# No. III.—SIPHONOPHORÆ FROM THE INDIAN OCEAN.

## Collected by Professor Stanley Gardiner in H.M.S. "Sealark."

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During the cruise of the "Sealark" in the Indian Ocean from May to October 1905, Professor Stanley Gardiner made a very good collection of Siphonophores. Both the quantity and quality of the specimens came up to the standard of an ideal collection. There were not vast numbers of individuals belonging to common species to make the examination long and tedious, but there were sufficient for all practical purposes. The species turned out to be numerous and the preservation on the whole was distinctly good, which is very important for any kind of jelly-fish. The Indian Ocean was the one region from which a good collection of Siphonophores was wanted for the completion of our knowledge of their geographical distribution. Some interesting species had already been found there, but many species known to be widely distributed in the Atlantic and Pacific had not been recorded for the Indian Ocean. It is this gap in their distribution that Professor Gardiner's collection has considerably helped to fill.

The collection was made on the western side of the Indian Ocean between Chagos, Mauritius and Seychelles, in the tropical zone where the surface temperature of the sea ranged between 70° and 86° F. during the cruise, and where the mean annual is between 77° and 82°.

Professor Gardiner obtained not less than 36 species belonging to 18 genera, and there were fragmentary indications of a few more species. None of the species proved to be absolutely new, but one has to receive a new name owing to its having been incorrectly identified by its author.

Huxley during the voyage of the "Rattlesnake" (1846—1850) traversed the Indian Ocean and in his well-known monograph *The Oceanic Hydrozoa* the following species are recorded as having been found by him in the Indian Ocean: *Sphæronectes köllikeri* Huxley (*S. truncata* Will); *Abyla pentagona* Quoy et Gaimard (*Abylopsis tetragona* Otto); *Aglaismoides eschscholtzi* Huxley (Eudoxid of *Abylopsis eschscholtzi*); *Sphenoides australis* Huxley (Eudoxid of *Bassia bassensis* Q. et G.); *Diphyes appendiculata* Eschscholtz; *Diphyes mitra* Huxley (*Diphyopsis mitra* Huxley); *Diphyes dispar* Chamisso et Eysenhardt (*Diphyopsis dispar* C. et E.); *Rhizophysa filiformis* Huxley (*R. eysenhardti* Gegenbaur); *Physalia utriculus* (Eschscholtz). All the above species have been found again in the "Sealark" collection.

Haeckel went to Ceylon in 1881 to study the marine fauna and especially the Siphonophores. In his report on the Siphonophora of the "Challenger" Expedition he gave the names of 23 new species (excluding eudoxids) as having been found by him in the Indian Ocean. Of these new species six were never described or figured, and have conse-

quently become *nomina nuda*; seven received such very inadequate descriptions, unaccompanied by figures, that it would be impossible to identify them again, but the following ten were described and figured along with the "Challenger" material: *Monophyes princeps* (*Sphæronectes princeps*); *Cymbonectes huxleyi* (*Muggiæa huxleyi*); *Desmophyes annectans*; *Dicymba diphyopsis* (? *Apolemia uvaria* Lamarck); *Crystallodes vitrea* (*Agalma okeni* Esch.); *Agalma eschscholtzi* (*Agalma haeckeli* Bigelow); *Discolbe quadrigata* (?*Physophora hydrostatica* Forskål); *Lynachnagalma vesicularia* (*Lynachagalma utricularia* Claus); *Cystalia monogastrica* (*Epibulia ritteriana* Haeckel); *Epibulia ritteriana*. The "Sealark" collection contains only one species in the above list, namely, *Crystallodes vitrea*, but their absence is not remarkable, as more than half of these species have so far only been seen by Haeckel himself.

On the other side of the Indian Ocean a large collection of Siphonophores was made by the Dutch "Siboga" Expedition which explored the Malay area for about a year (1899—1900). The specimens collected were reported upon by Mlles Lens and van Riemsdijk. About 4000 specimens were handed over to these ladies, who had many difficulties to contend with, especially those arising from material which had been badly preserved. Some of their new species have already been reduced to the rank of synonyms, and other species have had their names changed. After allowing for synonyms, very doubtful species and eudoxids the "Siboga" collection contained about 50 species, and 24 of them have been found in the "Sealark" collection.

Another large collection of Siphonophores was made during the cruise of the "Albatross" in the Eastern Tropical Pacific under the leadership of the late Professor Alexander Agassiz. This collection has been reported upon by Bigelow (1911), who accompanied Professor Agassiz on the cruise. With the material collected Bigelow has produced an excellent memoir, almost a monograph, on the Siphonophores. It contains not only an adequate description of the species accompanied by a large number of very good, clear figures, but also a careful survey of the whole group. I made considerable use of Bigelow's memoir for the identification of my specimens, and out of the 51 species dealt with in the memoir I found 30 of them in the "Sealark" collection. Later on were published by Bigelow further reports on Siphonophores collected on cruises in the north-western Pacific (Behring Sea and Japanese waters), Philippine Archipelago and adjacent regions, and lastly the western Atlantic (West Indies). These collections added much knowledge on the distribution of the Siphonophores and also some new species.

The German Antarctic ship "Gauss" made a collection of Siphonophores during her voyage over the Atlantic and across the southern region of the Indian Ocean on her way down to the Antarctic. This collection, with the addition of other specimens, has been reported upon by Moser (1925) in a memoir containing descriptions of over 60 species, of which 26 are regarded as being new. This important work contains a new system of classification and research on the development of the group. The memoir arrived too late to be of any real use to me, as the examination of the "Sealark's" specimens had long been completed and the manuscript was ready for publication. In the short time at my disposal I was able to check again certain species and add a few notes to the manuscript.

I have compiled a list of the Siphonophores which have been recorded for the Indian

Ocean to latitude 32° S. The total number of species known to occur there is 48, but at least four of them may be assigned to Haeckel's doubtful species reducing the number to about 44 species. Out of these Professor Gardiner succeeded in collecting 36 species, showing clearly how well the collecting work was done. Twelve of them were taken for the first time in the Indian Ocean, these being nearly all widely distributed species, also occurring in the Pacific and the Atlantic. Only two species stand out for special mention —*Galeolaria quadridentata* has so far only been found in the West Indies and the Mediterranean; and *Diphyes bigelowi* in the North Atlantic, but past experience tells me not to enlarge upon the distribution of Siphonophores with limited areas of distribution and to build up theories to account for such. A new record from some unexpected part of the world shatters the whole scheme, as has been well demonstrated recently in the case of *Diphyes arctica*.

A manuscript list was kept of the Siphonophores taken at every station and in every haul of the nets. To print all these details would take up too much space and moreover Siphonophores are always on the move. A complete list of stations, with details as to depth, temperature, nets, etc. was published by Professor Gardiner in the *Trans. Linn. Soc.* 1907, xii, p. 169. These stations have been grouped under the following names: Chagos Archipelago (stations A.—V.); Mauritius (stations a.—d.); Nazareth Bank, Cargados Carajos (e.—l.); Saya de Malha Bank (m.—n.); Farquhar Atoll (p.—y.); between Providence and Alphonse Is. (z.—bb.); Alphonse Is. (cc.—ee.); Amirante Group (gg.—oo.). Many of the stations were in the open ocean, the nets going down to 1000 fms. or over.

Self-closing nets were used at six stations and eight hauls were made with them. From three stations no specimens were received, and the total catch amounted to nine specimens. The number of medusæ found in the same series amounted to eight specimens from five stations. At one station (s.) the Fowler self-closing net working between 250—500 fms., 500—750 fms., 750—1000 fms. failed in the three hauls to catch a single Siphonophore or medusa, but the same net between 0—250 fms. caught 11 specimens of Siphonophores.

The following species were taken in the self-closing nets which were used at certain stations: between 250—500 fms.: *Muggiœa spiralis* (1 eudoxid), *Amphicaryon acaule* (1 complete specimen), *Diphyes appendiculata* (1 Ant. nectophore); at 500 fms.: *Muggiœa spiralis* (1 Ant. nectophore), *Abylopsis tetragona* (1 bract of eudoxid), *Diphyes mitra* (1 Ant. nectophore), *Diphyopsis dispar* (1 Ant. nectophore). All the above species were also taken in surface nets, except *Amphicaryon acaule* which was always absent in all nets that did not go below 100 fms.

An analysis of the contents of the open nets used at the different stations showed that the following species were taken at the surface or between the depths stated and the surface. Surface: *Sphæronectes truncata, Muggiœa spiralis, Hippopodius hippopus, Abyla leuckarti, A. trigona, Abylopsis tetragona, A. eschscholtzi, Bassia bassensis, Galeolaria australis, G. monoica, G. chuni, Diphyes appendiculata, D. contorta, D. mitra, D. subtiloides, Diphyopsis dispar, D. bojani, D. chamissonis, Anthophysa rosea*; 0—25 fms.: *Agalma okeni, A. elegans*; 0—50 fms.: *Praya cymbiformis*; 0—75 fms.: *Diphyes subtilis*; 0—100 fms.: *Cuboides vitreus, Diphyes fowleri*; 0—150 fms.: *Amphicaryon acaule*; 0—200 fms.:

*Galeolaria quadrivalvis*; 0—600 fms.: *Diphyes bigelowi*; 0—900 fms.: *Muggiœa arctica*; 0—1000 fms.: *Ceratocymba sagittata*; 0—1200 fms.: *Abyla hœckeli.*

The station lists were also analysed for the purpose of finding out whether there was any bathymetrical movement of Siphonophores during the day and night, as it is well known that many organisms found in the plankton move down during the day and come up to the surface at night. It was quite clear from the surface nets that there were plenty of Siphonophores either at or very close to the surface during the day. The comparison between two near stations, where nets were used during the day at one station, and by night at the other, and both under somewhat similar conditions, did show that fewer specimens were at the surface in daytime than at night. The evidence, however, where it could be obtained from other stations was not in favour of any diurnal movement; in fact, not sufficient evidence was obtained to prove such a movement.

I did not consider that it was necessary to give a full synonymy of the species, as a very complete list has been given by Bigelow, and another more recent one by Moser, but with regard to the latter list it would be well to verify the references, as I have found more than an average crop of errors, even with a very limited use of the work. The synonyms which I have selected are intended as a general guidance and a help to find others.

It is now 20 years since the "Sealark" left Ceylon for the cruise in the western part of the Indian Ocean, under the leadership of Professor Gardiner, and the many reports, which have been issued since then on the collections made during the cruise, testify that the expedition was a great success and has added very much to our knowledge of the marine fauna of the Indian Ocean. It has been a great pleasure to me to take part in the examination of the material collected, and I take this opportunity heartily to thank Professor Gardiner for allowing me the privilege of writing this report on the Siphonophores. The long delay over the completion of my share of the work may be put down to interruption caused by the Great War.

## A LIST OF SIPHONOPHORES WHICH HAVE BEEN FOUND IN THE INDIAN OCEAN.

[*Those marked with one star have been found in the "Sealark" collection and the numeration is that of the subsequent account. Those marked with two stars are new records for the Indian Ocean.*]

### CALYCOPHORÆ.

#### Sphæronectidæ.

1. **Sphæronectes truncata* (Will).
   „ *princeps* Haeckel.
2. **Muggiœa spiralis* (Bigelow).
   „ *huxleyi* Haeckel.
3. **Cuboides vitreus* Quoy et Gaimard.

#### Prayidæ.

4. ***Amphicaryon acaule* Chun.
5. ***Praya cymbiformis* (Delle Chiaje).
   *Desmophyes annectans* Haeckel.

#### Hippopodiidæ.

6. **Hippopodius hippopus* (Forskål).
   „ *serratus* Moser.
7. ***Vogtia pentacantha* Kölliker.

