are of no real value. He notes *D. Allieri* as frequent at Marseilles (while *D. inaequalis* is said to be rare).

Later on the species has been mentioned from Venice by IMHOF (1886, 1891), from Naples by DADAY (1888) and others, and from the western part of the Alboran Sea in October 1902 by CLEVE (1903). PAVILLARD (1905) found it to be very rare in the Étang du Thau June—July and October—December, and (1909, 1916) very frequent in the Golfe du Lion.

Dinophysis caudata is a very variable species, also in the Mediterranean, partly on account of the immigration of various forms, partly because the species itself is undoubtedly a very plastic one, being able to adapt itself to very extensive changes of the hydrographical conditions, especially as to salinity of the water.

At present I should propose to try to collect the various forms under two principal varieties, the *var. Allieri* (Gourr.) Lemm. and the *var. abbreviata* nov. nom., to which, outside the Mediterranean, is to be added the *var. pedunculata* Schmidt (1901 p. 221), from the Indian Ocean. The former variety, which might be considered the typical form of the species, is a relatively slender form, chiefly characterized by a very broad longitudinal fin, protracted below, and a relatively long and narrow process (prolongation). The fin makes about half the length of the body (processus included, but "funnel" above excluded) and decidedly more than half of its breadth, usually nearly two thirds of it. The breadth of the process at its upper broader end is much less than that of the fin at the level of the lower — third — rib or spine, which is elegantly curved in its distal half. Reticulations of the fin usually very conspicuous, while the intermediate (second) rib is rather obscure. The "funnel" is large and conspicuously striate.

A special form of this *α Allieri* is represented in fig. 30 p. 26, as *f. speciosa*. It answers very well to STEIN's figures 1, 2, except that the process in these figures is straight (directed along the axis of the body), while in my figure it is oblique. Similar forms with a nearly straight prolongation do occur in the Mediterranean, but only exceptionally.

GOURRET's figure of *C. Allieri* shows the distinctive marks of this typical form, except at the lower end of the fin. I have therefore used GOURRET's name (see below about young specimens).

The typical form of PAVILLARD (1916 p. 56 fig. 15 A) diverges a little towards the next variety — in regard to the shape of the body and, especially, as to the breadth of the fin, which is only half that of the body — but answers to my form in the length of the fin.

The type of SCHRÖDER (1911 p. 36 fig. 7 b) looks at first quite different — compare PAVILLARD l. c. p. 57 — but may nevertheless also belong here, as it answers to *α Allieri* in the best distinguishing mark, the length of the fin, as well as in the general shape of the body and the development of the "funnel"; it wants, however, the characteristic lower part of the fin, which is also too narrow, and it has a less distinctly defined process. STEIN's fig. 5, also of a specimen from the Adriatic, deviates in a similar manner, but seems to show that also this form — under a special denomination — may be included under *α Allieri*. I have myself met with similar forms from the Eastern Mediterranean in summer.

The other variety, *var. abbreviata*, has a broader body with a shorter and broader process, a relatively longer, but narrower fin, extending beyond the middle of the body and provided with a stronger intermediate rib. The breadth of the fin in its lower part is only half that of the body, or a little less, and but little more than the breadth of the process at its upper end.

Fig. 31 p. 26 shows a better developed specimen of this variety. The lower end of the fin is less protracted than in *α Allieri*, but otherwise similar. The process is more abruptly set off from the body at the ventral side.

Beside this form, which still recalls to mind the typical one, there exist a series of others, which distinctly lead over to smaller forms with much less distinctly developed characters of the main species. The end of the series is constituted by the *var. ventricosa* Pavill. (see fig. 32) and *Dinophysis diegensis* Kof., which is scarcely to be separated with certainty from *D. caudata*, in spite of its strikingly different appearance.

Fig. 33, *f. Marmarae n. f.*, is a form from the inner region of the Aegean Sea — where the fresher water from the Sea of Marmora exercises its influence — and from the Dardanelles and the Marmora. The length of the longitudinal fin is about $^2/_3$ of the length of body, and the breadth less than half the breadth of the latter. The "funnel" is still well developed and distinctly striate, the process abruptly set off and the fin conspicuously reticulate. Fig. 34, *f. pontica, n. f.*, from the Bosphorus and the Black Sea is, however, considerably modified, though still distinctly allied to the preceding form. It possesses a similar broad and large fin, but a process, much less abruptly set off, and a less developed funnel, which shows no distinct striae. The size also is somewhat reduced.

Fig. 32 is the end form of the series, still more reduced in size and deviating in the same manner as the preceding form, only in a more marked degree. Also the longitudinal fin has become much nar-

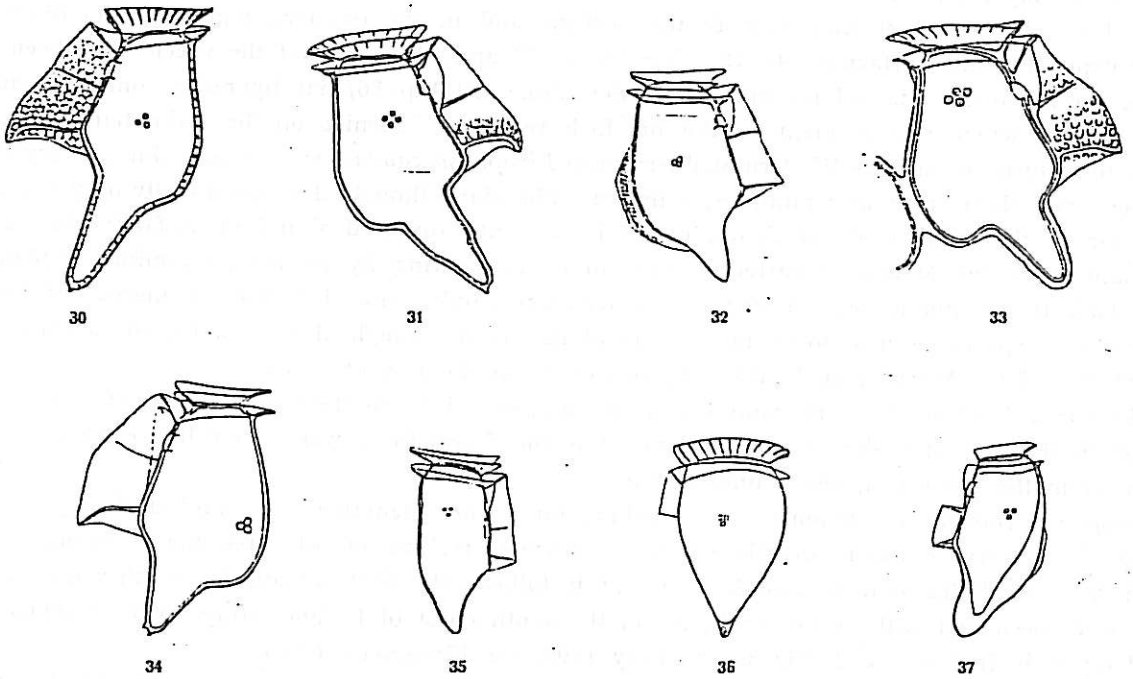


Fig. 30. *Dinophysis caudata* Kent, *α Allieri* (Gourr.), *f. speciosa*, $^{400}/_1$. St. 123. Fig. 31. *Dinophysis caudata* Kent, *var. abbreviata n. var.*, $^{400}/_1$. Malaga Roads. Fig. 32. *Dinophysis caudata* Kent, *var. ventricosa* Pavill., $^{400}/_1$. Lisbon. Fig. 33. *Dinophysis caudata* Kent, *fo. Marmarae*, after fission, $^{400}/_1$. St. 165. Fig. 134. *Dinophysis caudata* Kent, *fo. pontica*, $^{400}/_1$. Bosphorus. Fig. 35. *Dinophysis caudata* Kent, *var. subdiegensis* n. var., $^{400}/_1$. St. 60. Fig. 36. *Dinophysis diegensis* Kof. (?), left half of theca, $^{400}/_1$. St. 66. Fig. 37. *Dinophysis caudata* Kent, a degenerate form, after fission, $^{400}/_1$. Coast of Arabia near Ras Dschibsch, 20. X. 1910, Handel-Mazzetti.

rower, only amounting to one third of the breadth of body; the curvature of the lower spine and the reticulations of the fin are here wanting. Younger specimens generally show a feebler development of the characteristics of the lower part of the fin (a less protracted end, a less curved spine and feebler reticulations) and of the "funnel" (smaller and more or less obscurely striate).

The last mentioned end form (fig. 32) in my opinion clearly proves to be a degenerate form of the main species.

On the winter cruise of the "Thor" *Dinophysis caudata* was present everywhere, but generally scarce or even in single specimens. Relatively more numerous it was at some of the western stations in the Alboran Sea and in the Cadiz Bay.

In summer it was not met with in June until near Cape San Vincent (st. 87), but was thence forward almost continuously present all the way through the Mediterranean and back again in September, when it followed up to near Cape Finisterre (st. 238), and also appeared singly southwest of Brittany (st.

245). On the route outwards in June it was ± scarce, now and then even wanting, but from the Tyrrhenian Sea plentiful or even abundant at most stations, also in the South-eastern Balearic and the Western Sidra Sea, where it was especially numerous between Tunis and Sicily. Also in the Eastern Mediterranean it was everywhere present and often numerous, here and there even very abundant (optima at st. 164 off Asia Minor and at st. 189 off the south-west point of Italy, where it occurred in very great numbers). In the region influenced by the fresher water from the Black Sea it was remarkably frequent, occurring in the very surface as well as at deeper levels at all stations in the Dardanelles, the Marmora, the Bosphorus and the Black Sea. In the Dardanelles it was very scarce at the surface, in the Marmora, however, remarkably numerous at and near the surface, especially in the eastern part of the sea. In the Bosphorus it was likewise very numerous at the surface, and in the (western region of the) Black Sea still rather copious at the surface at st. 172. The figures 33 and 34 show that the species has been able to develope special forms, adapted for this region. SCHRÖDER (1911 p. 36) has figured a somewhat similar form (var. *gracilis*) which was frequent in the brackish region of Sebenico on the Dalmatian Coast.

On the return through the Western Mediterranean *Dinophysis caudata* was present almost everywhere, but only here and there in greater numbers, sometimes abundant, though also occasionally only occurring singly, as far as the south coast of Spain, where it suddenly appeared abundant as far to the west as Gibraltar, and at st. 226 (Malaga) occurred in huge numbers, making by far the predominating plankton species. Outside the Straits it again became suddenly scarce, only somewhat more numerous at Lisbon.

The main species seemed to be more frequent in winter, though also occurring in summer, both in the Eastern and the Western Mediterranean, as well as in the Bay of Cadiz.

The *var. abbreviata* was very common in summer, especially in the region of the Atlantic Current proper and in the Bay of Cadiz. Extreme forms, like the *f. ventricosa*, were generally very scarce, only more frequent in the innermost, less saline, region.

Dinophysis caudata is obviously a euryhaline, but rather stenothermous, and decidedly thermophilous, species, otherwise widely distributed in the warmer regions of all three main oceans. At the Azores it is present all the year (CLEVE 1901 a) and it follows the Gulf Stream far north-wards. Single specimens have been met with as far north as off the south coast of Iceland (July 1903, PAULSEN 1904 p. 29) and off Bodö in Norway (Helligvær, January 1899, see JÖRGENSEN 1905).

