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MEDUSAE AND SIPHONOPHORAE COLLECTED BY THE U. S. FISHERIES STEAMER "ALBATROSS" IN THE NORTHWESTERN PACIFIC, 1906.

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INTRODUCTION.

The medusae and siphonophorae described in the following pages were collected by the U. S. Fisheries steamer *Albatross* chiefly in the northwestern Pacific, Bering Sea, the Sea of Okhotsk, and the Sea of Japan during the summer of 1906. The itinerary of the cruise will be found in the Report of the Commissioner of Fisheries for 1906, but for the convenience of the reader the localities of the stations at which medusae were taken are tabulated below.

The material as a whole is in excellent condition, and I am indebted to Dr. H. B. Torrey for the use of his field notes.

The collection comprises 58 species of medusae and 22 of siphonophorae, of which only 5 species and 1 variety of medusae are new. But the paucity of the new species is no index to the value of the collection, because two of them are interesting additions to the mesoplankton, while additional data on most of its members are very welcome, and the opportunity to compare them with their nearest allies in the Atlantic has afforded much information of zoogeographic interest.

There are no new siphonophores; but the collection contains a series of the genus *Clausophyes* previously known only from a fragment (Lens and Van Riemsdijk) and from one record which has long been regarded as problematical. The genus proves to be of great anatomic interest.

The collection also shows that the species earlier described by me (1911*b*) as "*Muggiaea kochii* Will" is the *Diphyes truncata* of Sars—a discovery of geographic interest.

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Synonymies are omitted here as a rule, references for earlier literature being given to Dr. A. G. Mayer's Monograph of the Medusae, where complete lists will be found. Similar synonymies for the siphonophores will be found in my report on the eastern Pacific collection (1911*b*).

LOCATION OF STATIONS.

(For complete list see Report of the U. S. Commissioner of Fisheries, 1906.)

4757–4762, line San Francisco to Unalaska Island.
4763–4780, Bering Sea.
4781–4783, western Aleutian Islands.
4784–4793, line from western Aleutians to Kamchatka by way of Komandorski and Bering Island.
4794–4797, off the southeast coast of Kamchatka.
4798–4800, Sea of Okhotsk.
4801–4806, east of Kurile Islands.
4807–4810, Hakodate Strait (Tsugaru Strait).
4811–4882, Sea of Japan.
4883–4936, Eastern Sea.
4937–4945, Kagoshima Gulf.
4946–4960, off the east coast of Kiushiu Island, Japan.
4961–4980, south coast of Nipon, line Kobe to Yokohama.
4981–4996, Sea of Japan.
4997–5004, Gulf of Tartary.
5005–5013, Aniva Bay, Sakhalin Island.
5014–5030, Sea of Okhotsk.
5031–5033, Yezo Strait.
5034–5045, off the southeast coast of Hokkaido.
5046–5052, east coast of Hondo.
5053–5077, Suruga Gulf.
5078–5084, east coast of Hondo.
5085–5095, Sagami Bay.

Class HYDROMEDUSÆ.

Order ANTHOMEDUSÆ.

Family SARSIIDÆ Forbes emended.

Family CODONIDAE Haeckel.

The name Codonidae is commonly employed for this family, but it must be abandoned, because *Codonium* is a synonym of *Sarsia*.

Genus SARSIA Lesson.

This genus is represented in the collection by two species, *S. eximia* Allman and *S. japponica* Maas, belonging to what Hartlaub (1907) has named the "*eximia*" group, in which the manubrium is short and is clothed with genital products from close to its base to near the lip, and one, *S. princeps*, classed by him in the "*tubulosa*" group, in which the manubrium is long, and the gonad leaves the distal portion bare. The following species, *brachygaster* Grönberg, *barentsi* Linko, *prolifera* Forbes, *radiata* von Lendenfeld, and *angulata* Mayer, are all so closely allied to *eximia* that it is questionable whether any of them are actually distinct. Thus I can find nothing in Grönberg's (1897) figure to separate *brachygaster* from *eximia*. The only difference is that in the latter the ocelli, at first black, change to carmine with growth, while in *brachygaster* they retain their black color, and I doubt whether so slight a difference is a basis for specific separation. *Sarsia barentsi* is insufficiently described; but although Mayer (1910, p. 53) believes that it is probably a young stage of *S. tubulosa*, it has a short manubrium and might equally belong to *eximia*. *S. prolifera*, in which medusa buds are formed at the bases of the tentacles, is a puzzling form, which may be the young, or a budding phase, of some other *Sarsia*, as already suggested by Browne (1896). Like *eximia*, it has a short manubrium and well-developed ocelli. *S. radiata* von Lendenfeld (1884), from Australia, likewise resembles *eximia* in the structure of its manubrium, but unfortunately it is doubtful whether or not ocelli are present. The hydroid is certainly very closely allied to *S. eximia*, with which the hydranths agree in the arrangement of tentacles and medusa buds, the only differences of importance being that the hydranths arise directly from a creeping hydrorhiza. *S. angulata* Mayer may be a variety of *eximia;* its hydroid is not known. *S. resplendens* Bigelow, from the west coast of Mexico, was described as a new species because of its short tentacles, each with a few large nematocyst swellings; and, as it was studied alive, these characters can be assumed to be normal. It is likewise characterized by a very brilliant coloration. Mayer (1910) suggests that it is really *eximia;* and it is possible that it may prove to be a variety of that species. But until it is better known, and especially till its hydroid is described, it may be retained provisionally.

S. flammea and *S. japonica* lack ocelli, a character separating them from *eximia*, which they otherwise resemble in general appearance. They are closely allied to each other; but Maas (1909, p. 6), who has examined specimens of both, believes that they can be separated by the fact that in *flammea* the sexual products are arranged in a network ("Gitterwerke") over the walls of the manubrium, while in *japonica* they are irregularly massed here and there, though leaving

no part of the manubrium definitely free except its two extremities. It is doubtful whether larger series would show that this slight difference is of much importance; but as no specimens of *flammea* have been available for study, the name *japonica* is retained here.

SARSIA EXIMIA (Allman).

Coryne eximia ALLMAN, 1859, p. 141.

Dutch Harbor, May 25, surface; 5 specimens, 4–10 mm. high; in excellent condition.

Petropaulski, June 19, surface; 1 specimen, 8 mm. high; manubrium torn off.

These specimens agree very well with the various figures of *eximia*. Hartlaub (1907) has given so full an account that no description is called for here further than to point out the more important specific characters. Chief among these is the structure of the manubrium, correlated with the presence of ocelli. In all the *Albatross* examples the manubrium is entirely contained within the bell cavity; and in view of the fact that the specimens are expanded as a whole, as is shown by the condition of the tentacles, it appears that the manubrium was short in life. The smallest individual is a female, with large eggs; the others are males; in all of them the gonads occupy the whole of the manubrium, except the lip, and a very short region at the base, so that, as Hartlaub (1907) has pointed out, there is no such distinction into genital and nutritive zones as there is in *S. tubulosa*. There is no trace of an apical canal or chamber in any of the specimens.

Color.—The ocelli are now pale reddish-brown; the manubrium pale orange. Otherwise the specimens are colorless. No color notes were made from life, so that it is quite possible that the bases of the tentacles were pigmented before preservation.

Sarsia eximia has been recorded from numerous localities on the coasts of Great Britain; from the coasts of Normandy and Brittany, Iceland, and Norway; and its hydroid is already recorded from Juneau, Alaska, by Nutting (1901) and from California by Torrey (1902). If the records of *S. brachygaster* are added, as I believe should be done, then Spitzbergen and West Greenland ought to be included; and if *barentsi* be included, the distribution of the species is extended nearly to Nova Zembla.

SARSIA JAPONICA Maas.

Sarsia japonica MAAS, 1909, p. 6, pl. 1, fig. 1.

Station 4783; about 35 specimens, the largest about 8 mm. high. The specimens were so inextricably tangled with one another and with copepods that only about 10 were separable from the mass. All are much contracted, and most of them more or less damaged.

The only important respect in which they differ from Maas's figure is that the manubria fill the bell cavities almost entirely; but this is

evidently the result of the contraction of the bell as a whole. The short manubria, irregular arrangement of the sexual products over its wall and absence of apical canal and ocelli are all easily distinguished.

Color.—In formalin, manubrium and tentacle bases are pale brownish. The original records of *japonica* were from Todohokke and Hokkaido, Japan.

SARSIA PRINCEPS (Haeckel).

Codonium princeps HAECKEL, 1879, p. 13, pl. 1, figs. 1, 2.

(For synonymy, see Mayer, 1910, p. 60.)

Station 3604, southern Bering Sea, August, 1895; surface; 1 specimen, about 30 mm. high.

The single example is flattened, and its manubrium so strongly contracted, that it is a mere knob; but the specimen is readily identified by the long "still-canal" and by the irregular margins of the radial canals though the latter are somewhat less pronounced than in a specimen from Newfoundland (1909, p. 303), as well as by its large size.

For a list of occurrences of this species, which include Newfoundland, Greenland, Davis Strait, Spitzbergen, the White Sea, and Barents Sea, see Hartlaub (1907, p. 49).

Genus HYBOCODON L. Agassiz.

The medusae of this genus may be almost indistinguishable although budded off from hydroids which are perfectly distinct; for example, the medusae of *H. christinae* Hartlaub closely resemble those of *H. prolifer* Agassiz, but the hydroids of these two species can not be confused, because in the former the medusa buds are borne singly, in the latter on stolons. The following North Atlantic species are listed by Hartlaub (1907), who has made the most thorough study of the genus: *pulcher* Saemundsson, *prolifer* L. Agassiz, *christinae* Hartlaub, *gravidum* Linko, *islandicum* Greene, and *amphipleurus* Haeckel; but as Mayer (1910) has noted, it is probable that *gravidum* and *islandicum* are synonyms of *prolifer* (of neither of them is the hydroid known); and *amphipleurus* is known from only a single specimen (medusa).