#### Diphyidæ. Abylinæ.

8. **Abyla leuckarti* Huxley.
9. * „ *trigona* Quoy et Gaimard.
   „ *bicarinata* Moser.
10. ***Abyla haeckeli* Lens and Riemsdijk.
11. **Abylopsis tetragona* (Otto).
12. * „ *eschscholtzi* (Huxley).
13. **Bassia bassensis* Quoy et Gaimard.
14. **Ceratocymba sagittata* Quoy et Gaimard.

#### Diphyidæ. Galeolariinæ.

15. **Galeolaria quadrivalvis* Blainville.
16. ** „ *quadridentata* Quoy et Gaimard.
17. * „ *australis* Quoy et Gaimard.
18. ** „ *monoica* Chun.
19. ** „ *chuni* Lens and Riemsdijk.
20. ** „ *subtilis* (Chun).
    „ *campanella* Moser.

#### Diphyidæ. Diphyopsinæ.

21. **Diphyes appendiculata* Eschscholtz.
22. * „ *contorta* Lens and Riemsdijk.
23. * „ *mitra* (Huxley).
24. ** „ *fowleri* Bigelow.
25. * „ *arctica* Chun.

26. ***Diphyes subtiloides* Lens and Riemsdijk.
27. ** „ *bigelowi* nomen novum.
28. **Diphyopsis dispar* (Chamisso et Eysenhardt).
29. **Diphyopsis bojani* Eschscholtz.
30. * „ *chamissonis* (Huxley).

PHYSOPHORÆ.

**Apolemiidæ.**

*Dicymba diphyopsis* Haeckel (? *Apolemia uvaria* Lamarck).

**Forskaliidæ.**

*Forskalia tholoides* Haeckel.

**Agalmidæ.**

31. **Agalma okeni* Eschscholtz.
32. ** „ *elegans* (Sars).
„ *haeckeli* Bigelow.

**Physophoridæ.**

*Discolbe quadrigata* Haeckel (? *Physophora hydrostatica* Forskål).

**Anthophysidæ.**

33. **Anthophysa rosea* Brandt.

**Rhizophysidæ.**

34. **Rhizophysa eysenhardti* Gegenbaur.
*Epibulia ritteriana* Haeckel.

**Physaliidæ.**

35. **Physalia utriculus* (La Martinière).

**Porpitidæ.**

*Porpita porpita* Linnæus.

**Velellidæ.**

36. **Velella spirans* (Forskål).

## CALYCOPHORÆ. Family **Sphæronectidæ.**

1. *SPHÆRONECTES TRUNCATA* (Will) 1844.

*Ersœa truncata* Will 1844; *Diplophysa inermis* Gegenbaur 1853; *Sphœronectes Köllikeri* Huxley 1859, Agassiz and Mayer 1899, Moser 1925; *Monophyes gracilis* Claus 1874, Chun 1885; *Sphœronectes gracilis* Mayer 1900; *Sphœronectes truncata* Bigelow 1911.

The collection contains five nectophores and one eudoxid, none of which are in good condition, but they show clearly the characteristic features of the species. One specimen has well-advanced cormidia which are nearly ready for liberation.

*Loc.* Chagos; Farquhar (nectophore and eudoxid); Alphonse; Amirante. This species is widely distributed throughout the tropical and warm regions of all the oceans and is also found in the Mediterranean. Huxley was the first to find it in the Indian Ocean.

2. *MUGGIÆA SPIRALIS* (Bigelow) 1911.

*Diphyes spiralis* Bigelow 1911; *Muggiœa spiralis* Moser 1915 and 1925, Bigelow 1918.

This species was first found by Bigelow in the material collected by the "Albatross" in the eastern tropical Pacific. As Bigelow only found the anterior nectophore and expected the existence of a posterior nectophore, owing to the presence of certain buds on the stem, the species was considered by him to be a Diphyid. Moser with much material from the "Gauss" collection states that a posterior nectophore is not present, and consequently has placed it among the Monophyids in the genus *Muggiœa.*

The "Sealark" collection contains 26 nectophores, the largest being 4 mm. in length and 1·5 mm. in width, and five eudoxids with their gonophores.

There should be no difficulty in recognising this species at a glance as the ridges of the nectophore and of the gonophores are very much spirally twisted.

The eudoxid (with gonophore attached) is about 3 mm. in length and 1 mm. in width. The upper half of the bract is solid and contains the somatocyst which varies in shape, being either cylindrical or tapering, and extending to the apex. In general appearance the bract is similar to that of *Diphyes appendiculata.* The lower half of the bract is asymmetrical; it is closed by a wall on the dorsal and left sides, but open on the ventral and right sides. The edges of the bract and its gonophores are slightly serrated. The gonophore has a flat top, four spirally twisted ridges and its opening unprotected by teeth or spines, but there is a small projecting flap on one side.

*Loc.* Chagos; Mauritius; Farquhar; Amirante. The species has a wide distribution, extending over the tropical and warm regions of the Pacific, Atlantic and Indian Oceans.

3. *CUBOIDES VITREUS* Quoy et Gaimard 1827.

*Abyla Vogti* Huxley 1859; *Cuboides vitreus* Huxley 1859 (Eudoxid), Bigelow 1911; *Cuboides crystallus* Haeckel 1888 (Eudoxid); *Cymba crystallus* Haeckel 1888; *Halopyramis adamantina* Chun 1892, Lens and Riemsdijk 1908; *Cuboides adamantina* Chun 1892, Lens and Riemsdijk 1908 (Eudoxid).

There are eight specimens of the polygastric generation and three eudoxids. The largest nectophore is a very fine one and in very good condition. It exceeds all previous records for size and measures 14 mm. in height and 22 mm. in width on the dorso-ventral line, but laterally its width is 13 mm. The dorso-ventral ridges project outwards like arms. Smaller specimens also show that the greatest width is on the dorso-ventral line. Although the external shape of the nectophore is not quite like those which have been figured by previous authors, still I cannot detect differences of sufficient importance to show that these specimens belong to a new species.

*Loc.* Chagos; Nazareth; between Providence and Alphonse; Amirante. The species is widely distributed over the tropical Atlantic and also occurs in the tropical Pacific; the Malay area; and off the south-east coast of New Guinea.

## Family **Prayidæ.**

4. *AMPHICARYON ACAULE* (Chun) 1888.

*Amphicaryon acaule* Bigelow 1911, Moser 1925.

The collection contains 11 specimens and some of them are in very good condition. The largest one measured 8 mm. in height and 7 mm. in width.

This species was first described by Chun. Bigelow has given an excellent series of figures, from which it can be easily identified. I am able to confirm Bigelow's observations for my specimens are similar to his figures. The stem with its appendages is closely contracted between the two nectophores, and one specimen shows gonophores. The largest specimen shows very distinctly the secondary nectophore in the process of enfolding the primary nectophore.

*Loc.* Chagos; Farquhar; Amirante. *Amphicaryon acaule* though widely distributed has but yet only a few records. Chun found it at the Canary isles, Bigelow records it from the West Indies and the tropical Pacific, and Moser from the tropical Atlantic. It was found at six of the "Sealark" stations in the Indian Ocean, and it was absent in all nets that did not go below 100 fms. It was taken once within 150 fms. of the surface, and once in a self-closing net working between 250 and 500 fms.

5. *PRAYA CYMBIFORMIS* (Delle Chiaje) 1842.

*Rosacea plicata* Bigelow 1911; *Praya cymbiformis* Bigelow 1911, Moser 1925.

The collection contains five superior nectophores. The largest measured 10 mm. in length and 8 mm. in width. They resemble in general appearance Bigelow's figure of *Rosacea plicata* (1911, pl. 2, fig. 7) in his report on the "Albatross" collection from the eastern tropical Pacific. The somatocyst is alongside the hydrœcium, and is without any terminal knob or dilatation. The opening of the hydrœcium is less than half the length of the nectophore.

Moser has united the genera *Rosacea* and *Praya* and recognises four species. To which species the "Sealark" specimens belong leaves some doubt in my mind. *Praya diphyes* has a somatocyst which curves away from the hydrœcium and terminates in a dilatation or a small knob. Moser has placed Bigelow's specimens as a doubtful synonym of *P. diphyes*. On the other hand, the length of the opening of the hydrœcium is in favour of the "Sealark's" specimens belonging to *P. diphyes*, for in *P. cymbiformis* the opening extends along the whole length of the nectophore.

As my specimens are not in good condition I think it is best to rely upon the shape of the somatocyst, so I have called them *Praya cymbiformis*. The specimens have their stem contracted and the canal system of the nectosac has macerated away.

*Loc.* Chagos; Mauritius; Amirante.

## Family **Hippopodiidæ**.

### 6. *HIPPOPODIUS HIPPOPUS* (Forskål) 1775.

*Gleba hippopus* Forskål 1775; *Hippopodius neapolitanus* Kölliker 1853; *Hippopodius gleba* Leuckart 1854; *Hippopodius luteus* Vogt 1854, Lo Bianco 1904, Lens and Riemsdijk 1908, Moser 1925; *Hippopodius hippopus* Bigelow 1911 and 1913.

The collection contains two colonies in excellent condition. One has three and the other four nectophores. The largest colony measured 10 mm. in height and 9 mm. in width.

The nectophores have four protuberances over the dorsal or upper side of the nectosac. There are two in the middle and these are flanked on either side by a slightly larger one. There are none around the lower half of the nectosac. These protuberances are like little rounded mounds of jelly and are more conspicuous in small nectophores than in large ones. Their position is clearly shown in Lens and Riemsdijk's figure. The ventral sinus of the nectosac apparently decreases in width with age. In the young nectophores it forms a large broad patch, but in the older nectophores it is reduced to a mere streak. Both specimens show no signs of gonophores, but some may be present and covered over by the appendages of the contracted stem.

*Polyphes ungulata* Haeckel (1888, pl. 29, figs. 1—8) without doubt belongs to the genus *Hippopodius*, but at present there is some doubt whether the species is identical with *H. hippopus*. Haeckel has given a beautiful set of artistic figures, but whether he has exaggerated the size and shape of the protuberances around the nectosac remains to be seen.

*Loc.* Chagos; Farquhar. *Hippopodius hippopus* is a well-known species and it has been frequently recorded under different names. It has a very wide geographical range extending over the tropical Pacific and the Malay area. It has also been taken off Japan. It occurs in the tropical Atlantic and the Mediterranean, and has been previously taken in the Indian Ocean, west of Australia.

### 7. *VOGTIA PENTACANTHA* (Kölliker) 1853.

*Vogtia pentacantha* Keferstein und Ehlers 1861, Chun 1897, Bigelow 1911 (Biscayan Report) and 1918.

There are three loose nectophores, the largest about 9 mm. in width. They have rather spiny tubercles only on the edges of the facets and the surface of the facets is smooth. The tubercles are large and conspicuous like those on the nectophores figured

by Chun. Only one specimen shows the ventral sinus, which is similar to Bigelow's figure (1918, pl. IV, fig. 1). The position of the tubercles on the nectophores points to the specimens belonging to this species and not to *V. spinosa*.

*Loc.* Between Providence and Alphonse, 900—0 fms.; Amirante, 750—0 fms. It has been recorded for the Mediterranean and the Atlantic.

## Family **Diphyidæ**. Sub-family **Abylinæ**.

### 8. *ABYLA LEUCKARTI* Huxley 1859.

*Abyla leuckarti* Lens and Riemsdijk 1908, Bigelow 1911, Moser 1925; *Ceratocymba asymmetrica* Lens and Riemsdijk 1908.

There are two specimens of the anterior nectophore, about 7 mm. in length and 4 mm. in width. They are in good condition and show clearly their specific characters. Six eudoxids bearing gonophores were also found, but no posterior nectophores.