Fission stages and pairs of cells were not rare, especially in summer, when sometimes pairs of cells were much more frequent than solitary ones.

Dinophysis caudata is therefore undoubtedly indigeneous in the Mediterranean, occurring throughout this sea in winter as well as in summer, at the latter season frequent right into the Black Sea. It was in 57 summer samples the most frequent of the Mediterranean *Dinophysiaceae*. During the winter it decreases greatly in numbers, but increases again in summer, swelling up here and there to huge numbers. An immigration from the Atlantic seems to go on all the year, in autumn apparently followed by a most marked increase in numbers in the Alboran Sea.

12. DINOPHYSIS KOFOIDII n. sp. ad int. (Fig. 35 p. 26).

D. diegensis var. caudata Pavillard 1916 p. 57, pl. III fig. 2. D. diegensis Kofoid (p. p.) 1907 b p. 313, pl. XXXIII figs. 61 and 58 (the latter f. curvata n. f. Kof.), not figs. 57, 59, 60).

KOFOID's species *D. diegensis* seems (to me) to be a rather doubtful one. His various figures are so different from each other both in size and appearance that the organisms in question in my opinion rather make the impression of a series of variations than of a definite species.

His figures 57, 59, 60 seem, however, to belong to a larger species, of about the same size as *Dinophysis caudata*, but differing from it in the evenly tapering body and apparently also in the shape of the longitudinal fin and perhaps the less coarse structure of the theca, while his figures 58, 61 look like a degenerate little form of *Dinophysis caudata*, but differ essentially from the f. *ventricosa* of this

species, which in my opinion obviously is such a degenerate form of *Dinophysis caudata var. abbreviata*. At least provisionally this smaller form may be considered a separate species, including the *Dinophysis diegensis* var. *caudata* Pavillard (l. c.), found by him in the Golfe du Lion in November 1914, and including Stein's fig. 8, which by Kofoid was referred to *Dinophysis diegensis*. This little species I have only with certainty observed in a sample from the Formosa Straits (off Futschou July 1903, kindly lent me by Ostenfeld), in a form, answering to Kofoids fig. 61, but with a regular process as in Pavillard's figure quoted (directed a little ventrally, Pavillard's figure seems to be a somewhat oblique side view).

In the collections of the "Thor" I have seen a similar form singly at st. 60 (just east of the Straits of Gibraltar in February, see fig. 35). This form is very probably only a degenerate form of *Dinophysis caudata*, probably of the main species, which in some cases shows a slight modification of shape reminding one of the form in question (see f. i. Stein's fig. 5 (1883, pl. XXI) and Schröder's "typical form" (1911 p. 36 fig. 7 b), both from the Adriatic). At Malaga Roads (st. 226, September) a form intermediate between this *f. subdiegensis* and the *f. ventricosa* was seen. (See also fig. 37).

If there is not a mistake in the stated magnification of the figures 57, 59, 60 with Kofoid (1020 (1250?) in stead of 638) this larger form must (apparently) be specifically different from the smaller (figs. 58, 61), which is *Dinophysis diegensis* var. *caudata* Pavill. Provisionally I should propose to retain the name *D. diegensis* for this larger form, and to designate the smaller as *D. Kofoidii* n. sp. ad int. As a typical form of this latter species I should consider Pavillard's figure, only with the slight modification above suggested (process not exactly axial, but somewhat ventrally directed). The characteristic features of this new species are the narrow process not set off from the "body", only about one third of the length of the cell body, the narrow longitudinal fin with three almost straight ribs (spines) of about equal length and somewhat diverging, the indistinctly striated "funnel" and a characteristic pale appearance, due to its finer structure. Otherwise it reminds one of *Dinophysis caudata*.

My *f. subdiegensis* would answer to Kofoid's figures 57, 69, 60, if the dimensions with Kofoid are wrong (in the way above suggested). In that case all the mentioned forms are comprehended in *D. diegensis*, which, however, so defined, can scarcely be kept separate from certain forms of *D. caudata* f. *ventricosa*. My new specific name might be of some use by drawing attention to this interesting form which in my opinion is a parallel to *Ceratium Ehrenbergii* Kof., the heteromorphous Baltic forms of *C. tripos* (similar to *C. furca*), and other forms.

Finally I shall only mention that Kofoid's fig. 58 is his first figure of the smaller species, but is justly designated as a special form, *f. curvata*, on account of its flexuose "tail". We should therefore avoid considering this accidental form the type of a possible new species.

Dinophysis diegensis was by Kofoid found rare in neritic plankton off San Diego (California).

Since the foregoing was written, I have seen a further form which may answer to *D. diegensis*. I have, however, only seen an imperfectly developed specimen with very thin-walled theca and almost invisible structure, but with well-developed upper girdle list and here with distinct radial ribs (fig. 36). It resembled a (left) half after fission, still with the other half very pale and indistinctly developed. From this I think we can provisionally take it that the relation between the dissimilar figures of *D. diegensis* given by Kofoid, and his strangely varying dimensions (length 60—110 μ) is in all essentials as above indicated, that we have here a series of degenerate forms of *D. caudata*, but that we may for the present assume that there is a smaller form, without distinct radial ribs in the upper girdle list, with more or less or not at all off-set lower prolongation, and a somewhat larger form, especially broader, with obovate cell-body, pointed below, and no developed prolongation, with distinct radial ribs in the girdle list and (possibly) differently developed left longitudinal fin (the lower part narrowing and longly decurrent). This last species can for the present be maintained as *D. diegensis*, as it answers to Kofoid's first figure, 57, while the one noted above as *D. Kofoidi* should most properly be called *D. caudata var. subdiegensis*, both as regards Pavillard's and my own form (fig. 35).

I still consider it likely, however, that KOFOID's figures 57, 59 and 60 were drawn from a different degree of magnification than stated, probably 1020 (instead of 628) as fig. 56 on the same plate, or abt. 1200.

From the coast of Arabia I have seen forms near to *var. ventricosa* which after fission showed a remarkably reduced antapical prolongation of the theca of the young cell (see fig. 37). These forms, both the young and the old, are strikingly different from the *Dinophysis caudata var. pedunculata* Schmidt, here found in the open sea, and from which they are most probably derived. In this case, we should, in my opinion, have a similarly accelerated sequence of fissions to those which apparently give rise to the links of LOHMANN's heteromorphous chains of *Ceratium tripos* from Kiel, APSTEIN's gemmation in *Ceratium tripos* and the tiny forms of *Gymnodinium pseudonoctiluca* in cultures, discovered by POUCHET (see JØRGENSEN 1911, pp. 37—39, 103—104).

13. DINOPHYSIS TRIPOS Gourret (Figs. 38—39 p. 30).

Gourret 1883 (pl. 3 fig. 53). D. homunculus Stein 1883 p. p. (pl. XXI figs. 3, 4, not 1, 2, 5). D. homunculus var. tripos (Gourr.) Lemmermann 1900.

This easily recognizable and very constant species was already detected by GOURRET at Marseilles (singly). STEIN (1883) did not separate it from the preceding species, but figured it as a variety without a special denomination. ENTZ (1902 a. 1905) mentions it as *Din. homunculus var. tripos* from the Quarnerolo in May, obviously much rarer there than the preceding species, which occurred there almost all the year. PAVILLARD (1905) reports if from the Étang du Thau as very rare there in November. SCHRÖDER (1906) found it very scarce in the "Ionian Sea" in March 1902. ZACHARIAS (1906) mentions it as answering to STEIN's fig. 3 under the name of *D. homunculus var. appendiculata*, from Palermo in July 1905. PAVILLARD (1909 a. 1916) reports it from the Golfe du Lion, where it is perennial and sometimes abundant. SCHRÖDER (1911) found it off Lucietta (Dalmatian Coast) in July 1909, rare.

On the winter cruise of the "Thor" it was met with at most of the stations (23 among 37 in the Mediterranean), but only in small numbers and often but singly. In the Western Alboran Sea it was wanting, and also in the Cadiz Bay, except at the shallow st. 64 (singly). The distribution indicates a feeble immigration in January and February and probably a stronger one in late autumn. In December of the same year I have seen it in samples from the region of the Straits of Gibraltar, where it was continuously present in a series of four samples from Cadiz to the south-east coast of Spain.

In summer it was much more frequent and numerous. On the route outwards in June it was already met with in the northern region of the Bay of Biscay, where it was abundant at st. 79 south-west of Brittany, but only present singly at st. 80. Thence it was wanting all the way to sts. 116 and 118 in the middle of the Balearic, where it again appeared singly. From st. 123 in the Ligurian Sea and st. 126 in the northern region of the Tyrrhenian it occurred at almost all stations to some distance before the Dardanelles (st. 167), and back again (from st. 180) to the station 216 south-west of the Baleares, very varying in numbers, swelling suddenly up at intervals from scarce to abundant (sts. 129, 0—600 m., 138, 190, 194, 196, 199, 200, 208). Like *D. caudata* it was generally scarcer at deeper levels, exceptionally, however, more numerous there than in the surface (sts. 129, 0—600 m., and st. 160, 0—30 m.). Also on the return voyage it was entirely wanting in the region of the Atlantic Current proper, in the Cadiz Bay and off the Coast of Portugal, but reappeared near Brittany (st. 246 and at Brest), now — in September — however only singly there.

Fission stages were observed in winter at st. 46 (off the African Coast), where it occurred somewhat more numerous, and in summer at sts. 79 (near Brittany), 129 and 131 (Tyrrhenian Sea), at the latter station only as a pair of cells after fission, everywhere in the morning, except at st. 46 (6^{35} p. m.).

The four Mediterranean stations, where it proved most abundant in the surface (sts. 138, 190, 194, 196) give as mean values of salinity and temperature 37.89 ‰ and 24.0°.