H. prolifer is very abundant off the coasts of New England; and medusae recorded under that name have been taken by hundreds in northern European waters, but the *prolifer* hydroid has not been found on the eastern side of the Atlantic.

Three other Hybocodons have been described, *H. unicus* Browne from the Falkland Islands (medusa only); *H. chilensis* Hartlaub from the Chilean coast (hydroid only), and *H. occidentalis* Fewkes from the coast of California (medusa only). *Chilensis* is allied to the

pulcher-christinae group; *unicus* is insufficiently known; it may belong to *chilensis*, as suggested by Browne (1902) and Mayer; *occidentalis* is indistinguishable from *prolifer* so far as the medusa is concerned.

The Hybocodons of the fisheries steamer *Albatross* collection can be identified only provisionally, until the hydroid is known. But as the medusae agree perfectly well with *prolifer* they are referred to that species.

HYBOCODON PROLIFER L. Agassiz.

Hybocodon prolifer L. Agassiz, 1862, p. 243, pl. 23*a*, figs. 10, 11; pl. 25.

(For synonymy, see Mayer, 1910, p. 39.)

Dutch Harbor, surface, May 25; about 50 excellent specimens, 3–5 mm. high.

Most of the specimens have three large tentacles, with one or two medusa buds; but some have only one tentacle, some two, and several have four. The medusa buds vary in number from one (in specimens with three or four tentacles) to three or four; and they are in every stage of development from mere knobs to medusae which are themselves in the act of budding. The stages agree so well with the description by L. Agassiz (1862) that no account is needed here; his figures might almost have been taken from the present series. Some specimens have no buds, and among such the tentacle number is usually three or four. Besides budding off medusae, several of the specimens have actinula-larvae in various stages of development, attached to the manubrium, just as they have been described by Hargitt and Perkins (Mayer, 1910, p. 41). And a given individual may or may not show both types of development.

Since Hartlaub (1907) believed that a short manubrium was distinctive of *H. christinae*, it is interesting that in the *Albatross* series this organ varies from being tubular and hanging to the opening of the bell, to very short, almost globular, although the bell as a whole may show no signs of contraction. Evidently, then, this character is useless in preserved material. In the smaller specimens there are no gonads, consequently the manubrium is nearly transparent. But in the larger ones the sexual products are developed. There seems to be no connection between budding and the formation of gonads.

The radial canals are all of equal breadth, and the exumbral nettle ribs are well marked. Over most of their length they are linear, but near the margin they widen suddenly.

Color.—Manubrium and tentacular bulbs are pale yellow; the apex of the manubrium orange.

Family CYTAEIDAE L. Agassiz, 1862.

Genus TURRITOPSIS McCrady, 1856.

The most recent communication on this genus is by Hartlaub (1911), who gives a discussion of the three members of the genus from northern waters, *polycirrha* Keferstein, *nutricula* McCrady, and *pacifica* Maas. The first two are very closely allied to each other, so much so, in fact, that Mayer (1910) has united them. Hartlaub, arguing to the contrary, points out that in the European form the radial canals are broader, the entodermal "Zellpolster" lower, than they are figured by Brooks for the American species; that the radial canals are not dilated within the "Zellpolster," that the latter is not four-cornered, and finally that the eggs develop into planulae within the bell cavity, something which has never been observed in the American form. But Mayer's (1910) figure of an adult from Newport has broad canals, and these are not enlarged in the "Zellpolster." I have myself examined specimens from Bermuda, the Tortugas, and Newport, and in all of them the radial canals are quite as broad as in Busk's figure of the European form; and in no case do the canals expand within the "Zellpolster" to form distinct chambers with an ascending branch such as Brooks (1886) observed, though, to be sure, they are more or less dilated. Thus it appears that the supposed differences between *polycirrha* and *nutricula* are so unstable as to be worthless for specific diagnosis, and as Mayer has studied many *nutricula* in life, I believe that we can safely follow him and Maas (1909) in uniting the two. *Pacifica* described by Maas (1909) as var. *pacifica* of *nutricula,* is distinguished from the latter by large size; by having numerous tentacles arranged in several rows, and especially by the peculiarity that the ocelli lie on the abaxial instead of the axial faces of the tentacular bulbs; and these differences have seemed sufficient both to Mayer and to Hartlaub to show that *pacifica* is a distinct species.

The present collection adds to our knowledge by affording two perfectly typical specimens of *nutricula* from southern Japan; that is, from the same general region as *pacifica.* It was of course so interesting to find two species of *Turritopsis* in Japanese waters that I paid especial attention to the position of the ocelli, finding that there is an axial ocellus on each tentacular bulb exactly as in *nutricula.* But though this character sharply distinguishes the latter from *pacifica,* number and arrangement of tentacles do not, for large specimens of *nutricula* have 70–85 or more, *pacifica* about 120–150. In the *Albatross* specimens they are apparently in two rows, but in reality only in one, the appearance being due to differences in size of tentacles of different ages, and to crowding and contraction of the

margin. And were they in several rows—that is, of the "pacifica" type—this might easily be explained as the result of progressive development. So far, then, as size and tentacles are concerned, *pacifica* might be an advanced stage of *nutricula*, but the position of the ocelli can not be reconciled with this. When I first examined the present specimens the ocelli, showing clearly through the tentacular bulbs, seemed to lie on the abaxial surfaces of the latter, and it was only when the tentacles were examined in side view that the true position of the ocelli became evident. This, together with the fact that Maas (1909) has given only an abaxial view of the tentacles, suggests the possibility that the conditions in *pacifica* might be explained in the same way. But reexamination of the specimens alone can settle it. The *Albatross* specimens are recorded as *nutricula*, as I can find nothing to separate them from that species.

TURRITOPSIS NUTRICULA McCrady.

Oceania (*Turritopsis*) *nutricula* McCrady, 1856, p. 1, pl. 4, figs. 1–10.
Oceania polycirrha Keferstein, 1862, p. 26, pl. 2, figs. 11–13.

(For complete synonymy, see Mayer, 1910, p. 143.)

Station 4943, 2 specimens, both about 4 mm. high. One is in excellent condition, the other slightly contracted.

The better specimen has about 84 large, and 5 or 6 very small tentacles; their apparent location in two rows has been touched upon. One feature not previously emphasized for *nutricula*, although it is evident in specimens from Newport, is that each tentacle has a distinct terminal dilation. The "Zellpolster" is of the quadrate type figured by Brooks (1886), and the radial canals within it are dilated but slightly. The ova (both specimens are female) cover the interradial surfaces of the manubrium, leaving the perradii bare, but no planulae are to be seen.

Nutricula has been described so often and so fully, that no further discussion is needed here. For excellent accounts and figures, see Brooks (1883), Brooks and Rittenhouse (1867), Mayer (1910), and Hartlaub (1911).

Family BOUGAINVILLEIDÆ[1] Gegenbaur, 1856.

Genus BOUGAINVILLEA Lesson, 1843.

The collection contains one large specimen of *Bougainvillea* which I can not distinguish from *B. superciliaris*, and its identity seems assured because I have been able to compare it with excellent specimens of that species from Labrador. The diagnostic features of *superciliaris* are its large size, the presence of a short gelatinous

[1] The use of the name Margelidae (Hartlaub, 1911) is untenable because *Margelis* is a synonym of *Bougainvillea*.

peduncle, long manubrium, the fact that the gelatinous substance, thick aborally, grows thinner toward the margin; the large number of tentacles; purely interradial gonads; development of the planulae attached to the walls of the manubrium; and dense pigmentation; all of which are shown by our specimen. It would be interesting to know the true relationship between *B. superciliaris* and the other *Bougainvillea* from the northwestern Pacific, *B. bougainvillei* Brandt. Mayer (1910) unites them; but Hartlaub (1911) believes that they are distinct, the latter, according to him, being more nearly related to *B. britannica*. Without access to specimens of the *bougainvillei* type, it is impossible to settle the question; but I may point out that *bougainvillei* resembles *superciliaris* in the presence of a short peduncle; that its manubrium is no shorter than I have often seen it in *superciliaris* of the same size; and that so far as general form is concerned it agrees equally well with either. Hartlaub (1911) mentions as a point of resemblance to *britannica* that the ocelli in *bougainvillei* lie on the free tentacles at their bases; but the same is true of *superciliaris*, as is clearly shown in L. Agassiz's figures (1849).

The one peculiar feature of *bougainvillei* is the presence of "sehr feinen Börstchen" on the exumbrella (Brandt, 1838, p. 393). But these spines or hairs suggest the spines of radiolarians, with which medusae are often clothed. On the whole, then, I am inclined to believe that *bougainvillei* is identical with *superciliaris*. It has been recorded by Murbach and Shearer (1903), but the identity of their specimen (not figured) is uncertain. *B. mertensi* A. Agassiz is probably a synonym of *bougainvillei*, but the original specimens of *mertensi* in the collection of the Museum of Comparative Zoölogy are distorted past hope of recognition.

BOUGAINVILLEA SUPERCILIARIS (Gould) L. Agassiz.

Hippocrene superciliaris GOULD, 1841, p. 348.—L. AGASSIZ, 1849, p. 250, pls. 1–3.

(For further synonymy, see Mayer, 1910, p. 162, and Hartlaub, 1911, p. 171.)

Attu Island, June 11; 1 specimen, 12 mm. high by 10 mm. in diameter. The example was obviously much larger in life, and it appears to be the largest representative of the species yet recorded. *B. superciliaris* has been so well described and figured by L. Agassiz (1849), Mayer (1910), and Hartlaub (1911) that no account is called for, further than to point out that our specimen shows the specific characters in a typical way. The peduncle is short and broad, and, corresponding with the large size, the interradial sides of the manubrium are covered with planulae, but none are attached along four narrow perradial lines. The manubrium itself is large, and hangs to about the mid height of the bell. The numbers of marginal tentacles to the bundle are 16, 18, 15, 15, 18 being the greatest number yet recorded. The branching of the oral tentacles is more complex

than in the smaller specimens usually described, for each tentacle forks seven or eight times.