The species was solely known by its anterior nectophore until Bigelow found two complete specimens with both nectophores *in situ*. Bigelow also found cormidia sufficiently advanced to give the clue to its eudoxid, which is very much like the eudoxid of *Ceratocymba sagittata*. According to Bigelow (1918) the eudoxid of *A. leuckarti* may be distinguished by the bract having its apical facet quadrilateral in outline, and the facet flat or slightly convex. The baso-ventral teeth of the gonophore are about equal in length. Moser, however, states that the bracts of the eudoxids of *A. leuckarti* and of *Ceratocymba sagittata* are identical, and that the distinguishing feature between the two species is the length of the teeth on the basal margin of the gonophore. The eudoxids in the collection agree in shape and details with the descriptions and figures given by Lens and Riemsdijk and also by Bigelow (1911, pl. 15, fig. 4).

*Loc.* Chagos; Saya de Malha; between Providence and Alphonse. The species has been found in the tropical regions of the Atlantic and Pacific Oceans, and also in the Malay area.

### 9. *ABYLA TRIGONA* Quoy et Gaimard 1827.

*Amphiora alata* Huxley 1859 (Eudoxid), Lens and Riemsdijk 1908; *Abyla trigona* Gegenbaur 1860, Lens and Riemsdijk 1908, Bigelow 1911; *Eudoxia trigonæ* Gegenbaur 1860; *Abyla carina* Haeckel 1888; *Amphiora carina* Haeckel 1888.

The list of localities shows that this species was found along nearly the whole course of the "Sealark." It was not abundant, as only 17 anterior nectophores and 16 eudoxids were taken. The posterior nectophore should have been present, but I could not detect a single specimen. The anterior nectophore closely resembles that of *A. haeckeli*, and is distinguished from it by not having its ventral facet divided into two parts by a transverse ridge. The largest anterior nectophore measured 14 mm. in length and 10 mm. in width; the smallest one measured about 3 mm. in length. Most of the eudoxids had one or two gonophores. The largest bract measured 11 mm. in length and 12 mm. in width. This species has been so well described and figured by the authors mentioned above that one has nothing new to add.

*Loc.* Chagos; Mauritius; Saya de Malha; Farquhar; between Providence and Alphonse; Alphonse; Amirante. Though not previously recorded for the Indian Ocean the species was expected to occur there, as it is widely distributed: Malay Arch.; Eastern Tropical Pacific; Atlantic Ocean and Mediterranean.

10. *ABYLA HAECKELI* Lens and Riemsdijk 1908.

*Abyla trigona* Huxley 1859; *Abyla haeckeli* Bigelow 1911, Moser 1925.

This is apparently rather a rare species which was isolated from *Abyla trigona* by Lens and Riemsdijk, who found four anterior nectophores in the "Sigoba" collection. Bigelow also obtained six anterior nectophores in the Eastern Tropical Pacific, and Moser records a few specimens from the tropical Atlantic Ocean. In the "Sealark" collection there are three anterior nectophores.

The species is likely to escape notice unless every anterior nectophore of *Abyla trigona* is carefully examined on the ventral side. The anterior nectophore is distinguished from that of *Abyla trigona* by the presence of a well-marked transverse ridge which separates the ventral side into facets, a lower pentagonal and an upper rectangular facet. This ridge is absent in *A. trigona* and its place is occupied by a narrow groove joining the whole ventral side into one long facet, extending from the apex to the base. The largest anterior nectophore in the "Sealark" collection measured 7 mm. in length and 6 mm. in width. The posterior nectophore is only known from Huxley's original figures.

The eudoxid has not yet been definitely traced, but Bigelow has suggested that the eudoxid *Amphiroa dispar* Bedot (1895, p. 373, pl. XII, figs. 5—6) may belong to *A. haeckeli* and also the eudoxid *Amphiroa angulata* Huxley (1859, p. 64, pl. 5, fig. 2).

It is generally agreed that the Siphonophore described and figured by Huxley under the name of *Abyla trigona* is not the true *Abyla trigona* of Quoy et Gaimard, but that of another species now called *Abyla haeckeli*. Huxley obtained one complete specimen in Torres Straits and along with it he also found a detached bract, which he assumed to be a bract detached from that specimen. The figure given of it by Huxley (pl. 3, fig. 1 *e*) shows that it is distinctly cuboidal in shape and resembles the bract of the eudoxid of the true *Abyla trigona*.

One of the specimens of *A. haeckeli* in the "Sealark" collection has a bract attached to the stem, but, unfortunately, it is not sufficiently advanced to show its adult form. It has a thin leaf-like appearance, about 1·5 mm. in length and 1 mm. in width, and its somatocyst has two diverging processes. There is a deep narrow groove on the baso-ventral margin, and the lateral hydrœcial walls are symmetrical. The eudoxid *Amphiora dispar* has also a deeply concave baso-ventral margin, but its lateral hydrœcial walls are distinctly asymmetrical, as one side is provided with a large projecting tooth, which is absent on the other side. At present there is no evidence that the bract of *A. haeckeli* would develop into an eudoxid like *Amphiora dispar*. On comparing, side by side, the bracts of *A. haeckeli* and *A. trigona* Q. et G. still attached to their stems, the latter, though smaller in size, is distinctly cuboidal and is uncommonly like Huxley's figure of the detached bract of his so-called *A. trigona*. The "Sealark" found *A. haeckeli* and *A. trigona* Q. et G. in the same haul of the net, showing that the two species were living near together.

*Loc.* North of Chagos (lat. 4° 16′ S., long. 71° 53′ E.), 1200—0 fms., 17 May 1905.

11. *ABYLOPSIS TETRAGONA* (Otto) 1823.

*Pyramis tetragona* Otto 1823; *Abyla pentagona* Leuckart 1853, Kölliker 1853, Huxley 1859, Gegenbaur 1860, Lens and Riemsdijk 1908, Moser 1925; *Abyla trigona* Vogt 1854; *Eudoxia cuboides* Leuckart 1853, Chun 1885; *Aglaismoides elongata* Huxley 1859 (Eudoxid); *Aglaisma gegenbauri* Haeckel 1888 (Eudoxid); *Calpe gegenbauri* Haeckel 1888; *Aglaisma cuboides* Lens and Riemsdijk 1908 (Eudoxid); *Abylopsis tetragona* Bigelow 1911.

The collection contains five complete specimens, 12 loose anterior nectophores, nine

loose posterior nectophores, and 22 eudoxids. The largest complete specimen measured 17 mm. in length, the anterior nectophore occupying only about 4 mm. of that length.

The anterior nectophores of *Abylopsis tetragona* and *Abylopsis eschscholtzi* are very much alike, so much alike at times, that a feeling of uncertainty exists as to which of the two species a specimen should be assigned. Lens and Riemsdijk separated them by the shape of the dorsal and ventral facets. Bigelow found that the differences in shape were too minute, and he says "the exact outline and degree of curvature of the ridges is so variable that identification from these features alone is often impossible." He discovered another character by which he was able to separate the anterior nectophores of these two species. He noticed that the course of the lateral canals of the nectosac was not similar in the two species. In *A. tetragona* the lateral canals are highly arched before descending to the margin, and in *A. eschscholtzi* this conspicuous curvature is absent.

At first, I used the characters given by Bigelow for determining the anterior nectophore. Those specimens which had the lateral canals highly arched, as figured by Bigelow, could at once be written down as *A. tetragona*, but in about a dozen specimens the curvature was either slight or irregular so that they fell between *A. tetragona* and *A. eschscholtzi*. I next tested the characters mentioned by Lens and Riemsdijk and found them helpful. I avoided microscopic minuteness and took a general view of the dorsal and ventral facets. In *A. tetragona* both these facets are longer than they are broad, but in *A. eschscholtzi* the same facets have rather a squarish appearance. I, however, found another method of distinguishing these nectophores. *A. tetragona* when viewed from the ventral side shows the top of the nectosac projecting beyond the main body of the somatocyst, but *A. eschscholtzi* when viewed from the same position has the nectosac covered by the somatocyst. By applying my own method first and then checking the result by the methods used by Bigelow and by Lens and Riemsdijk I was able to reduce the refractory anterior nectophores down to one which was finally assigned to *A. eschscholtzi*. The largest loose anterior nectophore measured 4·5 mm. in length and 4 mm. in width.

There is no difficulty about distinguishing the posterior nectophores of the two above-mentioned species, as they are not at all alike. They can be distinguished at once by the course of the canal system in the nectosac, and if this should have become destroyed through bad preservation, then by the arrangement of the teeth along the walls of the hydrœcial cavity. Haeckel's figures of the posterior nectophore are bad ones, as they do not show the characters mentioned. The largest loose posterior nectophore measured 21 mm. in length and the smallest about 5 mm.

The eudoxid of *A. tetragona* is very much like that of *A. eschscholtzi*, but can be distinguished by the outline of the ventral facet, which has a straight edge on the basal side. This edge is highly curved in *A. eschscholtzi*. The largest bract measured 5 mm. in length and 4 mm. in width.

*Loc.* Chagos; Nazareth; Farquhar; Alphonse; Amirante. This species has a very wide geographical range. It occurs in the Mediterranean, Atlantic and Pacific Oceans. Huxley found it in the Indian Ocean, off Timor.

12. *ABYLOPSIS ESCHSCHOLTZI* (Huxley) 1859.

*Aglaismoides eschscholtzii* Huxley 1859 (Eudoxid); *Abyla pentagona* Mayer 1900; *Aglaisma cuboides* Mayer 1900 (Eudoxid); *Abyla quincunx* Mayer 1900, Agassiz and Mayer, 1902; *Chunia capillaria* Mayer 1900; *Abylopsis quincunx* Lens and Riemsdijk 1908; *Aglaismoides eschscholtzi* Lens and Riemsdijk 1908 (Eudoxid); *Abylopsis eschscholtzi* Bigelow 1911 and 1913.

The collection contains one complete specimen, 22 loose anterior nectophores, two loose posterior nectophores and 22 eudoxids. The complete specimen measured 5 mm. in length, and its anterior nectophore occupied 2 mm. of that length. None of the loose anterior nectophores exceeded 3 mm. in length. The largest loose posterior nectophore was about 3·5 mm. in length, and the largest eudoxid about 2·5 mm. in length.

This species has been well described and figured, and I have under *A. tetragona* pointed out how to distinguish the anterior nectophore and the eudoxid. Posterior nectophores are apparently scarce with this species and if present in the sea they should have been caught in the nets along with the anterior nectophores and eudoxids.

Both *A. tetragona* and *A. eschscholtzi* were occasionally found at the same station and twice taken together in the same net. To Bigelow we owe the connecting up of the free eudoxid known as *Aglaismoides eschscholtzi* with *Abyla quincunx*.

*Loc.* Chagos; Mauritius; Saya de Malha; Farquhar; Alphonse; Amirante. *Abylopsis eschscholtzi* has a very wide range over the Pacific and Atlantic Oceans in the warm regions. It had been previously recorded for the Indian Ocean by Huxley.

13. *BASSIA BASSENSIS* (Quoy et Gaimard) 1833.

*Diphyes bassensis* Quoy et Gaimard 1833; *Sphenoides australis* Huxley 1859 (Eudoxid), Lens and Riemsdijk 1908 (Eudoxid); *Abyla perforata* Gegenbaur 1860; *Sphenoides obeliscus* Haeckel 1888 (Eudoxid); *Bassia obeliscus* Haeckel 1888; *Abyla bassensis* Lens and Riemsdijk 1908; *Bassia bassensis* Bigelow 1911 and 1913.

One of the commonest Siphonophores in the collection, occurring at nearly all the stations. There are 12 complete specimens, 54 anterior nectophores, 66 posterior nectophores and 51 eudoxids. The largest complete specimen measured 9 mm. in length and 4 mm. in width, and the loose nectophores showed no excess in size. The largest eudoxid measured 6 mm. in length and 4 mm. in width. The action of formalin on the jelly of this species is not uniform. It sets firm the jelly of the anterior nectophore so that its shape remains good, but it apparently softens the jelly of the posterior nectophore and of the eudoxid. These show a shrinkage which spoils the shape of the ridges and facets. This species has been fully described and figured by the authors mentioned above.