Outside the Mediterranean the species has been found in all three warmer main oceans, but is

generally much less frequent than *D. caudata*, especially in warmer regions, while it proves relatively frequent in the temperate border regions. In the Bay of Biscay it seems to be present and more or less abundant all the year, to the north as well as to the south, where it f. i. was very common in October 1909. In the English Channel it seems to be frequent to about midway in, and extends farther to the north, at least somewhat beyond a line from the north point of Scotland to the south point of Greenland (July 1889, Plankton-Expedition), to the west into the Irminger Sea. Exceptionally it is also met with on the west coast of Norway (off Bergen December 1901). Another area of frequency extends from the coasts

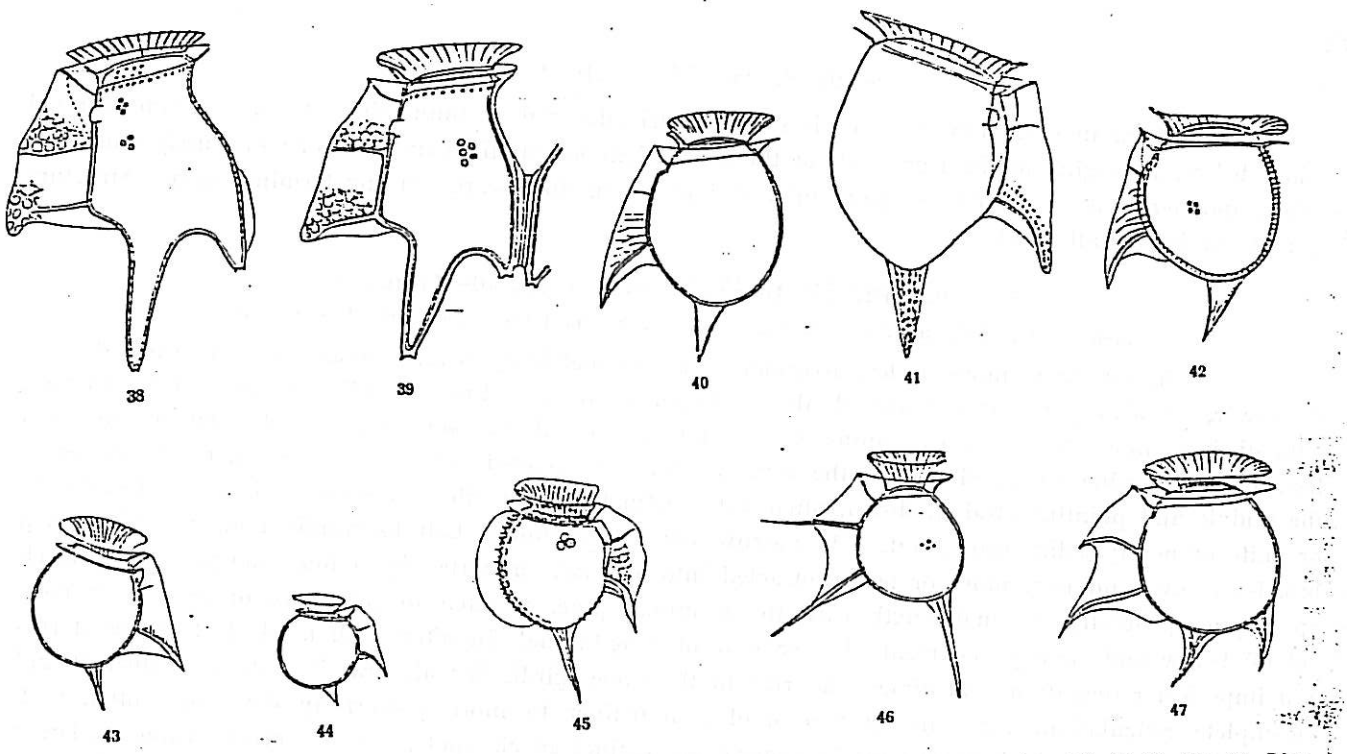


Fig. 38. *Dinophysis tripos* Gourr., $^{400}/_{1}$. St. 129. Fig. 39. *Dinophysis tripos* Gourr., *f. brevicauda*, after fission. $^{400}/_{1}$. St. 79. Fig. 40. *Dinophysis hastata* Stein, *f. uracanthides*, $^{400}/_{1}$. St. 187. Fig. 41. *Dinophysis hastata* Stein, *f. Phalacromides*. $^{400}/_{1}$. St. 156. Fig. 42. *Dinophysis uracantha* Stein, $^{400}/_{1}$. St. 231 (Cadiz Bay). Fig. 43. *Dinophysis uracantha* Stein, *var. mediterranea* n. var., $^{400}/_{1}$. St. 206. Fig. 44. *Dinophysis pusilla* n. sp., $^{400}/_{1}$. St. 206, 1945 m. wire. Fig. 45. *Dinophysis alata* n. sp., $^{400}/_{1}$. St. 187, 945 m. wire. Fig. 46. *Dinophysis Schütti* Murr. & Whitt., the smaller form, $^{400}/_{1}$. St. 152. Fig. 47. *Dinophysis triacantha* Kof., $^{400}/_{1}$. Deutsche Südpol-Expedition 18. IX. 1903 (Gulf of Guinea)

of South Africa along the west wind belt to Australia. In these extreme border regions of its occurrence it stands very well temperatures down to 13° and 12° C.

In the Mediterranean it proves, as mentioned, very constant in shape and size (see fig. 38), and answers very well to GOURRET's figure, which in this case is nearly perfect. In the form of the Bay of Biscay (see fig. 39) the larger process is a little shorter and broader, the end of the longitudinal fin less protracted and the structure of the theca perhaps a little coarser. It is the same form which GOUGH (1905 p. 333) figures from the Channel and which was found on the west coast of Norway. The area in the Southern Atlantic harbours another form, better answering to STEIN's fig. 4 from the "Südsee", which by LEMMERMANN (1900) was designated as *f. incurva*.

Like the preceeding species *Dinophysis tripos* also is a thermophilous species, but is stenohaline. It is undoubtedly indigenous or perennial in the Mediterranean and occurs throughout the Sea, in winter as well as in summer, in the latter season here and there swelling up in numbers to become by far the most numerous species, especially in the median regions of the sea. In winter it decreases seriously in

numbers and seems to vanish at many stations, perhaps especially in the Eastern Mediterranean. A successful immigration from the Atlantic seems to go on from late autumn to January and, to a lesser degree, to February; in summer, however, no immigration at all is to be traced.

Sectio V. HASTATAE Pavill.

Hypotheca in side view more or less asymmetrically oval or roundish, with one or two terminal spines below, belonging to the right half of the theca. Left longitudinal fin more or less acutely protracted below, and here with more or less powerful and long, often downward curving terminal spine. Structure of more or less small areoles.

14. DINOPHYSIS HASTATA Stein (Figs. 40—41 p. 30).

Stein 1883 pl. XIX, fig. 12. Phalacroma hastatum Pavillard 1909 p. 283, figs. A, B, (p. 282).

Cell in side view more or less irregular and asymmetrically oval, generally tapering a little toward the lower, rounded part, more flattened above. Upper girdle list directed obliquely upward to outward, with distinct, more or less close (numerous) radial ribs, of about same width as the cell or somewhat less. Terminal spine displaced toward the ventral side, and directed obliquely ventrally, rarely almost in the middle and pointing straight down, often with distinct median rib and more or less broad sail lists, or quite or nearly solid throughout, with narrow sail lists or none. Left longitudinal fin generally much broader below, and here more or less protracted into a point, supported by a long and powerfully developed spine, generally of equal length with the terminal spine, or often longer, more or less transversely cut off below and shortly decurrent. Lower half of longitudinal fin often with marked structure of ribs and imperfect reticulations; at times, the ribs in the upper girdle list also ramify into an indistinct and incomplete reticulation. Structure of fine areoles, indistinct to more powerfully developed, often with scattered "pores" which, however, rarely appear as distinct black spots, but are often visible as larger areoles. In our northern waters, the living cell is of a light rose, without cromatophores, or hyaline.

I have not been able with certainty to distinguish *Phalacroma hastatum* Pavill. from *Dinophysis hastata*, not even as a separate variety, though it is often rather characteristic. The species, however, varies at times to an extraordinary degree. In the northern waters, e. g. at Bergen, where it has been found in several places, albeit rarely — and in the Black Sea region, it is smaller, with narrower longitudinal fin, without the long curved lower spine, and with a small terminal spine, whereas in the middle part of the Mediterranean, and in warmer seas generally, it grows large, with powerfully developed spines. Very frequent is a pretty form which both in shape of cell and spine development points towards *D. uracantha*, with long and powerful, curved lower supporting spine in the longitudinal fin, and often powerfully developed, more centrally situate terminal spine, the upper girdle list not infrequently also higher and narrower. I tried for some time to distinguish this form as *var. uracanthides*, from a *var. Phalacromides*, answering to *Phalacroma hastatum* Pavill., but this again cannot, as far as my experience goes, be maintained with certainty.

Stein's first figure, 12, which should determine the type of the species, may, in my opinion, very well be my var. *Phalacromides*, the principal difference lying in the coarser structure of Stein's figure.

On the winter cruise of the "Thor", this species was very rare. I have only noted it from two stations at Naples, (sts. 23 and 26) and in addition, sts. 60, 62, 66, 68 and 69, in the Bay of Cadiz and just inside the Straits of Gibraltar. Here, at st. 66 (outside the Straits) it was fairly numerous, but otherwise very sparsely present everywhere. On the summer cruise it was found at 28 stations, everywhere very sparsely, from the Bay of Cadiz (st. 92 and at Cadiz itself) scattered throughout the whole of the Mediterranean right through to st. 172 in the Black Sea, in deeper water, but lacking in the Atlantic Current along the north coast of Africa. In the Tyrrhenian Sea it was frequent, but here and farther up in

the Mediterranean, often only present in deeper water. I have altogether seen it from the following stations (apart from the two mentioned outside the Straits): 126, 275 m. w., 128, 0—100 m., 129, 0—600 m., (Tyrrhenian Sea), 45 (Sidra Sea), 152 surface and 950 m. w. and 250 m. w., (southern Ionian Sea), 156, 250 m. w. and 950 m. w. and also at the surface, 158 (Levant), 161, 163, 0—80 m., (Ægean), 170, 0—20 m., 20—80 m., 85—200 m., 195—1000 m. (Marmora), 171, 172, 0—17 m., 17—50 m., several specimens, (Black Sea), 175, 350 m. w., 1150 m. w. (Marmora), 182, 545 m. w. (Ægean), 186, 245 m. w., 1145 m. w., 187, 0—25 m., 945 m. w., 190 (Ionian Sea), 194, 0 m., 1145 m. w., 195, 197, 198, 199, 200 (Tyrrhenian Sea), 204, 0 m., 985 m. w., 206, 1945 m. w. (Balearic Sea), 215 (Catalonian Sea), and 234, 95—200 m., 200—700 m. (s. w. coast of Portugal).

From this it would seem that the species must be considered as indigeneous in the Mediterranean, at any rate in the middle part, though it may appear to decline markedly in winter. Apparently, immigration from the Atlantic plays but a small part; according to the distribution at the stations there can at any rate be no question of any appreciable immigration in January, February, June, August or September, certainly not at the surface. Probably however, some individuals do come in at times from the Atlantic, also, the species seems to propagate. Fission stages were found, albeit seldom.

Recorded from the Mediterranean already by ENTZ 1902 (northern Adriatic). According to PAVILLARD (1916) the species is rare in the Golfe du Lion, and occurs there especially in summer; of "*Phalacroma hastatum*" he says that some few individuals may be found there at all seasons of the year. After PAVILLARD 1909, the species is noted by others from the Mediterranean only as *Phalacroma hastatum* (SCHRÖDER, 1911, SCHILLER 1912). Outside the Mediterranean, it has a scattered occurrence over a large area in the Atlantic, both north and south of the equator, but seems to be rare or lacking in the Florida Current and at the Azores.

15. DINOPHYSIS URACANTHA Stein (Figs. 42—43 p. 30).

? Stein 1883 pl. XX, fig. 22.

Cell in side view more or less asymmetrically roundish oval. Upper girdle list well developed, fairly high, at base abt. 0.6 maximal breadth of cell, marked funnel-shape, expanding upward, with distinct radial ribs. Left longitudinal fin very large, decurrent almost to end of the hypotheca; the lower part twice as broad as the upper, and prolonged into a long, downward curving, acute tongue supported by a long and powerful correspondingly curved (3rd) spine. Terminal spine long and strongly developed, at base without or with narrow sail lists, often set nearer the dorsal side and curving somewhat toward the ventral, or medially set, or ventrally set and so directed. Structure of theca small areoles, on strong, thick-walled cells very distinct.