Color.—Ocelli are dark brown, almost black; the manubrium pale reddish brown.

Genus RATHKEA Brandt, 1837 (Hartlaub).

It seems that at last the generic name for Bougainvilleidae, with eight groups of marginal tentacles and with the labial tentacles represented by nematocyst swellings at the corners of the lip, is settled. The stumbling block has long been *Rathkea blumenbachii* (Rathke) Brandt from the Black Sea, a form so poorly figured that it was impossible to determine the type of oral appendages; but Hartlaub (1911) has recently studied series from the Black Sea which prove indistinguishable from the common *Lizzia octopunctata* of the North Atlantic, and likewise specimens of that species from the Mediterranean (Trieste, Cette). There is, then, no further question that *blumenbachii* and *octopunctata* are identical, and *Lizzia* must give way to *Rathkea*.

The common Mediterranean species *fascicularis* thus loses the generic name which Maas (1905) and I formerly applied to it, and Browne (1910) has revived *Köllikeria* for it and similar species. Mayer (1910) uses *Rathkea* in a broad sense to include all Bougainvilleidae with eight groups of marginal tentacles. But I agree with Maas and with Hartlaub that the structure of the labial appendages is sufficiently important to afford a generic character of phylogenetic value, and it warrants at least two and probably three genera, *Rathkea* with simple nematocyst knobs, *Lizzia* with unbranched labial tentacles and *Köllikeria* with branched labial tentacles. The species included in *Rathkea* by Mayer are *blumenbachii* Rathke, *formosissima* Browne, *octopunctata* Sars, *fasciculata* Péron and Lesueur, *octonemalis* Maas, *elegans* Mayer, and *blondina* Forbes. According to the above definition, these species should be distributed as follows: *blumenbachii* (=*octopunctata*) to *Rathkea; fasciculata*, *octonemalis*, and *elegans* to *Köllikeria; blondina* to *Lizzia;* and *formosissima* also probably to *Lizzia*.

Hartlaub (1911) makes a different division, referring to *Bougainvillea* species with branched oral tentacles, and smooth, not folded, gonads and gastric walls, irrespective of the number of bundles of marginal tentacles; that is, *octonemalis* and *elegans*. But though Bougainvilleas do vary more or less in number of bundles, still the octoradial condition of *Köllikeria* is precise; it does not intergrade in any true sense with the quadriradiality of *Bougainvillea*.

Mayer (1910, p. 179) recognizes a variety of *blumenbachii, grata,* for specimens with a long peduncle; but I doubt whether the difference

in this respect is anything more than an individual variation, or perhaps partly consequent on contraction.

The *Albatross* collection contains a series of the genus which differs from *blumenbachii* in having more tentacles (five instead of three) in the interradial groups, and the case is an interesting one, because perfectly typical *blumenbachii*, with the usual number of tentacles, is common in Japan. There is, then, no question of a Pacific as opposed to an Atlantic species. The difference is merely the point to which development proceeds; the north Atlantic form at first has one tentacle in each interradial group; then a pair flanking it appear, and then in its Bering Sea relative the interradial groups simply progress one step further, just as do the radial groups. And as it appears that in some specimens from Bering Sea three is the final number, just as it is in the Atlantic species, there seems to be no justification for separating the series specifically from *blumenbachii*, though it may finally be shown that they represent a distinct local variety.

RATHKEA BLUMENBACHII (Rathke).

Oceania blumenbachii RATHKE, 1835, p. 321.

(For synonymy, see Mayer, 1910, pp. 177, 179, and Hartlaub, 1911, p. 229.)

Dutch Harbor, surface, May 25; about 40 specimens, 2–4 mm. in diameter; in excellent condition.

I have been able to compare this series with about 200 examples from Newfoundland (1909*c*., p. 306).

It is not at all surprising that *R. blumenbachii* should occur in Bering Sea, since it has already been found along the Arctic coasts of Europe as far east as Nova Zembla, and likewise in Japan.

The species has often been described, and excellent diagnoses are to be found in Mayer's (1910) and Hartlaub's (1911) papers, while the latter author has given a complete list of the localities where it has been taken.

The series contains both budding and sexual phases, besides a considerable number of specimens with both medusa buds and gonads. The largest are about 4 by 4 mm.—that is, about the same as my Newfoundland series—and the photograph of the oral appendages of the latter (1909, pl. 31, fig. 5) might equally well have been taken from one of the Bering Sea specimens. The largest individuals have seven or eight nematocyst organs in each cluster, as described by A. Agassiz (1865) and Browne (1896). According to the degree of contraction, the nematocyst knobs may be sessile, with no trace of stalk, or the lip may be extended in narrow prolongations, with the knobs at their tips, so that the latter are apparently stalked; but there is a very sharp distinction between such organs, which are merely projections of the edge of the lip, and the labial tentacles of *Cytaeis*, *Lizzia*, or *Köllikeria*.

The marginal tentacles are especially interesting, because they show the only difference between the Bering Sea and the Atlantic series. About half of the specimens have five tentacles in each interradial cluster, while the others have three. There are large specimens in each class; but the series, as a whole, suggests that most examples, at any rate, attain the large number sooner or later.

In the Atlantic form, on the other hand, the final number of tentacles in each interradial cluster is three, and no specimens have ever been recorded in which this number was surpassed. Japanese examples, likewise, have only three. Each of the radial groups has five tentacles. *Rathkea* has never been observed with more than five in each. One medusa bud, almost ready for liberation, the only one found at so late a stage, has five tentacles in each radial, three in each interradial, group. In the medusa buds of the Atlantic race there are usually three tentacles in each radial and only one in each interradial group when liberated. All the specimens are of the "short peduncle" type; indeed, I have never seen one of the "*grata*" type (Mayer, 1910).

Color.—In formalin manubrium tentacle bulbs are pale yellow.

Family PANDEIDAE Haeckel, 1879 (sens. em.).

Family TIARIDAE[1] Haeckel.

MEATOR, new genus.

This new genus is proposed for an interesting new Pandeid in which the gonads consist, in the adult, of eight smooth adradial masses, discontinuous in the perradii, and in which perradial and subradial tentacles are of different sizes, though structurally all alike, characters which separate it from all other members of the family.

Tpye.—*Meator rubatra*, new species.

MEATOR RUBATRA, new species.

Plate 1, figs. 1–3.

Type.—Cat. No. 31051, U.S.N.M.

Station 4800, 300–0 fathoms; 2 specimens, respectively 14 mm. high by 18 mm. in diameter (type) and 13 mm. high by 13 mm. in diameter.

Station 5019, 192–0 fathoms; 1 specimen, 17 mm. high.

Station 5028, 241–0 fathoms; 1 specimen, 17 mm. high.

Station 5030, 1,800–0 fathoms; 1 specimen, 17 mm. high.

Station 5030, 300–0 fathoms; 7 specimens; the smallest specimen is 10 mm. high by 11 mm. in diameter, the largest 17 mm. high by 18 mm. in diameter.

All are in excellent condition.

Meator rubatra is so striking in its general appearance that it can not be mistaken for any other known medusa. The gelatinous sub-

[1] Untenable, because *Tiara* is preoccupied for a mollusk.

stance is extremely thick and tough, the bell almost spherical, but in all of our specimens slightly broader than high. The bell cavity is subcylindrical, one-half to one-third higher than broad, the subumbrella densely pigmented, with the jelly very transparent; the specimen looks like a vitreous ball with its center occupied by an opaque plug (pl. 1, fig. 1). The entire animal, at least after preservation, is so tough and resistant that it will bear handling even when removed from its fluid.

Manubrium.—The manubrium is short, reaching hardly to the midlevel of the bell cavity; the mouth is surrounded by four separate lips, with slightly fimbriated margins (pl. 1, fig. 3). In the large specimens the manubrium is attached to the subumbrella along each radius, as in other Pandeids, only here to an extreme degree, the lines of attachment extending downward as far as the sexual products are developed.

Gonads.—In a specimen 17 mm. high the gonads consist of eight adradial masses, oval in outline, broadest at their lower ends. The sexual tissue is, of course, discontinuous in the perradii, where there is a broad band, reaching to the base of the manubrium, along which no sexual products are present (pl. 1, fig. 3). The specimen in question is a female, with large ova. The precise outlines of the sexual masses are easily followed, because their whiteness contrasts very strongly with the dense, almost opaque endodermic pigmentation of all other parts of the walls of the manubrium. In the smallest specimen the manubrium is much contracted, and consequently the gonads folded and crumpled, and in this case the adradial gonads of each pair are close together near the bases, though still distinctly separate in the interradius.

The question whether the pairs of adradial gonads are the arms of organs originally horseshoe-shaped and secondarily separated by the growth of the manubrium remains unanswered, but the probability is that they are. In a large male the gonads agree very well with those of the female described above.

Canal system.—The margins of the canals, both radial and circular, are smooth, but in most of the specimens there is a slight dilation of the radial canals marking the level of the lower end of the perradial attachment of manubrium to subumbrella. In one example the margins of the canals are jagged at this point.

Tentacles.—The arrangement of tentacles is characteristic, there being four large perradials and a considerable number of much smaller interradials (pl. 1, fig. 2). As in *Heterotiara* and *Calycopsis* the basal ends of the radials lie in furrows of the exumbrella; and the tentacles turn outward a short distance above the margin. The interradials, however, spring directly from the margin, not touching the exumbrella. None have terminal dilations of any kind, nor are

there any distinct basal bulbs. The number of interradials increases irregularly with growth. In the smallest specimen, 10 by 11 mm., there are 6, 7, 9, and 6 interradials in the four quadrants; in a large one, 14 by 18 mm., there are 10, 10, 9, 9; and in a still larger one,17 by 18 mm., 10, 9, 9, 10. Ten was the largest number counted in any quadrant.