*Loc.* Nearly all stations. The species has been recorded from the tropical regions of all the oceans, and its eudoxid was first described by Huxley from specimens taken by himself in the Indian Ocean.

14. *CERATOCYMBA SAGITTATA* Quoy et Gaimard 1827.

*Ceratocymba sagittata* Quoy et Gaimard 1827, Bigelow 1918, Moser 1925; *Diphyablyla hubrechti* Lens and Riemsdijk 1908, Bigelow 1911.

The polygastric form of this Siphonophore was first found by the "Siboga" Expedition in the Malay Archipelago near Paternoster Islands, north of Sumbawa. The expedition obtained one large anterior nectophore, and it was described by Lens and Riemsdijk as a new genus and species, and also placed in a new sub-family. Bigelow (1911) during the cruise of the "Albatross" also succeeded in finding an anterior nectophore in the Eastern Pacific, about half-way between Calleo and Easter Island. Moser, with the aid of specimens in the Berlin Museum and from the "Gauss" collection, was

able to connect this polygastric form with its eudoxid known by the name of *Ceratocymba sagittata*, and also to find the posterior nectophore. Bigelow (1918) with more specimens from the West Indies was able to confirm Moser's observations.

The "Sealark" contribution was only a single anterior nectophore, 8 mm. long and 3 mm. wide, in good condition. The apical prolongation of the nectophore is about 3 mm. in length and is longer than in the specimen figured by Bigelow. It is practically upright, and the nectosac extends about half-way up it in the form of a tube-like extension. The specimen, externally, has not such a triangular appearance as shown by the figures of the "Siboga" and "Albatross" specimens. The few appendages are all tightly contracted and as it is impossible to make out their structure nothing more need be added to the description of the specimen.

The most interesting feature about this species is its close relationship to *Abyla leuckarti*. Its anterior nectophore may be likened to that of *A. leuckarti* tapering dorsally to a point, with a corresponding elongation of the nectosac. It has all the characters of an Abylid, and there is no need for a special family as Bigelow has already pointed out. It has a further tie to *A. leuckarti* by its eudoxid, which Moser states is identical, and can only be distinguished from it by the shape of the gonophores.

Bigelow (1918), after a more critical examination of specimens from the Atlantic, has pointed out that the bracts of the two species do show some slight differences by which they can be distinguished. The bract of *Ceratocymba sagittata* has a triangular apical facet due to the left lateral ridge not extending up to the apical facet. The apical facet is deeply concave with prominent lateral angles or horns. In the gonophore one of the two baso-ventral teeth is very long, the other very short.

In Moser's synonymy of *Ceratocymba sagittata* there is placed *Ceratocymba asymmetrica* of Lens and Riemsdijk. This species according to Bigelow is the eudoxid of *Abyla leuckarti*. Another synonym is *Ceratocymba sagittata* of Bedot (1905), of which he only gave a very brief mention but added good figures. These have all the appearances of the eudoxid belonging to *C. sagittata* of Quoy et Gaimard, but the figures clearly show that the bract is symmetrical and there are no indications of an extra facet on the left side of the bract. There are still about three species of *Abyla* requiring eudoxids, and Bedot's specimens might belong to one of them.

*Loc.* Farquhar, lat. 10° 27′ S., long. 15° 17′ E. This species extends over the warm regions of the Atlantic; the tropical Pacific; the Malay area; and Indian Ocean.

## Sub-family **Galeolariinæ.**

### 15. *GALEOLARIA QUADRIVALVIS* (Blainville) 1830.

*Sulculeolaria quadrivalvis* Blainville 1834; *Diphyes quadrivalvis* Gegonbaur 1853; *Galeolaria auriantiacea* Vogt 1854; *Galeolaria filiformis* Leuckart 1854; *Galeolaria quadrivalvis* Lens and Riemsdijk 1908, Bigelow 1911.

The collection contains three loose anterior and four loose posterior nectophores of this well-known species. The largest anterior nectophore measured 10 mm. in length and 5 mm. in width. It shows the characters of the species by possessing only two dorsal teeth. There are two baso-ventral flaps, each with a small projecting process on the inner margin. The somatocyst is long and thread-like. The largest posterior nectophore measured 12 mm. in length and 5 mm. in width. There are two large triangular dorsal and two large triangular lateral teeth, and also two baso-ventral flaps, each with

a projecting process on the inner side not far from the base. The nectosac shows the characteristic transverse circular constrictions.

*Loc.* Chagos; Amirante. This species has a wide geographical distribution. It has been recorded from the Mediterranean, Canary isles, Eastern Tropical Pacific, and the Malay area. Its occurrence in the Indian Ocean is a new record.

16. *GALEOLARIA QUADRIDENTATA* Quoy et Gaimard, 1833.

*Galeolaria quadridentata* Bigelow 1918.

This species has been revived by Bigelow, who found specimens, to which he attached Quoy et Gaimard's old name, in collections from the West Indies, Straits of Florida, the Gulf stream (lat. 38° N., long. 70° W.) and two entire specimens from Naples. In general appearance the anterior nectophore is like that of *Galeolaria quadrivalvis*, but it can be distinguished by the number of teeth on the basal margin of the nectosac. It has two dorsal and two lateral teeth, and two ventral lobes. *G. quadrivalvis* has no lateral, but only the two dorsal teeth, and two ventral lobes.

The "Sealark" collection contained a single specimen of the anterior nectophore in fairly good condition. It measured 6 mm. in length and 4 mm. in width. Bigelow's figures (1918, pl. 8, figs. 1—2) illustrate the specimen very well, except that the somatocyst is a little longer and more thread-like. The two dorsal teeth and the two lateral teeth are distinctly triangular and are formed by folds in the margin. The two ventral lobes have a rounded margin, with a tooth-like projection on the inner sides, and are completely separated down to the base. The canal system of the nectosac corresponds with Bigelow's figure.

This appears to me to be quite a good species with a well-marked character. It is apparently rare, but unless the teeth of *Galeolaria* are carefully counted it is easy to pass it over, especially when the teeth are folded inwards.

*Loc.* Chagos.

17. *GALEOLARIA AUSTRALIS* Quoy et Gaimard 1833.

*Galeolaria australis* Blainville 1834, Bigelow 1911; *Diphyes biloba* Sars 1846; *Diphyes sarsii* Gegenbaur 1860; *Galeolaria biloba* Lens and Riemsdijk 1908.

Lens and Riemsdijk in the material collected by the "Siboga" in the Malay area found two species of *Galeolaria* without either dorsal or lateral teeth on the margin of the anterior nectophore. They identified one species as *Galeolaria biloba* Sars, which is a well-known species in the North Atlantic, and the other species they described as a new one under the name of *Galeolaria chuni*. In their review and criticism of the species belonging to this genus they make no mention of *Galeolaria australis* Quoy et Gaimard, though it happens to be the type species of the genus, and it was first found in the Indian Ocean. This species has also no dorsal or lateral teeth on the margin of the anterior nectophore.

Bigelow, however, has restored *Galeolaria australis* to its rightful place and has described and figured specimens of it from the eastern tropical Pacific. He evidently considers that *Galeolaria biloba* of Lens and Riemsdijk is the same species as *Galeolaria australis*, but is not quite certain as to whether it is identical with *Galeolaria biloba* of Sars. Bigelow does not accept *Galeolaria chuni* as a new species, but states that there is every reason to think that it is the young form of *Galeolaria australis*.

The "Sealark" collection contains specimens which are identical with *Galeolaria australis* of Bigelow, and with *Galeolaria chuni* of Lens and Riemsdijk, and some are certainly indistinguishable from specimens of *Galeolaria biloba* of Sars from the North Atlantic.

Lens and Riemsdijk gave only a brief description of the anterior nectophore of *G. chuni* and they state that "it differs from *G. biloba* in the course of the canals, which is as in Diphyopsinæ, the lateral canals not standing in any connection with the ventral one." Their figure of the anterior nectophore does not agree with the description, as it clearly shows a typical canal system of *Galeolaria*, with a cross canal connecting the lateral canals with the ventral one. This error, however, was worth making as it led me to find out that both their description and figure were quite accurate, and that they had described one specimen and figured another.

The examination of the canal system of the anterior nectophores in the "Sealark" collection led to the grouping of the specimens into two series: one with a canal system as in the genus *Diphyes*, and the other as in the genus *Galeolaria*; and both series contained specimens with long and short somatocysts. The presence of both types of canal systems in small specimens (5—7 mm.) of *Galeolaria biloba* from the North Atlantic confirmed my observations on the specimens from the Indian Ocean. As both types were found only among the small specimens, whilst the large ones (15—20 mm.) had the normal *Galeolaria* type, this tends to show that the branch connecting the ventral to the lateral canals is a later development of the canal system.

It is generally stated that the lateral canals of *Galeolaria biloba* arise from the circular canal and are connected to the ventral canal by an oblique canal. In the small specimens, about 5 mm. in length, the lateral canals come off from the ventral canal at the junction with the pedicular canal (the canal leading to the stem), and this junction is just above the circular canal. In the large specimens the lateral canals also leave the ventral canal at the same place and run parallel to the circular canal for a short distance and then curve sharply upwards. The oblique connecting canals leave the ventral canal higher up.

The canal system of *G. australis* and *G. chuni* is of the same type, but the chief distinction between the two species is in the length of the somatocysts. It is very short in *G. australis*, but long in *G. chuni*. The figures given by Lens and Riemsdijk (Pl. 9, figs. 75 and 78) show clearly the differences. The specimens from the Indian Ocean in this collection rather tend to strengthen the view that the two species are distinct, as the long somatocyst of *G. chuni*, extending half-way or more up the nectosac, is not characteristic of *G. australis*.

The "Sealark" collection contains 21 loose anterior nectophores, the largest not exceeding 11 mm. in length and 4 mm. in width, and the smallest about 3 mm. in length. The somatocyst does not exceed 1 mm. in length and in many specimens is less than 0·5 mm. It is either thread-like or oval in shape and in several specimens is only just visible. About half the specimens show a Diphyid type of canal system. All the specimens have a pair of baso-ventral flaps, with rounded margins. The stem and appendages are missing.

There are about 20 small loose posterior nectophores, the largest not exceeding 13 mm. in length, which probably belong to this species. There are no dorsal or lateral

teeth, and only a single baso-ventral flap. The lower margin of the flaps shows a slight indentation in the centre, but it is not of the same form as that found in specimens from the North Atlantic. Bigelow has pointed out that the posterior nectophore of *G. australis* has two lateral ridges, one on each side. To see clearly these ridges it is necessary to have very good specimens. I have found them in North Atlantic specimens, but failed to see them in those from the Indian Ocean, the nectophores being crumpled up externally.

*Loc.* Chagos; Farquhar; Saya de Malha; Amirante. This species has a very wide range. It has been recorded from the Indian Ocean, Malay area, tropical Pacific, Atlantic and Arctic Oceans.

### 18. *GALEOLARIA MONOICA* (Chun) 1888.

*Epibulia monoica* Chun 1888; *Galeolaria monoica* Lens and Riemsdijk 1908, Bigelow 1911 and 1913.

This species is apparently rather rare; at all events it has not been often recorded. The best and most complete description is given by Bigelow, who also found the posterior nectophore. Although the posterior nectophore was not actually seen in contact with the anterior nectophore, still there can be no doubt that Bigelow was right in his determination as the two nectophores have several characters in common.

Anterior Nectophore. There are nine loose specimens in the collection; the smallest measured 7 mm. in length and 3 mm. in width, and the largest 12 mm. in length and 6 mm. in width.