The Mediterranean form (*var. mediterranea* n. var., fig. 43) is smaller, with a more — and almost entirely regular — oval cell body, which is thinner-walled, with pale, often indistinct fine structure, less strongly developed terminal spine, funnel narrower at base (in dorso-ventral direction) and less powerful radial ribs in the "funnel".

It is not so easy to determine exactly what STEIN's *Dinophysis uracantha* is, partly because he gives two figures more or less unlike each other, (22 and 23) and partly because *D. hastata*, in luxuriating forms, resembles STEIN's figures. There is, however, a smaller species which in the Mediterranean seems to keep more or less constant, and answers fairly well to STEIN's figure 22, for which reason I have here described it as *D. uracantha*. The difference as compared with *D. hastata* lies chiefly in its smaller size, higher and dorso-ventrally narrower-based funnel, longer and narrower terminal spine, and a stronger, claw-bent, long third supporting spine (in the longitudinal fin). STEIN's second figure 23, looks to me as if it might be a form of my *D. hastata var. uracanthides*; it differs from *D. hastata* chiefly in having the hypotheca rounded and shorter, and the funnel higher.

The species is rare in the Mediterranean, and always present in very few specimens, or only singly.

On the winter cruise of the "Thor" I have only noted it from five stations: sts. 11 (Ionian Sea), 25, 26 and 29 (off Naples) and 68 (Bay of Cadiz). On the summer cruise, it was taken at altogether 16 stations: sts. 80 (Bay of Biscay), 87 (n. w. coast of Portugal), and otherwise at 14 stations, of which 12 in deep water samples — namely in the Tyrrhenian Sea (126, 275 m. w., 129, 0—1100 m. w., 194, 1145 m. w., 199, 80—200 m.), in the Ionian Sea (152, 250 m. w., 950 m. w., 186, 1145 m. w.), in the Bay of Ægina (183), in the Balearic Sea (206, 1945 m. w. and surface), in the Bay of Cadiz (231, 1145 m. w.) and off the s. w. coast of Portugal (234, 200—700 m.) — and only two (three) at the surface (212 and 213 in the Catalonian Sea, besides 206). There is thus no immigration from the Atlantic directly traceable, and the more delicate Mediterranean form, above noted, suggests that the species can exist for some time in the middle and inner Mediterranean — where it is presumably widely distributed in deeper water, far more so than the few above mentioned stations show—though it may be likely that it would disappear if it were not renewed by occasional immigration of single individuals.

The species was first recorded from the Mediterranean by SCHRÖDER, 1900 (from Naples, he does not mention the far more frequent form *D. hastata*, so that his note perhaps applies to the larger and similar *D. hastata var. uracanthides* in the foregoing) and later by CLEVE 1903 (from the Alboran Sea) and PAVILLARD 1916 (once in the Golfe du Lion, October).

Outside the Mediterranean, I have seen it from the Gulf of Guinea, and the southern Atlantic, also, on one occasion, off the coast here at Bergen, (Oct. 1901, surface).

16. DINOPHYSIS PUSILLA, n. sp. ad. int. (Fig. 44 p. 30).

Resembles a very small form of the foregoing. Cell-body in side view circular or broad oval. In all essentials as the foregoing, but in side view the "funnel" (upper girdle list) is comparatively far narrower at the base, less than half maximal breadth of body, and the left longitudinal fin proportionately shorter. Length and breadth: 27 by 29 μ and 30 by 26 μ, dorso-ventral diameter of funnel base 9 μ. No (distinct) striation of funnel and no distinct structure observed at all.

St. 206, 1145 m. w. Such small forms are evidently not very rare, but they are of course but little caught even with the finest plankton net. May possibly be a small, degenerate form of the foregoing species.

17. DINOPHYSIS ALATA n. sp. (Fig. 45 p. 30).

Resembles *D. uracantha*, but differing in having the left longitudinal fin broader above, not much broadening below, but with a nearly geniculate, strong, and longly excurrent lower spine, and in having an altogether different, coarsely reticulate structure, which in younger specimens is pale and less conspicuous, whereas older ones have high, elevated mesh-walls, which on the side contour produce the appearance of the cell being armed with numerous short spikes. Furthermore, the older individuals exhibit a broad sail list without visible structure along the dorsal side of the hypotheca for nearly its whole length. Terminal spine long, with narrow sail lists at base, funnel high, with distinct radial ribs. Length and breadth of cell in side view 45 by 38 μ, dorso-ventral diameter of epitheca (basal breadth of funnel in side view) half the maximal breadth of the cell, dorsal list $^1/_4$ to nearly $^1/_2$ breadth of cell, terminal spine more than $^1/_2$ length of cell.

A very remarkable species. Perhaps the highly peculiar *Dinophysis Rudgei* Murr. & Whitting is a species with similar structure.

I found it only in samples from the summer cruise of the "Thor": sts. 152, 250 m. w. and 950 m. w., 187, 945 m. w. (Ionian Sea), 199, 945 m. w. (Tyrrhenian Sea), 204, 945 m. w. and 206, 1945 m. w. (Balearic Sea), i. e. only in deep water samples, singly.

Sectio VI. SCOLOPS n. sect.

Besides the 3rd, also the 2nd (double) supporting spine in left longitudinal fin powerly developed with correspondingly projecting part of the list itself. Otherwise as previous section (Hastata).

18. DINOPHYSIS SCHUETTI Murr. & Whitt. (Fig. 46 p. 30).

Murray & Whitting 1899 p. 331, pl. 31, fig. 10. D. uracantha Schütt 1895 pl. 2, figs. 9 1-4, not Stein 1883.

A pretty and easily recognisable species, small, and not a little variable, but always easily distinguished by its three long diverging spines — two ventral in the left longitudinal fin and one antapical-dorsal terminal spine —, the asymmetrically roundish cell-form, and the high and narrow-based upper girdle list. It occurs in two forms, a larger, 54—62 μ long by 45—47 μ broad, often with downward curving ventral spines, and a smaller, 40—43 μ by 32—36, generally with straight ventral spines. Terminal spine often curved, in which case it and the lower ventral spine are often curved in opposite directions, so that the points turn down almost parallel (as in *D. uracantha*). Structure, "pores" and "poroids" (small areoles with regularly scattered larger ones).

In the winter cruise of the "Thor" it was taken at st. 11 (Ionian Sea) and at three stations in the Tyrrhenian Sea (sts. 26, 28 and 31) as also off the northern point of Corsica; otherwise it was only observed in samples from the Bay of Cadiz and just inside the Straits, (sts. 60, 66, 68 and 69). In the summer cruise, it was only observed in a single surface sample (st. 158, Levant) but otherwise in several deep water samples (14 stations out of 22) right in to the Marmora: sts. 234, 95—200 m., (coast of Portugal), 223, 1950 m. w. (Alboran Sea), 126, 100—200 m., 275 m. w., 199, 80—200 m. (Tyrrhenian Sea), 134, 75—125 m., 204, 945 m. w., 206, 1945 m. w., (Balearic Sea), 152, 250 m. w., (several specimens), 950 m. w., 186, 245 m. w., 1145 m. w., 187, 100—190 m., 945 m. w., 189, 945 m. w., (Ionian Sea), 156, 250 m. w., 950 m. w. (Levant), 163, 0—80 m., 182, 545 m. w., (Ægean), 170, 0—20 m., (Marmora).

The occurrence in deep water at st. 223, where also a fissioned cell with protoplasm was observed, suggests emigration from the Mediterranean; of an immigration from the Atlantic there is only a feeble direct trace in winter. This, together with the frequent occurrence in deep water samples, suggests that the species is indigenous in the Mediterranean in deeper water, apparently about 100 m. (?) below the surface.

It was first recorded from the Mediterranean by Pavillard 1896, (Golfe du Lion, once, Novr. 1913). Outside the Mediterranean it occurs in the tropical and subtropical Atlantic, especially south of the equator. Ostenfeld, (1900) notes it from 59°47′ N, 25°53′ W (abt. midway between the northern point of Scotland and the southern point of Greenland), at 7.4° C, but this is perhaps due to confusion with some other form (*Dinophysis uracantha?*).

19. DINOPHYSIS TRIACANTHA Kofoid (Fig. 47 p. 30).

Does not resemble any of the other species; most nearly related to the foregoing, with which it has in common a strongly developed medial spine in the left longitudinal fin, and correspondingly protracted point of the sail itself, so that this has two points, a smaller one in the middle and a larger one below, separated by an outwardly concave contour of the sail. Cell-body in side view broad ovate-oval to almost circular. Girdle lists broad, the upper medium high (or broad) with very distinct radial ribs. Breadth of epitheca (side view) more than half that of the cell. Left longitudinal fin broad and long, broadest below and longly and acutely protracted along the lower, strongly developed downward curving supporting spine. Two terminal spines, one dorsally and one nearer the ventral side, both curving toward the ventral side, and with more or less broad sail lists, either both free, or joined by the sail lists, or the ventral alone connected with the lower part of the large (left) longitudinal fin. Structure more or less distinct, of small reticulations or areoles.

It was surprising to find this rare species in the Mediterranean. I saw it only in 6 samples from

the summer cruise, in deep water, sts. 129, 0—600 m., 132, 195—600 m., 199, 945 m. w. (Tyrrhenian Sea), 156, 950 m. w. (Levant), 223, 1950 m. w., (western Balearic Sea), and 234, 95—200 m. (coast of Portugal), everywhere only singly. Previously, it was only known from a locality in the Pacific and one in the Indian Ocean; I have also seen it from the German South-Pole Expedition, 3° S 16° W (Gulf of Guinea, 18/9 1903). In the Mediterranean it seems only to be found below 200 m.

ORNITHOCERCUS Stein.

1. ORNITHOCERCUS MAGNIFICUS Stein p. p., Schütt (Fig. 48 p. 36).

Stein 1883 pl. XXIII, figs. 1—2 ("young specimens"), Schütt 1900 p. 262 figs. 8—10 (p. 255). O. minor Jørg. mscr.

When Schütt very rightly subdivided Stein's species *O. magnificus* into several, he retained Stein's name for the form corresponding to his first figure. This was unfortunate, in as much as it was evidently the larger species, Stein's figs. 4 and 5, which Stein actually meant, since he has taken the smaller species, fig. 1, as a not yet fully developed specimen. Schütt's name, however, should perhaps now be used for this characteristic and frequent, smaller species. I have partly employed an old manuscript name, which is therefore noted above.

Very easily recognisable from the double-scalloped antapical list, the narrowness of the epitheca (in side view) and comparatively high cell, proportionately narrow left longitudinal fin and the small dimensions. Cell abt. 40 μ long and broad.