The interradial tentacles are especially interesting because cross sections of them show that the stouter ones have a large lumen, whereas in smaller ones, either younger or more contracted, the lumen is obscured, so that they are apparently solid, though there is no definite core of chordate cells, such as is to be seen in *Protiara formosa* (Mayer, 1910, pl. 13, fig. 2).

Color.—The density of the pigment has been noted above. The entire subumbrella, and those parts of the manubrium which lack sexual products, are of a very deep claret red, so nearly opaque as to look black when held against the light, over which the radial canals show as pale bands. The tentacles and velum are of a very pale brownish-red, and the coloration, as well as the data of capture, shows that the species belongs to the mesoplankton.

Genus PANDEA Lesson, 1843.

Mayer (1910) admits five species to this genus: *conica* Lesson, *violacea* Agassiz and Mayer, *saltatoria* (Sars) Lesson, *minima* Lendenfeld, and *maasi* Mayer (= *Tiara*, sp., Maas, 1904*b*, p. 13, pl. 2, fig. 11). But *saltatoria* is probably an *Aglantha*, *maasi* a *Sarsia* (*S. flammea*), while *minima* was founded on a young stage. Vanhöffen (1911) has united *conica* and *violacea* on the supposition that the latter is the young of the former. But Mayer (1910) has studied large series of *violacea*, both from the Tortugas and from the Mediterranean, finding that the structure of the gonads separates them at all stages.

The collection contains a large species from the intermediate depths, referable to *Pandea*, and resembling *conica* in the structure of the gonads, but readily distinguished from the latter by size, dark red color, and other characters noted below.

PANDEA RUBRA, new species.

Plate 2, figs. 1–7.

I. ADULT.

Type—Cat. No. 31052, U.S.N.M.

Station 4758, 300–0 fathoms; 1 specimen.

Station 4760, 300–0 fathoms; 1 specimen and fragments of two others.

Station 4797, 300–0 fathoms; 1 specimen. Type.

Station 4800, 221–0 fathoms; 2 specimens, 1 very fragmentary.

The proportions of the better-preserved examples are as follows:

Station.	Height, mm.	Diameter, mm.	Interradial tentacles per quadrant.
4800	35	37	4, 2, 2, 2
4758	40	38	3, 3, 4, (?)
4797	47	38	4, 3, 3, 4
4760	[1] 75	(?)	5, 4, (?) (?)

[1] Approximate.

No one of the examples is perfect, but several of them are well enough preserved in parts to allow a general account.

The bell is about as high as, or slightly higher than broad, dome-shaped, the gelatinous substance very thin, and the bell cavity voluminous. In four of the specimens, including the largest, the entire subumbrella is so densely pigmented, except close to its aboral margin, that the manubrium is entirely hidden. In the others (pl. 2, fig. 1) the subumbrella surface is partially rubbed away.

Manubrium and gonads.—The manubrium, in all the examples, hangs to about the midlevel of the bell cavity; and it is attached to the subumbrella along the perradii for about four-fifths of its length (pl. 2, fig. 2). The lip, primarily cruciform, is thrown into many extremely complex folds. The gonads consist of a close network of ridges and corresponding depressions, which occupy the entire interradial areas. They do not connect with one another in the perradii below the attachment between manubrium and subumbrella, as they do in *P. conica*, but are discontinuous there (pl. 2, fig. 2). The ridges of the network are of different sizes, representing different periods of formation; and in the largest example, unfortunately a fragmentary one, they are exceedingly complex. Seen from within, the gastric wall is studded with prominences, corresponding to the hollows between the external ridges. In other words, the ridges are not simple thickenings, but are lines of outgrowth and folding.

Canal system.—The radial canals are proportionately broad and flat; their margins wavy, or jagged (pl. 2, fig. 5), and notched. In one specimen, the irregularities of their margins approach the condition in *Catablema vesicaria*, where they may be spoken of as diverticula; but there is considerable variation in this respect. The margin of the circular canal is smooth in such specimens as are well enough preserved to show it, including the largest one.

Tentacles.—As shown in the foregoing table, five interradial tentacles is the greatest number observed in any quadrant. If this number occurred in all four quadrants of any one individual, we should have a total of 24. But the condition varies from quadrant to quadrant in every example. Smaller specimens have fewer, 2–4, and tentacles were observed in various stages in growth.

The basal bulbs are large, conical, not laterally flattened, and clasp the exumbrella (pl. 2, fig. 4).

Color.—In the largest specimen the entire subumbrella is deeply pigmented, of a deep brownish-red, less opaque, however, than in *Meator rubatra*, the radial canals causing pale bands. The tentacles are of the same color, and manubrium, lips, and gonads are of a duller brownish-red, but equally strongly pigmented. In the specimen 47 mm. high the tentacles are faint reddish, but the pigmentation in this example is much paler in general, probably due to the poor condition of the subumbrella.

In two of the smaller specimens, which are in fair condition, the dense pigment ceases some distance above the margin, and is succeeded there by a clear zone, only faintly reddish next the radial canals, and with the tentacles colorless.

2. YOUNG STAGES.

Station.	Depth.	Height, mm.	Diameter, mm.	Interradial tentacles per quadrant.
4800 4764	221–0 1130–0	(?) 27	[1] 18 25	2, 2, 2, 3, 2, 3,

[1] Approximate.

In general form, voluminous bell cavity, and thin gelatinous substance, these small specimens agree very well with the large ones described above, and manubrium and lips (pl. 2, figs. 6, 7) are of the same type; but the gonads, as would be expected, are less advanced, the network being less prominent, the ridges lower, and the intervening hollows shallower. They are, however, of the same general structure, and it is especially interesting that they occupy the entire interradial regions just as they do in the larger specimens. Thus there is no evidence that the network is derived from a primarily horseshoe-shaped sexual swelling, as it is in *Pandea conica*. The margins of the radial canals are slightly wavy, that of the circular canal smooth.

There are fewer tentacles than in the large specimens, three being the most in any quadrant, with a total of 14 in the example shown in the photograph, but the conical basal bulbs are already well developed.

The pigmentation, instead of extending to the subumbrella as in the adult, is limited to the manubrium, which, with its lips and gonads, is of a deep brownish-red. This difference is a striking one; but the fact that the adults show a progressive development of pigment, which does not reach to the margin and tentacles until a height of 47 mm. is attained, is good evidence that the conditions in the two specimens now under discussion is merely an earlier stage in growth.

Genus CATABLEMA Haeckel, 1879. Maas, 1904 (Bigelow 1909*c*).

The three "species" listed in the genus by Haeckel, *vesicaria* A. Agassiz, *campanula* Haeckel, and *eurystoma* Haeckel, are undoubtedly identical, as Maas (1904*b*), Browne (1910), and I (1909*c*) have already pointed out. *Vesicaria* and *campanula* are successive stages in development; the only characters separating them are that the former has fewer tentacles, and usually has ocelli; but the first is a growth character, while I have myself found that the ocelli of *vesicaria* often disappear with preservation (*campanula* was based on alcoholic material). *Eurystoma*, with rudimentary stomach, is apparently only an abnormality. Mayer retains all three as distinct species (putting them in "*Turris*"); but gives no discussion of them.

Browne (1910) has recently added another species, *weldoni*, to the genus, from the Antarctic. But this form has gonads of the *Neoturris*[1] type, and therefore does not fall in *Catablema* as here defined.

The present collection contains a considerable series of *C. vesicaria* from Bering Sea which are perhaps sufficiently distinct from Atlantic specimens to be noted as a local variety. There are likewise four specimens which are distinguished from *vesicaria* by having upward of three times as many tentacles in both young and adult; by their large size, and by the form of the tentacular bulbs. Comparison with considerable series of the latter, both Atlantic and Pacific, shows that the differences are sufficient to separate them specifically. A *Catablema* with "many hundred" tentacles has been briefly described by Kishinouye (1910) from the Kurile Islands as *C. multicirrata*, and no doubt the four *Albatross* examples belong to it.

CATABLEMA VESICARIA A. Agassiz, var. NODULOSA, new variety

Plate 1, figs. 8, 9.

Dutch Harbor, May 25, surface; 14 specimens.

Type.—Cat. No. 31053, U.S.N.M.

In general form the specimens resemble the Atlantic examples of *C. vesicaria* which I have studied, having the same thick, rounded gelatinous swelling at the aboral pole. But the gonads and tentacle number are rather different from the usual type of the latter, though probably lying within its extreme range of variation.

The gonads, as defined by A. Agassiz (1865), by Maas (1904*b*), and by the writer (1909*c*), consist of a series of vertical folds in each interradius, becoming oblique or even transverse close to each perradius, and in two of the North Atlantic specimens I have observed a few irregular knobs and swellings near the lower end of the manubrium. In the Bering Sea series there is the same series of hori-

[1] *Neoturris*, new name, Hartlaub, 1911, p. 209.

zontal folds in the upper part of each interradius, but instead of being fairly regular and even, as they are in typical *vesicaria*, they branch and even anastomose, so that a very loose partial network results, and the folds are augmented in the lower part of the manubrium by numerous knobs and irregular swellings.

A comparison of photographs of the gonads of the two (cf. pl. 1, fig. 8 with Bigelow 1909*c*, pl. 30, fig. 3), will show the difference at a glance. If extremes only were taken, they would suggest two different species, but occasional Atlantic specimens approach the Pacific type so closely that there is no actual discontinuity between the two. In young specimens from the Pacific the folds are less irregular and branch little if at all, so that they resemble the usual Atlantic form more closely, but the knobs are already present in examples 9 mm. high. This type of gonad is present in all the specimens, though the degree of development of the knobs varies.

The tentacles are rather less numerous, and have basal bulbs of rather a different outline from those of the Atlantic specimens which I have seen.

