

SIPHONOPHORA

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WITH THIRTY-SIX TEXT-FIGURES

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1. INTRODUCTION.

THIS report deals with the Siphonophora only from the systematic point of view. Their occurrence and distribution in the region of the Great Barrier Reef will be discussed in detail in the general reports on the zooplankton which are in preparation by Mr. Russell and Mr. Colman.

A remarkable fact about the Siphonophora is that, in spite of their individual abundance in all seas, the total number of known species is only about 120, made up of 40 Physophorae, 60 Calycophorae, 12 Rhizophysaliae, and 8 Chondrophorae. Of these, 4 Physophorae and 25 Calycophorae were taken by the Expedition. In addition two new species are published, and the capture of four unnamed species is recorded.

Some points to which attention is invited are the discussion of the taxonomic value of Monophyism; the suggested regrouping of the Sphaeronectids; some general notes on the nomenclature and classification of Prayids, and on the classification of certain Galeolariids; the erection of a new genus *Lensia* for a group of small forms like *Galettea subtiloides*; and a new and more natural grouping of species of *Diphyes*.

It is often difficult to identify from published figures and descriptions the detached parts of colonies which continue to lead an active, free existence, and are often found free in the plankton. It has been thought desirable, therefore, to record fully the shapes of the various bracts and swimming bells brought back by the Expedition.

It is regretted that it has been found necessary to give up the use of the names *Galeolaria* and *Cuboides*, and to introduce such new names as *Chelophyes* and *Lensia*, as well as to reintroduce the old names *Sulculeolaria*, *Enneagonum* and *Eudoxoides*.

Terminology has been reviewed recently by Moser (1925), but I regret that I cannot adopt all her proposals. Since all the nectophores of polygastric stages of Calyco-phorae appear to be homologous structures, it is as well to use the same terms throughout for comparable parts. I therefore retain the term "dorsal" for the abaxial, and "ventral" for the axial side of the mouth of the nectosac of all such nectophores. Moser, who regards the inferior or posterior nectophore as a sterile gonophore and not a homologue of the anterior one, calls the abaxial side of one nectophore of a Prayid or Diphyid "dorsal" and that of the others "ventral." On the other hand, I agree with Gegenbaur, Huxley, Chun, and Bigelow in regarding the nectophores as homologous structures.

About the use of the terms "right" and "left" there is a difficulty. Having adopted the convention of calling the "abaxial" side of a nectophore "dorsal," and knowing that its apex is directed towards the aboral end of the whole organism, there should be no ambiguity about "right" and "left." Unfortunately the convention has been adopted by both Bigelow and Moser of viewing a nectophore from the dorsal side with aboral end uppermost, and applying the term "right" to the side opposite the right hand of the observer. Since Moser applies the term "dorsal" to that side of the posterior nectophore which Bigelow calls "ventral," there is no uniformity even in present usage. In the present report the term "dorsal" is used for the "abaxial" side of all nectophores, and "right" and "left" are employed in the morphological sense, assuming the apical end of a nectophore to be the aboral one. Thus if a Diphyid, with somatocyst uppermost, is momentarily swimming in a horizontal position towards the north, the eastern side of its anterior nectophore and the western side of its posterior nectophore is the right side; for it is swimming with its aboral end foremost, and with the "dorsal" side of the posterior and "ventral" side of the anterior nectophore uppermost.

In describing eudoxoids I have been consistent in the use of the same terms for homologous structures. Moser (1925) uses the terms "headpiece," "neck-shield," and "suture"*(Kopfstück, Nackenschild, Naht), which supply good points of reference. The surface opposite the "suture" she refers to as dorsal, and I have followed her in this throughout; so that it is easy to understand what she means by the statement that the edge of the left side of the neck-shield is a continuation of the left sutural ridge.† But in her description of *D. bojani* the dorsal side of the bract becomes the "Oberfläche" and the sutural surface the "Innensiete." In this I have not followed her. In *D. mitra* and *D. spiralis* the left side of the bract is termed by Moser the "right ventral" and the sutural surface the "left ventral," whilst the left edge of the sutural surface becomes the "ventral ridge." Here again I have not followed her practice, preferring to use throughout only one term for each structure. I adopt the convention of calling the abaxial side of the gonophore the "dorsal" one.

* The "suture" is the surface of the bract which lies next to the stem or axis. There is nothing in the nature of a suture about it in its development.

† I say that the right side is a continuation of the right ridge because the apex of the bract is the aboral end.

The term "basal" is applied to the oral, and "apical" to the aboral end of a nectophore or gonophore.

It had been hoped when the collection was first taken in hand that the tow-nettings would include material of all stages of development of such common forms as *Diphyes chamissonis*, but although prolonged and careful search has been made, only four diphyid larvae about three-quarters of a millimetre in length have come to light so far. They are referred to under *D. chamissonis*.

Most of the plankton hauls were made inside the edge of the Great Barrier Reef. Six stations were taken in the deep oceanic water outside the Barrier edge, and a few in intermediate positions.

The number of published observations on the behaviour of living Siphonophores is very small, but a study of the available accounts, such as those of Vogt (1854), and more recently of Berrill (1930), shows of what great importance in the animals' economy is the fishing-line apparatus of the tentacles. Evolutionary progress appears to have been in the direction of forming cover for this and other appendages when not in use, and providing for increased rapidity of retreat from enemies. I regret to have had little opportunity for studying living Siphonophores. A few observations which I have been able to make are mentioned later.

Species of six families belonging to two suborders were taken. The suborders Rhizophysaliae and Chondrophorae are not represented at all.

PHYSOPHORAE.

2. LIST OF SPECIES.

Agalmidae.

1. *Agalma okenii*, Eschscholtz.
2. *A. elegans* (Sars).
3. *Agalma*, sp. indet.
4. *Stephanomia bijuga* (Delle Chiaje).
5. *Cordagalma cordiformis*, gen. et sp. nov.

Forskaliidae.

6. *Forskalia*, sp.

CALYCOPHORAE.

Prayidae.

7. *Rosacea ? plicata*, Quoy and Gaimard.
8. *Amphicaryon acaule*, Chun.

Hippopodiidae.

9. *Hippopodius hippopus* (Forskål).

Abylidæ.

10. *Abyla haeckeli*, Lens and Van Riemsdijk.
11. *Abylopsis tetragona* (Otto).
12. *Enneagonum hyalinum*, Quoy and Gaimard.
13. *Abylopsis eschscholtzii* (Huxley).
14. *Bassia bassensis* (Quoy and Gaimard).

Diphyidae.

15. *Sulculeolaria quadrivalvis* (Blainville).
16. *S. monoica* (Chun).
17. *Galette chuni* (Lens and Van Riemsdijk).
18. *G. turgida* (Gegenbaur).
19. *Diphyes dispar*, Chamisso and Eysenhardt.
20. *D. bojani* (Chun).
21. *D. chamissonis*, Huxley.
22. *Chelophyes appendiculata* (Eschscholtz).
23. *Eodoxia russelli*, sp. nov.
24. *C. contorta* (Lens and Van Riemsdijk).
25. *Eudoxoides mitra* (Huxley).
26. *E. spiralis* (Bigelow).
27. *Dimophyes arctica* (Chun).
28. *Lensia subtiloides* (Lens and Van Riemsdijk).
29. *L. subtilis* (Chun).
30. *L. campanella* (Moser).
31. *L. fowleri* (Bigelow).
32. *Lensia*, spp. indet.

3. DESCRIPTION OF SPECIES.**PHYSOPHORAE.****Agalmidae.**

Two "Athorybia" larvae of Agalmids have been picked out of the catches, a larger one 2·5 mm. in length, with eight bracts, taken in an open vertical haul of the Nansen net from 180 m. outside Trinity Opening on 20th October; and a smaller one 1·1 mm. in length, with four bracts, taken nearby on the same day in a similar vertical haul from 250 m. to the surface. As the larvae are not in very good condition no attempt will be made to describe them. The bracts have three longitudinal ridges on the upper side, a small terminal saccule and a deep excavation on the lower or inner side. The angle between their two sides forms what might be described as another ridge on either hand.

Five species of Agalmids have fully grown representatives in the collection. Of three species, including *A. elegans*, there are only a few small loose nectophores. Two of them cannot at the moment be identified with any known species, but their form and the run of their lateral canals are in each case quite characteristic. One is regarded as the genotype of a new genus *Cordagalma*.

Agalma, Eschscholtz, 1825.

(?) *Cuneolaria*, Eysenhardt, 1821 [in Chamisso and Eysenhardt, 1821, p. 369].

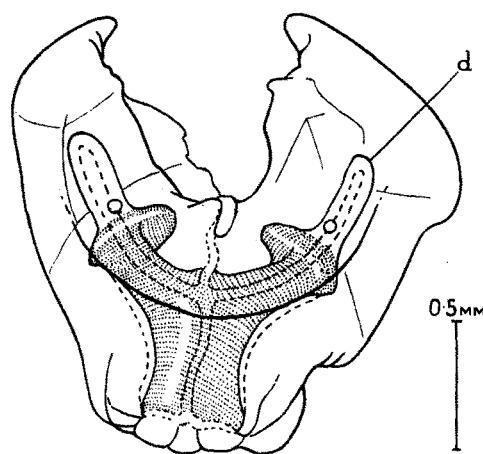
Bigelow (1911b), the last reviser of the genus, recognized four species of *Agalma*—*A. okenii*, Eschscholtz, *A. elegans*, Sars, *A. clausi*, Bedot, and *A. haeckeli*, Bigelow (= *A. eschscholtzi*, Haeckel). It may be possible to recognize and distinguish the last two in the field, but at any rate Bedot's figures do not appear to me to be sufficiently good to make

possible the identification of detached nectophores. If Haeckel's figures of the nectophore of *A. haeckeli* be correct, it can be at once distinguished by the direct, unlooped, lateral radial canals, and the shape of the bracts is diagnostic.

Bigelow (1911b), who has had the opportunity to study a large series of living specimens of *Agalma okenii*, states that "in very small specimens" the bracts associated with the oldest siphon are unlike those found on older specimens, in having only two facets. Some young specimens brought back by the expedition bear young bracts showing the transition between the two- and the four-facet stages.

Agalma okenii, Eschscholtz, 1825.

Five young specimens measuring from 3 mm. to 15 mm. in length were taken in the tow-nets. Medium-sized nectophores have on each side of the mouth an oblique dorso-lateral facet, divided from a triangular facet by a ridge opposite the end of the horn of



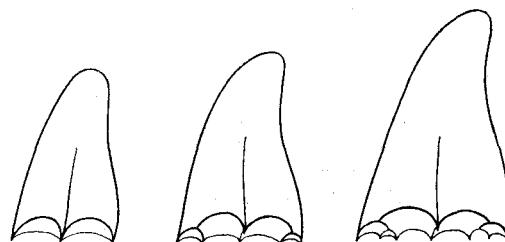
TEXT-FIG. 1.—*Agalma okenii*, Eschscholtz. $\times 34$. Young nectophore showing the diverticulum, *d*, of the lateral radial canal ascending over the lateral horn of the nectosac.

the nectosac. In older nectophores this triangular facet becomes divided into two by a second ridge, but it is clearly absent in young nectophores. In fact, the young nectophores of this species closely resemble the adult nectophores of *A. elegans*, and may be said to pass through an "*elegans*" stage. The ends of the horns of the nectosac are broadened obliquely—a feature not shown by Bigelow (1911b) in pl. 17, fig. 12. Viewed from the ventral surface—that is, the side turned towards the stem and the posterior end of the specimen—the course of the lateral canal is as follows: Starting from the pedicular canal, it runs outwards along the aboral and inner margin of the arm of the nectosac, to pass away obliquely over the middle of its broadened end. It then makes a semicircular sweep on the lateral wall of the nectosac-arm or horn towards its dorsal edge, loops down to its ventral edge at a point about midway between mouth and tip of arm, runs back obliquely on to the ventral side of the nectosac, where it appears as a loop, and finally runs up, obliquely, to the dorso-lateral side of the mouth of the nectosac.

In the smaller nectophores the loop made by the lateral radial canal on the ventral side is relatively much smaller, and the transverse ridge is often absent from the oblique dorso-lateral facet. In some of the smaller, not fully developed nectophores there is on

each side a large upstanding diverticulum of the lateral radial canal as much as 0·22 mm. in length and 0·15 mm. in diameter, at the point where it crosses the apex of the nectosac arm. These diverticula become absorbed later on, but often leave vestiges. Distally to this diverticulum the canal is not looped in the earliest phase of a growing nectophore. One of the distinguishing features of this species is the faceted bract.

The bracts taken with the youngest specimen are of two kinds, some shorter, 3·3 mm. in both length and breadth, and two longer, up to 6·6 mm. in length. Each kind is enantiomorphic. In both there are two asymmetrical main facets, but in the smaller ones there is a small subsidiary distal facet on the edge, which cuts off the distal end of one of the lateral ridges. In the largest bract from Station 49 there are two of these subsidiary facets. I have observed two similar facets, subsidiary to the usual four, as a constant character in *A. okenii*, though I have seen no mention of them in published accounts. Bigelow (1911b) figures one such facet with its two cusps on the extreme edge of the bract, just above the "10" of fig. 10, pl. 17, and the cusps of its fellow on the other side, but makes no mention of them in the text. There is one attached immature bract of the shorter type about 0·75 mm. in length which has rudiments of a subsidiary facet on each side.



TEXT-FIG. 2.—*Agalma okenii*, Eschscholtz. Diagram of three successive growth-stages of a bract to show the origin of secondary and tertiary facets on the distal edge.

In the accompanying text-figure can be traced the development of the mature bracts with three series of facets. In the first stage there is a single pair. The second and third pairs arise as flattenings of the outer and intermediate cusps.

Agalma elegans (Sars, 1846).

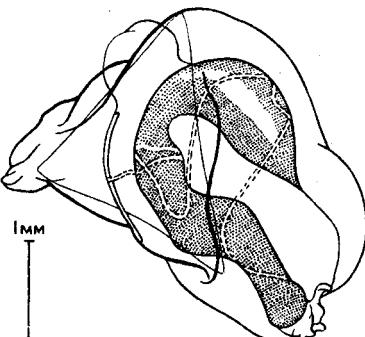
Four small nectophores 2 mm. in width from a vertical haul at St. 28, outside Trinity Opening, 23rd November, 1928. In the shape of the nectosac and run of the radial canals they agree with Bigelow's (1911b) pl. 19, figs. 2-3, which are characteristic of the species.

Agalma, sp. indet.

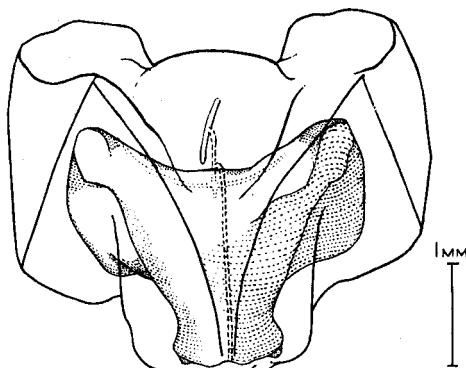
Six detached nectophores, the largest measuring 4·8 mm. in width, 3·5 mm. from the oral to aboral side, and 2·9 mm. dorso-ventrally; taken in a vertical haul of the stramin net from 400 m. to the surface outside Papuan Pass on 18th March.

The shape of the nectosac and run of the radial canals are the same in all six nectophores, and differ distinctly from the arrangement found in *A. okenii*, *A. elegans*, *A. haekeli* and *A. clausi*.

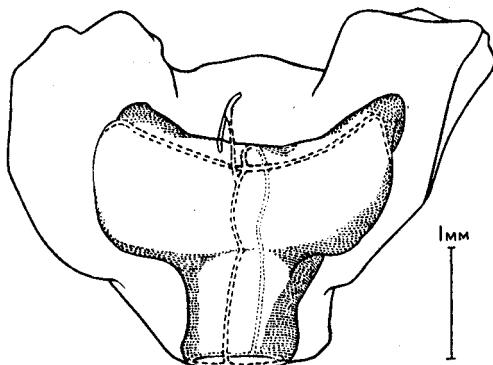
The lateral wedges of the nectophores, which probably belong to a young specimen, are not so drawn out and flattened as are those of other known species at an equivalent age, but nevertheless have the same arrangement of lateral facets. The nectosac is



TEXT-FIG. 3.—*Agalma*, sp. indet. $\times 13$. Lateral view of a nectophore to show the region of attachment, and the course of the lateral canal.



TEXT-FIG. 4.—*Agalma*, sp. indet. $\times 13.5$. Dorsal view of a nectophore to show the shape of the nectosac.



TEXT-FIG. 5.—*Agalma*, sp. indet. $\times 15$. Ventral view of a nectophore to show the pedicular and radial canals.

relatively deeper dorso-ventrally, occupying more of the volume of the nectophore. The pedicel is not nearly so long as in *A. okenii*. This character is best appreciated when a lateral view is taken. The ventral wall of the nectosac is relatively deep dorso-ventrally, and forms a gentle concave curve from side to side. There is on each side a deep oblique

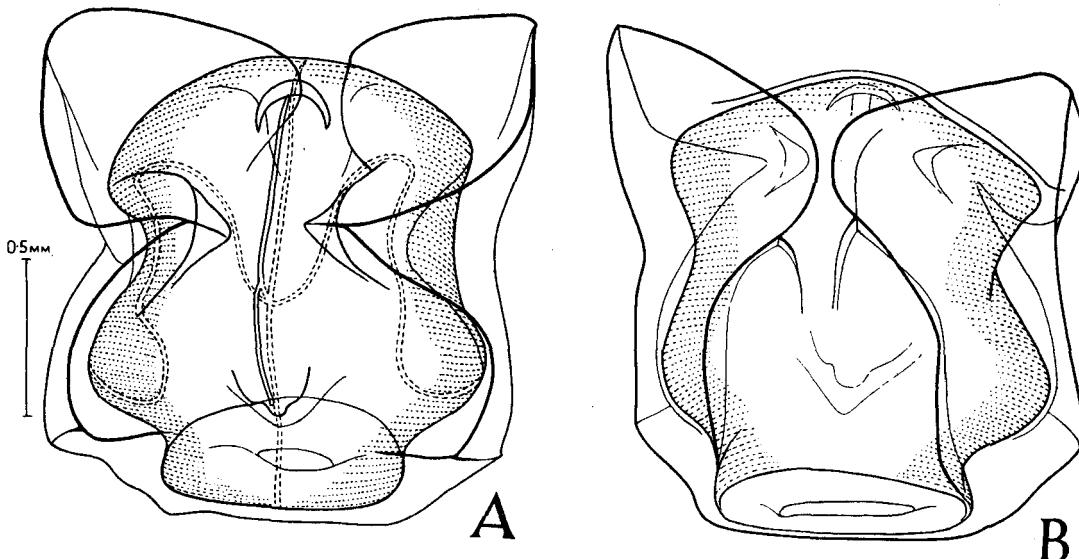
dorso-ventral expansion or horn of the nectosac. The transverse ventral wall does not curve away in a broad sweep towards the lateral side of the horn at this point as in *A. okenii*. Instead there is a distinct ridge between the ventral and lateral walls of the nectosac.

The course of the lateral radial canals is characteristic. From their junction with the pedicular canal they run out horizontally to the middle of the ridge on the lateral horns, and after a slight upward bend turn down and run to its ventral end. Each lateral radial canal then curves up to form a large vertical loop that covers the dorso-lateral surface of the nectosac. The descending limb of the loop passes just over on to the ventral surface before running up to the side of the mouth, but does not form what might be described as a ventral loop.

A series of special terms would be needed for an adequate and concise description of the various surfaces and angles of the nectophore and nectosac, and of the loops of the radial canals. At the present moment this extended description, illustrated by text-figures, will suffice to indicate the points in which these nectophores differ from those of previously described species. The nectophores of the various species seem to be highly characteristic, and a closer study of their morphology would facilitate the identification of material.

Stephanomia bijuga (Delle Chiaje, 1842).

This species occurred sparingly at both inside and outside stations, as well as intermediately throughout the year, although there were no records of it for the months February, May, August and September.



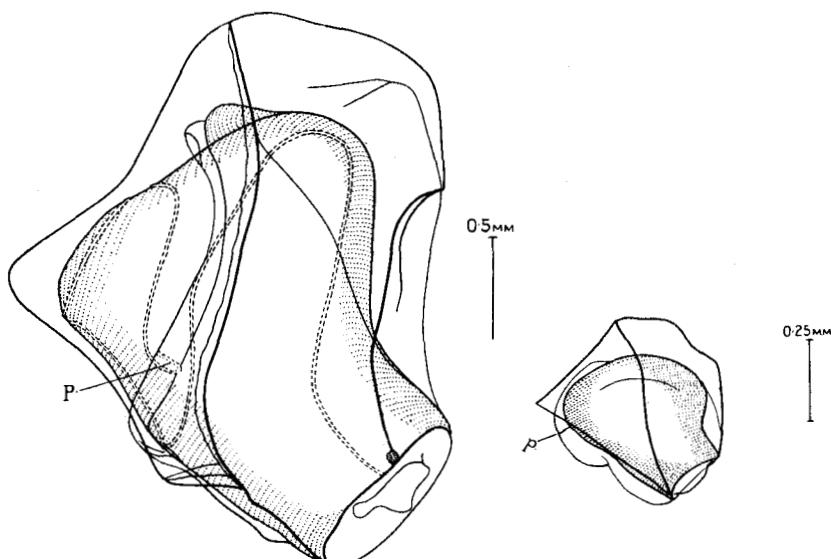
TEXT-FIG. 6.—*Stephanomia bijuga* (Delle Chiaje). $\times 42$. A, Ventral view of a young nectophore to show the region of attachment, and the pedicular and radial canals; B, dorsal view of the same to show the ridges.