It was found on the winter cruise of the "Thor" at nearly all stations, for the most part sparsely. I have noted it from sts. 10, 11, Port Alice, 14, 16, 20 (fairly abundant) Taormina, Naples, 24—26 (several specimens), 27—33 (likewise), 36—42, 45, 46, 53, 55, 59, 60, 66—69. It was most frequent and most numerous in the Tyrrhenian Sea. On the summer cruise it proved to be generally distributed throughout the whole of the Mediterranean from the Bay of Cadiz to st. 180 in the northern Ægean, numerous at several places, and at times predominating among the Dinophysiaceae. It was found at nearly all stations, sometimes also in deeper water (sts. 126, only in the sample drawn with 275 m. w., 129 at all depths, most numerous at 0—1100 m. — few specimens), 134, 0 m. very numerous, 125—200 m. singly, 152, 0 m., 950 m. w., 156, 0 m., 250 m. w., 950 m. w., 160, 0 m., 0—30 m., 184, 0 m., 945 m. w., 186, 1145 m. w., 187, 0 m., 945 m. w., 189, 0 m., 945 m. w., 192, 0 m., 545 m. w., 194, 0 m., 1145 m. w., 199, 0 m., 0—30 m., 945 m. w., 206 surface, very common, sparsely in sample drawn with 1145 m. w., 209, 0 m., 945 m. w., 1945 m. w., 234, 200—700 m.). In the western part of the Mediterranean and outside the Straits, it was sparsely found (sts. 92, 231 in the Bay of Cadiz, not noted for the Alboran Sea and in the Atlantic Current off the north coast of Africa, only sparsely present at st. 218, but numerous off the coast of Tunis farther east). Also in summer it was most numerous in the Tyrrhenian Sea, and also in the south-eastern and middle parts of the Balearic Sea, especially at sts. 134 and 206. North of the Bay of Cadiz, only observed at st. 234 off the west coast of Portugal, 200—700 m., singly.

From this, then, the species is doubtless indigenous in the Mediterranean, and not essentially dependent on immigration from the Atlantic. In summer, it propagates here and there to a marked degree; fission stages were observed at several places, (specially noted from sts. 134 and 136 off the coast of Tunis, and st. 194, north of the Straits of Messina).

Outside the Mediterranean, the species has a wide distribution in the Atlantic, from the southern point of Africa to the south coast of Brazil, and northward to 40° N, 74° W in the northern part of the Gulf Stream off the coast of North America. In the Florida Current it occurs frequently from the Mexican Gulf northwards.

2. ORNITHOCERCUS STEINI Schütt (Fig. 49).

Schütt 1900 p. 260, fig. 7. O. magnificus Stein 1883 pl. XXIII figs. 4—5, ("old" specimens).

This, then, is what STEIN really regarded as the fully developed *O. magnificus*. It is altogether different from the foregoing species being of much larger dimensions, and much coarser structure, with broader epitheca (in side view) and especially in the antapical sail list, which is obtuse-angled below, and bounded by two straight or slightly concave lines. Cell abt. 65 μ in diam., generally broader than long.

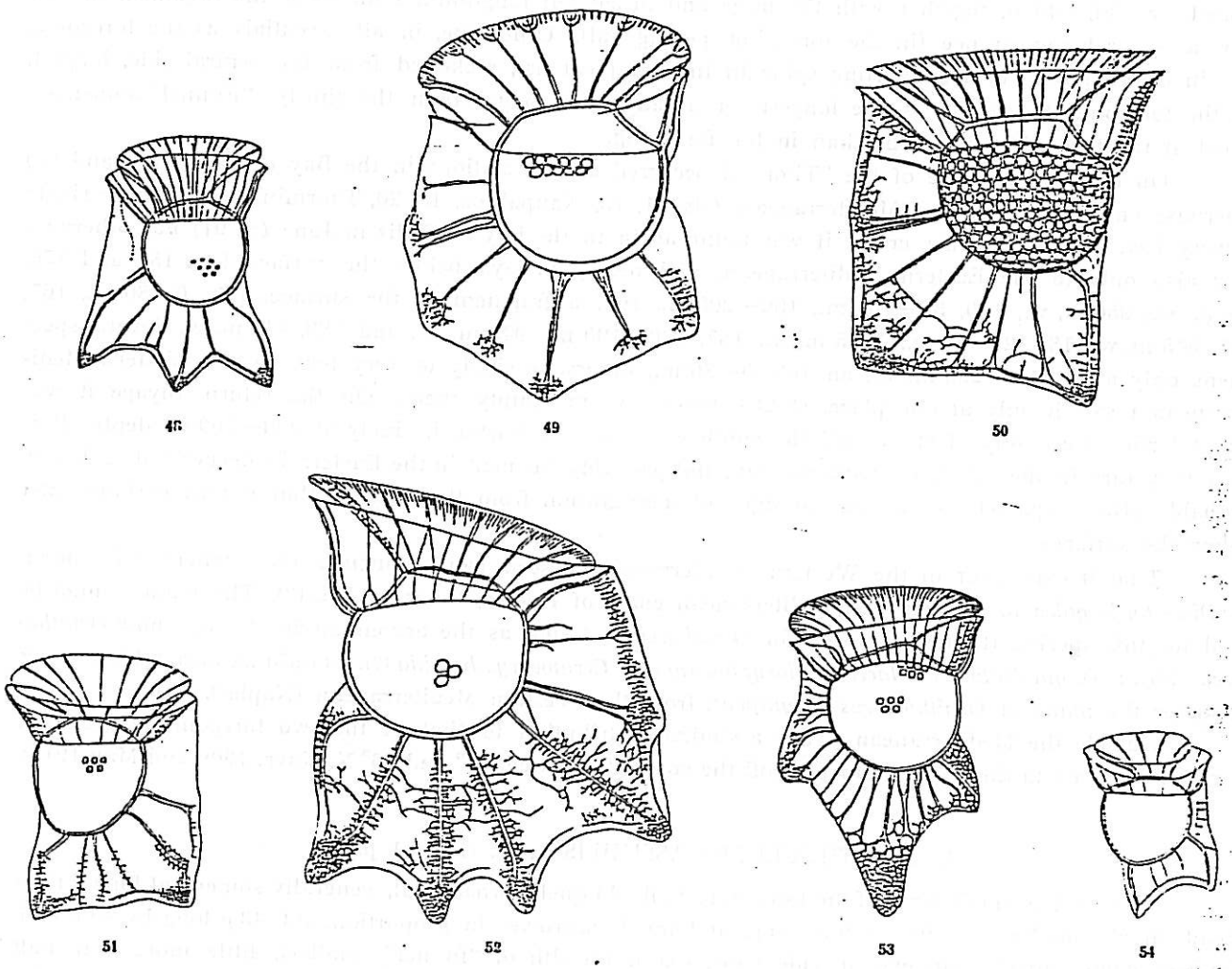


Fig. 48. *Ornithocercus magnificus* Stein, Schütt, $^{400}/_{1}$. St. 10. Fig. 49. *Ornithocercus Steini* Schütt, $^{400}/_{1}$. 1°46' N 10°46' W (Guinea Current) 11. VI. 1906, Chaves. Right half after fission; the left half still little developed. Fig. 50. *Ornithocercus quadratus* Schütt, $^{400}/_{1}$. St. 11. (The structure of epitheca and girdle is omitted in the figure). Fig. 51. *Ornithocercus assimilis* n. sp., $^{400}/_{1}$. St. 156. Fig. 52. *Ornithocercus serratus* Kof., $^{400}/_{1}$. St. 156. (Structure of theca only — as usual — suggested, otherwise the figure is complete). Fig. 53. *Ornithocercus Carolinae* Kof., $^{400}/_{1}$. St. 156. (As in fig. 52 only incomplete in regard to the structure of theca). Fig. 54. *Ornithocercus heteroporus* Kof., $^{400}/_{1}$. St. 11.

This large and handsome species has a similar distribution to that of the foregoing in the Atlantic, at any rate from 31° S. to 42° N. In the Florida Current it seems to be rare, at the Azores at any rate present in February. In the "Thor" material I have only seen it from sts. 66, 69 and 229 in the Bay of Cadiz (few specimens) and from st. 163, 0—80 m., (coast of Asia Minor) singly. It seems then only to occur accidentally in the Mediterranean, on occasions presumably having entered from the Atlantic. Like so many other tropical species it seems to thrive best in deeper water in the Eastern Mediterranean.

3. ORNITHOCERCUS QUADRATUS Schütt (Fig. 50 p. 36).

Schütt 1900, p. 254, figs. 1—4 (p. 256).

A large species, most like the foregoing, but very different in having the antapical sail cut off almost straight, which, together with the large and broad left longitudinal fin gives the organism in side view a squarish appearance (in the foregoing, pentagonal). Otherwise, in all essentials as the foregoing, also in dimensions. Third supporting spine in the antapical list, reckoned from the ventral side, longest, (in the foregoing, the fourth is the longest, or at any rate longer than the third). "Funnel" unusually broad at the top, with more ribs than in the foregoing.

On the winter cruise of the "Thor" it occurred at two stations in the Bay of Cadiz, (66 and 68) otherwise only in the Eastern Mediterranean, (sts. 11, 16, Naupaktos, 18, 20, Taormina) everywhere singly or very few. On the summer cruise it was found again in the Bay of Cadiz in June (st. 91) but otherwise now also only in the Eastern Mediterranean, and nearly always below the surface (sts. 152 and 156, 250 m. w., 950 m, w., 160, 30—100 m., 100—200 m., 161, a fragment at the surface, 163, 0—80 m., 167, 182, 545 m. w., 186, 245 m. w., 1145 m. w., 187, 100—190 m., 945 m. w., and 189, 945 m. w. Several specimens only at sts. 152, 250 m. w., an 163, 0—80 m., otherwise singly or very few. In the Western Mediterranean I saw it only at one place, st. 204, 945 m. w., an empty theca. On the return voyage it was found farther west only at st. 234 off the south-west coast of Portugal, singly at 200—700 m. depth. It is thus very rare in the Western Mediterranean, but probably frequent in the Eastern in deeper water, though probably always sparsely occurring. No signs of immigration from the Atlantic (but it may perhaps enter below the surface).

That it can occur in the Western Mediterranean is seen from Pouchet 1883, where it is shown as *Dinophysis galea n. sp.* from the Mediterranean coast of France, (or from Brest?). The name cannot be used for this species, (though possibly for *Ornithocercus Steini*) as the accompanying figures show *Ornithocercus Steini, O. quadratus, Phalacroma doryphorum* and *Ceratocorys horrida* (?). Schröder also, (1900) shows it, under the name of *Ornithocercus magnificus*, from the Western Mediterranean (Naples).

Outside the Mediterranean it has a similar distribution to that of the two foregoing species, but is rarer. It is rare in the Florida Current (off the coast of America, 33° and 36° N, Novr. 1909 and May 1910).

4. ORNITHOCERCUS ASSIMILIS n. sp. (Fig. 51 p. 36).

Very like a small form of the foregoing. Cell obliquely broad oval, generally somewhat longer than broad, much smaller than in the foregoing, and much narrower in proportion, abt. 43 μ long by 40 broad. Epitheca comparatively narrower in side view, (basal breadth of "funnel" smaller), little more than half max. breadth of the cell (in the foregoing abt. $^{2}/_{3}$ the breadth). Structure much less coarse than the foregoing. Otherwise with quadrilateral outline (in profile) as the foregoing, but more rectangular. It seems to occupy an intermediate position between the foregoing species and *O. heteroporus*, with which latter it has much in common.