The somatocyst has a quite rudimentary appearance and does not exceed 0·5 mm. in length even in the largest specimens. The appendages of the anterior nectophores have still escaped a description and figure owing to their becoming detached before the specimens are examined. The canal system of the nectosac agrees with the description given by Bigelow. The lateral canals arise from the ventral canal and not from the circular canal.

The margin of the nectosac is bounded by three triangular teeth towards the dorsal side. The central one, dorsal, is smaller in size and more pointed than the other two which may be regarded as lateral. In addition to these teeth there are also two flap-like lappets, one on each side, between the lateral teeth and the large ventral flaps. These teeth are neither so small nor so triangular as figured by Bigelow, and when stretched out show that their margin is rather rounded. There are two large ventral flaps, each with a tooth-like projection on the inner margin, side by side, near the base. Lens and Riemsdijk figure two of the dorsal teeth as terminating in a globular knob, but I am inclined to regard the knob as the result of imperfect preservation.

Posterior Nectophore. The collection contains eight loose specimens; the largest measured 13 mm. in length and 5 mm. in width. The canal system agrees with Bigelow's description. The arrangements of the teeth and flaps around the margin is practically identical with those of the anterior nectophore. Bigelow states that the central dorsal tooth is larger than the two adjacent ones, but I found them to be all about the same size. In one specimen the central dorsal tooth was the smallest, as on the anterior nectophore. The two small flap-like lateral teeth are similar in shape and size with those of the anterior nectophore. There is only a single ventral flap, with two teeth in the same

position as in the anterior nectophore. The flap is like that of the anterior nectophore in shape and size, but it is not divided down the middle into two parts.

For the identification of this species it is important to count the number of teeth and flaps.

*Loc.* Chagos; Alphonse; Farquhar; Amirante. This species was first taken by Chun at the Canary isles. Lens and Riemsdijk found two specimens in the "Siboga" material from the Malay area, and Bigelow obtained many specimens from the Eastern Tropical Pacific and the Japanese area.

### 19. *GALEOLARIA CHUNI* Lens and Riemsdijk 1908.

*Galeolaria chuni* Moser 1925.

The characters of this species have been mentioned in the account given of *Galeolaria australis*, which it closely resembles, except in the size of the somatocyst.

The collection contains 13 loose anterior nectophores, the largest measuring about 7 mm. in length and 3 mm. in width. Eight specimens show a *Diphyes* type of canal system and three the normal *Galeolaria* type. The somatocyst is either thread-like or cylindrical, and is about half to two-thirds the length of the nectosac. All the specimens have a pair of baso-ventral flaps with rounded margins. The stem and appendages are missing. Badly preserved specimens of *Diphyes truncata*, which have lost their ridges, stand a good chance of being mistaken for this species.

Along with the posterior nectophores of *Galeolaria australis* I found five specimens (largest less than 10 mm. in length) with the baso-ventral flap having an entire margin without any indications of a median indentation. They have the normal *Galeolaria* canal system. If *G. chuni* should finally prove to be a good species, then one would expect its posterior nectophore to be slightly different from that of *G. australis*, and these nectophores may belong to it.

Moser (1925), from the material collected by the "Gauss" and others, recognises *Galeolaria chuni* as a distinct species. Both the anterior and posterior nectophores have been described and figured. The posterior nectophores which I picked out as likely to belong to this species agree with the figures given by Moser. According to Moser both nectophores have longitudinal ridges, but my specimens are too much contracted into longitudinal folds to make out for certain any definite ridges.

*Loc.* Chagos; Saya de Malha; Amirante; Farquhar. The "Gauss" found specimens along its course in the tropical zone of the Atlantic, and other specimens came from the Tortugas and from New Guinea.

### 20. *GALEOLARIA SUBTILIS* (Chun) 1886.

*Monophyes irregularis* Chun 1885; *Diphyes subtilis* Chun 1886, Lens and Riemsdijk 1908, Bigelow 1911; *Galeolaria subtilis* Moser 1925.

Chun's original description and figure of this species was placed under a wrong specific name, but this was subsequently changed by Chun himself to *D. subtilis*. It can easily be recognised by the form of its somatocyst which is a globular body on a long thread-like stalk.

The "Sealark" collection contains five anterior nectophores, the largest not exceeding 3·5 mm. in length. The apex of the nectophore is rounded and the longitudinal ridges,

owing to shrinkage and contraction, are more or less obliterated so that the specimens might easily be passed over as small *Galeolaria*.

The hydrœcium is bounded on the dorsal side by two small overlapping lobes, which project a little way below the margin of the nectosac. The basal surface of the hydrœcium slopes sharply upwards and there is practically no well-marked cavity, but just a depression. The right and left lateral margins of the hydrœcium are continuous with the two longitudinal ventral ridges of the nectophore, and a groove-like depression occupies the space between the ridges as they curve round the ventral corners of the hydrœcium.

The stem leaves the pedicular canal close to the dorsal lobes and on a level with the margin of the nectosac. The somatocyst is exactly like Chun's figure in three of the specimens. In the other two, one has a slightly thicker stalk and the other has a very short stalk, which may be due to the small size of the nectophore (2 mm. in length).

Moser has transferred this species to the genus *Galeolaria* on the finding of the posterior nectophore in the "Gauss" collection.

*Loc.* Chagos. This species is abundant at times in the Mediterranean, and it has also been taken in the Atlantic; near the southern boundary of the Indian Ocean, and off New Guinea.

## Sub-family **Diphyopsinæ.**

### 21. *DIPHYES APPENDICULATA* Eschscholtz 1829.

*Diphyes appendiculata* Huxley 1859, Bigelow 1911 and 1913; *Diphyes acuminata* Leuckart 1853; *Diphyes sieboldi* Kölliker 1853; *Diphyes gracilis* Gegenbaur 1853; *Diphyes bipartita* Mayer 1900; *Diphyopsis appendiculata* Agassiz and Mayer 1902.

The collection contains 82 loose anterior nectophores, and 14 loose posterior nectophores, but no eudoxids.

The anterior nectophore can be easily recognised by its having three longitudinal ridges meeting at the apex, and the fourth ridge (left lateral) beginning a little way below the apex. This character is constant in all the specimens which I have examined. The basal margin of the nectophore is without any dorsal or lateral teeth. The somatocyst is vertical, about three-quarters the length of the nectosac, and cylindrical, with a tapering towards the base into a slender stalk.

The posterior nectophore has also well-marked characters. The hydrœcial groove is closed over by a long flap from the left side and adhering to the right side, so that a closed tube is formed. In three specimens the flap had become unfastened.

*Loc.* Chagos; Mauritius; Nazareth; Saya de Malha; Farquhar; Amirante. This is one of the commonest Siphonophores and has a very wide geographical range. It had been previously taken in the Indian Ocean by Huxley and by Bigelow.

### 22. *DIPHYES CONTORTA* Lens and Riemsdijk 1908.

*Diphyes contorta* Bigelow 1911, 1913 and 1919, Moser 1925.

This species was first found by the "Siboga" Expedition in the Malay Archipelago, where it was fairly common and widely distributed. Lens and Riemsdijk could only describe the anterior nectophore as none of the specimens had the posterior nectophore developed beyond the bud-stage. In the collections of the "Albatross" from the Eastern Tropical Pacific (off the coasts of Mexico; Peru; Galapagos Isles), and from the north-western Pacific (Eastern Sea, Japanese area), Bigelow found this species represented by

anterior nectophores. The anterior nectophore has been well described and figured by the above-mentioned authors, and as it possesses well-marked characters it is quite easy to determine this species at a glance.

The "Sealark" collection contains 93 specimens of the anterior nectophore and many of them are in good condition. The average length of the nectophore is about 5 mm.; the largest one measured 8 mm. and the smallest 2·5 mm.

The characteristic feature of this species is the shape and position of the somatocyst which is a club-shaped organ on a long slender thread-like stalk. The stalk is straight, but the club turns over to the right and, when viewed ventrally, is seen to slope across the nectosac. The amount of bending over is variable; in some specimens it is a slight curvature, in others it is a twisting nearly to right angles with the stalk. At the end of the somatocyst there is frequently a globular mass of whitish (by reflected light) granules.

Another character useful for the determination of this species is the position of the serrated ridges of the nectophore. The two lateral ridges run from the apex to the base of the nectophore and their curvatures' outline is an oval dorsal facet. The ventral ridge comes from the apex, curves to the left, and becomes the left outer ridge of the hydrœcium, but the corresponding right ridge arises a little way below the apex, so that at the apex itself only three ridges meet. The ventral facet has a slightly twisted appearance owing to the curvatures of its ridges. The dorsal side of the shallow hydrœcium is bounded by two slightly overlapping wings, with serrated edges, and the outer edge of each is continuous with a non-serrated ridge which runs up the nectophore nearly to the apex. The nectosac is without basal teeth. The dorsal wall of the hydrœcium below the level of the nectosac is divided into two overlapping lobes, which are about equal in size.

One specimen shows very clearly the canal system of the nectosac, which was omitted in the previous descriptions given of this species owing to its not being visible. Three canals arise close together from the ring canal. The central one runs up the ventral side of the nectosac, curves over the top, and runs down the dorsal side to join again the ring canal. The other two are the right and left lateral canals and they run up nearly to the top of the nectosac, then curve sharply and proceed downwards to the ring canal.

The existence of a posterior nectophore has, hitherto, been only known by the presence of very young buds. I have one specimen with the posterior nectophore beyond the bud-stage, but it is still not quite sufficiently advanced to show definitely its fully developed characters. This nectophore is about 0—5 mm. in length. Around the mouth of the nectosac there are no traces of any lateral or dorsal teeth, but on the ventral side there is a small undivided projecting lobe, with two small terminal teeth. The hydrœcial cavity is wide open; the lower half of its left margin is fairly straight and the upper half has a bulging curve to the apex. The right margin has a conspicuous projecting tooth-like lobe situated about half-way up the hydrœcial cavity. If this little nectophore continued to develop on the lines already laid down, the hydrœcial cavity should be covered over by lobes somewhat similar to those of *Diphyopsis mitra* (see Bigelow, 1911, pl. 10, fig. 5, WH, 1; WH, 2).

The cormidia are not sufficiently advanced to give a clue to the eudoxid stage, which remains unknown.

*Loc.* Chagos; Mauritius; Nazareth; Farquhar; Saya de Malha; Amirante; Alphonse.

Moser obtained some specimens in the "Gauss" collection from the Atlantic and the southern part of the Indian Ocean. The anterior nectophore is figured and shows the characteristic shape and position of the somatocyst. *Diphyes gracilis* of Bedot (non Gegenbaur) has been placed by Moser as a synonym of *D. contorta*. (Reference given by Moser should read "Bedot, 1895, p. 370, pl. XII, figs. 4 and 8.") I do not think that one can link Bedot's specimen from *Amboina* with *D. contorta*. Its somatocyst in no way resembles the peculiar curved club-shaped somatocyst as found in *D. contorta*.

### 23. *DIPHYES MITRA* (Huxley) 1859.

*Diphyes mitra* Huxley 1859, Moser 1925; *Diphyopsis diphyoides* Lens and Riemsdijk 1908; *Diphyopsis mitra* Bigelow 1908; *Eudoxoides sagittata* Huxley 1859; *Eudoxia campanula* Lens and Riemsdijk 1908; *Eudoxia* (*Diphyes*) *appendiculata* Bigelow 1911.

This species was first found by Huxley in 1847 in the Indian Ocean, south-east of Mauritius, and his description of it was based upon a single anterior nectophore. Lens and Riemsdijk obtained a large number of anterior nectophores in the "Siboga" material from the Malay area, and they described them as a new species under the name of *Diphyopsis diphyoides*. Bigelow with specimens collected in the Eastern Tropical Pacific was able to make an advance. He has not only placed *D. mitra* on a sound footing, for Huxley's description and figure were rather imperfect, but he has also rightly connected *D. diphyoides* with it.