Only five complete specimens were taken, varying in length from 2 mm. (an extended specimen) to 5 mm. (a contracted one). The greatest number of detached nectophores taken in one haul was twelve. The pneumatophores varied in size from 0.5 mm. to 3 mm.

in length and 0·3 mm. to 0·71 mm. in diameter. An extended specimen, 3·6 mm. in length, had a pneumatophore measuring 0·7 mm. in length and 0·3 mm. in diameter, and bore five nectophores (seven detached ones were present also) and four siphons.

The nectophores correspond with those of a specimen taken at Valentia Harbour, Ireland, by Miss Delap, and with figures given by Claus (1878) for *Halistemma tergestinum*, but differ from those figured by Bigelow (1911b), pl. 19, figs. 6 and 7, in that the junction of the radial canals with the pedicular is on a line drawn between the mouth and the tip of the lateral horn, so that the lateral radial canals make an ascending sweep on the inner side of the lateral horn of the nectosac. Bigelow's figure appears to show the origin of the pedicular canal at a point corresponding with the upper end of the semilunar muscular lamella.

The tentilla of the specimen from St. 37 are well preserved and distinctly unicornuate.



TEXT-FIG. 7.—*Stephanomia bijuga* (Delle Chiaje). $\times 42$. A, Lateral view of a young nectophore to show the course of one of the lateral radial canals; B, the same view of a younger nectophore, to show the position of the pedicular canal, p.

Cordagalma, gen. nov.

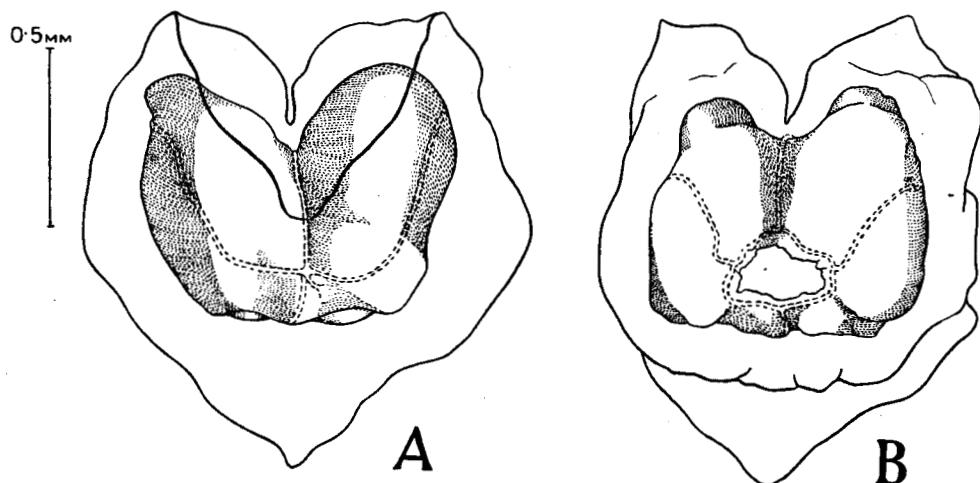
GENOTYPE.—*Cordagalma cordiformis*, sp. nov.

This name is proposed for a genotype whose detached nectophores differ from those of any existing genera in being attached by their bases to the muscular lamellae. The upper limit of attachment does not reach the level of the upper, median wall of the nectosac, and the lower extends well down on to a pointed basal process of the nectophore. The lateral radial canals are comparatively simple and unlooped.

Cordagalma cordiformis, sp. nov.

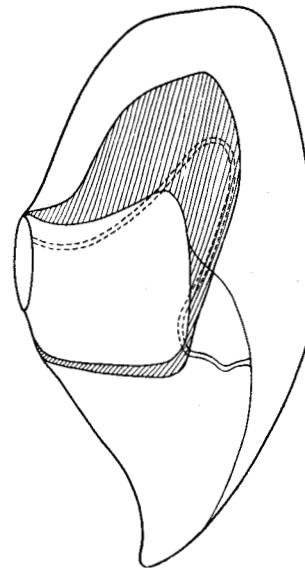
Six small nectophores, the largest measuring 2·5 mm. in length, 2·2 mm. in breadth, and 1·4 mm. in thickness from inner or ventral side to oral side, were taken in a vertical haul of the coarse silk net at St. 19 on 20th October.

The nectophores are not in a good state of preservation, but they agree with one another in several characteristics. Viewed from the oral or outer side they are shaped like the conventional heart with a point below and two rounded lobes above.



TEXT-FIG. 8.—*Cordagalma cordiformis*, sp. n. $\times 47$. A, Ventral view of a nectophore to show the radial canals; B, dorsal view of the same.

The semilunar process is attached unusually low down the nectophore, the upper end not reaching the level of the upper, median wall of the nectosac, and the lower extending well down on to the pointed process below (Text-fig. 9). This at once distin-



TEXT-FIG. 9.—*Cordagalma cordiformis*, sp. n. Diagrammatic lateral view, showing one of the simple lateral radial canals. The horn of the nectosac is cross-hatched.

guishes the nectophores from those of known species of *Agalma*, *Lynchnagalma*, *Anthemodes*, *Stephanomia*, *Nectalia*, *Physophora* and *Pyrostephos*. *Erenna* is not sufficiently well known for a description of its nectophore to be given.

The junction of the pedicular and radial canals is nearly on a level with the base of the nectosac. The two lateral radial canals sweep upwards to form a semicircle on the

inner face of the nectosac. Each passes round the lateral horn some distance below its blind upper end and sweeps down without any secondary loops to the side of the mouth of the nectosac. The lateral horns themselves extend chiefly upwards, and are divided from one another by a sharp cleft. They extend only slightly round the stem. The nectophores indeed appear not to dovetail into one another as is usually the case, since there are no lateral triangular processes or wedges.

The nectophores of this species should be recognized again with ease ; and it will be convenient for the present to give the species to which they belong the name *cordiformis*, and to make the species the genotype of the new genus *Cordagalma*. The six nectophores may be considered as parts of the holotype of the species.

I have since taken many small nectophores that correspond exactly with these off Kingstown, St. Vincent, B.W.I., at the surface at night in the month of February. I am still without a clue as to the species to which they belong, but they can be so easily recognized that they may be given a provisional name.

Foskaliidae.

Foskalia, sp.

Seven small loose nectophores 3 mm. in length, and a single bract measuring 4 mm. in length and 1 mm. in breadth, were taken in a vertical haul from 170 metres to surface at outside St. 50 on 18th March, 1929.

This was the only occurrence of any species of *Foskalia*. The condition of the specimens does not warrant a detailed description.

CALYCOPHORAE, Leuckart, 1854.

Although it is not proposed in this place to make a detailed criticism of the opinions on phylogeny expressed by Moser (1925), it is felt to be desirable at once to dissent from her conclusion that Calycophorae were the ancestors of the Physophorae. Moser considers the pneumatophores of the Physophorae to be altered swimming-bells of Calycophoran ancestors, but I consider them to be derived from primitive apical organs. The larval bells of the Calycophorae I regard as precociously developed homologues of the swimming-bells of the Physophorae.

Of the four families recognized by Bigelow (1911b), two, Prayidae, Kölliker, and Hippopodiidae, Kölliker, may be accepted as natural groups, but have only one and two representatives respectively in the collection. The third, Sphaeronectidae, Bigelow (=Monophyidae, Chun), does not appear to be a natural group, whilst the two sub-families of the fourth, Diphyidae, I regard as separate families. The character on which alone the family Sphaeronectidae is founded is the presence of a single nectophore. There is evidence that such a condition has been brought about along several converging lines of evolution. The phenomenon, which may be referred to as monophyism, appears not only amongst the Diphyidae, but in the Abylidæ as well. It will be seen, for instance, that *Enneagonum hyalinum* (=*Cuboïdes vitreus*) is an Abylopsid that has lost its second nectophore. It would only defeat the ends of a scheme of natural classification to name as a special group a heterogeneous collection of "Diphyids" (Dimophyidae, Moser, 1925) that included amongst other forms a species of *Diphyes* with a reduced posterior

nectophore (*Dimophyes arctica*), and an Abylopsid with none (*Enneagonum hyalinum*). As to Bigelow's two reasons for accepting Chun's group Monophyidae, there seem to be no grounds for assuming either that *Muggiaeae-* and *Cuboides*-like forms gave rise to Diphyids and Abylids respectively, or that monophyism was ancestral.

I reject Chun's group because of the fact that after careful consideration of the sum of the characters of each Calycophoran species we can arrange them in natural groups or genera that contain species not only of one sort—polypyid, diphyid or monopyid—but also that form any of the four combinations of these three kinds. It may be argued, therefore, that monophyism is not a character upon which alone to base conclusions as to natural relationship. For this reason I do not recognize as a single natural group an association of all the monopyid species. *Monophyes* and *Sphaeronectes* themselves may be neotenous forms retaining larval features rather than modern survivors of primitive adults, and for them the name "Sphaeronectidae" must be retained. The affinities of *Muggiaeae* are with Diphyids; and *Nectopyramis* is a Prayid.

The collection contains only one species included in the Sphaeronectidae of Bigelow, namely, *Enneagonum hyalinum*, and this is dealt with amongst the species of *Abylopsis*.

The main difference between Diphyidae and Abylididae is that while the Diphyids would appear, from the comparative sizes of the two nectosacs, to use the anterior one as their chief propulsive organ, the Abylids, as a rule, use the posterior nectosac almost exclusively. In fact I have observed that *Abylopsis tetragona* only uses the anterior sac intermittently, and then possibly for changing direction. The difference might be more accurately expressed by saying that whereas the Abylids have, as a rule, reduced their first formed bell and relied on the propulsive effort of the second, the Diphyids have entirely discarded it, but made use of a smaller third one. Two of the Abylopsids, however, appear to have struck out in a direction rather different from that taken by other Abylids. *A. eschscholtzii* has a reduced posterior nectophore, and *Enneagonum* or *Cuboides* has entirely lost it. Nevertheless, certain members of both families, Diphyids and Abylids, starting presumably from a stage of evolution comparable with that of the Prayids, have after following these diverging paths reached the same point and have become "monopyids"; but *D. spiralis* has become a small, stream-lined, active darter, whilst the larger, unwieldy *Enneagonum hyalinum* is probably not able to do much more than counteract the force of gravity. It would be most interesting to know how this curious species actually does behave.* We are tempted, then, as pure speculation, to suppose that the ancestral Physophore, with its numerous rapidly pulsating bells driving the colony along in a direction at right angles to the axis, was succeeded by forms like Prayids with a reduced number of bells which probably progressed in line with the axis; and that in turn arose forms like the Galeolariids and Diphyids with two bells staggered one behind the other, whose propulsive efforts reinforced one another, and the Diphyids, able to draw the stem under cover and increase their speed of escape from enemies. The posterior bell of some was at last found to be a drag and discarded. Meanwhile the ancestral Abylids found it a good plan to drive with the second bell and change direction with the first. The acquisition of this new function of the first bell led to its development on novel lines again in the Abylopsids, and culminated in its exclusive use in such a form as *Cuboides*.

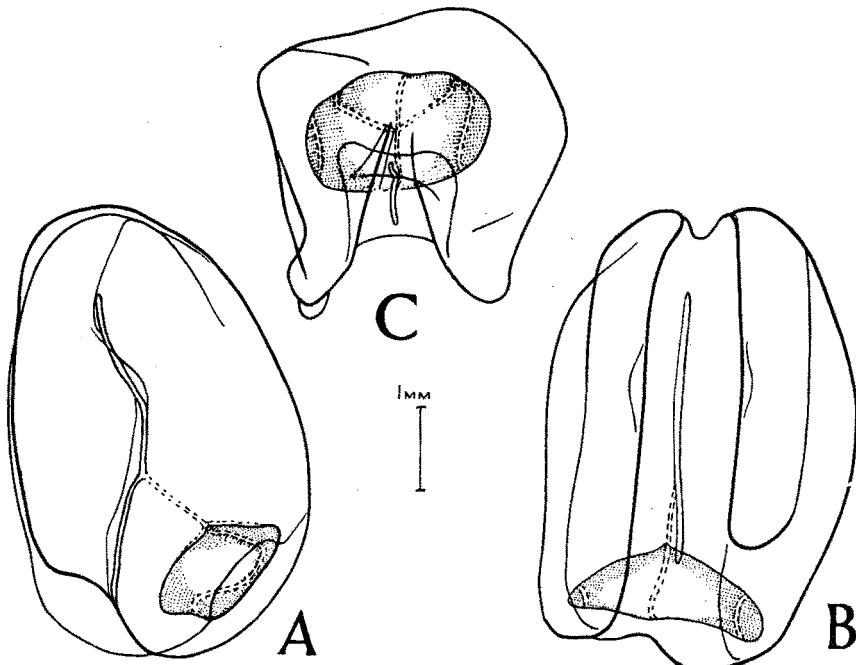
* Bigelow (1911b) said that throughout the 5-month cruise of the "Albatross" in the Eastern Tropical Pacific he had the opportunity of studying the siphonophores—one of the most extensive series ever collected—alive, but as far as I know he published nothing about their behaviour.

Prayidae.

There are ten recognizable and one doubtful species of Prayids which are to be assigned to six or seven genera. The only one that is at all common has for the last eighty-eight years been known as *Praya cymbiformis*, Delle Chiaje. Unfortunately strict adhesion to the rules of nomenclature results in the application of the name *Praya* (originally spelt "Praia") to the form for which Bigelow (1911) erected a new genus, *Nectodroma*.* Two other names are available for the genus of which *cymbiformis* is the genotype, namely, *Eudoxella*, Haeckel, 1888a, and *Huxleya*, Gravier, 1899. But I am inclined to believe it is congeneric with *Rosacea*, in which case that name would have priority.

Rosacea ? plicata, Quoy and Gaimard, 1827.

A single nectophore, probably the elder one, 5·6 mm. in length, taken in an oblique haul at St. 26 in Trinity Opening on 19th November, 1928.



TEXT-FIG. 10.—*Rosacea ? plicata*, Quoy and Gaimard. $\times 11$. A, Lateral view of the nectophore to show the course of one of the radial canals; B, ventral view of same; C, apical view of same.

The specimen corresponds in general with a nectophore of *Praya diphyes*, Blainville, figured by Vogt (1854). In the absence of any very critical published morphological details of this species I make this tentative identification following Bigelow's synonymy. The left hydrocial fold is shorter than the other, whether as the result of an accident it is not possible to say. The nectosac is somewhat deformed—probably a post-mortem change—and it is not easy to see exactly how the curved lateral radial canals run.

* *Praia* was clearly applied by Blainville to a form with laterally branched somatocyst. He said “ . . . j'ai pu très-bien apercevoir un vaisseau médian donnant deux branches latérales, avec des ramifications bien similaires.” The application of the name “*Praya*” has been discussed by Bigelow (1931) since this was written.

Amphicaryon acaule, Chun, 1888.

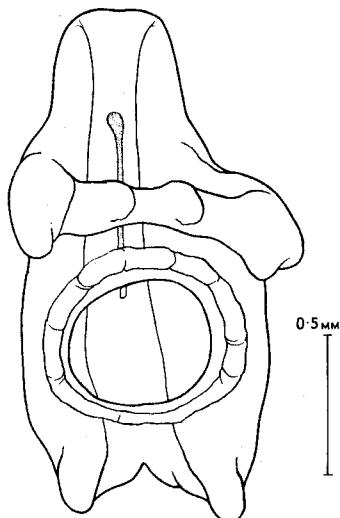
A single complete specimen was taken at St. 50, outside Papuan Pass, on 18th March, in a vertical open net fished from 170 m. to surface. The smaller, shield-shaped nectophore, with its vestigial closed nectosac, measures 2·47 mm. in length, and the larger one 3·14 mm. The state of preservation is not very good, but is sufficient to enable me to identify it without doubt.

Bigelow held the vestigial nectophore to be the primary one, chiefly because in a specimen 3 mm. long this nectophore was longer than the other. Moser, however, described a still smaller specimen, 2·5 mm. in length, in which the lengths of the two nectophores were equal. I am inclined to agree with Moser that the vestigial nectophore is probably the secondary one.

The known distribution is as follows : W. Indies (Bigelow); Chesapeake Bay (Bigelow); Canaries (Chun), Tropical and Subtropical Atlantic (Moser); Chagos, Farquhar and Amirante Is., Indian Ocean (Browne); Eastern Tropical Pacific (Bigelow). It appears to be a midwater species, and thus to have escaped much attention.

Hippopodiidae.(?) *Hippopodius hippopus* (Forskal, 1776).

The material consists of a single nectophore 4 mm. in length, a single larva or primary bell, 1·5 mm. long, and a female gonophore 1·9 mm. long. The nectophore is rounded, but not well enough preserved to show the dorsal prominences. The specimens were taken in a vertical haul from 400 m. to the surface outside Papuan Pass on 18th March, 1929.



TEXT-FIG. 11.—(?) *Hippopodius hippopus*. × 37. Dorsal view of a young nectophore.

Two small nectophores, 1·9 mm. and 3·6 mm. in length, from St. 50 outside Papuan Pass, 18th March, probably belong to this species. I have examined an even smaller nectophore removed from an undoubted specimen of *H. hippopus* taken in the Tropical Atlantic, and it agrees closely in shape with the one figured (Text-fig. 11); but the next

older nectophore of that same Atlantic specimen, although it is smaller than the second Barrier Reef one, has already assumed the characteristic shape found in older nectophores of *H. hippocampus*.

These young Barrier Reef nectophores resemble Bigelow's figure (1918, pl. 4, figs. 2, 3) of a nectophore of *Vogtia glabra* 7 mm. long in their elongate outline and pointed apex, but have four dorsal prominences as in *H. hippocampus* instead of two as in *V. glabra*. I have not seen any nectophores of *V. glabra* smaller than one 4 mm. in length, and that is already beginning to assume its definitive shape, and has only two prominences.

Abylidæ.

(Abylinæ, L. Agassiz, 1862.)

It might be argued that *Bassia* and *Abylopsis* are more primitive than *Abyla* and *Diphyabyla*. For in the posteror nectophore of both *Bassia* and *Abylopsis* there are lateral ridges, and in that of *Abylopsis* also a complete dorsal ridge, while the right and left hydroecial folds stretch across the hydroecium as in the Diphyidae. In *Abyla* and *Diphyabyla*, on the other hand, there is a general reduction of these ridges, and the hydroecial folds may be hypertrophied into very large parallel plates which no longer roof over the hydroecium. But *Bassia* and *Abylopsis* differ from all other Diphyids in the peculiar way in which the two nectophores are orientated and articulate with one another. They have, too, a peculiar arrangement of ridges of the anterior nectophores, which appears to be connected with the stream-lining of this new arrangement. It can therefore be argued, I think, that these genera are more specialized than *Abyla* and *Diphyabyla*. One way of reconciling these views is to suppose that in *Bassia* and *Abylopsis* the chief evolutionary changes have taken place in the anterior nectophore and its articulation with the posterior, while in *Abyla* and *Diphyabyla* it is in the posterior nectophore that these have occurred.

Indeed I have noticed, while observing living specimens of *Abylopsis tetragona* in the Gulf of Algeciras, that the two nectophores appear to function independently. Propulsion is effected by the rather slow rhythmic contraction of the posterior nectophore, while the anterior one appears to contract spasmodically, but more rapidly.

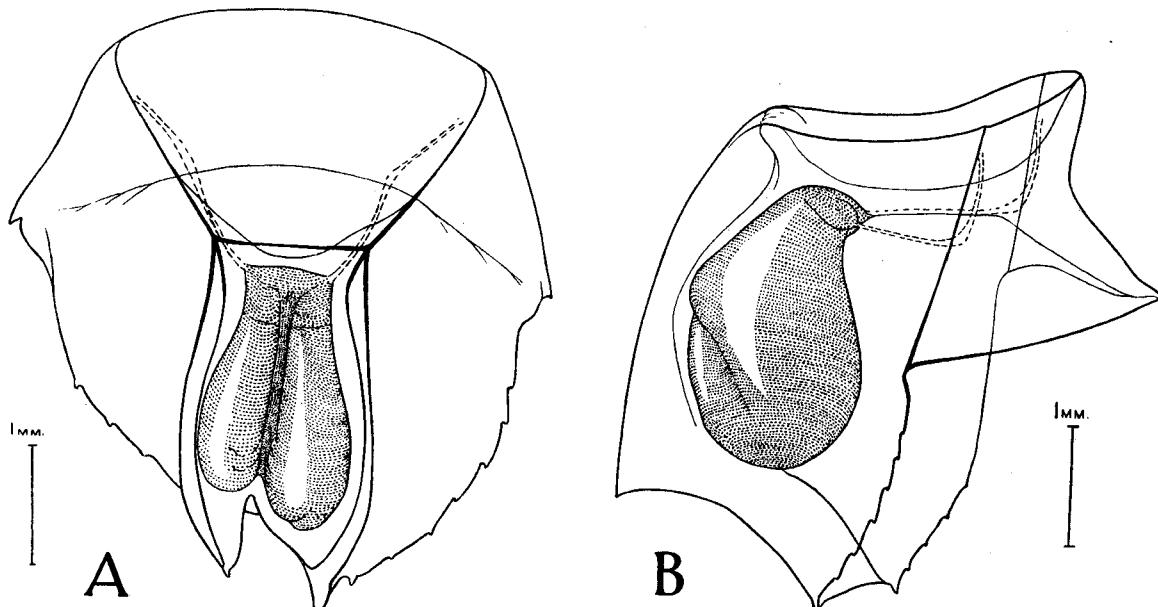
Abyla haeckeli, Lens and Van Riemsdijk, 1908.

One anterior nectophore, the identification of which rests upon the presence of a transverse ridge dividing the ventral facet into two parts, was taken at the weekly station 3 miles east of Low Isles on 2nd October. With it were taken two Abylid posterior nectophores, neither of which is in a good state of preservation. The characters of both were elucidated by manipulation with needles.