In the following table tentacle number is given of a series including the largest and smallest specimens:

Height, mm.	Diameter, mm.	Interradial tentacles of all sizes per quadrant.	Total tentacles.
9	10	2, 3, 2, 3	14
10	10	2, 3, 3, 3	15
10	11	3, 4, 3, 3	17
10	13	4, 3, 4, 4	19
15	17	4, 5, 4, 4	20
19	19	5, 4, 4, 5	22
11	14	4, 5, 5, 5	23
20	21	5, 5, 6, 5	25

Thus the number increases with growth, but so irregularly that it is seldom that two quadrants of any individual have the same number of tentacular organs at exactly the same stages of growth.

It is hard to classify the tentacles by size, because there are all gradations from large ones to mere knobs, and the latter are present in the largest as well as in the smaller specimens.

The order of development of tentacles is successively radial, interradial, adradial, and subradial. But after the first three series have appeared the formation of additional tentacles is exceedingly irregular.

Atlantic examples of *vesicaria*, of about the same size as the largest Bering Sea specimens, have twice as many tentacular organs of all sizes. Thus, in a specimen 19 mm. high by 17 mm. in diameter, I counted 22 large and 20 small, and in another 18 by 14.5 mm. there were 37 large and 2 small. Haeckel (1879) records 36–48 tentacles as the final number.

The bases of the tentacles are less compressed than is usual in Atlantic *vesicaria*, narrower, and do not clasp the exumbrella to the same degree.

The margins of the radial canals are lobed as in *vesicaria;* the circular canal is slightly wavy.

Color.—In the preserved specimens tentacles and manubrium are pale yellow.

C. vesicaria is known from the coast of New England, from the Labrador current, Greenland, and Spitzbergen.

CATABLEMA MULTICIRRATA Kishinouye.

Catablema multicirrata KISHINOUYE, 1910, p. 24.

Plate 1, figs. 4–7.

Orca, Prince William Sound, Alaska, July 19; 2 specimens, both in good anatomical condition, though somewhat contracted. One is 29 mm. high by 33 mm. broad, the other 36 mm. broad.

Dutch Harbor, Unalaska Island, Bering Sea, May 25; 2 young specimens, both about 14 mm. high by 13 mm. in diameter.

In the smaller of the two adults, which is the least contracted, the bell is nearly cubical, and it is evident that in life there was a considerable apical dome, now represented by a much wrinkled and flattened gelatinous cap.

Manubrium and gonads.—The manubrium, like the bell, is cubical, nearly fills the cavity of the bell, and is attached to the subumbrella along the perradii (pl. 1, fig. 4). The gastric portion of the manubrium hangs below the midlevel of the bell cavity, and the lip, primarily quadratic, is complexly folded, much more so than in any recorded specimen of *vesicaria*, either Atlantic or Pacific. The gonads consist of four series of folds, occupying nearly the whole of the four interradial areas, but entirely discontinuous in the perradii, even below the level to which the manubrium is attached to the subumbrella. In the center of each interradius the folds are vertical; near the perradii they become somewhat oblique, just as in *vesicaria*, but in no instance were they transverse. In the interradius shown in the photograph (pl. 1, fig. 4) there are 25 folds. The folds vary in breadth and in length, but in neither example are they supplemented by the irregular knobs and swellings which are a prominent feature in the gonads of the Pacific form of *C. vesicaria*. The ridges are simple folds of the gastric wall, not thickenings, and the sexual products, large ova in both specimens, are developed indifferently over the ridges and in the valleys which separate them. But few if any ova are to be seen below the level at which the ridges terminate, and none at all along a rather broad band marking each perradius.

Canals.—The canals, both radial and circular, are very broad (pl. 1, fig. 5). Owing to the large size of the manubrium, the radial

canals are very short from the margin and their attachment to the latter, less than twice as long as broad. Their margins are very irregular, jagged, or with broad, dendritic diverticula, the exact outlines varying from canal to canal. The margin of the circular canal is strongly jagged.

Tentacles.—The most distinctive character of the species is afforded by the very large number of tentacles and by the form of their basal bulbs. In the smaller specimens there are 34 and 41 tentacles in two successive quadrants, and the total is about 150. In one of the large ones the number of interradials to the quadrant is 43, 39, 34, 41; the total about 155. And even these large numbers are not, it seems, the final ones, for there are many young tentacles in various stages of development, besides minute knobs which have just commenced their growth. As is usual in Pandeids with large numbers of tentacles, these organs seem to be in two or more rows. But examination shows that this is only apparent, being due to the outward growth of the bases of the older tentacles (pl. 1, fig. 6).

In *C. vesicaria* the largest number of tentacles, old and young, which has ever been recorded, is only 48, and the numerous records of that species show that even this number is seldom attained.

The basal bulbs are of a characteristic outline (pl. 1, fig. 6), laterally flattened, triangular, and extending outward over the exumbrella. The bulbs of *vesicaria* are likewise triangular, but while in the latter species the axis of the filament lies at the inner face of the triangle, and the outward growth is in the form of a spur, in *multicirrata* the axis is opposite the center of the base of the triangle.

Color.—In the preserved condition, manubrium and tentacles are pale brownish-yellow.

The two young specimens are interesting because they show that this species is readily distinguished from *vesicaria* at an early age. The gelatinous dome, contracted in the adult, is well preserved here. The other differences between them and the latter are all such as would be expected; that is, fewer tentacles and less prominent gonads. The manubrium is proportionately shorter, and its perradial attachments to the subumbrella do not extend so far. The gonad folds are very short, occupying only a narrow zone at the upper part of each interradial area, and the lips are simpler. On the other hand, the margins of the circular and radial canals are nearly as irregular and as complexly lobed as they are in the adult.

The marginal organs consist of tentacles in every stage of development. The numbers of interradials of all sizes to the quadrant in one specimen are 25, 26, 21, 20, a total of 92, and in the other 24, 25, 24, 28, the total being 101. Of these, 41 in the former and 46 in the latter are minute knobs; and every stage is present connecting these with large tentacles.

This stage of *multicirrata* is readily distinguished from *vesicaria*, as is the adult, by the very large number of tentacles, for in the latter, at about the same stage of sexual development, there are usually only 16–28 tentacular organs of all sizes. Furthermore, the gonads are much farther advanced in *vesicaria* of the same size.

Family BYTHOTIARIDAE Maas, 1905.

[For discussion of this family see Maas (1905, 1910) and my earlier paper (1909*a*).]

Genus CALYCOPSIS Fewkes, 1882.

The credit for pointing out that my *Sibogita nauarchus* is a synonym of the insufficiently described and long-forgotten *Calycopsis typa* Fewkes is due to Dr. A. G. Mayer (1910, p. 491), and Vanhöffen (1911, p. 214) has likewise adopted this identification. To clinch the matter I have examined the type-specimen of Fewkes's species, now in the United States National Museum, finding that it agrees with my material even to minor details.

The following species of *Calycopsis* have been described: *typa* Fewkes (=*nauarchus*), *simulans* Bigelow, *chuni* Vanhöffen, *borchgrevinki* Browne, and *bigelowi* Vanhöffen, all closely allied to each other. The first three are known from large mature individuals, so that we have a fairly definite idea of their final state of development, but the last two have been described from small examples, not necessarily immature, however.

Vanhöffen (1911) in his survey of the genus has laid especial stress on the regularity of the sexual folds and on color as specific features; but there is another character which proves of greater value, the number of tentacles and their relation to the canals. Using this as a criterion, we find that in *typa* and in *simulans* there are about as many tentacles as canals, or to be more precise, tentacles are formed first, but the corresponding canals shortly follow. Thus there are often more tentacles than canals, but apparently every tentacle is eventually associated with a canal. In *chuni* there are about twice as many canals as tentacles. Three specimens have been described as *simulans*, two from the eastern tropical Pacific, one from Bering Sea, and the latter, having 30 tentacles and only 16 canals, might seem to be an exception to the above statement. But, as I shall show, I made an error in identifying this individual as *simulans;* in reality it probably belonged to a new species, *nematophora*, represented in the collection by an excellent series.

Vanhöffen has united *typa* and *simulans;* and unquestionably they are more closely related to each other than is either of them to *chuni*. But apart from the terminations of the canals—that is, whether or not they are permanently blind in *typa* instead of finally joining the base of the manubrium—there is one feature, minor it is

true, which distinguishes the Atlantic specimens of *typa* from their Indian Ocean representative (Vanhöffen) and from *simulans;* that is, the presence of a funnel-shaped apical depression in the former and its absence in the latter. I should not lay stress on this, were it not that Fewkes's example of *typa* shows it very clearly. And when specimens from the same general locality, but captured some 30 years apart, have so trifling a character well developed, it can hardly be looked on as an individual variation. The probable explanation is that *typa,* a form of very wide distribution, has local varieties. And this is not at all an unreasonable assumption, since it is probable that *Calycopsis,* though belonging to the Mesoplankton, has a fixed stage. *C. chuni* is distinguished from *typa* not only by the number of tentacles, but by a less regular arrangement of the genital folds, and, according to Vanhöffen, by the red color of its tentacles.

In *borchgrevinki,* according to both Browne (1910) and Vanhöffen (1911), there are 8 canals, 4 radial, and 4 interradial centripetal, and up to 16 tentacles. The gonads are restricted to the upper part of the manubrium. In small specimens, 10–18 mm. high, the genital products suggest transverse folds (Vanhöffen), but in large ones, 20 mm. high, they lie in irregularly arranged pockets (Browne), though probably the difference is one of terms of description only. Vanhöffen (1911) has suggested that *borchgrevinki* is a young stage of *typa,* stating that the restriction of the sex products to the base of the manubrium is evidence of immaturity. But this does not necessarily follow. On the contrary, the fact that all the specimens of this species agree in their general stages of development, though taken at far separated localities (south of Bouvet Island, and near Cape Adare), and especially that Browne (1910) observed large ova, as well as gonads emptied of their contents, suggests that we are dealing with a small, simply organized Antarctic species. If not, advancing development would seem to lead, not to *typa,* but to a stage resembling *bigelowi,* which agrees with *borchgrevinki* in having more tentacles than canals, and in the number of canals. It is true that it has more tentacles (about 48, large and small, in the one known specimen), and that the gonads are transversely folded, but both these features would naturally result from progressive development of *borchgrevinki.* Whether these two "species" are finally united, more extensive material alone can show.