The "Sealark" collection contains three complete specimens, 140 loose anterior nectophores, four posterior nectophores and 36 eudoxids. The complete specimens measured about 11 mm. in length; the posterior nectophore is much smaller than the anterior one.

The anterior nectophore has five longitudinal ridges and all of them meet at the apex. The ridges are serrated and the serrations are large and conspicuous towards the basal end. One of the characteristic features of the nectophore is the presence of a single dorsal tooth on the basal margin, and the absence of any baso-lateral teeth.

The hydrœcium extends a short distance alongside the nectosac. It has a rather flat top which slopes slightly upwards towards the ventral side of the nectophore. The greater part of the hydrœcium is below the level of the margin of the nectosac. Its dorsal side is bounded by two slightly overlapping flaps and the left flap is provided with a secondary tooth-like flap, small in size and variable in shape, situated just inside the right margin. This little secondary flap is always present on the left flap and is a very useful aid for identifying this species. The basal outline of the hydrœcium is quadrangular with tooth-like projections at the four corners. The margin between these teeth is concave, the lateral margins being less curved than the dorsal and ventral margins.

The somatocyst does not exceed half the length of the nectosac. It is rather variable in shape, but always tapers towards the apex and is connected with the peduncular canal by a very short stalk. When fully developed, it has usually a broad base with sides gradually tapering towards the apex where there is often a small mass of whitish granules. None of the anterior nectophores exceeded 9 mm. in length.

The presence of perfect specimens in the collection has enabled me to definitely determine the posterior nectophore, which was first figured by Lens and Riemsdijk, who found some loose specimens in the "Siboga" material, but they were unable to

identify them. ("Loose inferior nectophores of Diphyopsinæ," p. 55, pl. 9, figs. 71, 72, 73.) Bigelow found an anterior nectophore having a posterior nectophore *in situ* at a sufficiently advanced stage to allow him to connect a loose posterior nectophore which had reached its full development. This connection has proved to be correct.

The posterior nectophore has certain distinctive characters by which it can be distinguished and it is necessary to notice them carefully so as to prevent confusion with another very similar posterior nectophore belonging to *Diphyes gracilis* Bedot (1895). There is a minute baso-dorsal tooth, similar to the baso-dorsal tooth of the anterior nectophore, only smaller in size. Like the anterior nectophore it has no baso-lateral teeth. The top of the nectophore, containing the top of the nectosac, stands out by itself away from the pedicel of the nectophore, and in between there is a kind of notch or groove into which fits the ventral side of the basal margin of the anterior nectophore's hydrœcium. The hydrœcial groove is open and partly covered by a flap from the left margin. Both sides of the hydrœcial groove have a conspicuous tooth formed by a break or sudden incurving of the margin. These teeth are absent in *Diphyes gracilis* Bedot which has even margins. The nectophore has a dorsal and two lateral longitudinal ridges all of which are serrated, and its length is about 4 mm.

Moser (1925) gives a figure of a complete specimen and also of the eudoxid. The figure of the anterior nectophore shows too much twisting of the ridges when compared with any specimens that I have seen, and at first sight looks like a different species. The figure of the posterior nectophore does agree with my specimens. Lens and Riemsdijk in their description of *Diphyopsis diphyoides* stated they had seen the bud of a "special nectophore or gonocalyx," but apparently that was a mistake according to Moser.

I had some difficulty in identifying certain eudoxids which had no special gonocalyx, and the figure which approached nearest to them was that of Bigelow's eudoxid of *D. appendiculata*. Now that I have seen Moser's figure of the eudoxid of *D. mitra*, I feel more certain about them, as their bracts have the long upright appearance as shown in that figure. So I have transferred these eudoxids from *D. appendiculata* to *D. mitra*. Moser gives a figure of the eudoxid of *D. appendiculata*, but I cannot find any specimens in the collection like the figure.

*Loc.* Chagos; Mauritius; Nazareth; Saya de Malha; Farquhar; Alphonse; Amirante. The distribution of *D. mitra* is wide, and it inhabits the tropical zones of the Indian, Pacific and Atlantic Oceans.

### 24. *DIPHYES FOWLERI* Bigelow 1911.

*Diphyes fowleri* Bigelow 1911, p. 346, pl. 28, fig. 5 (Biscayan Report), and p. 255, pl. 8, fig. 4, pl. 9, fig. 5 ("Albatross" Report). Bigelow 1918.

This species was first described by Bigelow from the Bay of Biscay, and again found by him in material collected in the Eastern Tropical Pacific and the West Indies. Up to the present only the anterior nectophore is known and it has a well-marked character by which it can be easily recognised. Its somatocyst lies at right angles to the longitudinal axis of the nectophore, and extends above the margin of the nectosac.

The collection contains 14 anterior nectophores; the largest measured 11 mm. in length and 4·5 mm. in width. The specimens show clearly all the characters mentioned by Bigelow.

The nectophore has five slight longitudinal ridges, and is without baso-lateral and dorsal teeth. The hydrœcium is well below the margin of the nectosac and the pedicular canal has to run downwards to it. The basal margin of the hydrœcium is rectangular, but a few specimens show a very slight depression on the ventral margin. The hydrœcial cavity is very small, funnel-shaped, and bounded on the dorsal side by two overlapping lobes (the right one a little larger than the left one) which scarcely project beyond the margin of the hydrœcium.

The somatocyst varies in shape but is always very small. Its position is best seen when it is rather cylindrical or pear-shaped as it then extends across the top of the hydrœcium, but its characteristic position across the top of the hydrœcium (see Bigelow, 1911, pl. 8, fig. 4) is not so easily recognised when it is spherical in shape. If the exact position of the somatocyst is not clearly recognisable, the position and shape of hydrœcium is the next best character to take. The stem of all the specimens, with its appendages, is either broken off or only the basal portion remains in a contracted condition. Two specimens have a minute bud of the posterior nectophore.

Moser (1925) has placed *D. fowleri* as a synonym of *Galeolaria truncata* Sars, but I fail to see that it has any connection with that species. The somatocyst, both in shape and position, is a distinctive character, sufficient to separate it from any other species.

*Loc.* Chagos; Farquhar; between Providence and Alphonse; Amirante. Bigelow calls attention to the fact that this species was rarely taken at the surface. The "Sealark" records show that it was taken in eight hauls and all were from 100 or more fathoms to the surface. None occurred in nets between 75 fms. and the surface.

### 25. *DIPHYES ARCTICA* Chun 1897.

*Diphyes arctica* Bigelow 1913; *Dimophyes arctica* Moser 1925.

The collection contains a single specimen of the anterior nectophore, taken between Providence and Alphonse (lat. 8° 16′ S., long. 51° 26′ E.) on 6th October 1905, and at this station the tow-net was working between 900 fms. and the surface.

Although the specimen agreed with Chun's description and figures I took the precaution to compare it with specimens from the Arctic Ocean (lat. 75° 48′ N., long. 13° 04′ W.). For these Arctic specimens I have to thank Dr Hjalmar Broch of Trondhjem who most kindly responded to my request for specimens.

The specimen is, fortunately, in very good condition. It is the anterior nectophore and measures 5·5 mm. in length and nearly 3 mm. in width; and is about half the maximum size of Arctic specimens. The nectophore has a rounded top and is without the slightest trace of any longitudinal ridges and without any teeth on the margin of the nectosac. The wall of the nectophore is very thin except on the ventral side where the somatocyst lies. The canal system is clearly visible and is similar to Chun's figure.

The character for distinguishing *Diphyes arctica* from the other species of the genus is the shape of the hydrœcium which is peculiar. The wall of the hydrœcium projects below the nectosac and its shape is something like the spathe of an arum lily, closed on the dorsal side but fully open on the ventral side. The hydrœcium of the Indian Ocean specimen is exactly like that of an Arctic specimen and agrees in every detail with Chun's figures. The somatocyst is long and slender, extending nearly two-thirds up the

nectosac, and is similar to that in Chun's figure 2. The stem is closely contracted and only the basal portion is left with a few appendages.

Moser in her new classification of the Calycophoræ has transferred this species to a new genus named *Dimophyes*, and into a new family called the Dimophyidæ. Specimens with the posterior nectophore *in situ* and also its eudoxid have been fully described by Moser.

Until the voyage of the "Gauss" this species was regarded as a typical Arctic species, not extending far outside the Arctic circle either in the Atlantic or the Pacific. Moser now records it over a wide area in the Tropical Atlantic Ocean and also in the Antarctic regions, showing clearly that it stretches across the oceans from Pole to Pole. An eudoxid taken at Port Natal is its only record for the Indian Ocean.

### 26. *DIPHYES SUBTILOIDES* Lens and Riemsdijk 1908.

The "Sealark" collection contains 11 anterior nectophores of this species, the largest not exceeding 6 mm. in length, the average size being about 5 mm.

The nectophore has a rounded or blunt apex, without any well-marked longitudinal ridges. According to the original description, the nectophore is smooth but marked with five very low longitudinal ridges. My specimens have longitudinal wrinkles due to contraction and quite sufficient to mask any ridges. There are traces of longitudinal lines, but they are too indefinite to be recognised as distinct ridges. The nectosac reaches nearly to the top of the nectophore, and its canal system is of the normal Diphyid type. The somatocyst in most of the specimens is ovoid, about one-quarter the length of the nectophore, and connected with the canal system by a minute stalk. Some of the specimens have the basal end of the stem left in a closely contracted condition. Three specimens possessed a minute bud which should develop into a posterior nectophore.

The margin of the hydrœcium is smooth and without any teeth or lobes, and it is circular. It extends downwards just beyond the margin of the nectosac and has a slight slope upwards as shown in Lens and Riemsdijk's figure No. 59. The basal surface of the hydrœcium is slightly convex in all the specimens, with the stem in the centre, so that there is really no hydrœcial cavity. Lens and Riemsdijk state that they found a bud of the future posterior nectophore and it was the only clue they obtained of its existence.

In the "Sealark" collection there are two little loose posterior nectophores, about 4 mm. long and 2 mm. wide, exactly alike and in good condition. The top of the nectophore has a circular margin, with a slight depression in the centre. It is just the kind of top which one would expect to see on the posterior nectophore of *D. subtiloides*. I selected two small anterior nectophores of *D. subtiloides* and placed these loose posterior nectophores in position and they fitted perfectly.

In these two posterior nectophores the hydrœcial groove runs the whole length of the nectophore. It is a deep groove going back to the nectosac, and looks just as if one had cut the jelly of the nectophore with a knife. Externally the nectophore is smooth, without any teeth or serrations. There is a longitudinal dorsal ridge present in both specimens, but it may be artificially formed by the shrinkage of the jelly. It is more likely that a living specimen would have a slightly convex dorsal facet, bounded by two lateral lines. The basal margin of the nectophore has a small projecting flap formed by

the prolongation of the walls of the hydrœcial groove. The nectosac is cylindrical and extends nearly the whole length of the nectophore. It has a straight, level top, and in the corner next the hydrœcial groove the pedicel canal enters. Four longitudinal canals run down the nectosac to the circular canal. Although these posterior nectophores have every appearance of belonging to *D. subtiloides*, still we have so far no definite proof, which can only be obtained by the finding of a perfect specimen with both nectophores in union.

*Diphyes subtiloides* is one of the new species taken by the "Siboga" Expedition to the Malay Archipelago, where over 100 anterior nectophores were found.