One of these posterior nectophores, which is 10 mm. in length, I believe to belong to this species. Its nectosac is relatively short in comparison with the pedicel. There is a large median dorsal tooth and corresponding ridge, a right lateral tooth and ridge, and a left lateral tooth without ridge. The left hydroecial ridge is not toothed, but appears to have a thickened edge ("Polster") in the middle region, where both ridges are most prominent. The right hydroecial ridge has a proximal toothed flap and a distal toothed

edge. The five teeth in this basal region decrease in size from the middle region towards the velar end, the last being just above the level of the velum. There is no thickened mouth-plate with oblique basal facet, such as is found in *A. trigona*. Instead the plate connecting the two ventral teeth is quite thin.

I have assigned tentatively to this species two Abylid eudoxoids that resemble the type ("*Amphiroa*") usually assigned to *A. trigona*. In the past, Abyline eudoxoids have been referred, if of the "*Ceratocymba*" type, either to *Ceratocymba sagittata* or *C. asymmetrica*; if of the "*Amphiroa*" type, to *Abyla trigona*; and if of the "*Cymba*" type, to *A. leuckartii*. But the eudoxoids of *Abyla dentata* and *Diphyabyla hubrechti* are of the "*Ceratocymba*" type too. It is clear that much critical work remains to be done on the Abylid eudoxoids. For instance, I am unable to find sufficiently critical descriptions and figures of eudoxoids definitely known to belong to *A. trigona*.



TEXT-FIG. 12.—*Abyla haeckeli*, Lens and van Riemsdijk. $\times 16$. The bract of a eudoxid.
A, dorsal view, showing artefact; B, lateral view.

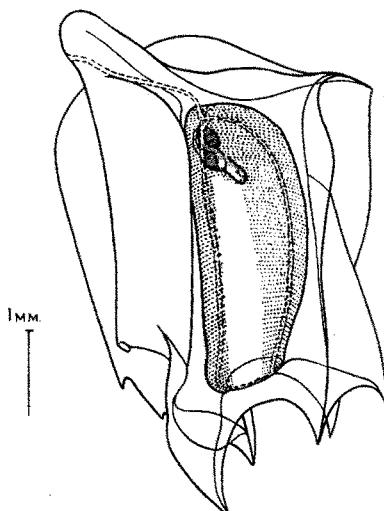
We know that *haeckeli* occurs in the Barrier Reef region. Now since its eudoxid is likely to resemble that of *A. trigona* because of the similarity of their anterior nectophores, and since eudoxoids differing slightly from those found in association with *trigona* have been taken there, it is probable that these eudoxoids can be assigned to *haeckeli*.*

The outline of the bract, when viewed from the dorsal side, somewhat resembles that of *Ceratocymba*, the edges of the lateral walls of the hydroecium being bowed out and toothed. The ventral facet is convex. The arrangement of teeth on the hydroecial flap or "Leiste" of the gonophore differs from that figured by Lens and Van Riemsdijk for *A. trigona*. Bigelow, it will be remembered, maintains that the bract of the eudoxid of *haeckeli* has a concave ventral facet and an asymmetrical greatly developed "left" ventrobasal angle as in *Amphiroa dispar*, Bedot (1896).

* Since this was written, anterior nectophores of *A. haeckeli* and "*Amphiroa*" eudoxoids have been found in association in hauls made in the New Zealand region by the British Antarctic ("Terra Nova") Expedition, 1910-13.

One of these eudoxids, with gonophore attached and a single gonocalyx 6 mm. in length, was taken at an intermediate station inside Papuan Pass on 17th March. It is crushed, but the general shape of the phyllocyst with its large ovoid descending branch can be plainly seen. The loose gonocalyx (Text-fig. 13) has a small vermiform manubrium. There is a well-developed right ventral (hydroecial) ridge, toothed on its basal margin. A small delicate left hydroecial flap (Leiste) with a pronounced tooth is visible, but is crumpled slightly. The median dorsal and other four teeth are in a good state of preservation. Viewed from the side, the mouth-plate can be seen to have a flattened, oblique, basal facet, such as is found in the posterior nectophore of this and other species of *Abyla*. The attached gonophore is the mirror image of the loose one. Its manubrium is not visible.

The second, consisting of a well-preserved but slightly damaged bract and a well-preserved loose female gonophore, was taken the next day at St. 50, outside Papuan Pass.



TEXT-FIG. 13.—*Abyla haackeli*, Lens and Van Riemsdijk. $\times 16$. Lateral view of a gonophore, showing the incomplete dorsal ridge and tooth.

The flap or "Leiste" of the gonophore has one large basal recurved hook-like tooth, and a smaller vestigial one close to the ventral wall of the hydroecium. The base of the left ventral (hydroecial) ridge bears two strong teeth. The dorsal median ridge, which extends for only half the length of the dorsal facet, lies asymmetrically, nearer to the right dorsal ridge. The radial canals, which appear to be reticulated, do not run in the usual dorsal, ventral and lateral positions. The dorsal canal runs under the right lateral ridge, though it meets the circular canal under the median dorsal tooth. The right lateral runs inside the right ventral ridge, but the left lateral canal lies inside the left lateral ridge in its normal position, and the ventral canal lies inside the remaining left ventral ridge. The manubrium bears two ova.

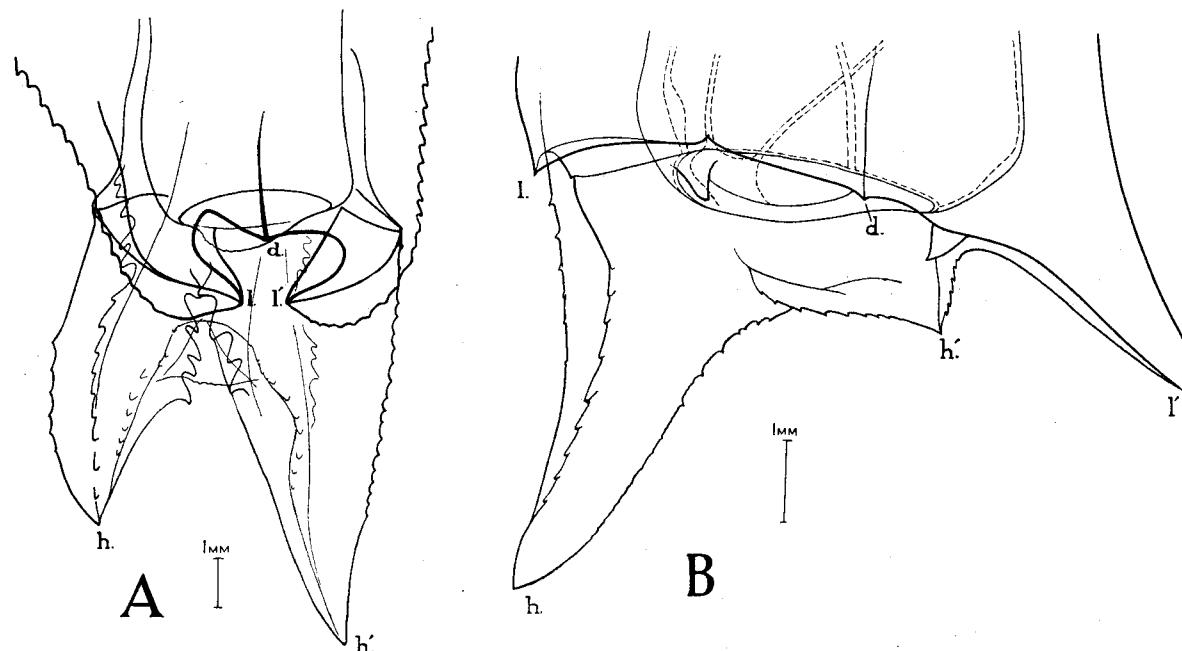
Abylopsis tetragona (Otto, 1823).

Specimens of the polygastric and eudoxid stages were taken in ones and twos in all months of the year except December, April, May and July at the weekly inside, three outside and one intermediate stations. The estimated total numbers taken are 15

polygastric specimens and 18 eudoxids—a remarkably small number for a year's tow-netting work.

Five specimens of the two stages were taken at the vertical distribution stations 16 and 62 in the upper layers (3–8 m.).

This species links the genera *Abyla* and *Abylopsis* together. The two peculiar oblique folds at the base of the mouth-plate (Text-fig. 14) can be homologized with the margins of a flattened elliptical area of the same structure in *Abyla dentata*, Bigelow (= *A. quadrata*, Moser) (Text-fig. 15). This rather trivial feature may be of some importance in considering questions of phylogeny, as it appears to be a vestigial character. The significance of the peculiar arrangement of radial canals is that it is a device for making a new arrangement



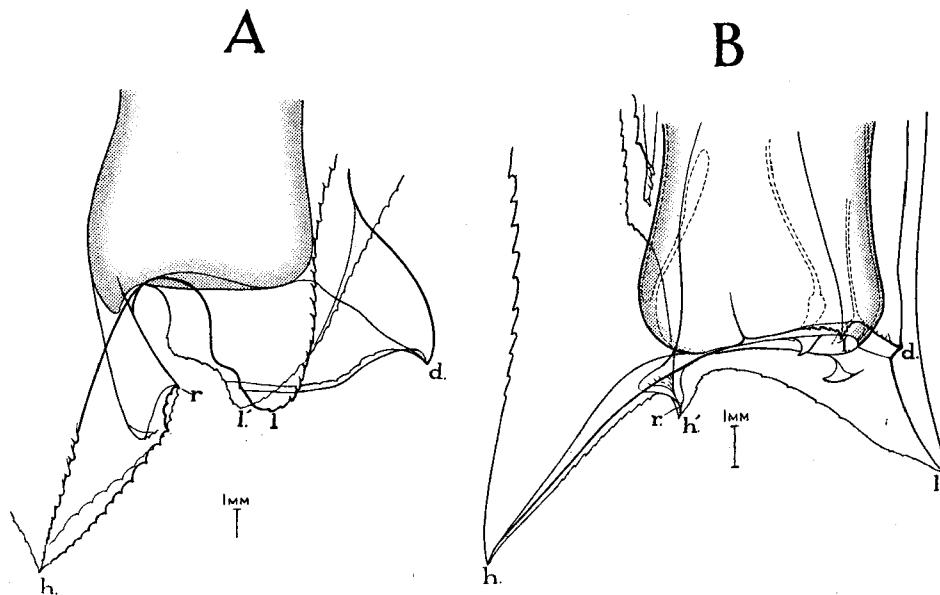
TEXT-FIG. 14.—A, *Abyla dentata*, Bigelow. $\times 6.5$. Dorsal view of the base of the posterior nectophore; B, *Abylopsis tetragona* (Otto). $\times 11$. Same view. r, The ridge at the base of the mouth-plate; d, dorso-basal tooth; l, latero-basal teeth; h, h¹, basal ends of the right and left hydrocial walls.

of five radial canals out of four, the new one lying under the right ventral ridge. The proximal part of this fifth canal is formed by the deflected and altered left lateral. There is then a gap, and the distal part is a new oblique offshoot from the ventral "Gefässplatte." In *A. dentata* this left ventral ridge is associated with a canal by a change in the course of the median dorsal, over which there is no longer a complete ridge, and the left lateral, the first taking the place of the second, which in its turn comes to lie inside the left ventral. It is this left ventral ridge that becomes displaced and finally reduced in *Abyla*, and the changes in the arrangement of the radial canals in Abylidids appear to be correlated with this.

There are two small, pointed, prominent, basal projections (Text-fig. 15b) underlying the two lateral "Gefässplatten." They are referred to by Haeckel as "the distal prolongations of the two dorso-lateral edges," but appear to be independent formations connected with the close proximity of the "Gefässplatten."

I observed that numerous specimens taken alive in the Gulf of Algeciras in March, 1931, swam slowly by rhythmical contraction of the posterior nectophore. Like many salps that I observed at the same time they swam in open spiral courses, with the hydroecium of the posterior bell on the inner side of the spiral, and with stem contracted. It was only occasionally that the minute anterior bell pulsated, which it did with a rhythm more rapid than that of the posterior bell.

Bigelow (1931) has already referred to two criteria for separating the loose anterior nectophore from that of *A. eschscholtzii*. A third one I would mention is that in *A. tetragona*, the length of that part of the ventral wall of the nectosac that extends from the



TEXT-FIG. 15.—A, *Abyla dentata*, Bigelow. B, *Abylopsis tetragona* (Otto). $\times 6\cdot5$. Lateral views of the bases of the posterior nectophores to show the ridge, r, at the dorsal side of the flattened elliptical area of the mouth-plate. Lettering as in Fig. 14.

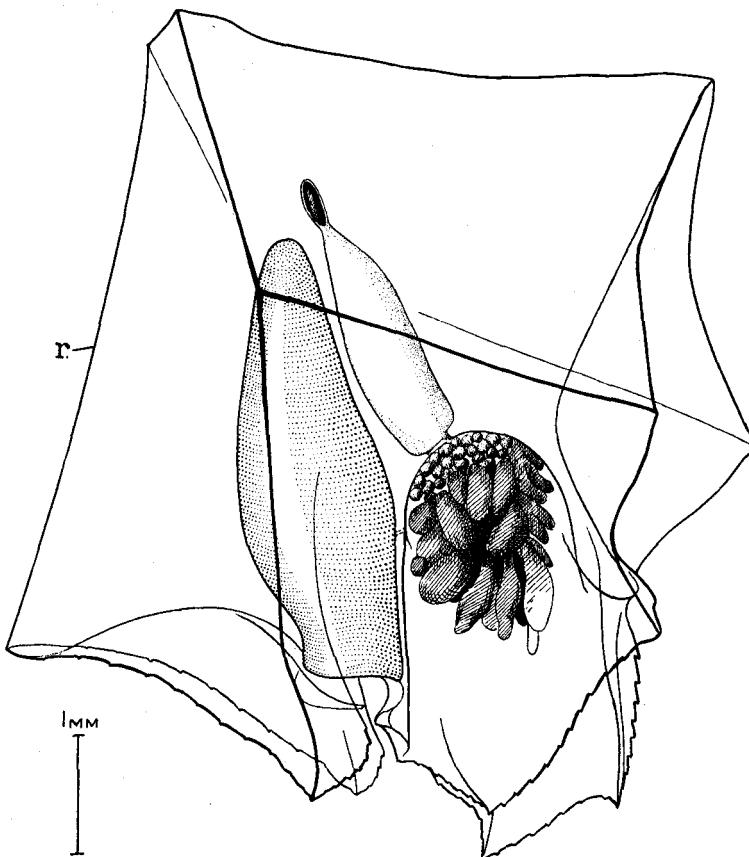
velum to the point where the pedicular canal joins the subumbrial canal system is shorter than the other part between this junction and the apex of the nectosac. In *A. eschscholtzii* the reverse holds true.

Enneagonum hyalinum, Quoy and Gaimard, 1827 (= *Cuboides vitreus*, Quoy and Gaimard, 1827).

Specimens of both stages were taken regularly at the weekly station, two outside stations, and three intermediate stations from 4th January until 17th July. For the rest of the year no specimens were taken. The estimated total numbers taken are 36 polygastric and 286 eudoxids. Twenty-one specimens were taken at one "vertical distribution" station in daylight, a single polygastric specimen at the surface, 11 eudoxids at 8 m., 2 at 16·5 m., and 7 a little deeper still.

Huxley (1859) carefully homologized the facets of the polygastric nectophore which he called *Abyla vogtii* with those of *Abylopsis tetragona* and *Bassia bassensis*. The essential difference was, he said, that there is a median dorsal ridge instead of a pentagonal dorsal

facet (see Text-fig. 22). This homology appears to have been overlooked by some subsequent authors, especially Chun (1892), whose beautifully executed lithographs obscure this point completely. One is at first tempted to believe that this dorsal longitudinal ridge, which is found in the gonophore as well, is homologous with the dorsal ridge in *Diphyes*, and is a primitive feature; but *Enneagonum* is the only Abylid known with such a ridge in the anterior nectophore, and it seems more probable that it is a secondary feature, perhaps introduced after the loss of the posterior nectophore to restore balance in some way.

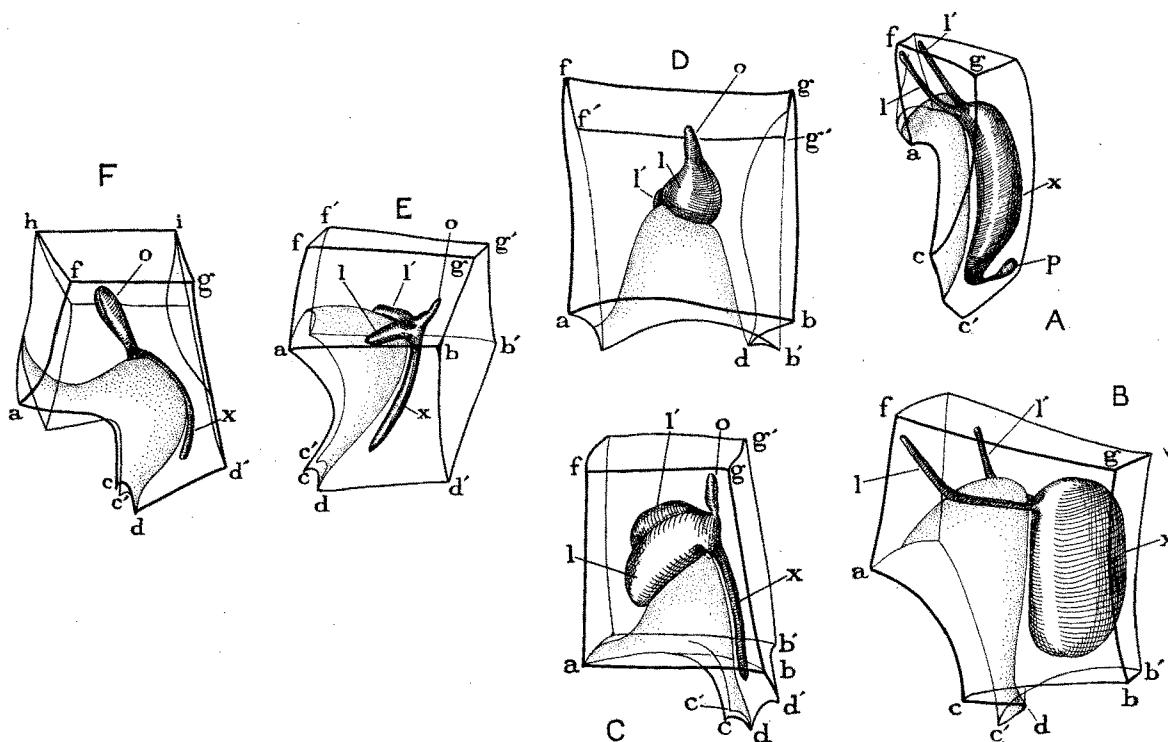


TEXT-FIG. 16.—*Enneagonum hyalinum*, Quoy and Gaimard. $\times 16$. Lateral view of a nectophore to show its homologies with those of *Abylopsis tetragona* and *A. eschscholtzii*. *r*, The dorsal median ridge peculiar to this species. The appendages are shown diagrammatically.

I do not share the view of some authors that Quoy and Gaimard's *Enneagonum hyalinum* cannot be recognized, or that there is more than one species to which the description and figures could apply, and for this reason I am obliged reluctantly by the rules of nomenclature to reintroduce their name. The description and figures, which will fit no other species, together with the fact that the polygastric and eudoxid stages were found together, and the fact that the authors commented on a similarity in the behaviour of each when alive—all these points leave me without the slightest doubt about the identity of Quoy and Gaimard's species.

As to the meaning of Quoy and Gaimard's "seconde partie" which is enclosed in "la moyenne cavité," or hydroecium, I take it to be the gonophore of one of the eudoxids,

since it has five teeth and a lateral canal. The figures in Quoy and Gaimard's plate 2D can be recognized as follows: Fig. 1, lateral view from left side, showing the nine points, but not illustrating the full extent of the hydroecial walls; fig. 2, basal view looking into hydroecium; fig. 3, apical view (*cf.* Chun, 1892, pl. xi, fig. 2); fig. 4, lateral view (*cf.* Chun, fig. 4); fig. 5, young gonophore; fig. 6, nectosac and somatocyst with apical projection, and appendages. In fig. 1 the arrangement of the nine points is correct, although they could not be seen as illustrated from any one view-point. It should be noticed that in their explanation of the plate these naturalists state that the apical angle "se trouve toujours en dessous." This seems to imply that the live animals take up that position.



TEXT-FIG. 17.—Diagrams of the bracts of Abylid eudoxids. A, "Cymba" type (*Abyla leuckartii*) ; B, "Amphiroa" type (*Abyla trigona*, *A. haackeli*) ; C, E, "Aglaisma" type (*Abylopsis tetragona*, *A. eschscholtzii*) ; D, "Cuboides" (*Enneagonum*) ; F "Sphenoides" (Bassia). The bracteal cavities have been dotted, and the phyllocysts hatched. The bracts are so orientated as to show their homologies. *a b*, Cross ridge ; *a c d*, hooked baso-lateral wall of bracteal cavity ; *d d'*, baso-sagittal ridge ; *h i*, apico-sagittal ridge ; *c c' b b'*, square, basal facet ; *b c, b' c'*, baso-lateral ridges.

It seems opportune to invite special attention to the Abylopsine relationship of *Enneagonum*; and some detailed morphological considerations will make the understanding of it more easy.

The eudoxids of the Abylopsinae are of the "Aglaisma," "Cuboides" and "Sphenoides" types, and their study reveals their homologies with those of the Abylinae, which are of the more generalized "Amphiroa," "Cymba" and "Ceratocymba" types. The "Aglaisma" of *Abylopsis tetragona* may be regarded as the most generalized of the Abylopsine eudoxids; and the asymmetrical "Cymba" and "Ceratocymba" are perhaps

the most generalized of the Abyline eudoxids, because they have no cross ridges (Text-fig. 17 *a, b*), running from the baso-ventral rim of the bracteal cavity of the bract to its dorso-lateral ridges, and the dorsal facet is not divided by the ridge *b b¹*; most of their other ridges and facets can be homologized with those of the "Aglaisma" of *Abylopsis tetragona*. Development from this "Aglaisma" type seems to have led in two directions, firstly to the suppression of the hooked baso-lateral walls of the bracteal cavity and of the baso-sagittal ridge (Text-fig. 17, *d, d d¹*, "Cuboides"); and secondly to the enlargement of these same parts in *A. eschscholtzii*. The bract of *Bassia* ("Sphenoides") seems to be a retrograde development of the *eschscholtzii* type, in which the cross ridge *a b* has been suppressed, and the paired (ventral) horns of the phyllocyst have been lost, whilst an apico-sagittal ridge (Text-fig. 17*F, h i*) has transformed the original rectangular facet *f g f¹ g¹* of the other types into a pair of apical facets, *f g h i, f¹ g¹ h i*.