I have seen this species (or form of the foregoing?) in one of the winter samples from the "Thor" (st. 11 in the Ionian Sea), and in four summer samples from the Eastern Mediterranean, generally from deeper water (sts. 152, 250 m. w., 950 m. w., 156, 250 m. w., 950 m. w., 163, 0—80 m., and 167). For a long time I regarded it as a smaller form of the foregoing species, and it is remarkable that it has only been found together with that. The constant and considerable difference, however, in shape of cell, structure, dimensions and to some extent also in basal breadth of funnel, rendered it natural to consider it as a distinct species.

Outside the Mediterranean I can up to now only give three localities for its occurrence, viz. 30°45′ S, 13°25′ W (the "Fram" $^{5}/_{7}$ 1911), in the Florida Current, 30$^{1}/_{2}$° N, 80° W, $^{30}/_{11}$ 1909 (s. s. "Texas") and near Ras Ekab on the south-east coast of Arabia (Handel-Mazzetti $^{23}/_{10}$ 1910).

5. ORNITHOCERCUS SERRATUS Kofoid (Fig. 52 p. 36).

Kofoid 1907, p. 206, pl. 15, fig. 93.

A large handsome species, in size, shape of cell, "funnel" and structure approximately as *O. Steini* and *O. quadratus*, but the antapical sail generally 3—4 scalloped with third supporting spine of same length as the fourth.

It was found in the "Thor" winter samples only at the two stations 66 (very sparsely) and 69 (several specimens), in the Bay of Cadiz. In the summer samples it was found again at one place in the Bay of Cadiz, (st. 92) and otherwise only in the Eastern Mediterranean and there in deep water samples at nearly all stations where such were taken (sts. 152, 950 m. w., 156, 250 m. w., 160, 0—30 m., 162, 163, 0—80 m., 167, 182, 545 m. w., 189, 945 m. w., everywhere singly save at st. 163, where specimens were somewhat more numerous).

The species seems thus to be not altogether rare in the Eastern Mediterranean in deeper water during summer; whether it is also to be found there in winter cannot be (certainly) determined from the "Thor" material. A fission stage was seen at st. 92 (Bay of Cadiz, June). It has probably come in from the Atlantic; whether it can continue to exist throughout the year in the Eastern Mediterranean is doubtful.

Outside the Mediterranean, it has been found, rarely, in the Florida Current, (30—32° N, coast of America, May 1910), far west of the Straits of Gibraltar (14° W, $^{29}/_{8}$ 1901) and in the Guinea Current $^{1}/_{10}$ 1903 (German South-Pole Exped.) and fairly common in the southern Atlantic between South Africa and South America 11° W to 38° W, 31° N to 17° N, June to August 1911 ("Fram").

6. ORNITHOCERCUS CAROLINAE Kofoid (Fig. 53 p. 36).

Kofoid 1907 p. 205, pl. 15, fig. 92.

Somewhat resembles *O. Steini*, especially in the pentagonal outline in side view, but is much smaller and with far more ribs in the antapical sail (the longest, or the two longest being the 8th or 7th from ventral side, the 4th is short) which has also a far more protracted end below. Cell about same height (length) as breadth, abt. 48—50 μ, structure coarse.

May perhaps be identical with *Histioneis Francescæ* Murr. & Whitting, which name in such case would take precedence.

This handsome and rare species I found in the "Thor" material from st. 20 (southern point of Italy, January), st. 66 (Bay of Cadiz, Feb.), st. 156, 250 m. w. (Levant, July) and st. 163, 0—80 m. (coast of Asia Minor, August) everywhere singly. Thus again a sub-tropical species which in summer seems only to occur in deeper water in the Eastern Mediterranean.

Outside the Mediterranean I have only seen it from the southern Atlantic, far east of the coast of Brazil, (20° 35′ S, 29° 30′ W, $^{12}/_{8}$ 1911 ("Fram"). Kofoid found it in the Pacific.

7. ORNITHOCERCUS HETEROPORUS Kofoid (Fig. 54 p. 36).

Kofoid 1907, p. 206, pl. 12, fig. 70.

A small species differing widely from all the foregoing by the far smaller (narrower) antapical sail which reaches but little, if at all, beyond the antapex of the cell, and here, at the dorsal side, is often most drawn out in a downward direction.

Kofoid's figure differs somewhat from the specimens I have seen, especially in structure, and also in the position of the lower supporting beam. The structure is (in well-developed specimens) according to my experience coarse, with large areoles, unlike in size, and I have hardly ever seen the lower supporting beam so far ventrally set as in Kofoid's figure. This is evidently drawn from a cell in slanting position. Length and breadth of cell about equal; 32—34 μ by 31—32.

It was surprising to find this dainty sub-tropical species so frequently in the Mediterranean. It

the "Thor" material from the winter cruise I found it at 17 out of the 37 stations in the Mediterranean, and 2 of the 5 in the Bay of Cadiz, but nearly everywhere singly or very sparsely. It was most frequent in the Tyrrhenian Sea, where it is noted from all stations but two (sts. 23 and 27); here, it was particularly frequent off Naples, at sts. 25 and 26 in somewhat greater numbers. At st. 33, close to the boundary between the Ligurian and the Tyrrhenian Sea, several specimens were also found; at the other stations, 10, 11, 14, 20, Taormina (Ionian Sea) and 42 (Balearic Sea) everywhere sparsely. On the summer cruise it was much rarer, again recorded from 17 stations, 9 in the Western Mediterranean and 8 in the Eastern: 120, 202, 204, at the surface, 206, 1945 m. w., 218 (Balearic Sea), 210, 213, (Catalonian Sea), 194, 0 m., 1145 m. w., Naples (Tyrrhenian Sea), 148 (Sidra Sea), 152, 0 m, 186, in salpæ, 187, 945 m. w., 192, 0 m., 545 m. w. (Ionian Sea), 156, 250 and 950 m. w., 158 (Levant), 161 (coast of Asia Minor), everywhere singly, only several specimens at the surface at st. 192.

Being small and light, the species is both difficult to take in the net, and easily overlooked or lost on examination, so that it is probably of more frequent occurrence than these records show.

It seems from this to be a true Mediterranean species, essentially independent of immigration from the Atlantic.

Outside the Mediterranean it has been found south-southeast of St. Helena and in the Guinea Current ($^{26}/_{8}$ and $^{1}/_{10}$ 1903, German South-Pole Expedition) as well as in the Pacific (Kofoid) and off the south-east coast of Arabia ($^{24}/_{10}$ 1910, Handel-Mazzetti).

HISTIONEIS Stein.

H. REMORA Stein (Fig. 55).

Stein 1883 pl. XXII, fig. 11. H. elongata Kofoid & Michener 1911 p. 295?

On the summer cruise of the "Thor", there was found at st. 152, 250 m. w., and st. 163, 0—80 m., a *Histioneis* species tolerably corresponding to Stein's figure of *H. remora*. Length (height) of cell 31 μ, breadth 38 μ. Stein's figure is doubtless at fault, for instance in the "collar" (lower girdle list).

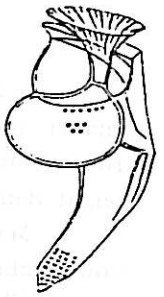


Fig. 55. *Histioneis remora* Stein, $^{400}/_{1}$. St. 152, 250 m. wire.

The species is recorded by Pavillard 1916 from the Golfe du Lion (very rare, Aug. Oct. Decr.).

AMPHISOLENIA Stein.

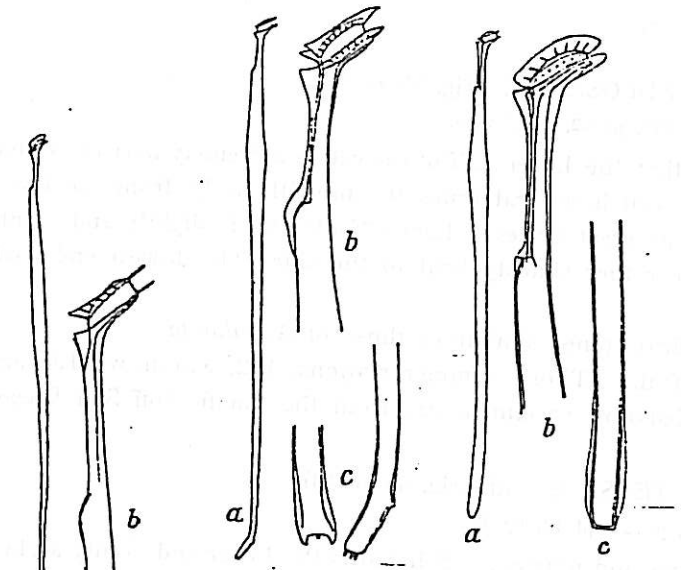
1. A. BIDENTATA Schröd. (Fig. 56 p. 40).

Schröder 1900 p. 20 pl. 1, figs. 16 a-c.

This, the most common of the *Amphisolenia* species, is known by the long and narrow cell in conjunction with the moderately broad, cross-cut and bidentate apex (in ventral or dorsal view).

On the winter cruise of the "Thor" it was found singly at by far most of the stations (27 out of 37 in the Mediterranean and two out of five in the Bay of Cadiz), from the Bay of Cadiz to the Bay of Ægina. Outside Naples it was somewhat more numerous than elsewhere. On the summer cruise it was rarer, and on the inward voyage it was not met with until st. 109, (the easternmost station in the Alboran Sea), and further present at sts. 111 (Balearic Sea), 148 (Sidra Sea), 152, 0 m., 250 m. w., (southern Ionian Sea), 160, 0—30 m., 161, 163, 167, 181, 182, 545 m. w. (Ægean), 187, 0—25 m., 945 m. w., 189, 945 m. w., 192 (Ionian Sea), 194, 199, 0—30 m. (Tyrrhenian Sea), 206, 1945 m. w. (Balearic Sea), 210, 215 (Catalonian Sea), 218, 219 (Balearic Sea, north coast of Africa) and 223 (Alboran Sea), again everywhere sparsely. Not seen after this.

It seems to immigrate from the Atlantic in the winter, and in summer to be rare, especially at the surface.



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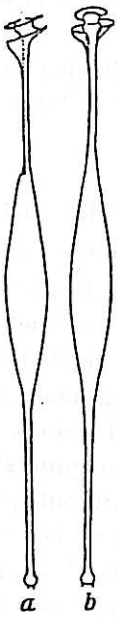

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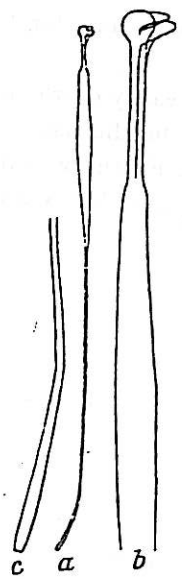

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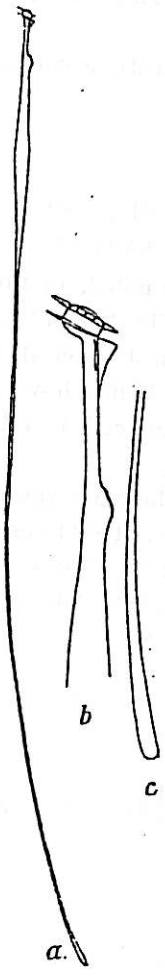

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It was first recorded from the Mediterranean (Naples) by SCHRÖDER 1900. PAVILLARD (1916) finds it in the Golfe du Lion Novr. and Decr. very rare).

Outside the Mediterranean it has a wide distribution in the Atlantic, both the northern and the southern parts.