Bigelow (1913) in his report on the Siphonophores from the north-western Pacific has placed *Diphyes subtiloides* as a synonym of *Diphyes truncata* Sars. Mr Bigelow was kind enough to send me a specimen of *D. truncata* from the Behring Sea, and after comparing it with my specimens of *D. subtiloides* I felt quite certain that the two species are absolutely distinct. I believe that Bigelow has been led astray by Lens and Riemsdijk's figure No. 60, which shows a broad depression on the ventral side of the hydrœcium. In all my specimens the margin of the hydrœcium is distinctly circular, without any indentation or a groove, and this is shown in Lens and Riemsdijk's figure No. 61. Moreover the nectophore of the specimen from the Behring Sea has well-marked, conspicuous ridges, such ridges are not present in *D. subtiloides*.

Moser (1925), in the synonymy of *Galeolaria truncata* Sars, has also placed *D. subtiloides*, but I cannot agree to this.

*Loc.* Chagos; Mauritius; Farquhar; Amirante.

27. *DIPHYES BIGELOWI* nomen novum.

*Muggiœa kochii* Bigelow 1911, *Trans. Linn. Soc. Lond.* Vol. x, p. 340 (Biscayan collection) and *Mem. Mus. Comp. Zool.* Vol. xxxviii, p. 188, pl. XII, figs. 2—4 (Eastern Tropical Pacific collection).

In this collection there are five specimens of a species which I regarded at one time as being quite new, but fortunately I received from Mr Bigelow three specimens which he had himself identified as *Muggiœa kochi* Will. These came from the Bay of Biscay and were a part of the collection made by Dr G. H. Fowler in 1900, and reported upon by Mr Bigelow. The specimens from the Bay of Biscay are identical with mine from the Indian Ocean. Unfortunately the specimens do not agree with the descriptions and figures of *Muggiœa kochi* of Will (1844), Busch (1851), Chun (1882), and Moser (1925). After due consideration I have decided to leave all these under their old name, and to re-name my specimens after Mr H. B. Bigelow, and thereby get out of a tangle.

The re-christened specimens (*D. bigelowi*) which I have placed in the genus *Diphyes*, as the shape of the hydrœcium is not in favour of their being a *Muggiœa*, have one character which has escaped notice. The anterior nectophore has five longitudinal ridges meeting at the apex, and also two more long ridges which do not come up to the apex, so there are altogether seven ridges. These seven ridges I have seen quite clearly in the specimens from the Bay of Biscay sent to me by Mr Bigelow. *Muggiœa kochi* has always been described with only five ridges. Another character, which so far has not been fully considered and made the most of, is the shape and the position of the hydrœcium. The shape of the hydrœcium as figured by Busch, Chun, and Moser, shows

a rather deep bell-shaped cavity into which the stem and its appendages could contract, with no groove on the ventral side, and also that the top of the hydrœcial cavity is well above the margin of the nectosac. In the figure by Will, which is the figure of the type species, the top of the hydrœcial cavity is on a level with the margin of the nectosac and in this respect it resembles the position of the hydrœcium of *Diphyes bigelowi*. However, as the general shape of the hydrœcium is not similar to that of *D. bigelowi*, I think it is best to associate it with *M. kochi* of Busch, Chun, and Moser, and regard it as the type species, rather than use that name for the specimens which I am dealing with, and thereby save further confusion.

Bigelow in his Biscayan Report states that his *Muggiœa kochi* has five prominent ridges on the nectophore, but his specimens, as I have pointed out, show seven. The hydrœcium lies wholly below the level of the nectosac, whereas the figures of Busch and Chun whose names appear in his synonymy show clearly that the hydrœcium is above the margin of the nectosac. Bigelow in his report on the Eastern Tropical Pacific Siphonophores states that the specimens from the eastern Pacific are identical with those from the Bay of Biscay, and he also gives good figures of them. These figures show very clearly the general appearance of the species and especially the position and shape of the hydrœcium, but no mention is made of the extra two ridges, which have still escaped his notice. Bigelow (1913) after the examination of the Siphonophores from the north-western Pacific decided that his specimens mentioned above under the name of *Muggiœa kochi* are not that species, but are *Diphyes truncata* Sars. Mr Bigelow very kindly sent me a specimen of *Diphyes truncata* Sars from the Behring Sea. I found that it had only five ridges on the nectophores instead of seven so that it could not be identical with the Biscayan specimens. But it does somewhat resemble *D. bigelowi* in the shape and position of its hydrœcium.

I may here remark, in passing, that I do not think that Bigelow's *Diphyes truncata* from the Behring Sea is identical with the true *Diphyes truncata* of Sars, unless I have wrongly identified specimens in my own collection from the Faeroe Channel and off the west coast of Ireland. His specimen shows that the hydrœcium has a groove on the ventral side, and there is a distinct hydrœcial cavity, whereas the specimens which I call *D. truncata* have the margin of the hydrœcium distinctly rectangular, without any groove on the ventral side, and there is no hydrœcial cavity.

Bigelow has also linked under *D. truncata* as a synonym *Diphyes subtiloides* Lens and Riemsdijk, but elsewhere in this report I have given reasons for recognising *D. subtiloides* as a good species.

*Description of the Anterior Nectophore.* The nectophore is conical in shape with rather thin walls. It has seven ridges, of which five meet at the apex and two terminate a little way below the apex. A dorsal ridge runs from the apex to the basal margin; two lateral ridges run from the apex and terminate just above the basal margin; two ventral ridges run from the apex down to the hydrœcium and form the ventral corners of the hydrœcium. The other two ridges are situated between the lateral and the ventral ridges, one on each side of the nectophore, and about in line with the dorsal margin of the hydrœcium. They are a little shorter than the five principal ridges, beginning just below the level of the top of the nectosac and terminating a little farther from the basal

margin than the principal lateral ridges. All the ridges show slight serrations along the lower half of the nectophore, but on the upper half they are usually smooth.

The nectosac is large and has a conical top. Its basal margin is without teeth. The canal system belongs to the Diphyid type, a dorso-ventral canal and a pair of looped lateral canals. The somatocyst extends about half-way up the nectosac. It is long and slender, on a long thread-like stalk, or short and thick, sausage-shaped, on a short stalk.

The hydrœcium is very small, and is just below the level of the margin of the nectosac. It is bounded on the dorsal side by two lobes. On the ventral side there is a deep groove which runs a little way up the nectophore, between the two ventral ridges. Owing to the groove the hydrœcium is not closed in on the ventral side. Except for the two lobes on the dorsal side the margin of the hydrœcium is smooth, being without teeth.

All the specimens have the stem either completely or very closely broken off. The largest nectophore measured 12 mm. in length and 5 mm. in width.

*Loc.* Chagos, 0—600 fms., 1 specimen; Amirante, 0—750 fms., 2; 0—400 fms., 2.

28. *DIPHYOPSIS DISPAR* (Chamisso et Eysenhardt) 1821.

*Diphyes dispar* Chamisso et Eysenhardt 1821, Huxley 1859, Lens and Riemsdijk 1908; *Eudoxia lessoni* Huxley 1859, Fewkes 1881; *Diphyes campanulifera* Gegenbaur 1860; *Diphyopsis compressa* Haeckel 1888; *Ersœa compressa* Haeckel 1888; *Doramasia picta* Chun 1892; *Diphyopsis campanulifera* Mayer 1900, Lens and Riemsdijk 1908; *Ersœa lessoni* Mayer 1900, Lens and Riemsdijk 1908; *Diphyopsis angustata* Agassiz and Mayer 1902; *Ersœa angustata* Agassiz and Mayer 1902; *Diphyes nierstraszi* Lens and Riemsdijk 1908; *Diphyopsis anomalia* Lens and Riemsdijk 1908; *Diphyopsis dispar* Bigelow 1911.

The collection contains two complete specimens, 55 loose anterior nectophores, nine loose posterior nectophores and about 25 eudoxids. This is a well-known species with a good list of synonyms. When the specimens are large it is quite easy to recognise the species on account of the great width of the nectophores, but small specimens are liable to be confused with *Diphyes bojani*. If attention be paid to the following characters the difficulty of determining small specimens may usually be overcome.

In *D. dispar* the nectosac of the anterior nectophore is prolonged into a distinct canal-like tube. The top of the hydrœcium curves outwards towards the ventral side, and the somatocyst slopes inwards towards the nectosac.

In *D. bojani* the nectosac is more conical at the apex. In some specimens it is distinctly conical; in others it may be prolonged into a short tube, something like that of *D. dispar*. When the apex of the nectosac approaches *D. dispar* in appearance, it is best to look at the position of the hydrœcium and the somatocyst. In *D. bojani* there is no curving of the hydrœcium over to the ventral side, and consequently the somatocyst is nearly perpendicular and keeps alongside the nectosac.

The posterior nectophores of these two species are also very much alike, especially when that of *D. dispar* is small in size. The easiest and safest method of distinguishing them is by observing the shape of the flap which covers over the hydrœcial cavity. In *D. dispar* the two sides, at the top, meet in the middle, and are sometimes joined or stuck together; then from this point the margin of the flap curves over to the right side of the hydrœcium. In *D. bojani* the left side overlaps the right side at the top and the margin of the flap is straight.

One of the specimens in the collection is like Chun's figure (1892, Taf. 8, fig. 3) of

*Doramasia picta.* I have but little doubt that *D. picta* is only a small *D. dispar*, especially as the specimen shows a bud for a posterior nectophore.

The largest anterior nectophore in the collection measured 20 mm. in length and 10 mm. in width, and the largest posterior nectophore was 18 mm. in length and 8 mm. in width.

The eudoxid stage is well known and may be distinguished by the presence of a "special nectophore" and a medusiform gonophore with a fully developed umbrella. The bract, when denuded of its nectophore and gonophores, may be distinguished by its lateral edges being smooth and curving more or less inwards. The bract may easily be confused with that of *D. chamissonis*, which has rather straight lateral edges, with usually a slope outwards towards the base, and a shallow concavity in the jelly between the edges.

*Loc.* This species is widely distributed throughout the tropical and warm regions. It was taken very many times throughout the cruise of the "Sealark."

### 29. *DIPHYOPSIS BOJANI* (Eschscholtz) 1825.

*Eudoxia bojani* Eschscholtz 1825, Huxley 1859; *Ersœa bojani* Chun 1892, Lens and Riemsdijk 1908, Bigelow 1911; *Ersœa picta* Chun 1892; *Doramasia bojani* Chun 1892; *Diphyes indica* Lens and Riemsdijk 1908, *Diphyes malayana* Lens and Riemsdijk 1908; *Diphyes gegenbauri* Lens and Riemsdijk 1908; *Doramasia pictoides* Lens and Riemsdijk 1908; *Diphyes bojani* Bigelow 1911, Moser 1925; *Diphyopsis bojani* Bigelow 1919.

The collection contains one complete specimen with anterior and posterior nectophores *in situ* (15 mm. long), 45 loose anterior nectophores (largest 14 mm. in length and 4 mm. in width), 13 loose posterior nectophores (largest about 10 mm. long) and 54 eudoxids.

Bigelow has given a nice series of figures of this species so that its identification has become fairly easy. He has also connected with it no less than four species described by Lens and Riemsdijk, who apparently tried to separate their imperfect specimens rather than unite them. These superfluous species show clearly all the characters of *D. bojani*, and some of their figures are very much like the specimens in this collection.

*Diphyopsis bojani* is liable to be confused with *Diphyopsis dispar*, and in my account of the latter species I have tried to show how to distinguish them. According to Bigelow and Moser there is a row of small teeth situated on a vertical crest in the middle of the dorsal wall of the hydrœcium, and by the aid of these teeth it is easy to distinguish *D. bojani* from *D. dispar*. In my specimens in the same position is a thickening of the jelly into a kind of broad ridge and at the marginal end of it there is usually one spine or tooth, occasionally two, rarely three, and sometimes none at all.