The bracts of "Aglaisma" and "Sphenoides" differ from that of "Amphiroa," which has a square basal facet *c c¹ b b¹*, in the possession of a new baso-sagittal ridge *d d¹*, the baso-lateral ridges *b c, b¹ c¹* being absent. In "Cuboides" the baso-sagittal ridge *d d¹* has shortened to the vanishing point *d*. Even in *Abylopsis tetragona* (Text-fig. 17*c*) it is of variable length, being sometimes very much shorter than is shown in the figure.

The fact that the oily content of the phyllocyst collects in an apical horn in "Aglaisma" and in a dorso-basal horn in "Cymba" and "Ceratocymba" is probably due to differences in habit and posture.

The differences in shape of the phyllocyst in Diphyids and Abylidids can generally be correlated with differences in the relative volumes of the parts of the bracts. In *D. bojani* it will be remembered that there is a very thin bract, and that no apical horn is developed at all. In *Bassia*, where the basal part of the bract is long and narrow, we find an elongated basal horn; so in "Cuboides" where the basal part of the bract has been suppressed, we find no basal horn at all.

Abylopsis eschscholtzii (Huxley, 1859).

About 70 specimens of the polygastric stage and upwards of 320 eudoxids are estimated to have been taken at the weekly station three miles East of Low Isles, at four outside stations, and intermediately during the greater part of the year. Between 4th January and 7th June they were taken only twice, on 17th March at an intermediate station, and on the next day at an outside one.

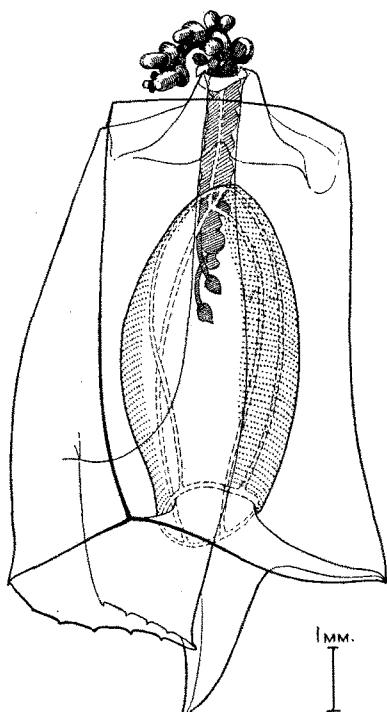
Forty-four specimens were taken at vertical distribution Station 16, the four polygastric specimens coming from between the surface and a depth of 8 metres. Sixteen more were taken at vertical distribution Station 68, the six polygastric specimens being taken at about the same depth.

Some of the bracts of the eudoxids are parasitized by young Hyperiid amphipods, which probably feed on the reserve food stored in the phyllocyst. Hyperiids were found also in *Sulculeolaria quadrivalvis*, apparently feeding on the musculature of the bell of the posterior nectophore, and also in *Enneagonum hyalinum*, close to the phyllocyst of the bract of the eudoxid. In *Lensia subtiloides* what may be similar amphipods were found close to the somatocyst of the nectophore.

Bassia bassensis (Quoy and Gaimard, 1833).

Specimens of both stages were taken in most of the catches made at inside, outside and intermediate stations throughout the year, except for a period of nearly three months between 17th March and 7th June. The numbers estimated to have been taken are about 80 in the polygastric stage, and 350 eudoxids. The material is not in very good condition, and includes only one complete polygastric specimen, which has a small, though unmistakable reserve nectophore bud.

I can see no trace of the almost obsolete ridge marked by a very small pointed prolongation of the distal wall of the hydroecium of the posterior nectophore figured and



TEXT-FIG. 18.—*Bassia bassensis* (Quoy and Gaimard). $\times 8.5$. Dorsal view of posterior nectophore, showing how the posterior end of the right lateral ridge twists up on to the dorsal side, and the left hydroecial fold forms a ventral keel in the centre line.

mentioned by Huxley. It is neither figured nor mentioned by Haeckel. Bigelow (1911b) says that the "right" lateral ridge is entirely suppressed. In my judgment it is not one of the laterals which has been suppressed, but the median dorsal ridge. The after end of the posterior nectophore is twisted round slightly (Text-fig. 21), so that the posterior end of the right lateral is brought near the middle line. On the opposite side the left ventral ridge bounding the hydroecium forms a keel near the middle line. *Bassia* has no caecal prolongation of the somatocyst such as is found in *Abylopsis*, and the whole somatocyst seems to have been secondarily displaced to a forward position. There is in its ventral side a cleft-like compartment, apparently bounded within by a membrane, and running nearly the whole length of the somatocyst. At its distal end is usually found the oil globule. The somatocyst of most Siphonophora is divided longitudinally in a similar way. Some individual variation is observable in the branching of the radial canals.

The normal arrangement appears to be that figured by Bigelow (1911b), pl. 14, fig. 9, where the four canals make a single junction with the pedicular. In some nectophores the laterals join the dorsal midway between the junction of the pedicular and the blind apex of the sac, the right lateral effecting a junction proximally to the left.

Diphyidae. Eschscholtz, 1829.

Galeolarinae, Chun, 1897 + *Muggiinae*, Bigelow, 1911 (pars) + *Diphyinae*, Moser, 1925.

GALETTINAE, Stechow, 1921.

Galeolarinae, Chun, 1897.

TAXONOMY.—There are still a number of questions to be settled before the species of the genus known for so long as *Galeolaria*, and characterized by looped lateral canals in the posterior nectophore, can be clearly delimited. A group of species included with them by Moser and others, *campanella*, *truncata*, *subtilis*, *subtiloides*, *multicristata* and *fowleri*, has been separated off (see p. 364) as a new genus *Lensia*. Its species have simple and not looped lateral canals in the posterior nectophore, and have affinities with the Diphyinae.

Available data lead to the tentative conclusion that there are at least six or seven species. Firstly there is a group of four—*biloba*, *australis* (these may prove to be one and the same), *chuni* and *turgida*—all without basal teeth on the anterior nectophore, some of them, if not all, passing through a young phase in which there are no cross lateral canals, and all possessing an undivided or slightly notched basal flap in the posterior nectophore. There remains a group of three, *monoica*, *quadrivalvis* and *quadridentata*, all with basal teeth in both the anterior and the posterior nectophores, but none of them, as far as known, passing through a young stage which lacks the cross laterals. Whether there are intermediates between *quadrivalvis* and *quadridentata* is uncertain.

NOMENCLATURE.—If this delimitation of species can be definitely established, the two groups may be given definite subgeneric or generic rank, the latter group retaining the old name *Sulculeolaria*, and the former the name *Galette* (= *Galeolaria*).

Genus *Sulculeolaria*, Blainville, 1830.

GENOTYPE.—*Sulculeolaria quadrivalvis*, Blainville, 1834, Lesueur MS.

Synonymy: *Sulculeolaria*, Blainville, 1830, p. 126; Blainville, 1834, p. 138.
Galeolaria (pars), Quoy and Gaimard, 1833, p. 43; Chun, 1897, p. 16; Haeckel, 1888, p. 150; Lens and Van Riemsdijk, 1908, p. 56; Bigelow, 1911b, p. 233; 1918, p. 415; 1919, p. 336; Moser, 1925, p. 135; Browne, 1926, p. 66; Candeias, 1929, p. 270; non *Galeolaria*, Lamarck, 1818, p. 371; Van-höffen, 1906, p. 15.

Epibulia, Chun, 1888, p. 765 (1157).

Galette (pars), Stechow, 1921, p. 261; Bigelow, 1931, pp. 540, 549.

Sulculeolaria is a valid generic name, since its publication by Blainville in 1830 was accompanied by a sufficiently good description. But the three specific names cited by him at that time were not accompanied by indications, definitions or descriptions within the meaning of the rules,* since, according to the first opinion rendered by the International Commission on Zoological Nomenclature, one cannot accept the reference by

* See International Rules of Zoological Nomenclature reprinted in 'Proc. Biol. Soc. Washington,' XXXIX, 1926, p. 81.

Blainville to Lesueur's unpublished figures as an "indication" of the identity of such species. In 1834, however, Blainville's citation of the same three specific names was accompanied by a good figure of the posterior nectophore of the first of them under Lesueur's manuscript name *S. quadrivalvis*.* The species so designated *ipso facto*† became the genotype of the monotypic genus *Sulculeolaria*, Blainville, 1830. Bigelow (1911b) selected *Galeolaria australis*, Q. & G., as the genotype of *Galeolaria*, Blainville, 1830. Blainville's use in 1830 of *G. australis* is not accompanied by an "indication" save a reference to a figure at that time unpublished, so that *G. australis* must be assigned to Quoy and Gaimard, 1833. Quoy and Gaimard's figure shows no somatocyst, so that it cannot be identified with actual specimens of the species that Bigelow (1911b) calls *australis* rather than with those referred by Candeias (1929) to *turgida*, Gegenbauer. We shall assume that *australis*, Q. & G. included all toothless forms, and that the name is applicable to the residual species after the separation off of *turgida*, *chuni* and any other toothless species. *Galeolaria* was preoccupied by Lamarck in 1818 for a worm, and was displaced by *Galletta*, Stechow (1921). If *Galletta australis* (Q. & G.) is considered to be congeneric with *Sulculeolaria quadrivalvis*, Blainville, then *Galletta* becomes a synonym of *Sulculeolaria*, which has page preference over *Galeolaria*; but the toothed forms may be retained conveniently in a separate genus *Sulculeolaria*, genotype *S. quadrivalvis*, Blainville, 1834, and the untoothed forms in a genus *Galletta*, Stechow, 1921 (= *Galeolaria*, Blainville, 1830, non *Galeolaria*, Lamarck, 1818), genotype *G. australis*, Quoy and Gaimard, 1833.

Sulculeolaria quadrivalvis, Blainville, 1834.

MATERIAL.—Parts of twenty specimens coming both from inside the Barrier and the deep water outside, as well as intermediately. Of the 19 hauls in which the species occurred, 10 were made at the weekly station three miles East of Low Islands on 17th August, 11th and 20th September, 2nd October, 11th November, 27th December, and 7th June, and 1 inside Cook's Passage on 28th February; 3 at outside stations, namely outside Trinity opening on 20th October, outside Cook's Passage on 28th February, and outside Papuan Pass on 18th March; and 5 at intermediate stations in Trinity opening on 24th August, 6th September and 19th November.

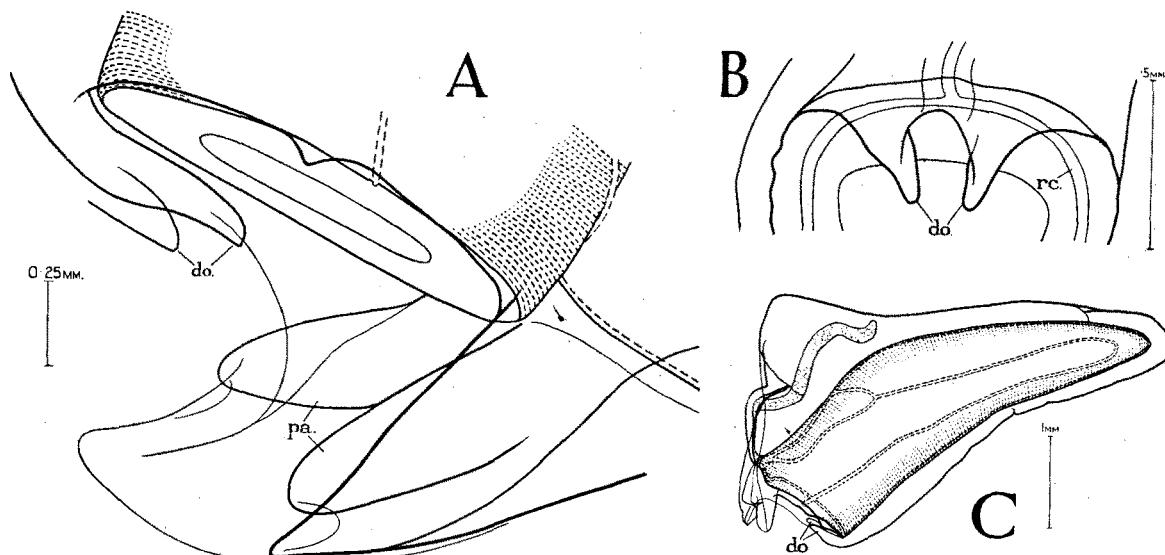
The 15 anterior and 15 posterior nectophores (except one, taken at 8 m. in a closing net at St. 16, three miles East of Low Isles at 11.15 a.m.) were all taken in vertical or oblique hauls of open nets. In ten cases there were associated a single anterior and posterior nectophore, which probably formed the two nectophores of a single specimen.

The criterion for identification of the anterior nectophores has been in each case the presence of the two characteristic "dorsal" teeth (Text-fig. 23, *do*). At present there is nothing known to distinguish the posterior nectophores of *S. quadrivalvis* and *S. quadridentata*, which Bigelow (1918) redescribed. I have examined specimens of the latter taken by the R.R.S. "Discovery" off Cape Verde and at other Atlantic stations, and others taken by myself off Kingstown, St. Vincent, B.W.I.

* Although Blainville's figure might represent the posterior nectophore of either *quadrivalvis* or *quadridentata*, yet the name *quadrivalvis* must be retained for the residual species after *quadridentata* and any others have been separated off.

† See Opinion 46 rendered by the International Commission on Zoological Nomenclature, reprinted in 'Proc. Biol. Soc. Washington,' XXXIX, p. 96.

Four of the fifteen specimens have small lateral teeth comparable with that figured by Bigelow (1931, fig. 197), one has teeth slightly longer and narrower, two have very slight eminences, and the rest have no lateral teeth at all. In one specimen, where lateral teeth were absent, the two dorsals were abnormally short.



TEXT-FIG. 19.—*Sulculeolaria quadrivalvis*, Blainville. A, Base of anterior nectophore, $\times 45$, to show the oval vertical pads, *p a.*, on the inner sides of the two lamellae of the mouth-plate; B, oral view of the nectosac, $\times 45$, to show the two dorsal teeth, *d o.*, and the ring canal, *r c.*, in the velum; C, lateral view of anterior nectophore, $\times 12$, in the position for horizontal progression.

Sulculeolaria monoica (Chun, 1888).

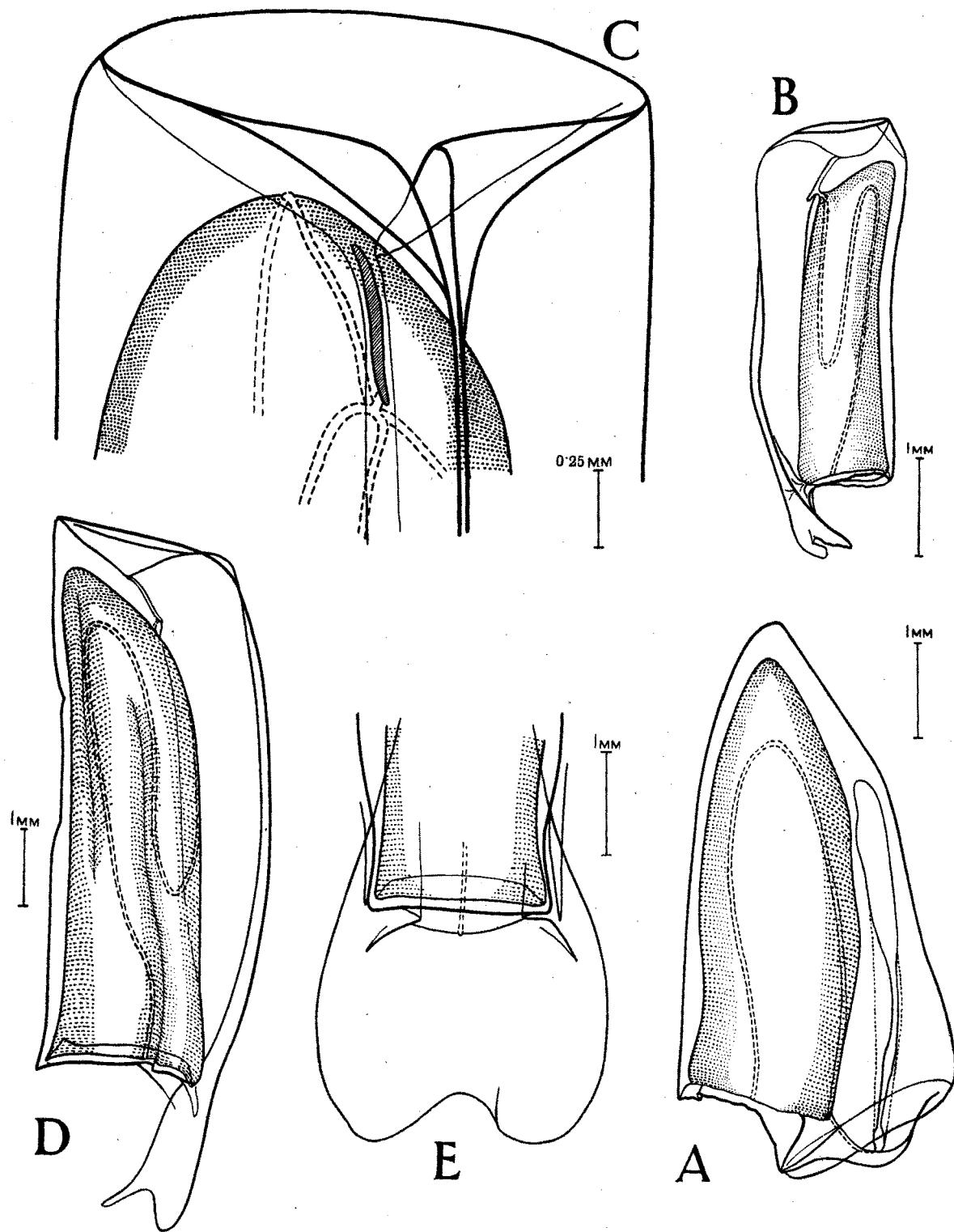
A single, crushed, anterior nectophore 8.5 mm. in length was taken at St. 16 in a closing silk tow-net, at a depth of 3.1 metres on 3rd October.

The characteristic narrow dorso-basal and two narrow latero-basal teeth, two small lateral flaps, two large ventro-basal wings with projections on their inner edges, and small somatocyst are sufficient for assigning the specimen to this species. I have recently seen a similar nectophore from the Atlantic which has very broad latero-basal teeth, and it is probable that two species will have to be recognized.

Galettea chuni (Lens and Van Riemsdijk, 1908).

The chief character by which Lens and Van Riemsdijk (1908) differentiated this species was the absence of lateral commissures between the dorsal and lateral radial canals. Browne (1926) maintained that the chief difference between *G. chuni* and *G. australis* was the longer somatocyst in *chuni*, the younger nectophores of which had at first no lateral commissures, but acquired them in the later stages of development.

I now have to record from the Great Barrier Reef 22 anterior nectophores without marginal teeth in which the lateral commissures are certainly absent. With these anterior nectophores were associated a number of loose posterior nectophores of the *Galettea* type; that is, with folded lateral canals, which appear to be of at least three types, none of them corresponding with those of *quadrivalvis*, *quadridentata*, *monoica* or



TEXT-FIG. 20.—*Galetta chuni* (Lens and Van Riemsdijk). A, Anterior nectophore, $\times 15.5$, showing the small extent of the hydroecial cavity, the short mouth-plate and the long somatocyst, the basal part of which is unnaturally shrunken (a more normal outline is indicated in broken line); B, posterior nectophore with damaged apex, $\times 16$, showing the folded lateral radial canal and notched lamella or ventral wing; C, ventro-lateral view, $\times 50$, of the apex of the posterior nectophore of a specimen taken by the "Terra Nova" Expedition, 1910-13, at $6^{\circ} 10' N.$, $24^{\circ} 5' W.$ (scale = 0.25 mm.); D, lateral view, $\times 12.5$, of the same; E, dorsal view, $\times 17$, of the mouth-plate or ventral wing of the last specimen.

biloba. One specimen has a long rounded lamella which is devoid of an emargination. All of those others which are in reasonably good condition have a notched lamella (Text-fig. 20), one side of which is usually rather longer than the other. In one or two the notch is deeper than in the majority, in which it is shallow. A much larger series of 34 anterior and 35 posterior nectophores brought back from the Atlantic by the "Terra Nova" 1910-13 Expedition enables me to describe the posterior nectophores of *G. chuni* as having a notched lamella. Besides 15 anterior nectophores in which the somatocyst is relatively long (Text-fig. 20b), there are 7 in which it is very short. It soon became apparent that a short somatocyst and absence of cross-lateral canals could be correlated with two other characters, namely, a larger mouth-plate and hydroecial cavity, and a relatively greater distance between the apex of the nectosac and the apex of the nectophore, and a different origin of the lateral canals. I have had to abandon the laborious search for more specimens in the tow-nettings with which to test this difference, but that this second series belongs to a different species is borne out by the existence of a series of seven similar specimens I took off Kingstown, St. Vincent, B.W.I., in February, 1931. If such a correlation can be definitely established, it will mean the existence of a second species, related to *G. chuni* in having no cross-lateral canals in the early stages. Gegenbaur's name *turgida* may be used for it, since there is only a very small somatocyst, which we may suppose Gegenbaur overlooked.