In the several species of *Calycopsis* so far considered, the lip, though more or less folded, has a smooth margin without projections or papillae of any kind, but in a series in the present collection it is not only extensively folded, but is studded with a marginal row of stalked nematocyst knobs, a structural character so distinctive that it alone would warrant the institution of a new species. And the structure of the gonads is likewise characteristic. In the proportionate number

of canals and tentacles, the new species, *nematophora*, falls with *borchgrevinki* and *bigelowi*. The Bering Sea specimen which I referred (1909) to *simulans* probably belonged to *nematophora* because of the numerous tentacles. Its geographic origin likewise points in that direction, but unfortunately the lip is badly damaged.

CALYCOPSIS NEMATOPHORA, new species.

Plate 2, fig. 8; plate 3, figs. 1–3.

The series gives the following data:

Station.	Depth, fathoms.	Height.	Flattening.	Canals at margin.	Large tentacles.	Small tentacles.	Total.
4785	300–0	25	None.	16	16	16	32
4785 Type.	300–0	22	Interradial.	17	6	30	36
4766	Surface?	21	Interradial.	18, 1 blind.	8	31	39
4763	300–0	17	Interradial.	16	16	27	43
4764	1130–0	20	Interradial.	16	9	33	42
4793	300–0	Diam. 29.	Radial.	16	16	32	48
4766	Surface?	17	Interradial.	16	8	40	48
5028	Surface?	31, × diam. 30.	Interradial.	17	16	41	57

Type.—Cat. No. 31054, U.S.N.M.

At stations 4773, 338 fathoms to surface, and 4804, 229 fathoms to surface, one specimen each was taken, but they were too battered for counting the tentacles. Also Bering Sea, July, 1890 (station 3307), surface, 21 specimens in alcohol, much contracted, now about 15 mm. high; Bering Sea, August, 1895 (station Hyd. 3629), surface, 4 specimens in alcohol, much contracted.

The specimens are of the usual "*Calycopsis*" outline, rather higher than broad except when contracted, and most of them laterally flattened. But inasmuch as the flattening may be either radial or interradial, and as one example is not flattened at all, this character is probably the result of temporary contraction or of preservation, as it is in *C. typa* (Bigelow, 1909*b*).

It is interesting that several of the specimens have a slight funnel-shaped apical depression. These being the best preserved examples, and those in which it is lacking being somewhat damaged in that region, it is probable that the depression is a normal feature. But it is neither as deep nor as narrow as it is in *typa* (Bigelow, 1909*b*, pl. 30, fig. 1).

Manubrium.—The manubrium is barrel-shaped; separable into well-defined basal, gastric, and labial portions. When expanded it is about as long as the bell cavity is deep; but in several examples it is very much contracted.

Gonads.—In *C. typa*, *C. simulans*, and *C. bigelowi* the gonads consist of double series of very regular folds; and in *C. chuni* they are of the same general type though less regular (Vanhöffen, 1911). In *nematophora* they are rather different, for the two series of folds are less

precise and less crowded, and they are supplemented by a number of intervening folds at least over part of the manubrium (pl. 2, fig. 8), though the gonads as a whole show considerable variation in different specimens, and even in different interradii of a given specimen. The difference between this gonad-type and that of the *typa-simulans* group is so striking that this character alone is sufficient to separate them. But the lip affords an even more diagnostic feature. In all the other members of the genus this structure is simple, quadrate, but slightly folded, if at all, with a smooth margin (Bigelow, 1909*b*). In *nematophora* it is extremely extensible; capable of being thrown into complex folds, and, most important, its margin is thickly set with a very large number of stalked nematocyst knobs (pl. 3, fig. 3).

Canal system.—The specimens are all far advanced in development, and in most of them all the canals are united with the cruciform base of the manubrium. But in one, from station 4766, 21 mm. high, one of the 18 canals is still blind, and reaches only to about one-third the height of the bell cavity, and in another there are two very short blind canals close together (pl. 3, fig. 1). In several instances two canals unite, the union being either close to the margin or higher, and in one instance a canal bifurcates close to the margin, the two resultant trunks reuniting just below the base of the manubrium; furthermore, canals may be connected by a transverse bridge, as also happens in *C. simulans* (Bigelow, 1909*b*). Evidence of the readiness with which canals may send out such branches is afforded by the fact that their margins, particularly near the circular canal, are sometimes jagged (pl. 3, fig. 1), sometimes smooth. The position of each canal corresponds to the center of a longitudinal band of subumbral muscle fibers (pl. 2, fig. 8). No such condition has ever been observed in any of the specimens of *Calycopsis* previously studied.

Tentacles.—As a rule every canal which reaches the margin of the bell is associated with a tentacle; but in the specimen noted above the two short centripetal canals bear no definite relation to the neighboring tentacles. This fact suggests that these canals are merely sporadic outgrowths from the circular canal, and that they would never have attained much greater length. Judging from this, we must assume either that tentacles precede canals in development or that the number of canals present, 16–18, is about the final one, and that the intermediate tentacles would never be associated with canals.

The different sizes of the canalar tentacles gives us an idea of the relative ages of the canals with which they are associated. Thus in one example only 4 of the canals have large tentacles, 12 have small ones, and if we follow the series through, from the data given above, we find a specimen with 6 large and 11 small; 2 with 8 large, 8 and 10 small—that is, large and small roughly alternating (pl. 3,

fig. 1)—and 3 in which all the canals, 16 in each case, are associated with large tentacles. In general, then, we may assume that after the 4 primary radial canals, 4 more, and then a third series of 4–6 more, are formed.

In addition to the canalar tentacles every specimen has a large number of tentacles which alternate with the canals. In the youngest example, age being judged by the condition of the canalar tentacles, there are only 16 of these—that is, 1 between every 2 canals. They increase irregularly in number, and in the older specimens there are usually 2, often 3, between each pair of tentacles. The largest number is 41, in an example with 17 canals.

The fact that the increase of tentacles so far outstrips that of canals—the latter, indeed, being almost stationary—indicates that the canals have probably nearly or quite attained their final number. Except for size, the tentacles are structurally all alike, there being no very young ones in any of the specimens. Each has a large terminal nematocyst knob which is spherical, instead of pear-shaped, as it is in *typa*. The older tentacles curve upward at first, and lie in furrows of the exumbrella, just as in other members of the genus, but the younger ones project directly from the margin, the course of development in this respect being precisely what it is in *typa* (Bigelow, 1909*b*).

Color.—No color notes were made from life. After preservation the gonads are pale brownish-red. But it should be noted that specimens of *typa* in which these organs are a very deep chocolate in life fade to the same pale tint after preservation in formalin.

The localities of capture are restricted to the Bering Sea region and the Sea of Okhotsk.

Genus HETEROTIARA Maas, 1905.

Two species of *Heterotiara*, *anonyma* Maas and *minor* Vanhöffen, have been described, and my own examination of considerable series of both (*minor* from the Philippines) shows that they are undoubtedly distinct. They are separated by the number of tentacles correlated with size, *anonyma* having 12 tentacles (or less) when adult, and reaching a height of 20 mm.; whereas *minor* has about twice as many tentacles, though much smaller (only about 10 mm. high). The Philippine series of *minor* will be described elsewhere. The present collection contains an excellent series of *anonyma*, a species previously known from four specimens only.

HETEOTIARA ANONYMA Maas.

Heterotiara anonyma Maas, 1905, p. 19, pl. 3, figs. 19–21.—Bigelow, 1909*a*, p. 216, pl. 41, figs. 12, 13.—Vanhöffen, 1911, p. 211, pl. 22, figs. 3, 4.

The series gives the following data:

Station.	Depth, fathoms.	Height.	Diameter.	Interradial tentacles per quadrant.	Total number of tentacles.
4797	300–0	21	13	0, 1, 1, 1	7
4766	(?)	18	13	0, 1, 0, 1	6
4793	300–0	12	10	0, 2, 1, 0	7
4767	771–0	20	15	0, 1, 2, 1	8
4763	300–0	21	12	1, 0, 1, 1	7
4775	200–0	13	12.5	1, 1, 1, 1	8
4759	300–0	(1)	12	1, 1, 2, 2	10
4759	300–0	Too shriveled to study.			

[1] About 13 contracted.

Most of the specimens are in such excellent condition that I can add some details to the previous accounts of this interesting species. The high, domed outline, with thick gelatinous substance, is characteristic, as is the deep, rather narrow bell cavity. The precise proportions of the bell vary, but when not contracted it is always considerably higher than broad.

The manubrium is more or less contracted in all the examples. In one specimen, in which large ova are visible, the gonads are slightly wrinkled; in three others, apparently males, the contraction takes the form of more regular folds. In all cases the sexual masses occupy the entire interradial areas, from the base of the manubrium to close to the lip; but there is no sexual development in the perradii. One specimen, the smallest, has no gonads, and in two others the manubrium is lost. Transverse folding of the gonads, due to contraction, is also usually present in the closely allied *minor*. But in one of the eastern Pacific specimens of *anonyma*, a female, the manubrium was smooth (1909*a*, pl. 41, fig. 13). This fact together with the irregularity of the folding, is good evidence that it is not normal.

Tentacles.—The *Siboga* and the *Valdivia* specimens had 8 tentacles; the two eastern Pacific examples 11 and 12, respectively. Vanhöffen has suggested that the large number of tentacles in the latter was evidence that they did not belong to *anonyma*, but the present series shows that the number is variable, and that it varies independently of size. Thus the two specimens 21 mm. high have only 7 tentacles each, while specimens of 13 and 20 mm. have 8, and one which, judging from its diameter, was probably about 20 mm., has 10. Quadrant by quadrant, as well as from individual to individual, the tentacles vary in number. Occasionally there is no interradial tentacle in a quadrant; usually there is 1, sometimes there are 2; but a larger number has never been observed, and consequently we have reason to believe that a total of 12 is the normal limit in this species, one, however, not often attained. No young tentacles have ever been observed in *anonyma;* but whether this is merely a coincidence or whether it means that the final number for any individual is attained

at an early stage in growth can not be answered from the evidence yet at hand.