The anterior nectophores have a long slender appearance. The nectosac is prolonged into a tube-like extension, which nearly reaches the apex of the nectophore. The somatocyst is long and varies somewhat in shape and thickness. It runs alongside the nectosac and reaches nearly to the top of it. The figures given by Lens and Riemsdijk of *D. malayana*, *D. indica* and *D. gegenbauri* illustrate the specimens found in this collection.

*Loc.* Chagos; Mauritius; Saya de Malha; Farquhar; Alphonse; Amirante. The species is widely distributed in the warm and tropical regions of the Atlantic, Pacific and Indian Oceans.

30. *DIPHYOPSIS CHAMISSONIS* (Huxley) 1859.

*Diphyes chamissonis* Huxley 1859, Browne 1904, Moser 1925; *Diphyopsis weberi* Lens and Riemsdijk 1908; *Diphyopsis chamissonis* Bigelow 1913.

Lens and Riemsdijk unaccountably failed to recognise this species from Huxley's original description and figures, so they have described it again as a new species under the name of *Diphyes weberi*. I agree with Bigelow that *D. weberi* is undoubtedly Huxley's *D. chamissonis*.

The "Sealark" collection contains seven anterior nectophores (largest not exceeding 8 mm. in length) taken at seven different stations. It was evidently very scarce in the Indian Ocean at the time of the cruise, and records show that either only a few specimens are taken or a large number.

The species can be recognised by the great length of the cavity of the hydrœcium which extends about half-way up the nectosac. The cylindrical somatocyst is not so long as the hydrœcium. The opening of the hydrœcial cavity is well below the level of the margin of the nectosac, and its basal margin is rectangular and has a slight slope upwards. The dorsal and ventral sides of the hydrœcial margin are deeply curved, more so on the ventral side than on the dorsal side, but the lateral sides are fairly straight. The nectophore has externally five longitudinal ridges. One dorsal and two lateral teeth are situated on the margin of the nectosac.

The posterior nectophore is still unknown, but a bud denoting the existence of one has been detected by Lens and Riemsdijk, and I am able to confirm its presence.

Some of the specimens have a nice series of appendages upon their stem, but the oldest cormidium is not sufficiently advanced to provide a clue to the eudoxid stage, as the bracts have not passed beyond the stage figured by Huxley.

*Loc.* Chagos; Cargados Carajos; Farquhar; Alphonse; between Providence and Alphonse; Amirante. The species is well distributed over the Indo-Pacific Oceans, but it has not been found in the Atlantic.

### AN EUDOXID OF A *DIPHYOPSIS* PROBABLY BELONGING TO *D. CHAMISSONIS*.

After the preliminary sorting of the specimens of the whole collection, I found that I had placed in the same bottle under the name of *Diphyopsis dispar* some eudoxids which evidently did not belong to that species. Though very much like the eudoxids of *D. dispar* in appearance they possessed certain characters by which they could be distinguished from them. I believe that I am now able by circumstantial evidence to show their connection with the polygastric generation of *D. chamissonis*, but it must be clearly understood that I have no direct proof.

Some years ago Mr James Hornell kindly sent me some bottles containing plankton taken during December 1905, along the coast of Okhamandel, Gulf of Cutch, on the western coast of India. In that series of tow-nettings I found two species of Siphonophores, namely, *Bassia bassensis* and *Diphyopsis chamissonis*, and along with them a large number of eudoxids, which looked very much like the eudoxid of *D. dispar*. It was evident that *D. chamissonis* and this eudoxid were quite common along the coast of Okhamandel during the month of December, but there was no trace of the polygastric generation of *D. dispar*, nor of any other Diphyid, except *Bassia*. I suspected, at the

time, that these eudoxids had some connection with *D. chamissonis*, but as none of the specimens were in good condition I failed to determine them with any degree of certainty.

In the "Sealark" collection many of the eudoxids in the bottle labelled "*D. dispar*" were in good condition, so that the material could be relied upon. On comparing, side by side, the eudoxids from Okhamandel with those in the "Sealark" collection, I soon discovered that there were two distinct species in the bottle labelled "*D. dispar*." One species, without doubt, being *D. dispar*, and the other identical with all the eudoxids from Okhamandel. If one were examining living specimens of these two species of eudoxids, it is probable that they would at once have been recognised as distinct species, and one would have had no difficulty about finding characters suitable for their identification. In the case of preserved specimens it is often otherwise, as one does not know how much may be safely allowed for changes due to preservation, contraction and general shrinkage. They often considerably alter the shape of such soft-bodied animals. It was, afterwards, clear to me that I had made too great an allowance for the results of preservation when I sorted out the eudoxids of *D. dispar* and consequently I mixed the two species.

When the bracts only are compared together the differences seen are very slight. In *D. dispar* the two sides, over the upper and solid part of the bract, curve more or less inwards towards one another, and the space between the edges lessens towards the bottom. In the other species the two sides are more or less straight with a tendency to widen outwards towards the bottom. The gelatinous surface between the edges is distinctly concave, but in *D. dispar* it is usually flush with the edges or even convex.

Both eudoxids have a "special nectophore." The top of the special nectophore of *D. dispar* is lower down the bract than that of the other species, and this brings about a very useful character, which is quite constant, for separating at a glance the two species.

The canal leading from the bract to the "special nectophore" runs downwards in *D. dispar*, and the apex of the nectosac is below the level of the place where the canal leaves the bract. In the other species the canal has a course nearly horizontal and the tip of the nectosac is entirely above the level of the canal.

The gonophores of *D. dispar* have a fully developed umbrella, with marginal teeth, but in the other species the umbrella is absent. This is a distinct character when the gonophores are present, but when they are absent then the position of the above-mentioned canal is a safe guide.

The "Sealark" collection contains ten specimens of this eudoxid; the largest measured 5·5 mm. in length and 2 mm. in width. The largest specimen from Okhamandel measured 7·5 mm. in length and 2·5 mm. in width. The somatocyst is usually long and cylindrical, but it varies very much in shape and size.

Moser (1925) gives a figure of the eudoxid of *Diphyopsis chamissonis* and my specimens agree with it, thereby confirming my identification of the eudoxids taken at Okhamandel and in this collection.

## PHYSOPHORÆ.

### 31. *AGALMA OKENI* Eschscholtz 1825.

*Agalma breve* Huxley 1859; *Crystallodes vitrea* Haeckel 1888; *Agalma pourtalesii* Mayer 1900; *Crystallomia polygonata* Lens and Riemsdijk 1908; *Agalma okeni* Bigelow 1911.

There are seven specimens, the longest being less than 20 mm. in length, and all in bad condition through the loss of nearly all their nectophores and bracts. The nectophores are angular externally and the nectosac is prolonged into two lateral lobes. The bracts are solid and thickest on the distal side. Two show the characteristic thick margin shaped in facets as figured by Bigelow (1911, pl. 17, fig. 10). All the specimens have tricornuate tentilla. No gonophores present.

*Loc.* Mauritius; Farquhar. This species inhabits the tropical and warm regions of the Atlantic and Indo-Pacific Oceans.

### 32. *AGALMA ELEGANS* (Sars) 1846.

*Agalmopsis elegans* Sars 1846 partim; *Agalmopsis sarsii* Kölliker 1853; *Agalma sarsii* Leuckart 1854; *Agalma elegans* Fewkes 1881, Bigelow 1911.

A single specimen, from Chagos Archipelago, contracted within 3 mm., is probably *Agalma elegans*. It has lost all its nectophores, but has a small bract left. The bract belongs to the type found on *A. elegans*; it is rather thin and leaf-shaped, but thick in the middle. The tentilla belong to the tricornuate type.

This is a well-known species in the North Atlantic and Mediterranean.

It has been recorded by Bedot for the Malay area and by Bigelow for the Eastern Tropical Pacific.

### 33. *ANTHOPHYSA ROSEA* Brandt 1835.

*Anthophysa formosa* Lens and Riemsdijk 1908; *Anthophysa rosea* Bigelow 1911.

A single colony was taken at the surface off Saya de Malha Banks. Owing to the poor condition of the specimen it is difficult to make a satisfactory determination of the species. It is probably *Anthophysa rosea*. The twisting of the bracts round the pneumatophore and the absence of any definite stem indicate the genus *Anthophysa*. The colony is less than 5 mm. in diameter, and it has a few male gonophores. It is widely distributed in the tropical regions and was taken by the "Siboga" in the Malay area.

### 34. *RHIZOPHYSA EYSENHARDTI* Gegenbaur 1860.

*Rhizophysa filiformis* Huxley 1859 (non Forskål); *Rhizophysa eysenhardtii* Gegenbaur 1860, Fewkes, 1883, Lens and Riemsdijk 1908, Bigelow 1911; *Nectophysa wyvillei* Haeckel 1888, Agassiz and Mayer 1902.

A single specimen was taken off Saya de Malha and preserved in alcohol. It is in a fairly good state of preservation, but has apparently lost most of its appendages. From the size of the pneumatophore (3 mm. in length and 2 mm. in width) it is a small specimen though not a young one, as two fairly advanced gonodendra are present upon the contracted stem. There are also a siphon and a tentacle upon the stem. The tentacle has the appearance of not having completed its development. At its distal end is a filiform tentillum and close by a row of small protuberances which are probably *tentilla* at an early stage of development.

This species was taken by Huxley in the Indian Ocean, and it has been recorded from the Malay area; and from the Tropical Pacific and Tropical Atlantic Oceans.

### 35. *PHYSALIA UTRICULUS* (La Martinière) 1787.

*Medusa utriculus* La Martinière 1787; *Physalia utriculus* Huxley 1859, Lens and Riemsdijk 1908, Bigelow 1911.

There are 35 specimens of *Physalia* in the collection and many of them are in very good condition. They form a series of small specimens with pneumatophores from 10—50 mm. in length. All have one main tentacle and a number of small tentacles, which do not approach in length and thickness the great main tentacle. Many of the specimens have gonodendra in different stages of growth, but none show the fully-ripe adult condition.

Lens and Riemsdijk call attention to a "remarkable polypoid structure" possessing a mouth and situated on the main stem of a gonodendron. The organ is, no doubt, a siphon (gastrozooid) as they have suggested. They have, however, put forward a view, on the strength of the presence of this siphon, that the main branch of the gonodendron is a part of the stem of the siphosome and that the side branches are real gonodendra. I have found a gonodendron with two siphons, one above the other, not on the same branch. The occurrence of one or two siphons on the gonodendra is not uncommon and it is quite likely that a gonopalpon may at times develop into a siphon.

There are probably only two species of *Physalia*; one, *P. utriculus*, with one main tentacle inhabiting the Indian and Pacific Oceans; the other, *Physalia physalis* Linn., with several main tentacles, belonging also to the Atlantic fauna.

As *Physalia* is completely at the mercy of the winds, having no means of sinking below the surface, it drifts hither and thither in the tropical oceans. Sometimes shipwrecked by the thousands on a lee shore, sometimes drifted far away into the cold water areas where it must slowly die. At Diego Garcia in the Chagos Archipelago *Physalia* was washed ashore and formed a piled-up ridge over a foot broad.

### 36. *VELELLA* sp.

There are five small *Velella* in the collection, but they are too young and small for making a satisfactory determination of the species. The largest measured 13 mm. in length and 9 mm. in width. It has a triangular crest about 7 mm. high. The margin of the disc has an oval outline. Two specimens have a N.W. crest and three have a S.W. crest.

Bigelow recognises at least two species, namely, *Velella velella* Linn. for the Atlantic, and *V. lata*, Chamisso et Eysenhardt, for the Pacific. We have still to find out whether a third species inhabits the Indian Ocean, or whether this *Velella* is similar to one of the above-mentioned species.

During the cruise of the "Sealark" in the Indian Ocean there must have been a scarcity of *Velella*, but it is interesting to note that the "Siboga" in her long cruise through the Malay Archipelago only obtained five small specimens.

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