Specimens of a *Galetta* with neither marginal teeth nor lateral commissures have now been recorded of lengths between 1·23 mm. and 12 mm. Browne (1926) held that because some specimens of *Galeolaria biloba* in the length group 5-7 mm. have commissures and others have not, whilst from the 15-20 mm. group specimens without commissures are absent, the specimens without commissures are early growth stages of the larger forms

Measurements of Anterior Nectophores of *Galetta chuni*.

[Unit of measurement = 1 millimetre.]

Station.	Nectophore.		Somatocyst.		Mouth-plate.	Distance between ward end of nectophore and apex of nectosac.
	Length.	Depth.	Length.	Diam.	Length.	
20, c.	1·23	0·26	1·06	0·26	0·15	0·17
50, c.	2·2	1·1	1·14*	..	0·24	0·24
20, c.	2·4	1·2	1·1	0·15	0·15	0·15
50, s. 170 m.	3·8	1·9	2·6	..	0·38	0·23
19, 1 m.-c.	3·9	1·8	2·6	..	0·27	0·26
50, s. 400 m.	4·8	2·4	3·0	..	0·47	0·33
50, s. 170 m.	4·9	2·4	2·66	0·38	0·47	0·38
19, 1 m.-c.	4·9	2·4	2·0	..	0·54	0·18
50, s. 400	5·0	2·7	2·9	..	0·47	0·27
50, s. 170 m.	5·3	2·2	2·66	..	0·66	0·33
20, c.	5·4	2·6	2·4*	0·13	0·47	0·19
26, c.	5·8	2·8	3·9	..	0·66	0·3
50, s. 400 m.	5·9	3·0	3·8	..	0·66	0·33
13, s.	5·9	3·1	4·0	..	0·54	0·27
50, s. 400 m.	6·2	3·0	4·0	..	0·66	0·3

An asterisk (*) denotes that the somatocyst is curved, and was measured along the chord.

with commissures. If this can be definitely confirmed for a single species, it will be a point of some importance. The smallest of the three anterior nectophores without marginal teeth, but with lateral commissures and a long somatocyst (adult *G. chuni*) taken by the Expedition measured 5.5 mm. by 3 mm., and the smaller of the two with lateral commissures and a short somatocyst (adult *G. turgida*) 5.1 mm. by 2 mm. The largest specimens measured respectively 9 mm. by 4.5 mm., and 9.5 mm. by 4.8 mm.

MEASUREMENTS.—Fifteen specimens of *G. chuni* were measured. Their lengths are from 1.23 mm. to 6.2 mm. There is a corresponding range in the length of the somatocyst of from 1.06 mm. to 4 mm. The depth of the anterior nectophore is half of its length, and the length of the mouth-plate about one-tenth.

Galetta turgida (Gegenbaur, 1854).

Six specimens; all except one, which was taken inside on 20th September, from three outside stations in March and October.

Though none are in a good state of preservation, it will be of interest to record the presence of these anterior nectophores characterized by the absence of teeth, very small somatocysts, and lamellæ and hydrocial cavities relatively larger than in *G. chuni*. The critical definition of the species must be deferred until a more abundant material is available.

That such a species is to be distinguished from *G. australis* is made probable by the record of Candeias (1929), and by the capture I made recently of seven young specimens off St. Vincent, B.W.I.

As Bigelow has already suggested (1931), Gegenbaur's name seems to be both applicable and available.

DIPHYINAE, Moser, 1925.

With the exception of *Diphyes arctica* and *D. antarctica*, all the species generally assigned to *Diphyes* and *Diphyopsis* may be classified in three natural groups which can conveniently be given generic rank. When it is remembered that the total number of species of Siphonophora is only about 120, it is not surprising to find that these genera contain only two or three species each. Some difference of opinion has existed in the past on the question of whether the presence of a special swimming-bell in the eudoxid is sufficient warrant for separating certain species as a genus *Diphyopsis*. The three species in question are *D. dispar*, which is the genotype of the monotypic genus *Diphyopsis* (Haeckel, 1888), *D. bojani* (Chun), and *D. chamissonis*, Huxley. In view of the peculiarity of their eudoxids, the possession by the polygastric stages of these three of certain characters which are not found in other Diphyinae fully justifies the recognition of the genus *Diphyopsis*. The anterior nectophores of all three possess well-marked oral teeth, an undivided mouth-plate, and a deep hydroecium. The posterior nectophores of the first two are strikingly similar in every detail and quite unlike those of other species. *D. chamissonis* has evidently lost its posterior nectophore, and for that reason may be regarded as less closely related to *dispar* and *bojani* than each is to the other. It seems, however, hardly worth while to create two separate subgenera. A loss or reduction of the posterior nectophore is found elsewhere, for instance in *Enneagonum*, and is a phenomenon that apparently has taken place independently in more than one group.

Secondly we have a small group of two species closely related to each other, but less so to the rest—*D. spiralis*, Bigelow, 1911, and *D. mitra*, Huxley, 1859. Here again consideration of the sum of the characters of the eudoxid and polygastric stages justifies the separation of the two species as a new genus with genotype *D. mitra*, Huxley. The peculiar lancet-shaped wings of the mouth-plate, the shallow hydroecium with truncated apex and the peculiarly shaped eudoxid bract and elongated gonophores are characters that mark species of this genus.

Thirdly there is a group of two species, *D. appendiculata* and *D. contorta*, which resemble each other more closely than the members of other groups in the shapes of the anterior and posterior nectophores,* the mouth-plate, and the hydroecial cavity of the anterior nectophore. Free eudoxids of *D. contorta* have not been described, and it is open to doubt whether *Eudoxia campanula*, Leuckart, which is ascribed to *D. appendiculata*, or any other known eudoxid, is really the eudoxid of that species.

Left over for consideration are two interesting species—*D. arctica*, of which there was taken a single eudoxid, and *D. antarctica*, with which, though not represented in this collection, I am familiar. It may be regarded as a primitive representative of the first group.

Proceeding now to a discussion of the proper names of the genera of Diphyinae here defined, the first genus is found to contain a species, *D. dispar*, that is at the same time the genotype of Cuvier's *Diphyes*, 1817, and of Haeckel's *Diphyopsis*, 1888. The latter, therefore, must give way to *Diphyes*, Cuvier.

The first available name for the second genus is *Eodoxoides*, Huxley, 1859. This name Huxley used for the bract of the eudoxid of what we now know to be *D. mitra*.

The only available old names for the third genus are *Eodoxia* and *Cucullus*. Both, however, were originally applied to the eudoxids of *D. dispar*, and therefore are synonyms of *Diphyes*, Cuvier. In consequence there is no course open but to give, as I now do, a new name, *Chelophyes*,† to this new genus, which has for its genotype *D. appendiculata*, Eschscholtz.

Diphyes, Cuvier, 1817.

Diphyopsis, Haeckel, 1888.

Diphyes dispar, Chamisso and Eysenhardt, 1821.

Specimens of polygastric and eudoxid stages were taken at both inside and outside stations, as well as intermediately, from early September, 1928, to the end of the following March.

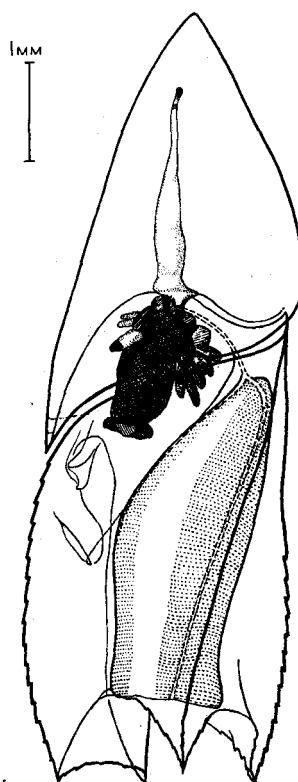
The eudoxid (Text-fig. 21) has hitherto been known as *E. lessoni*, but the only reasons for identifying it with Eschscholtz's *Eodoxia lessonii* are that he figures what may be taken as a long pedicular canal, and a nectosac which is curved in a manner that somewhat recalls that of *D. dispar*. At the same time it is difficult to see why he should have drawn the bract and the mouth of the special swimming-bell of *D. dispar* in the way represented in his figure.

* The posterior nectophore of *E. mitra* bears some resemblance to those of *Chelophyes appendiculata* and *C. contorta*.

† The allusion is to the claw-shaped outline of the hydroecium as seen in a lateral view.

It might be argued that the figure of *E. lessonii* is more like the eudoxid of *Heteropyramis maculata*, especially as Eschscholtz says that the bract is "an dem freien Ende spitz." However, the "Schwimmhölenstück" is too long and the nectosac too wide for *H. maculata*, although the mouth of the figured specimen of *E. lessonii* is characteristic. Again, should the inferior canal of the somatocyst in Eschscholtz's figure be really a bracteal canal and not the canal in the peduncle of a special swimming bell or gonophore, the identification with *D. arctica* would have to be considered, although it seems very unlikely.

The identification with Quoy and Gaimard's *Diphyes cucullus* seems to have very little foundation. Huxley's (1859) *Eudoxia lessonii* is certainly *D. dispar*, although he



TEXT-FIG. 21.—*Diphyes dispar*, Chamisso and Eysenhardt. $\times 13$. Lateral view of the eudoxid.

could not distinguish between it and Leuckart's *E. campanula*, which has no special swimming bell, and a rounded mouth-plate to the gonophore, besides being much smaller.

Eschscholtz's *Ersaea gaimardi* may possibly be this species. The shape of the special swimming-bell and its mouth resemble *D. dispar*. Huxley regarded *E. quoyi*, Eschscholtz, in addition to *E. gaimardi* as a synonym of his *E. lessonii*, but the figures of the special swimming-bell of that ersaeid make this very improbable.

Huxley's figure of *Eudoxia lessonii*, which is the earliest recognizable one of the eudoxid of *D. dispar*, omits details of the apex of the special swimming-bell and radial canals, although he mentions that these branch off a little below the apex of the nectosac. In the figures of Fewkes (1881) and of Agassiz and Mayer (1902, fig. 41) the canals are represented as meeting at the apex. In their fig. 40 the canals do not meet at the apex. The apex of the nectosac and the arrangement of the canals are sound criteria, and

are not subject to much variation. Haeckel's (1888) figure is poor, and Lens and Van Riemsdijk's (1908) not good.

The most satisfactory figure of the eudoxid is that of Mayer (1900, fig. 96), although it does not show mature gonophores.

Now I will give a detailed description of the bract, special swimming-bell and gonophore.

The "sutural" surface of the bract of the eudoxid makes an acute angle with the dorsal side. The oral end of the sutural surface extends slightly beyond the level of the apex of the bracteal cavity. There are two teeth on the margin of the bract of the eudoxid, one lying just over the left ventral ridge of the swimming-bell, and the other just over the hydroecium, and projecting further in the oral direction. I took one eudoxid of this species off St. Vincent, B.W.I., in which the hydroecial fold and tooth were on the right side instead of on the left, which is the normal condition. The subumbrella of the special swimming-bell, which is closely coupled to the bract, does not extend very far into the saddle-shaped aboral part of the bell. The apex of the nectosac does not quite reach the level of the junction of the radial canals. The distance from its blind end to the canal-junction is relatively short. The terminal oral end of the nectosac is cylindrical and relatively long, the hydroecium not extending much below its middle region. The dorsal teeth are relatively long and wide apart. The pedicular canal is very long and the hydroecium is correspondingly deep. On the right side of the dorsal end of the "saddle" is a projection or tooth, rather similar to that found in the hydroecium. The special swimming-bell (text-fig. 31) figured by Moser (1925, p. 191) is so unlike any that I have studied, and indeed so unlike that drawn in her sketch (pl. viii, fig. 2) of the whole eudoxid, that I think it may have been included by mistake in her description of the species.

The gonophore shown in her text-fig. 32 is distinctly recognizable, but does not clearly indicate the run of the ridges. What is described and figured as "ein kleiner spitzer Ausläufer" appears to be a short transverse ridge, sometimes only visible in its middle region as a small projection, that runs across the dorsal surface rather above the level of the apex of the nectosac from the upper part of the right* dorsal ridge to the upper part of the left ventral, and limits the oral end of the peduncle, which is very much flattened dorso-ventrally. The left dorsal ridge is incomplete above and does not reach this transverse ridge. The four radial canals lie under the ridges, and the oral ends of the two ventrals curve in towards one another. The dorsal teeth are broad and lie close to one another. Moser's gonophore is considerably more twisted than any I have seen. The apophysis or peduncle is very much flattened obliquely on the left side, where it is pressed against the bract as described by Moser. The left ventral ridge which forms one side of the hydroecium extends up on to the projecting ventral edge of the flattened peduncle, and curves round to the right to meet the apex of the peduncle. The right ventral ridge on the other side of the hydroecium is twisted above towards the dorsal side, and curves round to the apex of the peduncle, so that the upper part of the hydroecium is wide, shallow and twisted. The left and right ventral ridges meet above, and then join the left dorsal ridge on the ventral edge of the flattened apophysis. Younger gonophores fit into the hydroecial cavity of the older ones. All the gonophores borne by any individual eudoxid appear to be of one sex.

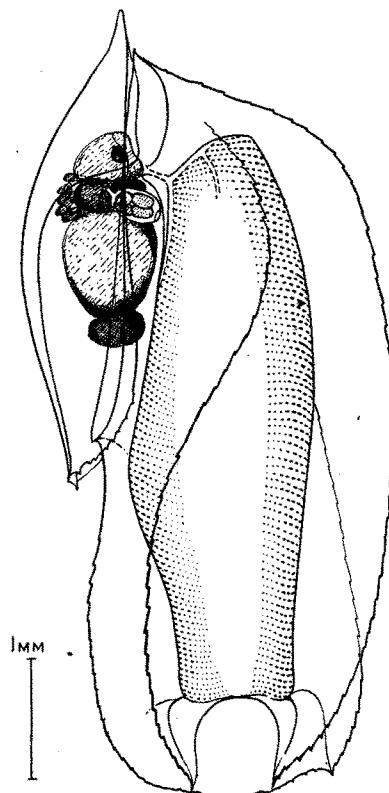
* The gonophores are of two kinds, the mirror-images of one another, so that the terms "left" and "right" may have to be reversed.

Diphyes bojani (Eschscholtz, 1825).

Polygastric and eudoxid stages were taken at inside and outside stations, as well as intermediately from the latter part of August to the middle of March.

The variations in the shape of the nectophores of the polygastric stage have been dealt with by Bigelow (1911b); and their study led him to a settlement of the synonymy.

The eudoxid (Text-fig. 22) appears at first sight very unlike other Diphyid eudoxids because of the shield-like bract. A further comparison shows that it is essentially similar, except that the semi-annular phyllocyst of the young bract never develops a secondary upstanding portion. The bract remains thin, the "sutural" surface being roughly



TEXT-FIG. 22.—*Diphyes bojani* (Eschscholtz). $\times 16$. Lateral view of the eudoxid, to show the thin, shield-shaped bract.

parallel with the dorsal side as in the developmental stages of the eudoxids of *D. dispar* and *D. chamissonis*. Only a very shallow bracteal cavity is developed. The "saddle" of the special swimming-bell* or surface that articulates with the sutural surface is nearly vertical, instead of horizontal as it is in *D. dispar*. The ends of the phyllocyst grow out horizontally into horns, neither of which appears to be strictly homologous with the upstanding somatocyst of *D. dispar*. The bract is, in fact, one of the most primitive.

The mature gonophore has a cylindrical peduncle which is set on at an angle towards its right ventral side. No ridges are visible, but there are small vestiges of dorsal teeth, and a small elliptical mouth-plate can generally be seen. There are four straight radial canals, and the manubrium, which carries six or seven eggs in the female, nearly fills

* Bigelow (1911b) agrees with Lens and van Riemsdijk in denying the presence of a special nectophore.

the umbrella cavity. The right dorsal and left ventral ridges of the special swimming-bell lie in a plane which cuts the flattened bract at right angles, while the other two ridges lie in a plane parallel with that of the bract. The radial canals do not meet in a point, as noted by Chun (1892) and Moser (1925); the junction of the dorsal canals is at some little distance from the origin of the right ventral canal, and this again is slightly separated from the origin of the left ventral, the upper part of which is curved parallel to the margin of the hydroecium. The nectocalyx is asymmetrical, having an enlargement in the middle of the left side.

Eschscholtz's (1825) fig. 15, pl. 5, and (1829) fig. i, pl. 12, undoubtedly represent a specimen of this species, and serve as a useful criterion as to the accuracy of his figures, for the bract is drawn much too small, the spiral twist of the swimming-bell is not indicated, and the large undivided mouth-plate is shown divided. With the aid of binocular microscopes to-day, it is of course possible to examine and draw such complex structures more easily.

Huxley (1859) gave a good figure of the phyllocyst, feeding polyp and male gonophore *in situ*, but his fig. 7 of the complete eudoxid gives an erroneous idea of it. The bract is shown as being set on to the bell at a curious angle, the large right dorsal ridge, which would be visible in the position shown, is not indicated, and the undivided mouth-plate, which would be visible "en face," is shown as divided.

Chun (1892) gave some lithographed figures of the whole eudoxid and of details, but whilst the artistic technique is admirable, the details are mostly inaccurate. In the figures of the whole eudoxid on his plate viii, the asymmetrical shape of the nectosac is not shown. In his fig. 4 the mouth of the swimming-bell is shown as not twisted far enough round relatively to the bract, although his fig. 5 shows the normal condition.

If Mayer's (1900) fig. 118 represents this eudoxid the bract is badly drawn, and what appears to be a male gonophore is labelled female. I have never seen male and female gonophores present in one and the same eudoxid. The drawing of the apex of the nectosac and the origin of the canals does not represent the usual condition. The apex of the sac extends up to the level of the phyllocyst and beyond the junction of the pedicular canal. His fig. 100 of *Diphyopsis hispaniana* will not convince anyone who is familiar with the eudoxid of *D. bojani*, but it probably represents this species; and the same criticisms apply to this figure that I have just made upon Chun's figure of *Ersaea picta*. The mouth-plate is drawn as divided—almost certainly in error. Bigelow (1911b) has given good figures. The homology of the bract with those of other eudoxids would have been made more clear by indicating the extent of the bracteal cavity. When the eudoxid is viewed so that the bract is seen in profile, as in his fig. 7, the twist of the bell is such as to bring the centre of the dorsal edge of the mouth more nearly in line with the centre of the mouth-plate. The drawing of the apex of the sac and the run of the canals does not show the normal state of affairs. The concavity of the nectosac in the region of the hydroecium is not indicated. When the eudoxid is viewed from the dorsal side of the bract, as in his fig. 8, the left edge of the mouth-plate would hardly cover the right dorsal tooth, and the diverticulum of the left side of the nectosac would be visible. The bract is often proportionately wider than the one figured by Bigelow.

Retia mirabilia are to be found at the velar ends of all four subumbrial canals of the anterior nectophore, as in the related species *D. dispar* and *D. chamissonis*. The whole length of the ventral canal forms such a "Gefässplatte."

Diphyes chamissonis, Huxley, 1859.

With the exception of *Lensia subtiloides* this was the most abundant species inside the Barrier, and was taken both in the eudoxid and polygastric stages throughout the year. It occurred at three of the six outside stations in very small numbers, and was present at all the seven intermediate stations in some quantities, but never in such great abundance as that in which it appeared at the inside stations, three miles East of Low Isles.

This species, perhaps one of the lesser known Diphyids, was found originally in numbers during the voyage of H.M.S. "Rattlesnake" in the ship channel within the Barrier and in the Louisiade Archipelago (Huxley, 1859). Subsequent records are: Seychelles (Moser, 1925); Islands between Seychelles, Mauritius and Chagos (Browne, 1926); Maldives (Browne, 1904); Okhamandel Coast, W. India (Browne, 1926); Sumatra (Moser, 1925); Islands of Malay Archipelago (Lens and v. Riemsdijk, 1908); New Guinea (Moser, 1925; Lens and v. Riemsdijk, 1908); Sulu Archipelago (Lens and v. Riemsdijk, 1908); Phillipine Islands (Bigelow, 1919), and Japan (Moser, 1925). An additional record not hitherto published is off Noumea, New Caledonia, where numerous specimens of polygastric and eudoxid stages were taken on 8th and 9th August, 1895, at the surface in daylight, in water of a temperature of 71° F., by H.M.S. "Katoomba," Capt. J. E. Merryon, R.N. Four hundred and sixty eudoxids were taken in one of the surface hauls at 5 p.m.

Lens and Van Riemsdijk (1908) stated that in many specimens of their *D. weberi*, which is a synonym, they found a well-developed bud for the future inferior nectophore. Moser (1925) recorded that she could see no sign of either bud or posterior nectophore in the "Gauss" or "Siboga" material of this species. However, Browne (1926) said of this bud in his "Sealark" specimens, "I am able to confirm its presence." In the absence of further description or figure it was hoped that it might be possible to confirm this statement, but none of Browne's specimens showing the bud can now be found.

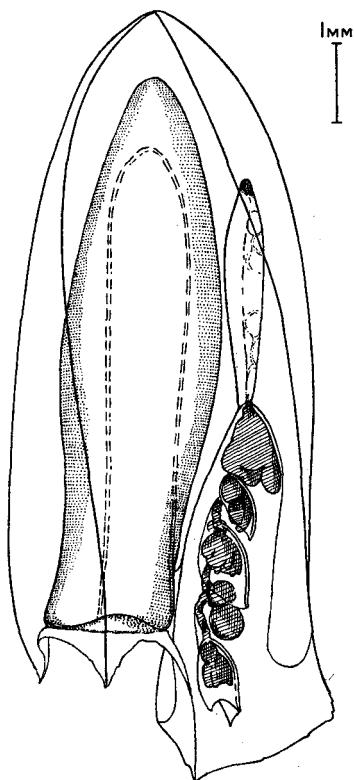
Through the kindness of Dr. L. F. de Beaufort and Dr. H. Engel, of the Zoölogisch Museum, Amsterdam, I was permitted recently to re-examine 91 of the Siboga specimens, namely 29 from St. 109, 33 from St. 117a, and 29 from St. 165. In none of them could I see any sign of a bud for an inferior nectophore. Moreover, there is no sign whatever in any of the innumerable Barrier Reef specimens that I have examined either of a posterior nectophore or of a bud.