2. AMPHISOLENIA PALMATA Stein (Fig. 57).

Stein 1883 pl. XXI, figs. 11—15.

Much like the foregoing, and has been confused with it, but it has, apart from the two teeth in the dilated antapical end, also a smaller middle tooth. The cell seems as a rule also to be shorter and somewhat broader.

Specimens which, according to my opinion, belong to this species were found at sts. 11, 23, 45, 111, 192, 194, 204, 945 m. w. and 228, 1145 m. w.

PAVILLARD (1916) found it in the Golfe du Lion, very rare. Its Atlantic distribution cannot yet be stated, as it has been confused with and included under *A. bidentata*.

3. AMPHISOLENIA TRUNCATA Kof. et Mich. (?) (Fig. 58).

Kofoid & Michener 1911 p. 294.

Resembles a short and almost straight form of the foregoing, differs, however, from the two foregoing forms in the fact that the lower end of the cell lacks the characteristic foot-like form, with a small heel a little way up, found in the two former. In this species the antapex is not (distinctly) dilated, and is cut off transversely, without spines. Length 663 μ, max. breadth 24 μ, or 36 ‰ of the length. (In *A. bidentata* 22, in *A. palmata* 27 ‰).

My specimen differs slightly from the description quoted, particularly in the fact that the cell towards the lower end is slightly curved.

I have only seen it from st. 46 (Balearic Sea, off the coast of Africa, in February, one specimen). KOFOID's specimens are from the Pacific, (far to the north-east of Paumotu).

Fig. 56. *Amphisolenia bidentata* Schröd., Sevilla (6. XII. 1908, capt. Röd.). *a*, the whole theca, $^{100}/_{1}$. *b*, „head" and "neck", $^{403}/_{1}$. *c*, antapical end, in different views, $^{400}/_{1}$. Fig. 57. *Amphisolenia palmata* Stein, st. 111. *a*, *b*, *c* as in fig. 56. Fig. 58. *Amphisolenia truncata* Kof., st. 46. *a*, *b* as in fig. 56; *c* antapical end, $^{400}/_{1}$. Fig. 59. *Amphisolenia spinulosa* Kof., st. 192, 545 m. w. *a*, *b*, *c* as in fig. 58. Specimen after fission; the right winged lists still little developed. Fig. 60. *Amphisolenia extensa* Kof., st. 194. *a*, *b*, *c* as in fig. 58. Fig. 61. Amphisolenia globifera Stein. $^{400}/_{1}$. St. 192, 545 m. w.; *a* left side view, *b* ventral view.

4. AMPHISOLENIA SPINULOSA Kof. (Fig. 59 p. 40).

Kofoid 1907 b, p. 315, pl. 32, figs. 53—55.

Differs from all the foregoing in the fact that the lower half of the cell is extremely narrow, (often only 3 μ broad) so that the max. breadth of the cell is several times the breadth at $^1/_3$ from the lower end (in the three previous species it is abt. twice as great or less). Lacks "foot" and is slightly and evenly dilated below for a considerable length, and here rather sharply bent to the side. The lowest end itself has small indistinct spines. Abt. 720 μ long.

KOFOID's species should have three antapical spines similar to those of *A. palmata*.

I have only seen it (singly) from three of the "Thor" summer stations, 192, 545 m. w., 194 and 200 (near Straits of Messina and off Sardinia). KOFOID's specimens are from the Pacific (off San Diego).

5. AMPHISOLENIA EXTENSA Kofoid (Fig. 60 p. 40).

Kofoid 1907, p. 198, pl. 13, fig. 78.

Very like the foregoing, but unusually long and narrow, and towards the lower end evenly arched. Length 1292 μ, maximal breadth 17 μ, or 13 $^0/_{00}$ of the length, as in the foregoing several times the breadth at $^1/_3$ from the lower end. The latter with small processes, and slightly rounded off ("without spines", KOFOID).

I have seen it from st. 194 (south-eastern Tyrrhenian Sea, August); according to my notes, it also perhaps occurs at the two winter stations 25 and 26 (off Naples).

KOFOID's specimen was from the Pacific.

6. AMPHISOLENIA GLOBIFERA Stein (Fig. 61 p. 40).

Stein 1883 pl. XXI figs. 9—10. A. tenella Gran 1912 p. 935 fig. 8 b.

A dainty little species, altogether different from the four above noted, in the shape of the "head", position of maximal cell breadth, shape of the lower end, and size. The "head" is high and narrow, not so low and elongated as in the foregoing forms (least so in the lwo last species), the greatest breadth of the cell lies about the middle, not, as in the foregoing, more or less high above the middle; the lower end is swollen out to a globe shape, with two small spines, and the cell is (abt.) 200 μ long (or less) while all the foregoing are over 600 μ. The cell is also quite straight.

STEIN draws the antapical end as spherical, without spines. These are small and easily overlooked; also, the species seem to vary in this respect. GRAN's species (not described?) seems to be the same.

I have seen this species from four of the "Thor" samples; st. 68 (Bay of Cadiz, February, several specimens), st. 192, 545 m. w. (near Straits of Messina, August), sts. 199, 80—200 m., and 200 (east of Sardinia, August). STEIN's and GRAN's specimens were from the Atlantic.

TRIPOSOLENIA Kofoid.

Of this remarkable genus, three species occurred in the "Thor" material, only from the summer cruise.

1. T. BICORNIS Kof. (Fig. 62 p. 42).

Kofoid 1906 p. 105, pl. XV, figs. 1—2.

This is the most frequent species, with both posterior horns almost equally curved and turned slightly outward at the points, without spines at the ends. Distance between points of horns almost constantly 102 μ, the mid-body (32—)34 μ high by (38—)43—47 μ long, distance from upper end of the cell to lowest boundary line of the mid-body 80—85 μ.

It was found in the "Thor" material from the following localities: sts. 87, 234, 95—200 m. (south-west coast of Portugal, at the last-named, several specimens, otherwise, everywhere but singly) 126, 275 m. w., 129, 0—600 m., 0—1100 m., 132, 195—600 m., 194 (Tyrrhenian Sea), 134, 125—200 m., 185—350 m. (south-eastern Balearic), 152, 950 m. w., 187, 945 m. w., 189, 945 m. w., 194 (Ionian Sea), 182, 545 m. w., (Ægean), 209, 85—200 m., 1945 m. w. and 211 (Catalonian Sea).

It is thus found almost exclusively in deep water, between 120—200 m. in the Tyrrhenian Sea, at a similar depth in the Catalonian Sea, at st. 134 in the Balearic Sea both at this depth and between 185 and 350 m. As it was found at no less than 9 stations out of the 22 (in the Mediterranean) where deep water samples were taken, it is probably of wide distribution — albeit in small numbers — below the surface, especially, it would seem, between 100 and 200 m. As it was not found in the winter samples, we may suppose that it is not generally able to survive the winter at the surface; possibly it may also be found at that season deeper down, which cannot be seen from the "Thor" material.

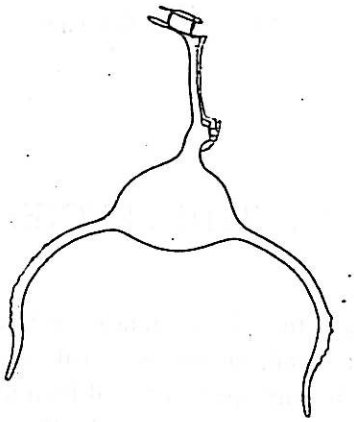

Fig. 62. *Triposolenia bicornis* Kof., $^{400}/_{1}$. St. 132.

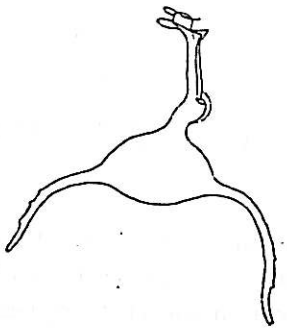

Fig. 63. *Triposolenia ambulatrix* Kof., $^{400}/_{1}$. St. 175.

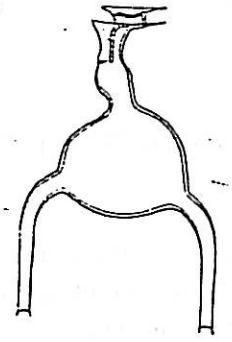

Fig. 64. *Triposolenia truncata* Kof., $^{400}/_{1}$. St. 126.

Outside the Mediterranean, it does not appear to have been recorded hitherto from the Atlantic save from the above mentioned "Thor" stations, (87, 234) off the coast of Portugal. Presumably, it occurs in the Atlantic also chiefly in deeper water. Kofoid found it off San Diego ("frequently in small numbers in vertical hauls from 135—30 fathoms to the surface, and rarely in surface catches").

2. TRIPOSOLENIA AMBULATRIX Kof. (Fig. 63).

Kofoid 1907 p. 203, pl. IV, fig. 24.

Much like the foregoing species, but differing in the lower mid-body (25 μ high) and especially in the unequally curved posterior horns, that in front curving more downward than the one behind. The points of these horns are, as in *T. bicornis*, tapering, and turned slightly outwards, the point of the front one most, and both have two tiny spines at the tip.

Differs somewhat from Kofoid's description and drawing, (his figure has "somewhat squarish shoulders" and the ventral posterior horn is pointed, without spines) but seems to be the same species. Distance between points of posterior horns 89 μ, mid-body 25 μ high and 38 broad, distance from apex to lower part of body 65 μ.

Closely related to *T. bicornis* and perhaps only a form of the same. Found only at st. 175, 350 m. w. in the Marmora, and probably also at st. 132, 195—600 m.

Kofoid found it in the Pacific, 9° S. 95° W.

3. TRIPOSOLENIA TRUNCATA Kof. (Fig. 64).

Kofoid 1906, p. 102, pl. 15, fig. 55.

Resembles the foregoing species, but is less slender, smaller but more robust, and is especially easily distinguished by the points of the antapicals, which are not rounded off, but apparently emarginate, not bent outward at the points (in side view) and here furnished with two small spines. Distance between points of the antapicals 62—81 μ, mid-body 34 μ high and 38—42 μ long; distance from apex to lowest (convex) boundary line of the mid-body 68 μ.

It was found at the following stations: 126, 120—500 m., 275 m. w. (east of Corsica), 170, 20—80 m., 175, 350 m. w. (Marmora), 182, 545 m. (near Euboea) and 206, 1945 m. w. (Balearic Sea), everywhere singly. It is thus only found in deeper water, at two places together with the foregoing species, in the Marmora in water (of high salinity) from the Ægean.

Only (?) previously known from San Diego ("plankton from 180—30 fathoms to the surface, but always sparingly").

III. BRIEF SURVEY OF THE OCCURRENCE OF THE SPECIES

As with the Ceratia, so also in the case of the Dinophysiaceae, the Mediterranean exhibits a remarkable wealth of species, the number of specimens, on the other hand, being as a rule no less strikingly small. Only a few species occur in the Mediterranean proper in any quantity, and then almost invariably at but very few localities. Only one species forms a distinct exception here, to wit, *Dinophysis caudata*, (*homunculus*) which in summer is abundant or numerous at many places, and covers a wide area. There are, however, a number of species which occur only singly, and at only a few of the "Thor" stations.