The tentacles are as long as the bell height, or longer, when expanded, but they are usually contracted, and many of them are broken short off. Each of those which remain intact bears a spherical terminal nematocyst knob much as in *H. minor.*

The specimens are colorless.

The previous localities for this species are the Humboldt current off the coast of Peru, the Malaysian region, and the Indian Ocean, near Nias Island. All the records are from "intermediate" hauls.

Order LEPTOMEDUSAE.

Family LAODICEIDAE, L. Agassiz, 1862 (Browne 1907).

Genus STAUROPHORA Brandt, 1838.

Mayer (1910), in his discussion of *Staurophora,* has pointed out the necessity of comparing specimens from the Pacific with material from the Atlantic, to settle definitely whether the two are identical. This I am able to do, thanks to an example from Bering Sea, several from Prince William Sound, and Atlantic specimens from New England and from Newfoundland, with the result that I have been unable to find any differences sufficient to separate them.

The recent record of *S. mertensii* (*"laciniata"*) by Vanhöffen (1911) from the Indian Ocean is very interesting, not only in extending the range of the species from the Arctic to the Tropics, but also for bearing on the *Staurophora* described by Browne (1902, 1908) from the Falkland Islands, *S. falklandica.* This species is evidently a close relative of *mertensii,* the only difference being that the small tentacles of the single specimen lack ocelli, and it is very desirable that more extensive material of *falklandica* be studied to show whether, as Mayer suggests, the small (young) tentacles might develop ocelli later. Hardly any species would have been more of a surprise in the Tropics, because many years' observations have shown that *Staurophora* is limited to cold waters in its distribution along the American and European coasts of the north Atlantic. But Vanhöffen had North Sea specimens at hand for comparison.

STAUROPHORA MERTENSII Brandt.

Staurophora mertensii Brandt, 1838, p. 400, pls. 24, 25.
Staurophora laciniata L. Agassiz, 1849, p. 300, pl. 7, figs. 1–15.
Staurostoma arctica Haeckel, 1879, p. 149.
(For further synonymy, and a full discussion of the genus and species, see Mayer, 1910, p. 291.)

Dutch Harbor, May 25, surface; 4 young specimens, 8–15 mm. in diameter.

Prince William Sound, Alaska; 5 large specimens, 50–60 mm. in diameter; in fragments.

Although the large specimens are broken into segments, both they and the small ones are in good anatomical condition, and I have been able to compare them with Atlantic examples of corresponding sizes, without finding anything to separate them.

Genus PTYCHOGENA A. Agassiz.

Six "species" of *Ptychogena* are now known, among which the Arctic *P. lactea* is distinguished by the great breadth and shortness of its gonads and by the regularity and length of the diverticula of the radial canals along which they are developed. In adults of this species the sexual mass as a whole is about as broad as it is long, and it is restricted to the middle $\frac{1}{3}$ of the radial canals; while in all the other species—that is, *longigona* Maas, *erythrogonon* Bigelow, *californica* Torrey, *hertwigi* Vanhöffen, and *antarctica* Browne—it is spindle-shaped. None of the latter species is known from more than a few specimens, and it is possible that some of them may be found to merge into one another.

The collection contains a series which differ from *lactea* only in having fewer tentacles than were described first by A. Agassiz, and as the gonads show that they are less advanced in development than any of the specimens of that species yet recorded, and as the series shows that tentacle-number increases with growth, I have no hesitation in referring them to *lactea*.

PTYCHOGENA LACTEA A. Agassiz.

Ptychogena lactea A. Agassiz, 1865, p. 137, figs. 220–224.

(For synonymy, see Mayer, 1910, p. 215.)

Station 4767, 771–0 fathoms; 1 specimen.
Station 4769, 244–0 fathoms; 1 specimen, 30 mm. in diameter.
Station 4793, 300–0 fathoms; 1 specimen, 30 mm. in diameter.
Station 4803, 299–0 fathoms; 1 specimen.
Station 5030, 300–0 fathoms; 1 specimen, 45 mm. in diameter.
Station 5043, 300–0 fathoms; 1 specimen.

These stations are all in Bering Sea and in the Sea of Okhotsk, except for 5043, which is off the east coast of Hokkaido, Japan.

The specimens are more or less flattened and the margins are damaged; otherwise they are in good condition. The descriptions by Agassiz (1865) and by Haeckel (1881, "*pinnulata*") are so complete that the only points needing discussion here are the changes which the gonads undergo with growth and the number of marginal organs.

Gonads.—In the largest specimen, a female, 45 mm. in diameter, the gonads are large and full of large ova. A view from the exumbrella

side agrees very well with Haeckel's figure (1881, pl. 2, fig. 1), the folds and the corresponding transverse diverticula of the radial canals being very regular, about 20 on each side, and so long that the organ as a whole is of a broad oval form; it occupies little more than the central $\frac{1}{3}$ of the canal. The free subumbrellar edges of the folds are neither scalloped, as Haeckel represented them, nor perfectly smooth, as in A. Agassiz's figure, but sometimes smooth, sometimes irregularly wavy or lobed; that is, they are intermediate between the two extremes, as were Linko's examples from Barents Sea.

A much contracted specimen, now about 30 mm. in diameter, has younger gonads, with only about 15 folds on each side, and the folds so much shorter that the whole organ is lanceolate. A still earlier stage is to be seen in the specimen from station 4793, likewise 30 mm. in diameter, but fully expanded, so that this is about life size, and this specimen is especially instructive, for two of the gonads illustrate as many successive steps in development. In the younger the radial canal is somewhat dilated in the region of the future sex organ, and there are eight or nine short lateral branches on each side—the proximal ones minute, the more distal longer. The gonad tissue is, so far, only a slight thickening of the walls of the diverticula. In a further developed gonad there are about twice as many lateral branches on each side of the radial canal, the ones in the middle being the longest, the proximal ones obviously more recently formed, and the sexual thickenings now extend from the distal end to the mid-region.

Tentacles and cordyli.—In the youngest specimen there are 13, 11, and 9 subradial tentacles, in three successive quadrants—that is, a total of about 50; and from 1–8, usually 4 or 5, cordyli between each pair of tentacles, with about 40 in the only quadrant in which they could be counted, or a total of about 160. In the somewhat older specimen with intermediate gonads there are 11 and 16 tentacles in two quadrants, and in the latter the tentacles are crowded. In the largest and oldest specimen the number of tentacles is much greater. In two quadrants there are 27 and 32—that is, a probable total of about 125, of various sizes, some obviously very young; and the presence of a considerable number of minute tentacular knobs suggests that a much greater number of tentacles would have been attained eventually. There are from 1–3, often 2, cordyli between every two tentacles or knobs; thus the number of cordyli does not keep pace in its increase with that of tentacles. In Haeckel's specimens, 50–60 mm. in diameter in alcohol, but no doubt still larger in life, there were 200–300 tentacles, with about the same number of cordyli; and in the large examples described by A. Agassiz (1865) the cordyli alternate with the very numerous tentacles.

Whether or not the bases of the tentacles are laterally compressed depends on how crowded they are; in our intermediate specimen they are noticeably flattened, in the largest hardly at all so. This may be partly individual variation, partly accidental.

The previous records of *P. lactea* are from Massachusetts Bay (A. Agassiz), off the coast of Nova Scotia (Haeckel), between Iceland and Ireland (Haeckel), west coast of Greenland (Levinsen), and Barents Sea (Linko).

Family MITROCOMIDAE Haeckel (Torrey, 1909; Browne, 1910).

Family LAFOEIDAE Maas (1905).

Mayer (1910) does not recognize the structure of the sense organs as a family character; but like Maas (1905), Torrey (1909), and Browne (1910), I believe that the group characterized by open sense-pits in the velum is a natural one, and, as Torrey has pointed out, the best available name is Mitrocomidae.

Among the interesting "finds" of the collection is the discovery that the large conspicuous medusa so common in Puget Sound, first described by A. Agassiz as *Laodice cellularia*, and recently redescribed from mature specimens by Murbach and Shearer (1903) as *Thaumantias cellularia*, has open sense pits in the velum, and therefore is not a *Thaumantias* at all, but belongs to the Mitrocomidae. But it does not fit in any of the genera of the family recognized by Browne (1910), for though it has numerous sense pits without ocelli, like *Mitrocoma*, it differs from the latter in lacking marginal cirri. And inasmuch as there are at least four species of *Mitrocoma*, as well as one of *Mitrocomella* with cirri, the difference warrants the establishment of a new genus, *Halistaura*. Except for the sense-organs, our series agrees with the earlier accounts of *cellularia* even to minute details.

HALISTAURA, new genus.

Mitrocomidae with 4 radial canals; with numerous open sensory pits; without marginal cirri.

Type.—*Halistaura cellularia* A. Agassiz.

HALISTAURA CELLULARIA (A. Agassiz).

Laodice cellularia A. Agassiz, 1865, p. 127, figs. 195, 196.
Thaumantias cellularia Haeckel, 1879, p. 129.—Murbach and Shearer, 1903, p. 172, pl. 17, fig. 2, 2*b*.—Mayer, 1910, p. 199.

Station 4754, off Southern Alaska, October, 1905, surface; 7 specimens 40-50 mm. in diameter. Also several specimens from Puget Sound.

None of the specimens are perfect, most of them being flattened out, but several of them are in sufficiently good anatomical condition for individual quadrants of the margin to be studied.