A point of interest that does not appear to have been recorded about this species is that in it, as well as in the related *D. dispar* and *D. bojani*, is to be found a *rete mirabile* or "Gefässplatte" at the velar end of each of the four subumbrial canals. That of the ventral canal extends the whole way from the circular canal to the peduncular canal, and the laterals are given off from its forward side. The others are smaller.

Although there are no specimens in this collection of the most primitive member of the genus, *D. antarctica*, it may be useful to point out in this place that in that species the "Gefässplatte" is found in its least specialized form. Other primitive features of that isolated species are the still divided mouth-plate, and the fact that the unspecialized swimming-bell of the eudoxid still functions as a gonophore.

The polygastric stage of *D. chamissonis* (Text-fig. 29) has been figured by Huxley (1859), Browne (1904), Lens and Van Riemsdijk (1908), and Moser (1925), who also figured the eudoxids. In addition Bigelow (1913, 1919) and Browne (1926) have added to our knowledge of the species.

Moser's figure represents a young specimen 2 mm. in length, viewed from the left side. It illustrates the curved dorsal ridge or keel at that stage. In mature specimens the keel is straighter at the after end, as in Browne's figure. The ventral wall of the nectosac in Moser's specimen appears to have collapsed. Browne has figured this wall accurately. At the after end is the horizontal "Gefässplatte." In front of the point where the peduncular canal joins this, the wall swells out abruptly to form a gentle curve towards the apex. Huxley, Moser, and Lens and Van Riemsdijk have figured the twisted left lateral ridge. That on the other side, figured by Browne, is straight. None of the figures except Lens and Van Riemsdijk's show the twisted ventral facet, the forepart of



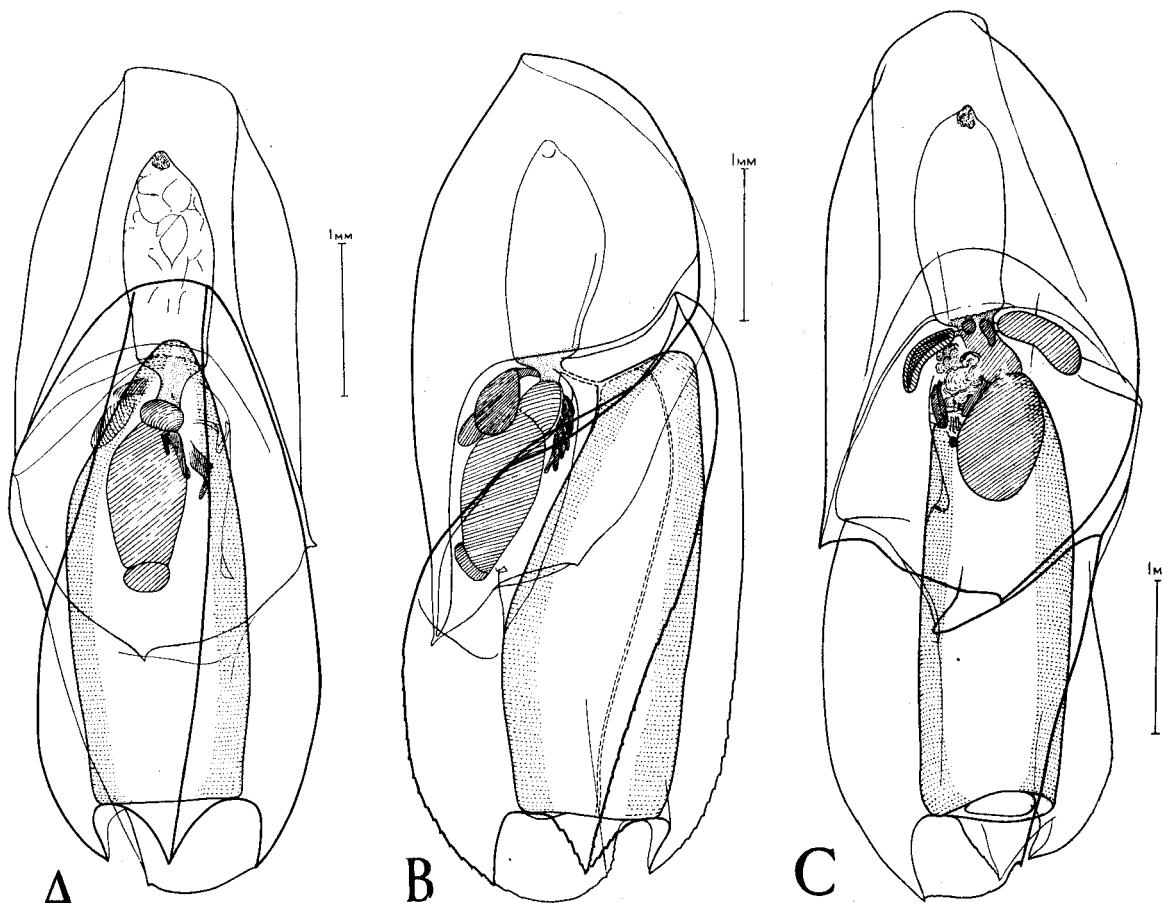
TEXT-FIG. 23.—*Diphyes chamissonis*, Huxley. $\times 10\cdot5$. Lateral view of the solitary (anterior) nectophore, to show the asymmetrical twist of the ventral facet.

which can be seen from the left side. Lens and Van Riemsdijk indicate this, but in their figure the after part of the facet does not return to the horizontal as it should. The after end of the right ventral ridge in their figure should be hidden by the end of the left ventral ridge. In Browne's figure the oral teeth and mouth-plate are abnormally short. The mouth-plate, which is seen in optical section in a side view, is five-sixths the diameter of the nectosac at its oral end. Browne's figured specimen is narrower than the majority that I have examined. The dorsal side of the somatocyst and hydroecium are in line, as shown by Browne, but the ventral sides meet at an angle as shown by Huxley, Lens and Van Riemsdijk and Moser.

The eudoxid (Text-fig. 24) was recorded for the first time, very briefly described, and rather inadequately figured by Moser (1925), and more fully described by Browne in the following year.

The two *Diphyes* eudoxids with normal bracts and special swimming-bells, *D. dispar* and *D. chamissonis*, can at once be distinguished by details of bract and bell, and by the way in which the two articulate.

Browne (1926) has commented on the difference in the shapes of the sutural surfaces. The plane of articulation between bract and bell in *D. dispar* is at right angles to the axial line, in *D. chamissonis* at 45°. In *D. bojani* it is almost parallel with it. When the bract of *D. chamissonis* is viewed from the right or left side it will be seen that the lengths of head-piece and neck-shield are about equal. In *D. dispar* the head-piece is



TEXT-FIG. 24.—*Diphyes chamissonis*, Huxley. × 20. A, Ventral; B, lateral; C, dorsal view of bract. The appendages are shown semi-diagrammatically.

50% larger. In *D. chamissonis* the dorsal wall of the head-piece is more convex. Owing to the forward extension of the articulating areas of bract and bell, the after-part of the sutural surface is more cut away and rounded off, so that this side, too, is convex. The apex of the head-piece is therefore much less pointed than in *D. dispar*, in which the dorsal and sutural surfaces are nearly straight, and meet at an acute angle.

In *D. chamissonis* the apical wall of the nectosac of the eudoxid bell is longer than in *D. dispar* and inclined at an angle to the axis, whereas in *D. dispar* it is very short and at right angles to the axis. The pedicular canal in *D. chamissonis* is very short in comparison with *D. dispar*, being shorter than the apical wall. The ventral teeth of

the special swimming-bell are connected by a convex plate which projects beyond them. The hydroecial cavity of the bract in *D. chamissonis* is shallow, and the tooth on the hydroecial "Leiste" is relatively smaller.

The sexes of eudoxids are separate, six or seven simple sac-like gonophores being produced. The females contain from six to eight eggs. A gonocalyx does not appear to form round the manubrium of the gonophore, as pointed out by Browne.

The reasons for assigning this eudoxid to *D. chamissonis* are the association between the eudoxid and the polygastric stage of that species, noted by Moser (1925) and Browne (1926), in the absence of other possibly related species, the similar association of stages from New Caledonia recorded above, and the special abundance of both stages at all times of the year near Low Isles, when other species were less abundant or absent.

Only four Diphyid larvae have been picked out from the various hauls. They measure from 0·7 mm. to 0·8 mm. in length, and from 0·4 mm. to 0·5 mm. in diameter, but are as yet without the rudiment of the future anterior nectophore. Three of them came from the weekly station three miles East of Low Islands in oblique hauls of the fine tow-net from 32 metres to the surface in January, at a time when no other diphyids but *D. chamissonis* were taken, so that they probably belong to this species. One other larva was taken in a closing net at 8 m. from the surface at the weekly station in October, at a time when other diphyids were also taken, so that it cannot definitely be assigned to this species. The larvae are conical in shape, the cylindrical broad-topped nectosac occupying about half its length. There is a very shallow hydroecial groove bounded below by a small rounded mouth-plate. Viewed from the aboral end the larva appears to be pentagonal in outline. The somatocyst is small, oblique and rudimentary, and a single siphon and tentacle are present. The course of the radial canals cannot be seen, but the pedicular canal joins them on one side instead of at the apex.

Chelophyes, gen. nov.

GENOTYPE.—*Diphyes appendiculata*, Eschscholtz, 1829.

GENERIC DIAGNOSIS.—Baso-dorsal and lateral teeth absent from both nectophores. Posterior nectophore retained, its basal lamella with two strong teeth.

Chelophyes appendiculata (Eschscholtz, 1829).

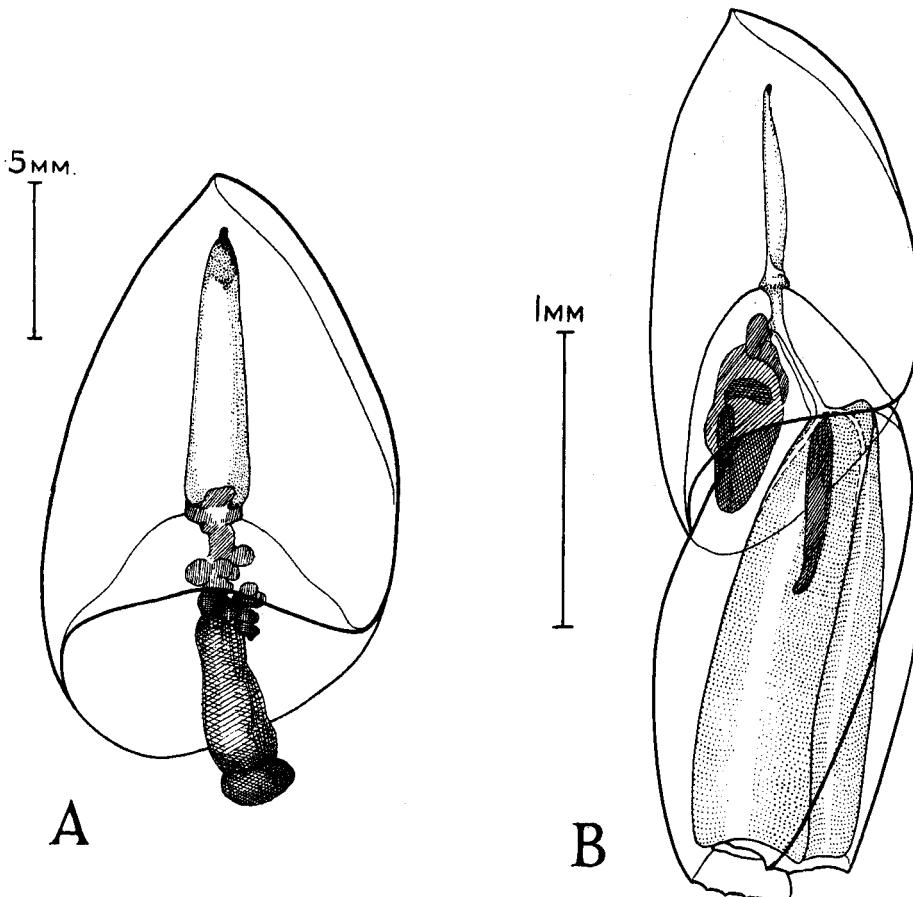
About 150 specimens were taken at both inside, outside and intermediate stations. The species was taken regularly in August, September, October and November, being perhaps most plentiful in September, when 62 of the specimens were taken in five hauls at three stations. It was found again outside on 18th March, and at the weekly station on 7th June. At St. 16 its vertical distribution was as follows :

Depth.		Number of specimens.
3·1 m.	.	9
8·0 m.	.	9
11·1 m.	.	1
12·5 m.	.	1
16·5 m.	.	2

It still seems to be doubtful which, if any, eudoxid is budded off by this species. In the 1-metre coarse silk tow-net haul at St. 19 were taken 4 complete specimens, 33 loose bracts, and 60 loose gonophores of a small eudoxid (Text-figs. 33–36), with neither special swimming-bell nor mouth-teeth, but with a rounded mouth-plate to its gonophores, and a pronounced bracteal cavity. They agree pretty well with Moser's descriptions and figure of *E. campanula* (1925, pl. xii), said to belong to *D. appendiculata*, but which, on account of its size and characters, appears to be more like a *Lensia* eudoxid. It will be convenient to deal with the specimens at this point. I give them the name *Eodoxia russelli*.

“*Eodoxia russelli*,” sp. nov. = *C. appendiculata*

The bract (Text-fig. 25) resembles that figured by Leuckart (1853) on pl. iii, fig. 18, for his *E. campanula*. There is a deep bracteal cavity, the ventral wall meeting the sutural



TEXT-FIG. 25.—*Eodoxia russelli*, sp. n. A, Lateral view of bract, $\times 41$; B, lateral view, $\times 39$, of a complete eudoxid, showing the deep bracteal cavity.

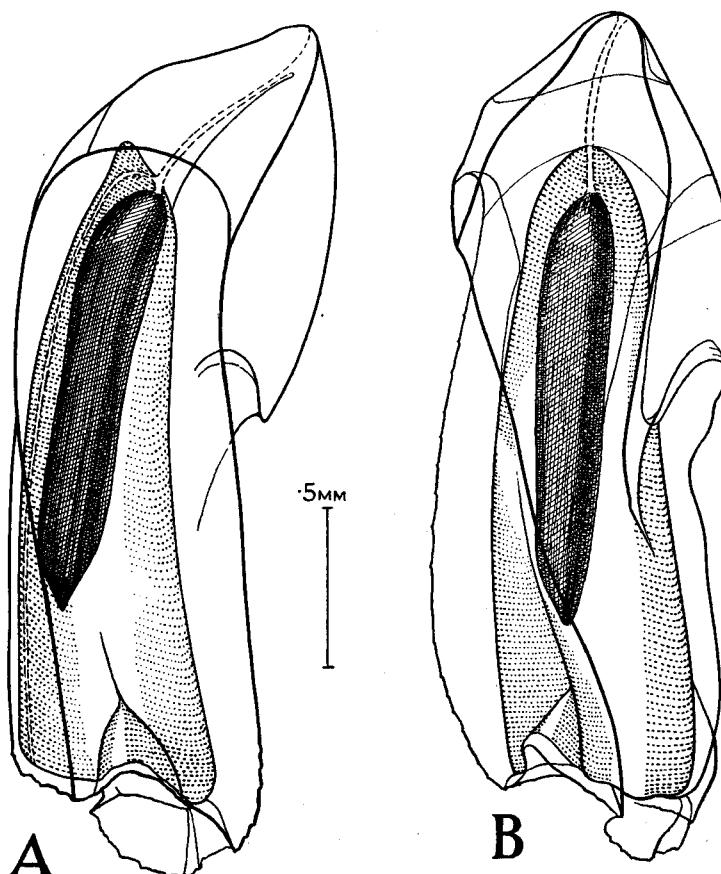
surface at an angle of 75° . The somatocyst in the better preserved specimens is cylindrical, with a tapered apex, and often an enlargement in the middle. It reaches nearly to the apex of the sutural surface.

The margin of the neck-shield of the bract is evenly rounded, and teeth cannot with certainty be distinguished.

The sutural surface ends posteriorly in a ridge, so that there is no articulation between it and the gonophore, the peduncle of which is completely within the bracteal cavity.

The second gonophore of each eudoxid, the sexes being separate as usual, is the mirror-image of the first.

There is in the middle of the right hydroecial wall (left wall of mirror-image) of the first gonophore an oblique basally projecting spur ridge (Text-fig. 26), dividing the basal from the proximal part of the twisted hydroecium. It sometimes forms a hook. The basal part of the hydroecial wall on that side is not produced into a high ridge, as are the other parts of the walls.



TEXT-FIG. 26.—*Eudoxia russelli*, sp. n. × 42. A, Lateral view; B, ventral view.

The two inconspicuous dorsal ridges, which end in small teeth, are connected at the level of the apex of the nectosac by an arched ridge. The left ventral and left dorsal (right dorsal in mirror-image) of the first gonophore are connected at the same level by a similar ridge. The ventral ridges are connected below by a rounded mouth-plate.

The gonophore's four radial canals lie under the ridges, the two dorsal ones curving over on either side of the pointed apical blind end of the nectosac.

The point in which these eudoxids differ from Leuckart's (1853) *Eudoxia campanula* is in the shape of the gonophore, which he described and figured (fig. 19) in some detail. The mouth-plate of his gonophore was not rounded, but toothed, and the dorsal wall of the nectosac is not S-shaped as figured and described by him.

The eudoxid figured by Moser (1925) on p. 245 has a shallow bracteal cavity, and the gonophore, which is probably deformed, appears to have no apical blind end. It seems to differ both from Leuckart's *E. campanula* and from *E. russelli*. Neither her description nor figure appear to be sufficiently critical for identification.

Moser cites as a synonym for the eudoxid stage of *D. appendiculata* the *Eudoxia messanensis* of Gegenbaur (1854). *E. messanensis* is described as having six longitudinal ridges on the gonophore, there being two lateral ridges which extend for half its length. The two dorsal ridges are described as terminating in teeth, but the two ventral as uniting in a projecting keel-like flap, presumably, and so illustrated, without obvious teeth. In these respects *E. messanensis* differs from *E. campanula*, Leuckart. The free eudoxid figured by Schneider (1896), pl. 45, fig. 30, under the name *D. appendiculata* has a gonophore whose longitudinal ridges do not end in teeth, and the details of which are not very convincingly drawn, so that it would be difficult to recognize it.

Chelophys contorta (Lens and Van Riemsdijk, 1908).

This species occurred sparingly (specimens estimated at 50 in all) at outside and intermediate stations only, except for a comparatively large catch (estimated at 20) from the inside station 13, where specimens appeared earliest in the year. No intermediate or outside station appears to have been made in January, and no specimens are recorded for that month.

A specimen of this species was first recorded by Bedot (1896), who assigned it to *D. gracilis*, Gegenbaur, 1853. He figured a complete specimen from Amboina and a detached posterior nectophore. Some eudoxids which were associated with the polygastric stages he referred to Gegenbaur's *Eudoxia messanensis* without further description, except to state that they did not differ from the *Eudoxia campanula* of Leuckart. Moser, too, recorded the posterior nectophores of this species, having had for examination a complete specimen from the North coast of New Guinea, and many loose posterior nectophores from various localities. Bigelow (1919), recorded three specimens with buds of inferior nectophores.

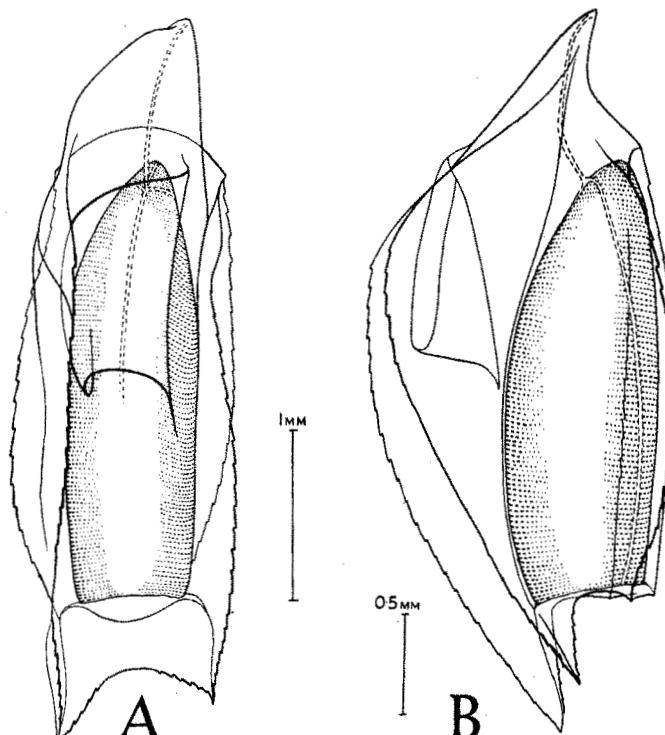
One specimen in the Barrier Reef Collection, 5.23 mm. in length, has within the hydroecium a young posterior nectophore measuring 0.85 mm. in length, and at least four other specimens have younger buds. From St. 26, at which these specimens with buds were taken come three loose posterior nectophores, and from St. 19 come four others, the largest of which measures 3.52 mm. × 1.52 mm.

Moser (1925) has already compared the posterior nectophore with that of *D. appendiculata*. In addition to the differences pointed out by her there are others which should be noted. In *D. contorta* the ventral ridges are relatively less deep near the mouth, but wider in the middle region, giving the ventral side a bowed appearance in lateral view. The peduncle is relatively shorter than in *appendiculata*, and the nectosac ends in a pointed blind end. The apical wall is oblique and runs into the dorsal wall without the marked angle that is usually seen in *appendiculata*, but this is not a constant character in that species. Moser's statement that Bedot's figure makes the length of the ventral teeth too much alike is confirmed by my observation that the right-hand tooth is the shorter in these specimens. The arrangement of the canals is similar to that found in *appendiculata*,

the dorsal and ventral median and two laterals being given off by the pedicular at a little distance from the apex.