With regard to the occurrence at different seasons, the cruises of the "Thor" present a comprehensive view of the state of things in summer, embracing the whole four months of June—September. The winter material is scantier by far, embracing only the period from mid-December to end February. It would have been of great importance here to have had samples from the western parts of the Mediterranean on the inward voyage, and a number of deep water samples.

The present material shows — again as in the case of the Ceratia — that there are but very few or hardly any species which can be called exclusively "winter-species", known only from the winter cruise, and all these are extremely rare (*Phalacroma favus*, sts. 10, 66, *Amphisolenia truncata* st. 46, and the doubtful species or degenerate forms *Dinophysis diegensis* and *Kofoidii* (= *D. caudata var. subdiegensis*)). On the other hand, there are no less than 14 species which were only found in summer, (*Phalacroma striatum*, (*elongatum*), *circumsutum* and *pugiunculus*, *Dinophysis alata*, *triacantha*, (*punctata* and *pusilla*), *Ornithocercus serratus*, *Histioneis remora* — which was, however, found by PAVILLARD in the Golfe du Lion also in December — *Amphisolenia spinulosa* and the three *Triposolenia* species).

This last group, exclusively summer species, forms a very interesting section, being — as indeed is also the case with the two "winter-species" — sub-tropical, and for the most part found only below the surface. This applies to no fewer than 9 of them (*Phalacroma elongatum*, *striatum*, *Ornithocercus serratus*, the *Dinophysis* species, and *Triposolenia ambulatrix* and *truncata*); there are also two (*Phalacroma circumsutum* and *Triposolenia bicornis*) each of which was only taken at the surface at a single station.

This remarkable fact, that sub-tropical (and tropical) species were found only, or almost exclusively, in deeper water with correspondingly lower temperature and sometimes only in the Eastern

Mediterranean, also applies to the Ceratia, and was further mentioned under that head (JÖRGENSEN 1920 pp. 105—108). The subtropical Dinophysiaceæ were in part also found only in the Western Mediterranean, or both there and in the Eastern.

As regards division into alien immigrants, the allogenous species, and native, indigenous species, the foregoing material in itself suffices to show that most of the species undoubtedly immigrate from the Atlantic, or at least that their stock in the Mediterranean is, during one or more of the months of February, June and September, augmented by immigration. It is for these three months that the "Thor" material permits of direct conclusions as to immigration, probably also, sts. 45, 46, may serve as evidence in regard to immigration (via the Straits of Gibraltar) during the month of January. See also JÖRGENSEN 1920 (p. 105).

Of the other species, for which no direct immigration can be noted, there are several which belong to these very sub-tropical species above mentioned. That they should really belong to the deeper and correspondingly colder places is hardly likely; in all probability, they will soon perish, though the less changeable conditions in deep water may give them a certain length of life. They are invariably found singly, or in very small numbers, and have thus presumably lost their power of reproduction.

Surer conclusions might be drawn from the lack of fission stages, or occurrence of the same, but as these are in any case the exception and not the rule, it is really only the presence of fission stages that can be used as material for conclusions, not the lack of them. Fission stages of *Dinophysis caudata* were found in quantities, and at many places, so that this species can doubtless be regarded as indigenous to the Mediterranean; here also, however, the material showed a distinct, and in winter marked, immigration through the Straits of Gibraltar. Apart from this, fission stages of the following were also found: *Phalacroma rotundatum, doryphorum, rapa* — only in the Bay of Cadiz, June — *Dinophysis acuta*, Bay of Cadiz, *D. intermedia, tripos, hastata, Schuetti, Ornithocercus magnificus* and *O. serratus* in the Bay of Cadiz. The most, however, we can conclude from these fission stages is that the species in question thrive or are "naturalised" in the water concerned; as regards the above-mentioned, *Phalacroma rotundatum* in the Balearic Sea, *Ph. doryphorum* likewise, *Dinophysis intermedia* in the Alboran Sea in June, *D. tripos* at sts. 46, 129, 131, *D. hastata* at st. 156 in the Levant, *D. Schütti* st. 223 in deep water, and *Ornithocercus magnificus* in the Middle Mediterranean.

True endemic species, exclusively Mediterranean forms, are doubtless rare among organisms which, like the Dinophysiaceæ and Ceratia, are chiefly surface forms. At present, there are some few species not known outside the Mediterranean, (*Phalacroma elongatum, stenopterygium, pugianculus, Dinophysis pusilla, punctata, alata* and *Kofoidii* = *D. caudata var. subdiegensis*) but these are nearly all more or less exclusively deep water forms. On the other hand, these deep water organisms would surely be those among which we might chiefly expect to find endemic Mediterranean species, as they must be supposed to be most independent of the inflowing Atlantic water, which, of course, keeps mostly to the surface.

This inflowing Atlantic current will always be introducing new forms into the Mediterranean from without, so it is only natural that the Dinophysiaceæ and Ceratia of the Mediterranean should correspond in all essentials with those of the Atlantic. That they are not absolutely alike is due more particularly to the fact that not all species are able in the same degree to survive the comparatively abrupt transition to the Mediterranean. Hydrographical observations show that the inflowing Atlantic water is colder in summer and warmer in winter than the Mediterranean water, and this difference of temperature, together with the difference of salinity, seems to prove fatal to many species. The "Thor" material not infrequently shows that a species may be numerous in the Bay of Cadiz, but disappear immediately or very shortly in the Alboran Sea. The reverse case, of a species showing marked increase on entering the Mediterranean, also occurs, especially among the Ceratia; with the Dinophysiaceæ, it was rare, but was nevertheless noted, e. g. with *Phalacroma rapa* and *Dinophysis sphærica* in September, and *Dinophysis caudata* in June.

It would therefore seem likely that once or twice between summer and winter, conditions especially favourable to immigration exist; or at any rate, that the difference in temperature between Atlantic

and Mediterranean water in the neighbourhood of Gibraltar disappears. The distribution of species in the winter plankton also suggests that in late autumn (November?) there is a considerable immigration of such species as are either more frequent in the winter plankton than in the summer, or are found in summer for the most part in deep water samples (see JÖRGENSEN 1920 p. 105).

Immigration into the Mediterranean might also be supposed to take place from the Black Sea region, which, with its fresher water, has a plankton flora widely different from that of the Mediterranean, and consisting of but few species, some of which occur in very great numbers. The fresher water from this region can be traced at the surface far out into the Ægean, from its content of *Ceratium tripos* (see JÖRGENSEN 1920 p. 49). The only species of Dinophysiaceæ which showed any corresponding increase in this fresher water, however, were *Dinophysis caudata* — which occurred in two special forms, *f. Marmaræ* in the outer, and *f. pontica* in the inner regions, — and *D. acuta*. The question as to immigration from the Black Sea region therefore is, as far as the Dinophysiaceæ are concerned, reduced to the question, whether the *D. acuta* found in the Mediterranean can have immigrated from the eastward. The present material, however, offers no definite sign of such immigration; it is far more likely on the other hand, that the *D. acuta* found in great numbers in the Black Sea at st. 172, in deep water (below 50 m) found its way to that locality with the salter water from the inner part of the Mediterranean, and encountered more favourable conditions in the colder and less saline water. There are also distinct indications of immigration of *Dinophysis acuta* from the Atlantic to the Mediterranean.

The plankton of the Mediterranean naturally exhibits the character of a warm water plankton. The great majority of species are what I should call southerly-temperate; but there is also, as above mentioned, a considerable contingent of more sub-tropical character, which gives the plankton as a whole a more pronounced appearance of warm water plankton than would be expected from the latitude. For the causes of this, and the (presumably) greater immigration of sub-tropical species during the cold season, see JÖRGENSEN 1920 (p. 105—106).

Northern species, on the other hand, are almost or entirely lacking in the Mediterranean plankton. Sub-arctic or distinctly cold-water forms are altogether absent. The only species which can be called northern forms are *Phalacroma rotundatum*, *Dinophysis acuminata* and *D. acuta*. The first of these, however, is so much like certain warm water forms, e. g. *Phalacroma parvulum* and *Ph. operculoides*, and occurs in so many, as yet not properly distinguished forms that the statements in extant works as to its distribution are either so unreliable or so greatly at variance that for the present, it would be unwise to take the species as an indicator for cold water plankton generally. The same applies to *D. acuminata*, which in certain forms is closely allied to the warm-water form *D. ovum*, while others again lead over to the sub-arctic *D. granulata*. There remains then only *D. acuta*, which, though perhaps rather a cold than a warm-water form, must nevertheless be regarded as at any rate northerly-temperate. It occurs at many places in the Mediterranean, but is on the whole somewhat rare, and by no means numerous, and far more prevalent in deep water samples than at the surface. (Compare the remarks above (p. 21) about a supposed genetic connection between *D. acuta*, *D. intermedia* and *D. Schroederi*.)

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V. DIAGNOSES IN LATIN

OF NEW GENERIC AND SPECIFIC NAMES (ACCORDING TO THE RULES OF INTERNATIONAL BOTANICAL NOMENCLATURE).

Pseudophalacroma n. gen.

Sulca longitudinalis usque ad apicem continuata, fistula terminata. Ala longitudinalis sinistra angusta, spinis nullis vel inconspicuis instructa. Cetera ut in Phalacroma.

Paradinophysis n. sect.

Theca e latere visa rotundata, e facie ventrali elliptica, epitheca ± alte supra cingulum prominente, structura pro more subtiliter foveolata.

Euphalacroma n. sect.

Theca e facie ventrali et laterali cuneata, epitheca ± late convexa, structura ut in sectione praecedente, saepius tamen crassiore vel reticulum densum formante.

Cuneus n. sect.

Theca ut in sectione praecedente, saepissime tamen eximie cuneata structuraque crassa. Ala longitudinalis sinistra infra decurrens, non protracta nec spina excurrente instructa.

Argus n. sect.

A sectione praecedente affini praecipue differt structura crasse reticulata, theca minus evidenter cuneata, epitheca altius convexa.

Podophalacroma n. sect.

Hypotheca infra in processum crassum brevemque ± subito angustata. Cetera ut in sectione Euphalacroma, structura tamen saepius crasse reticulata.

Urophalacroma n. sect.

Theca spina antapicali solida instructa, partem dimidiam dextram hypothecae attinentem. Cetera ut in sectionibus Paradinophysi et Euphalacroma.

Phalacroma elongatum n. sp.

A Phalacroma acuto affini praecipue diversum magnitudine, epitheca minus alte convexa, hypotheca parum asymmetrica, infra magis protracta.

Dinophysis punctata n. sp.
A *D. lenticula* ala longitudinali sinistra longiore, epitheca minore atque structura subtiliore diversa.

Dinophysis pusilla n. sp.
A *D. uracantha* diversa minore magnitudine, hypotheca fere rotunda, ala longitudinali sinistra breviore.

Dinophysis alata n. sp.
Species egregia, uracanthae proxima, ala dorsali atque structura crasse reticulata subechinataque diversa.

Scolops n. sect.
Ala longitudinalis sinistra in medio acute protracta, spina secunda valida et excurrente spinae tertiae inferiori simili instructa.

Ornithocercus assimilis n. sp.
O. quadrato simillima, ab ea tamen diversus minore magnitudine, hypotheca e latere visa asymmetrica, comparate, ut et epitheca, angustiore.