The only eudoxids so far recorded as attributable to this species are those found at Amboina, and referred by Bedot (1896) to Gegenbaur's *E. messanensis*. The present material has provided no evidence on this point.

Lens and Van Riemsdijk's original description is worded badly, but Bigelow (1919) seems to have made a slip in alleging that they stated that there were five ridges at the apex.* They described and figured three in their fig. 49. Bigelow himself (1911b, pl. 8, fig. 3) figured correctly only three ridges meeting at the apex, and evidently made a second



TEXT-FIG. 27.—*Chelophysa contorta* (Lens and Van Riemsdijk). $\times 25$. A, Ventral view of posterior nectophore to show the right hydrocial fold; B, lateral view of the same nectophore.

slip in stating (1919) that there were four. The left ventral and dorsal ridges do not reach the apex in the Great Barrier Reef specimens.

Eudoxoides, Huxley, 1859.

GENOTYPE.—*Diphyes mitra*, Huxley, 1859.

Eudoxoides mitra (Huxley, 1859).

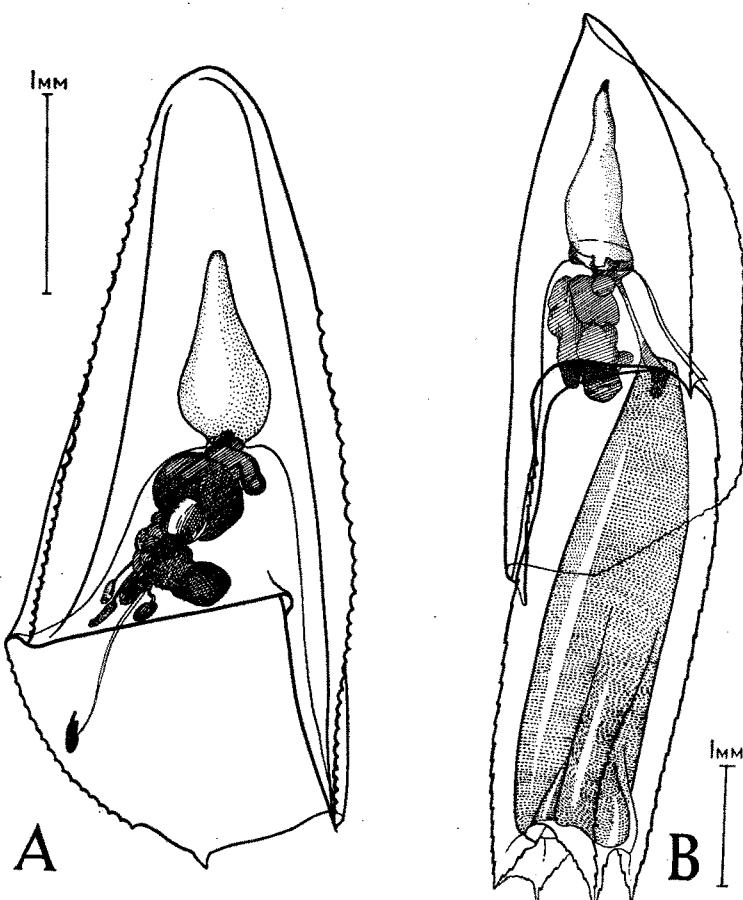
Syn.: *Eudoxoides sagittata*, Huxley, 1859.

Sixteen specimens of the polygastric and fifteen of the eudoxid stage were taken. Outside stations were made only in October, November, February and March. The

* Bigelow (1911b) alleged that the authors of the species stated that there were four ridges at the apex.

species occurred at all except the February one, and also at an intermediate one in Trinity Opening on 19th November. But it was taken only four times at the weekly station, three miles E. of Low Isles, on 11th and 20th September, 3rd October, and 27th December.

The bract of the eudoxid was well figured from two view-points by Huxley (1859). Bracts of mature eudoxids are often broader in proportion to length than shown by him. The edge of the posterior embayment is not generally so strongly toothed, and the posterior right marginal tooth does not extend so far behind as is shown in his upper view, fig. 1. The left sutural ridge curves off broadly at the hinder end of the bracteal cavity to meet



TEXT-FIG. 28.—*Eudoxoides mitra* (Huxley). A, Ventral view of the bract of the eudoxid, $\times 26$; B, lateral view of a complete eudoxid, $\times 16$.

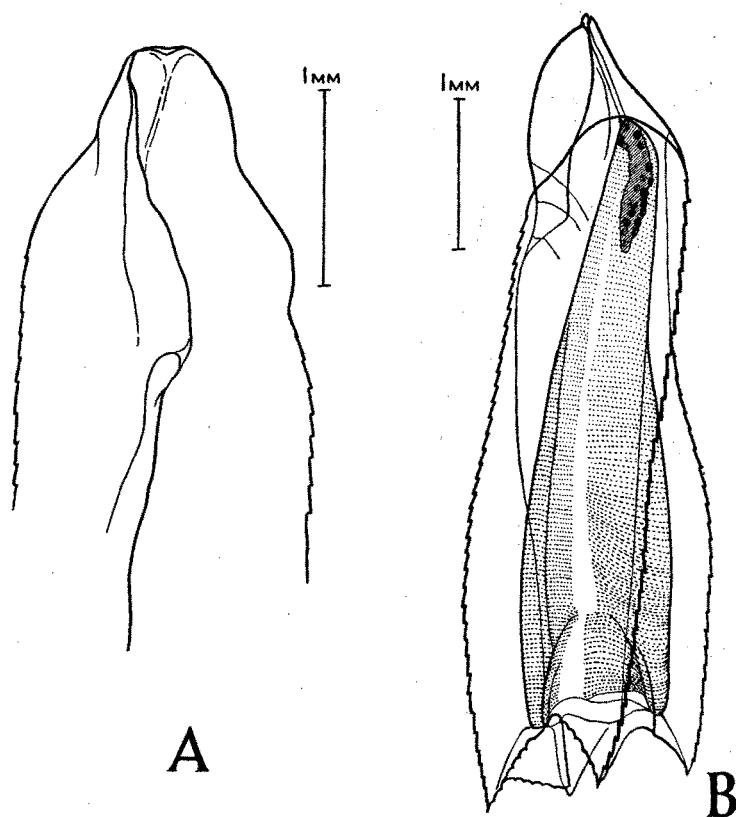
the posterior embayment, and does not form the angle shown in his lower figure. Huxley did not indicate the serration of the posterior parts of the sutural ridges of the bract in his lower view, and emphasized it too much in his upper view.

Lens and Van Riemsdijk's figure of the eudoxid (1908, pl. vii, fig. 62) is good. They have drawn a specimen whose bract has an abnormally recurved tip and an abnormally squat somatocyst, but they indicate the correct amount of twist in the gonophore.

Bigelow's (1911b) fig. 9 of plate 11 is a good representation of this eudoxid, but the bract as drawn is unnaturally twisted round relatively to the gonophore. When the gonophore is viewed from that direction the sutural surface of the bract is seen edge on.

The bract usually extends further down the gonophore than is shown. Moser's fig. 11 of the whole eudoxid is good. In her fig. 7 the contour of the posterior part of the bract is not good.

The nectosac of the gonophore (Text-fig. 29B) is quadrangular, and the radial canals lie on the corners under the ridges. At the level of the apex of the nectosac there are low rounded ridges connecting the right dorsal and right ventral ridges, and right and left dorsal ridges. These connecting ridges mark the contact with the bract, that on the dorsal side lying at the oral margin of the sutural surface. The area proximal to these connecting



TEXT-FIG. 29.—*Eudoxoides mitra* (Huxley). A, Ventro-lateral view of the apex of a gonophore, $\times 26$, to show left hydroecial fold; B, view of right side of a female gonophore of a eudoxid, $\times 20$.

ridges is the apophysis or peduncle. It is convexly rounded on the dorsal side, where it fits into the bracteal cavity and slopes off from the connecting ridges to its apex. On its ventral side (Text-fig. 29A) it is concave in section, and is continuous with the proximal parts of the two ventral expanded ridges that form the hydroecium.

Eudoxoides spiralis (Bigelow, 1911b).

MATERIAL.—Specimens of the polygastric stage appeared sparingly between 17th August and 18th March, 1928, at both deep water stations and inside the Barrier, as well as intermediately as follows :

Station number.	Depth from which an open net was fished to surface.
6	32 m.
8	45 m.
10, 12, 14, 15, 18	32 m.
19	180 m.
20	250 m.
26	57 m.
28	580 m.
34	32 m.
49	46 m.
50	400 m.

The total number taken at these stations was estimated at 168. It is quite possible that *E. spiralis* was taken at other stations, but that it has been overlooked. Very few eudoxoids were noticed in these catches.

At St. 16, where a closing net was fished at six depths between 10.13 a.m. and 12.27 p.m., specimens of *E. spiralis* occurred in the catches as follows :

	Surface.	3·1 m.	8 m.	11·1 m.	12·5 m.	16·5 m.
Polygastric stage	.	0 .	6 .	10 .	0 .	0 .
Eudoxid stage	.	1 .	2 .	5 .	2 .	0 .

In the catches from the eighteen hauls of closing nets fished at Sts. 62, 65 and 68 on 15th June, 10th and 18th July, 1929, respectively, a single specimen of the polygastric stage was found. It came from a depth of 50 m. at about midday. There is evidence, then, that the polygastric stage extends in daylight from 3 to 50 m. from the surface, and the eudoxid from the surface down to 17 metres ; but there is no evidence that these are the limits of its vertical distribution in daylight in the Barrier Reef region ; indeed, five specimens were taken in the Bottom Stramin Plankton net which was fished on the bottom at 205 m. at St. 29 on 24th November, but they may have been taken anywhere between the bottom and the surface.

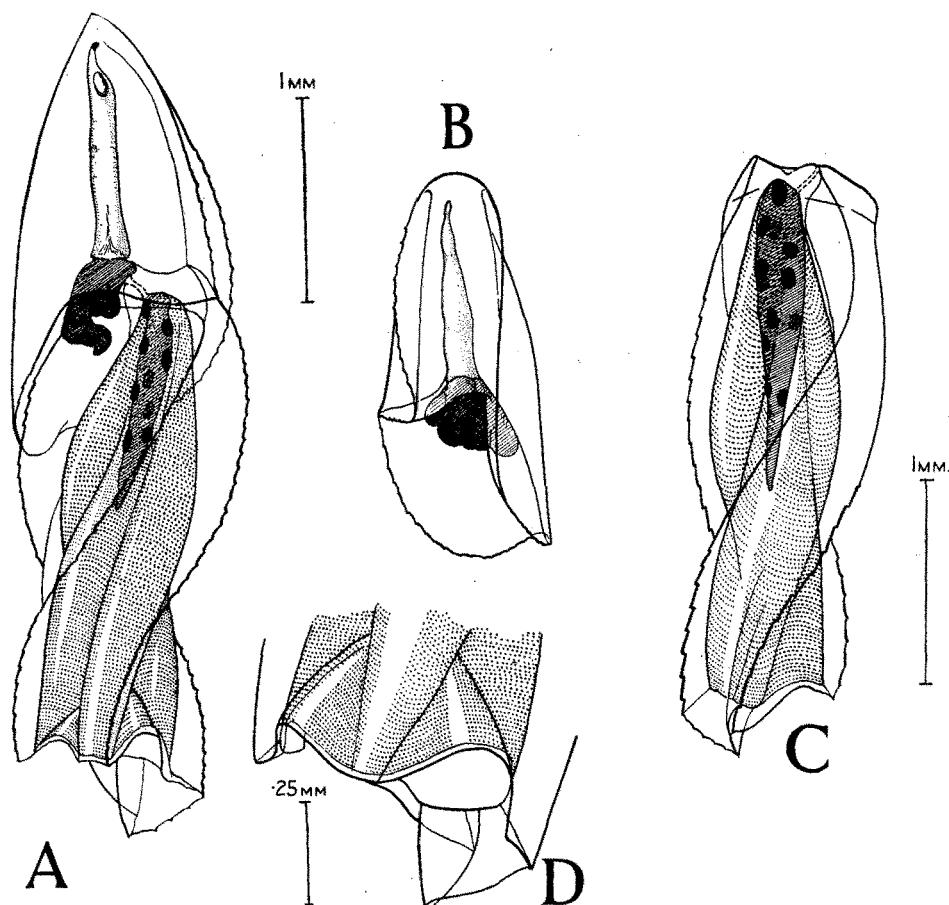
Browne (1926) records the capture of this species in the Indian Ocean by self-closing nets as follows :

457–914 m.	.	.	.	1 eudoxid.
At 914 m.	.	.	.	1 anterior nectophore.

He did not state whether or not the hauls were made in daylight.

The eudoxid (Text-fig. 30A) has been figured by Moser (1925), who so far has given us the only account of it. Her fig. 8, pl. 1, will be found to show the mirror-image of the bract figured immediately above it in fig. 9. In no species have I observed such enantiomorphism of the bract. The bracts of eudoxoids appear to be always of one kind. As this question is not mentioned in the text, the drawing of fig. 8 may be an artist's error. The gonophores, presumably first and second respectively, are mirror images of one another as in *Diphyes dispar* and *E. mitra*. The details of Moser's fig. 9 do not correspond very closely with those of the present specimens, although the eudoxids of this species

are peculiar enough to be instantly recognizable. The dorsal and left sides of the neck-shield (Text-fig. 30B) are at right angles to one another, with a rounded instead of a pointed embayment between them. The dorsal half projects as a rule further aft than that of the left side, and the right-hand side is more cut away posteriorly than in the one figured by Moser. The whole neck-shield is rather larger in proportion than she has represented it to be.



TEXT-FIG. 30.—*Eudoxoides spiralis* (Bigelow). A, Lateral view of a complete eudoxid, $\times 27$, to show the twisted gonophore; B, ventral view of a bract of a eudoxid, $\times 27$, to show the absence of large teeth on the edge of the neck-shield; C, lateral view of a detached female gonophore, $\times 27$, to show the very short pedicel; D, enlarged view of the base of the gonophore shown in A, $\times 54$.

The gonophores (Text-fig. 30C) are spirally twisted rather more than one quarter of a turn to the left or right, according to the order of appearance, presumably. The pedicular canal is very short, and there is no apparent peduncle, the two walls of the hydroecium arching inwards towards the apex of the nectosac, and over to meet each other. Between this point and the dorsal side, where the two dorsal ridges are connected by a flat asymmetrical arched ridge, there is a slightly depressed "saddle-area" which articulates with the bract. On the right side* of the first gonophore a low arched ridge connects

* The terms "right" and "left" are interchangeable according to whether the gonophore referred to is the first or second.

the tops of the dorsal and ventral ridges. The right dorsal and right ventral corners of the upper truncated surface of the gonophore are sloped off to the respective longitudinal ridges. On the left side there is a very slightly marked ridge separating the saddle-area from the concave left side of the gonophore. The ventral longitudinal ridges which form the hydroecial walls broaden gradually in the promixal third of their length. The right-hand one is interrupted as a rule at a third of its length from the truncated apex by the vestige of an obliquely descending projection, which in other species forms a hydroecial tooth. At this level is often observed a line or crease running across the outside of the left hydroecial wall of the gonophore. The distal extremities of the ventral ridges are connected by a semicircular mouth-plate.

Live polygastric specimens examined by me in March, 1931, in the Bay of Algeciras were found to be relatively very rapid "darters" that took an open spiral course. In their habits they are strongly contrasted with specimens of such slowly moving species as *A. tetragona*.

Dimophyes, Moser, 1925.

GENOTYPE.—*Diphyes arctica*, Chun, 1897.

Moser's generic name may be used conveniently for Chun's species, whose systematic position was left out of the discussion on p. 345.

Dimophyes arctica (Chun, 1897).

One eudoxid, 3·6 mm. in length, of this species was taken at St. 28, outside Trinity Opening on 23rd November, in a vertical haul from 580 m.

The eudoxid of this species is easily recognized by its long neck-shield containing a descending branch of the phyllocyst, which also gives off an apical branch. There are no marked ridges or mouth teeth, but a very inconspicuous shallow rounded mouth-plate is present.

This species has a very much wider distribution than was supposed some years ago. It occurs in both the Arctic and Antarctic, being particularly common in the subantarctic; throughout the Atlantic; in the Indian Ocean (Port Natal, Moser); between Providence and Alphonse Is. (Browne, 1926); in Sagami Bay, Japan (Moser); and in the Northern Pacific (Bigelow, 1913). The present record from the Barrier Reef therefore helps to fill in a large gap.

Genus *Lensia*,* gen. nov.

GENOTYPE.—*Diphyes subtiloides*, Lens and van Riemsdjik, 1908, p. 46, pl. vii, figs. 59–61.

Small diphyid Calycophorae, with pentagonal anterior and smaller fragile posterior nectophores. The anterior nectophore has a very shallow hydroecium, a short and divided mouth-plate and no dorsal or lateral teeth. Its radial canals have no commissures, and its somatocyst is short or of medium length.

* Not to be confused with *Lenzia*, Kieffer, 'Ann. Soc. Sci. Bruxelles,' XLI, p. 360, 1922. My colleague, Dr. F. W. Edwards, tells me that *Lenzia*, Kieffer, is sunk in the synonymy of *Phaenopsectra*, Kieffer, 1921 (*Chironomidae*).

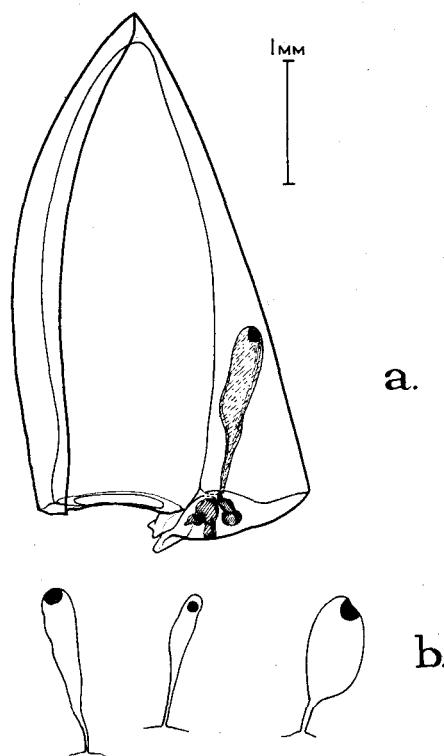
The posterior nectophore is truncated anteriorly, has a rounded mouth-plate and no teeth. The lateral radial canals are not looped.

The eudoxid has no special swimming-bell. Its bract has a broad rounded posterior edge without teeth, and its gonophores are truncated anteriorly, with small dorsal teeth, and with narrow rounded mouth-plate.

Very numerous specimens that correspond closely with Lens and Van Riemsdijk's *Diphyes subtiloides* occur in most of the catches inside the Barrier Reef. Some of them have a mature fragile posterior nectophore. It appears to be desirable to associate in a separate genus this *Diphyes subtiloides* of Lens and Van Riemsdijk with three other small Diphyids—*Diphyes subtilis*, Chun, 1886, *D. fowleri*, Bigelow, 1911, and *D. truncata*, Sars. With them may be included some so-called *Galeolaria* species—*G. campanella*, Moser, and *G. multicristata*, Moser. This authority had included *D. subtiloides*, Lens and Van Riemsdijk, and *D. fowleri*, Bigelow, in the synonymy of *G. truncata*. I have examined thousands of specimens of *D. subtiloides*, numerous specimens of *G. truncata* from Hjeltefjord, near Bergen, as well as the type and seven paratypes of *D. fowleri* in the Museum, and ten more kindly lent by Dr. Bigelow. There is nothing approaching transition from one of these species to another, and I recognize the three species as distinct.

Lensia subtiloides (Lens and Van Riemsdijk, 1908).

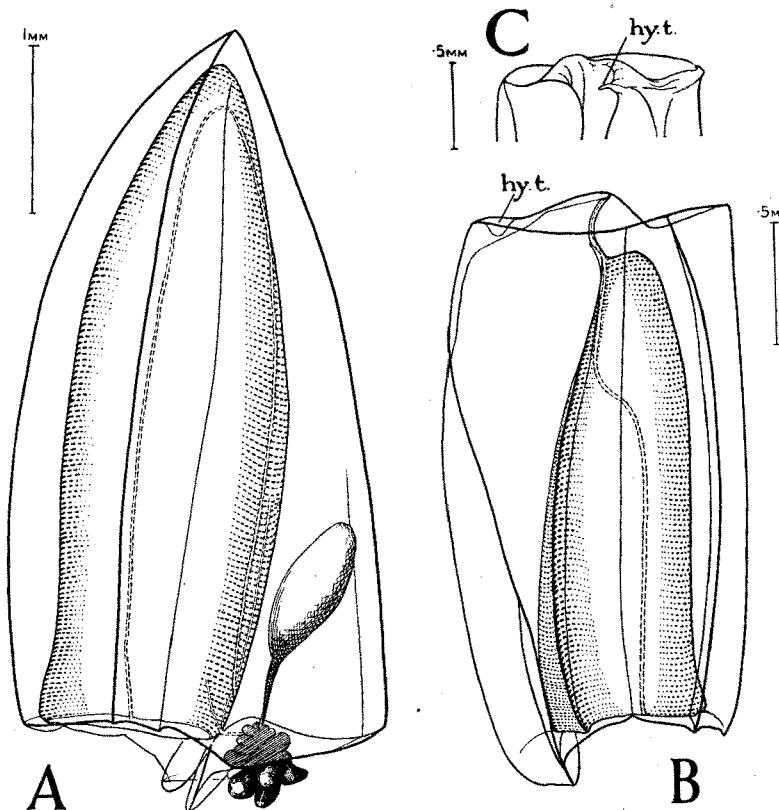
OCCURRENCE.—This was perhaps the most abundant species, nearly 1300 specimens of the polygastric stage having been taken at St. 16 alone, where its vertical distribution



TEXT-FIG. 31.—*Lensia subtiloides* (Lens and Van Riemsdijk). $\times 16$. *a*, Anterior nectophore; *b*, three separate somatocysts, to illustrate the range in variation of that organ.

was studied. Here the bulk of the specimens were at a depth of 8 metres in the day-time, many more being taken between that depth and 12·5 metres. The time of its greatest abundance seems to have been from the beginning of December to the middle of February. It was absent from two intermediate stations at the end of February; also from the weekly station on nine occasions between April and July, and on seven occasions in August and September.

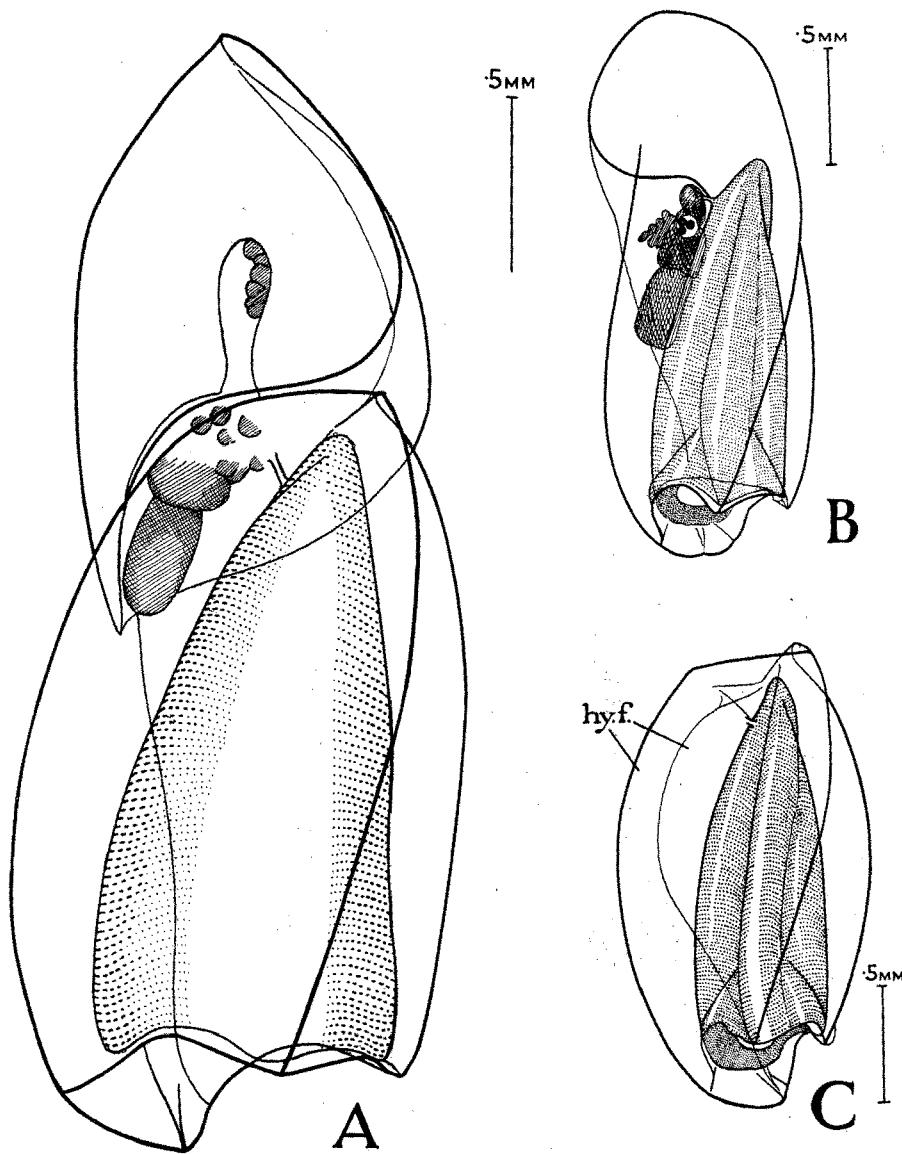
DESCRIPTION.—The resemblance between the very numerous specimens and Lens and Van Riemsdijk's description and fig. 59 is so close as to make it certain that we are dealing with their species. The larger anterior nectophores are from 4·5 mm. to 5 mm. long



TEXT-FIG. 32.—*Lensia subtiloides* (Lens and Van Riemsdijk): A, Anterior nectophore, $\times 22$; B, posterior nectophore, $\times 32$, to show the course of the lateral radial canal, and the tooth *hy. t.*, at the apex of the right hydroecial fold; C, ventral view of the apex of the posterior nectophores, $\times 23$, to show the tooth of the right hydroecial fold.

and 2 mm. deep. The smallest anterior nectophore is 0·62 mm. in length and 0·37 mm. in depth. The specimens vary very little in the shape of the somatocyst (Text-fig. 31). This differs slightly from that figured by Lens and Van Riemsdijk. The summit of the very shallow hydroecium of the anterior nectophore is level with the mouth of the nectophore. The distance between the base of the somatocyst and the mouth-plate is about half that between it and the ventral wall. The peduncle of the somatocyst which arises from this point may be distinguished as a fine canal for a distance of between one-fourth and one-half the length of the somatocyst before gradually passing into it. The anterior end of the somatocyst is rounded, and lies near the ventral wall, the axis of the somatocyst being inclined towards that side from its base, which with its peduncle lies nearer the

nectosac. The somatocyst of average specimens varies in length from 0·54 mm. to 0·66 mm., and in diameter from 0·23 mm. to 0·28 mm. The course of the subumbrial canals was not observed by lens and Van Riemsdijk. In a Barrier Reef specimen measuring 3·41 mm. in length the lateral canals run up, without any cross connection



TEXT-FIG. 33.—*Lensia subtiloides* (Lens and Van Riemsdijk). A, Lateral view of a complete eudoxid, $\times 55$; B, right lateral view of a detached gonophore with enlarged apex, $\times 31$; C, similar view of a normal, detached gonophore, to show the hydroecial folds, *hy.f.*

with the ventral canal, to within a distance of 0·20 mm. of the anterior end of the nectosac, and of 0·37 mm. of the apex of the nectophore, before bending back on a parallel course to meet the ring canal.

DIFFERENTIATION.—The anterior nectophore (Text-fig. 32A) is similar in general outline to that of *L. truncata* (Sars), but differs from it in the following ways: The two lobes of the mouth-plate are almost equal in size, whilst in *truncata* the right is the larger. And instead of being flush with the posterior end of the nectophore, as they are in *truncata*,

they project posteriorly. The anterior wall of the hydroecium extends forward to the level of the opening of the nectocalyx, which is not the case in *truncata*. Also the somatocyst is relatively shorter and has a longer, though not sharply differentiated pedicel than that of *truncata*, whilst the dorso-basal tooth is relatively smaller. The posterior nectophore (Text-fig. 32B) does not exhibit the diverticulum in the nectocalyx anterior to the entry of the pedicular canal that is characteristic of *truncata*.

The eudoxids (Text-fig. 33A) are similar to those of *truncata*. Mature gonophores are rarely found attached to the bract. In the numerous preserved eudoxids of *truncata* that I have examined only young buds of gonophores were present, although detached mature ones were abundant in the tow-nettings. The bracts of *truncata* eudoxids, like those of *subtiloides*, have no projections on the posterior margin, such as are found in species of *Diphyes*. The two species are very closely related, but quite distinct from one another.

In *Lensia subtilis* (Chun) the fine peduncle is much longer in proportion, and the somatocyst globular.

Lensia subtilis (Chun, 1886).

One complete specimen, twelve anterior and two posterior nectophores in all were taken from three stations outside Trinity Opening, 19, 20 and 28, on 20th October, 19th and 23rd November respectively.

The condition of the material is not such as to enable me to add much to our knowledge of this species. Although the presence of the globular stalked somatocyst is a distinctive character which marks out typical specimens of this species from those of any other that we know at present, the amount of variation in length of this stalk is not known.* There are eight other poor specimens with shorter stalked somatocysts which probably belong to the species, but until this question of variation has been determined in a large series of specimens, it is useless to make a definite assignation of such material.

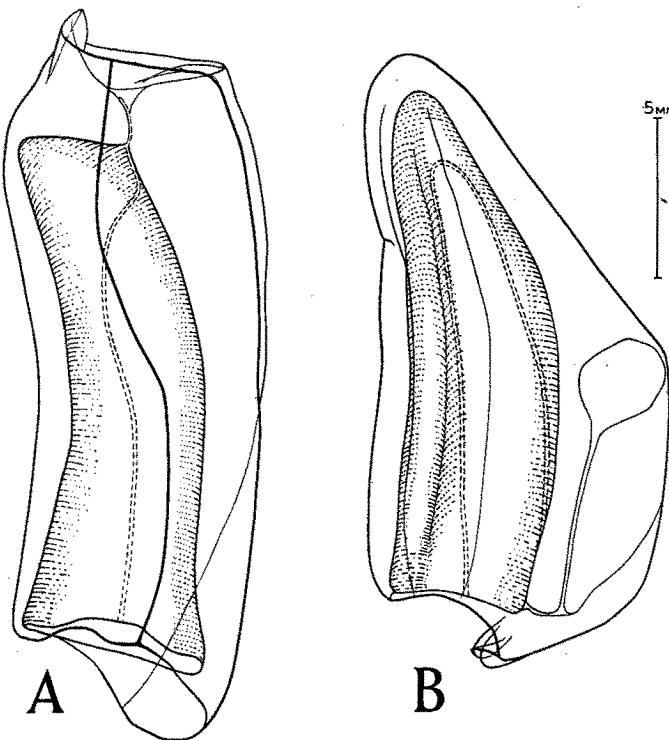
The species has been recorded from the Mediterranean (common); the Atlantic, from the Bay of Biscay (52° – 66° F.) to latitude 35° S.; the Indian Ocean, Madagascar, Rodriguez, Chagos; and off New Guinea (N.E.).

Chun (1886) described but unfortunately did not figure the eudoxids which he raised from the polygastric stage of this species. He said that without doubt they were identical with Will's *Eodoxia elongata*. The fig. xxx, given by Will (1844) is not very easy to interpret, but it appears to show a gonophore without any bract, although Will labelled part of it the "Athemhöhle" or phyllocyst. Chun's judgment, however, cannot be lightly disregarded, since he had active living eudoxids before him; but it is difficult properly to interpret Will's figure, and not possible to substitute his name *elongata* for Chun's, since it was preoccupied by Hyndmann (1841). It should be borne in mind that *subtilis* is a very common Mediterranean species, and that it is very likely that Will did have its eudoxid before him as well as those of the other two species he figured, namely *Muggiae kochii* and *Sphaeronectes kollikeri*. The gonophores should be easily recognizable by the peculiar canal system described by Chun, but his account does not appear to have received any subsequent confirmation. The eudoxids found by Moser at Villefranche and Monaco and assigned to this species had normal canal systems. There would appear, therefore, to be some doubt as to what the eudoxids of this species are really like.

A characteristic feature is the way in which the furrowed basal facet, or hydroecium,

* Lens and Van Riemsdijk (1908) took specimens at Naples every day during January and February, 1906. They reported that in all these specimens the somatocyst had "a long thread stalk."

of the anterior nectophore slopes away anteriorly into the ventral facet (Text-fig. 34A). In the posterior nectophore at its anterior end is a projection of the dorsal wall that evidently fits closely into the anterior nectophore at this point. The two nectophores are drawn by Moser in her text-fig. 29 as being very loosely coupled, and with the dorsal side of the posterior and anterior nectophores on one and the same side of the longitudinal axis. I suggest that these are post-mortem phenomena.



TEXT-FIG. 34.—*Lensia subtilis* (Chun). $\times 42$. A, Left lateral view of a posterior nectophore, to show the course of the lateral radial canal; B, left lateral view of an anterior nectophore, to show the hydroecium.

Another feature of this species is the shape of the blind end of the nectosac in the posterior nectophore. There is a considerable anterior wall, which makes nearly a right angle with the dorsal wall.

Lensia campanella (Moser, 1925).

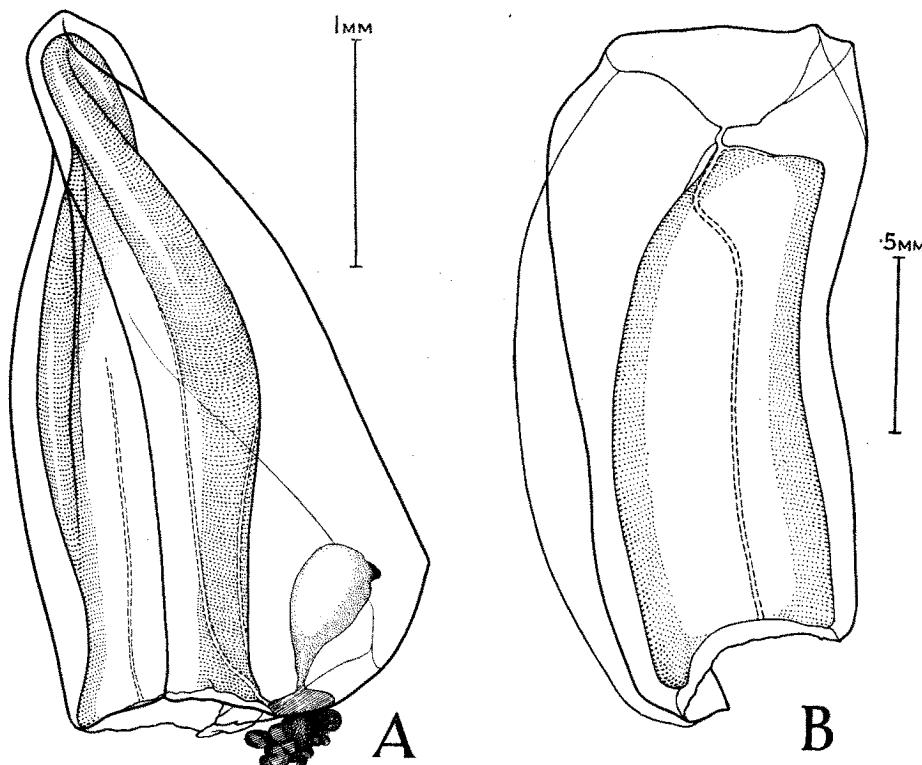
One anterior nectophore was taken with the coarse silk net, and three more with a single posterior nectophore in the stramin net at outside St. 19 on 20th October; one anterior nectophore at intermediate St. 49 on 17th March; and one anterior nectophore at St. 50 outside Papuan Pass on 18th March, all being taken in vertical hauls of open nets.

This is a very small species, of which only seven anterior and a single posterior nectophore have been described hitherto. It is said to be cosmopolitan. Previous records are: Tortugas; W. of Colombo, Ceylon; and German New Guinea.

The largest anterior nectophore in the collection measures 3.33 mm. in length, and the smallest 1.85 mm.

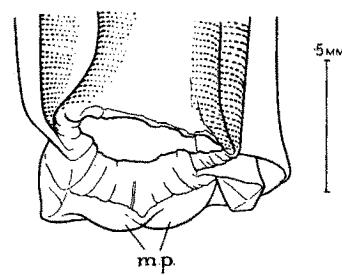
Both anterior and posterior nectophores (Text-fig. 35) are of the same general build

as those of *L. subtiloides* and *L. subtilis*. The mouth-plate is very small indeed and divided (Text-fig. 36), and the longitudinal ridges are scarcely visible. The tip of the nectophore is twisted through nearly half of a complete turn. The small size, the twisting, the well-



TEXT-FIG. 35.—*Lensia campanella* (Moser). A, Left lateral view of an anterior nectophore, $\times 30$, to show the asymmetrical twist; B, right lateral view of a posterior nectophore, $\times 46$, to show the course of the lateral radial canal.

preserved musculature, the shape of the somatocyst and the oblique sloping off of the ventro-basal facet all point to identity with Moser's species, and yet the longitudinal ridges do not run as shown in her figure. But basing my judgment on my experience of



TEXT-FIG. 36.—*Lensia campanella* (Moser). $\times 35$. Ventral view of the base of an anterior nectophore, to show the small size of the mouth-plate, m.p.

the extent to which Moser's figures correspond with actual specimens, I feel confident that these specimens belong to this species. On account of its great size there appears to be some element of doubt as to whether the large specimen, 11 mm. in length recorded by Moser from W. of Colombo, really belongs to the same species. Unfortunately this is the

specimen selected for Moser's figure, pl. iv, fig. 1. I regard the specimens from German New Guinea as the typical forms, and select the larger one taken in 1910 as the holotype. Moser figures a well-marked right lateral ridge in the anterior nectophore. In the Australian specimens it is the right and left ventral ridges and the ventral facet that take part in the twist, the right lateral ridge being practically suppressed. Viewed from the oral end the nectosac appears to be lobed. There is a large ventral lobe, a left lateral and a dorsal. The latter is not in the median line, but balances the left lateral. Towards the apex it can be distinguished as a double lobe, the dorsal predominating in size over the right lateral. In short, viewed from the right side no lateral ridge such as drawn by Moser can be seen, and in this respect the Australian specimens differ from the Colombo one figured by Moser. Viewed from the ventral side the somatocyst is seen to be displaced towards the left ventral ridge. All the ridges are very low, and can only be seen in an oral or apical view. The somatocyst has a very short pedicel, is relatively large and globular or ovoid in shape, and lies obliquely, closely applied to the basal wall of the nectophore.

Whilst collecting in the West Indies in H.M.S. "Rodney" in 1931, I took two specimens of this little-known species off Kingstown, St. Vincent, at the surface at night in February.

Lensia fowleri (Bigelow, 1911).

A single anterior nectophore, 4·8 mm. in length, was taken at St. 28, outside Trinity opening, on 23rd November. The state of preservation is not good, but the specimen was compared directly with types kindly supplied by Dr. Bigelow, and also with *L. truncata* from Norwegian waters.

The somatocyst occupies the position characteristic for *fowleri*, but is shrunken, as it often is in that species. In two respects it agrees very closely with the types and differs from *truncata*. The apex of the nectosac reaches very nearly to the apex of the nectophore; and the dorsal longitudinal ridge is comparatively shallow, and does not project beyond the opening of the nectosac. These two points may escape attention unless specimens of the two species are closely examined side by side. The differences, however, are clear cut, and furnish two more useful characters for the separation of these two species. The lateral ridges at their oral ends slope back in a characteristic way towards the mouth-plate, and the lateral radial canals lie almost directly under the ridges. All of the ridges are rather obtuse-angled.

In *Lensia fowleri* (Bigelow) the somatocyst is nearly globular, and extends down to the posterior end of the nectophore on the ventral side of the hydroecium. Its summit extends well above the level of the mouth of the nectophore, which reaches a much larger size than in *Lensia truncata* and *L. subtiloides*. The figures of the somatocyst and hydroecium of *L. fowleri* given by Bigelow (1911b) do not very closely represent the conditions found in the Museum's seven syntypes, and in ten more from the Museum of Comparative Zoology, Cambridge, Mass., kindly loaned by Dr. Bigelow. The hydroecium is confined to a very small space on the dorsal side of the somatocyst. In all cases the somatocyst had partly collapsed, but there was sufficient indication of the space that it originally occupied.

Lensia, spp. indet.

From St. 20, outside Trinity opening, come seven small specimens of a species of *Lensia* from 3 mm. to 4·8 mm. in length. The five longitudinal ridges are distinct.

The somatocyst, which is short, unstalked and oblique, is 0·6 mm. in length in the longest specimen. The dorsal ridge is not so deep as in *G. truncata* from Norwegian waters, and it does not project so far beyond the velar level. Three of the specimens are fairly well preserved, but it is not possible to say definitely whether the lateral ridges reach the level of the velum owing to longitudinal folding of the nectophore walls. The basal plane is oblique to the longitudinal axis owing to the shortness of the ventral wall. The mouth-plate is short, and divided with rounded inner angles. The two lateral canals come off separately at varying levels from the base of the ventral canal. The canal system is normal.

Probably these specimens will prove, later on, to belong to a new species, but since it is not possible to give a sufficiently critical description of it owing to the condition of the specimens, it is not proposed at this time to establish the new species, but to wait until more material becomes available.

Two specimens of what will probably prove later on to be another new species come from St. 50, outside Papuan Pass. Some description of them may be given, although it is not intended thereby to establish the species. The lateral ridges do not reach the velar level, and the dorsal ridge is very shallow. The inner angles of the two flaps of the mouth-plate are but very slightly rounded, and project down further than the outer angles. The somatocyst is about half the length of the nectophore. The hydroecium, which is entirely below the level of the velum, is more extensive than in *G. truncata* from Norwegian waters, and is continued as a very shallow depression on to the lower part of the ventral facet. Thus there is no sharp ventro-basal ridge as in *G. truncata*.

The two specimens, neither of which is in a good state of preservation, measure about 10·5 mm. in length. They closely resemble the specimen figured by Bigelow (1911b), plate 12, fig. 2, and called ? *Muggiae kochii*, but later (1913) referred to as *Diphyes truncata*, Sars. Sars's species, however, judging by specimens kindly provided by the Bergens Museum Biological Station, is quite distinct.

One eudoxid, 1·8 mm. in length, with a rounded bract and short cylindrical upright phyllocyst, together with fourteen gonophores measuring from 1·2 mm. to 3·9 mm. in length, were taken at St. 20, outside Trinity opening on 20th October. They are of the *Lensia* type, and the gonophores correspond with one figured by Moser (1925), pl. iv, fig. 11, as *Eudoxia galathea*. As suggested by her on p. 267, the type of loose gonophore figured can hardly be held to belong to the same species as the complete eudoxids bearing that name, for they have a conspicuous rounded mouth-plate and a very narrow apex. This narrowed blind end of the nectosac projects between the two dorsal canals, and is a constant feature of the Barrier Reef specimens. The gonophores are longitudinally folded, but the mouths of the nectosacs flare wide open. The male manubrium may have a length of nearly as much as one-half of that of the whole, but the female is considerably shorter.

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