The descriptions of this species by L. Agassiz and by Murbach and Shearer cover two successive stages in its development, the former

being of specimens about 30 mm. in diameter, with a hundred tentacles, the latter of ones 50–90 mm. broad, with about 340 tentacles. The present series is intermediate between the two: 35–50 mm. in diameter, with 69–81 tentacles to the quadrant, a total of from 200–250.

The earlier accounts are so detailed and the figures so satisfactory that there is little to be added, except an account of the otocysts. I may note, however, that a very short manubrium, with long, crenulated lips, gonads extending over most of the length of the radial canals, swollen cylindrical tentacular bulbs, and entire absence of cirri, prove to be constant characters. The present specimens are flatter than those previously recorded, but the difference may be due to preservation.

Sense pits.—The sense pits are not associated with ocelli, thus resembling those of *Cosmetira* and *Mitrocoma*, and differing from the corresponding organs in *Tiaropsis*. For this reason, and because, at least in formalin material, they lack otocysts which might attract attention by their high refrangibility, they are very easily overlooked. Indeed, it was not until I examined a specimen under the compound microscope that I suspected their presence, although they are so large that once located their "open" nature is easily made out with a hand lens. Their inconspicuous nature is of course the reason that they were not observed by earlier students. As in *Mitrocoma*, they are simple pits or pockets in the velum, the opening being on the subumbrella side, lying close to the marginal ring. Their number is variable; in one quadrant (with 79 tentacles) there were six, in another (81 tentacles) only three; in a third, six in the two-thirds which is intact, and in one quadrant, which was well preserved, I could find none. I could not count them over the whole margin of any specimen. Judging from these quadrants, we may assume, tentatively, a total of 12–24. Structurally the pits closely resemble these of *Mitrocoma* (O. and R. Hertwig, 1878, pl. 7, fig. 14), except that no otoliths could be found. As is seen in cross section the pits are flatter than a hemisphere, and the exumbrellar ectoderm covering them consists of high, columnar cells, which merge into the much smaller cells of the exumbral surface of the velum at the outer margin, while centrally they merge into the marginal ring. A very thin "stuzlamella" separates these large cells from the much smaller ones composing the subumbrellar layer, clearly visible in optical sections. It is in this layer, of course, that the otoliths are to be sought, but no such structures can be found. The only thing suggesting that they were present in life, but have been destroyed by the formalin in which the specimens are preserved is that the cells of the subumbrellar layer, within the pit, are occasionally replaced by large, irregular masses which may be the remnants of the otolith cells.

Genus TIAROPSIS L. Agassiz.

The species of *Tiaropsis* fall into two distinct groups, one with very numerous tentacles all alike, the other with four or eight large tentacles and a considerable number of rudimentary subradial tentacular bulbs. The latter group consists of *rosea* Agassiz and Mayer, *mediterranea* Metschnikoff, and *kelseyi* Torrey, all of them tropical or at least warm water forms, which therefore need not concern us here. The first group, comprising *diademata* L. Agassiz, *multicirrhata* Sars, *maclayi* von Lendenfeld, and *davisii* Browne, belongs to the colder waters of both hemispheres, and its members are very closely allied to one another. *Diademata* and *multicirrhata* are separated only by the fact that ocelli are said to be present in the latter, absent in the former. (For details, see Mayer, 1910, p. 259.) The fact that *diademata* lacks tentacular ocelli has been established on great numbers of specimens, but the tentacular bulbs are not altogether without pigment, for in all the numerous specimens which I have studied they contain a small amount of entodermic pigment of a pale greenish or yellowish-brown color, which is visible only when the animal is studied against a white background. Now, the various figures of the north European *multicirrhata* by no means establish the presence of tentacular ocelli; all they show is the presence of the same entodermic pigment, only in much denser masses, and black instead of pale greenish. Thus the distinction between the species is not an organic one, being nothing but a question of the density and color of the pigment masses.

Under these circumstances it would not be at all surprising if intermediates should turn up, and as a matter of fact the specimens described below have denser tentacular pigment than is usual in *diademata*, though it is of the same color. On the whole it seems to me likely that *diademata* and *multicirrhata* are the extremes of a single varietal series, but I hesitate to unite them unequivocally without having had an opportunity to study specimens of the latter. It is interesting in this connection that the bases of a few, but not all, of the tentacles of the Australian *T. maclayi* are pigmented. It is impossible to determine at present just what relationship the latter species bears to the northern forms, because the figure (von Lendenfeld, 1884, pl. 23, fig. 37) is diagrammatic, and the description in very general terms. But it is apparently distinguished by having small, instead of large, crenulated lips. *Davisii* is apparently closely allied to *maclayi*, but without a figure or a detailed description I hesitate to make a definite assertion.

The present collection contains a considerable series which I have compared, side by side with numerous large and well-preserved

diademata from Newfoundland, without finding a single character to separate them except in the density of pigmentation.

TIAROPSIS DIADEMATA L. Agassiz.

Tiaropsis diademata L. AGASSIZ, 1849, p. 289, pl. 6, figs. 1–16; pl. 8, fig. 11.
(For further synonymy, see Mayer, 1910, p. 258.)

Dutch Harbor, May 25, surface; 22 specimens, 10–22 mm. in diameter.

Agattu Island, June 7, surface; 8 specimens, 18–20 mm. in diameter.

The material is in excellent condition.

For the sake of identification, of course, one of the first questions to be answered was to what extent the bases of the tentacles were pigmented. In the specimens from Agattu Island they are apparently colorless, seen by transmitted light, though opaque. But when studied against a white background it is evident that the entoderm of each bulb contains pale greenish, or in some cases greenish-brown, pigment, in a roughly triangular mass. Though the pigment is of the same color that it is in the Atlantic *diademata*, it is rather more dense than I have observed it in the latter, but in none of the specimens is it black, as it is represented in *multicirrhata*. I was surprised to find that in the Dutch Harbor series there was no pigment to be seen in the bulbs; but as the preservation in these was not quite so successful, I do not feel certain that there was none in life. It may have faded as it so often does in medusae.

In a specimen 20 mm. in diameter there are 59, 64, 65, and 62 tentacles in the four quadrants, a total (with four radials) of 254, all large. In a smaller one of about 15 mm. the numbers are 37, 38, 39, 42, total 160, among which large and small roughly alternate. In a specimen from Newfoundland of 20 mm. the total number is 256, all large; apparently, then, the final number is about 250, which is rather more than Mayer (1910) credits it with.

In the length of the gonads, frilled lips, and short broad peduncle the series agrees perfectly with Atlantic specimens.

T. diademata has been recorded from the coasts of New England and Newfoundland, where it is often very abundant; Greenland, and from the White Sea (Linko, 1899); it is therefore not surprising to find it in Bering Sea.

The more deeply pigmented *multicirrhata* (whether species or variety) is known only from the northwestern coasts of Europe.[1]

[1] Since the above was written I have studied excellent specimens from Massachusetts Bay in which the tentacular bulbs were densely pigmented with black granules, thus exactly reproducing the European type.

Family EUCOPIDÆ Gegenbaur, 1856.

Genus OBELIA Péron and Lesueur, 1809.

The collection contains two mature medusae of *Obelia*, a male and a female, each with about 128 tentacles. It is, of course, impossible to identify these without any knowledge of the hydroid from which they were released.

OBELIA, species ?

Dutch Harbor, Alaska, May 25, surface; 2 specimens.

Genus EUTONINA Hartlaub, 1897.

Eucopidae with eight adradial otocysts, with a peduncle, with numerous tentacles, but seldom with marginal cirri or warts.

Mayer uses the name *Eutimium* Haeckel for this group (he, however, does not include the number of tentacles as a generic character), but the type species of that genus, *E. elephas* Haeckel, was beyond question a *Eutima*. I formerly used the name *Eutimalphes;* but *Eutonina* seems to have the better claim, because its type species is well known, while that of *Eutimalphes*, *E. pretiosa* Haeckel, was founded for a fragmentary specimen which may have been a *Tima*. It has never been seen since first recorded.

The question whether *E. indicans* Romanes and *E. socialis* Hartlaub are distinct is still open. Mayer believes that they are probably identical, and I can see no good reason for separating them. On comparing the figures of the two, the only apparent difference, as Hartlaub (1897) himself pointed out, is that *socialis* is flatter than a hemisphere, while *indicans*, in Romanes's (1877) figure, is considerably higher than broad, though according to the original account it is hemispherical; but the figure is obviously imperfect in that the gelatinous substance is entirely omitted, and when we consider that *indicans* agrees with *socialis* in all other respects—that is, length of peduncle, structure of gonads, number of tentacles, number of otocysts, and even number of otoliths (12) to the otocyst—the reasonable conclusion is that the figure of *indicans* was drawn from a specimen in systole; that is, when fully contracted, as in normal swimming. Similar outlines could readily be sketched for even flatter medusae, as, for instance, *Phialidium*. The two are therefore combined here as *indicans*.

EUTONINA INDICANS (Romanes) Hartlaub.

Tiaropsis indicans Romanes, 1876, p. 525; 1877, pl. 15, fig. 1.
Eutimalphes indicans Haeckel, 1879, p. 195.—Hartlaub, 1894, p. 194.
Thaumantias, sp. McIntosh, 1889, p. 282, pl. 5, figs. 6–9.
Eutonina indicans Hartlaub, 1897, p. 507.
Eutonina socialis Hartlaub, 1897, p. 506, pl. 20, figs. 19, 20; pl. 22, figs 3, 4, 6, 7.

Dutch Harbor, May 25, surface; 15 specimens, 25–35 mm. in diameter; well preserved.

The identification rests on comparison with two excellent specimens from Helgoland. In the largest of the Bering Sea specimens, about 35 mm. in diameter, the number of tentacles to the quadrant is 43, 49, 43, 42, of various sizes, a few being very young, but the greater number full grown. In one of 30 mm. the numbers are 39, 37, 36, 36, besides 11 marginal swellings still too young to be dignified with the name of tentacles. In an Atlantic specimen of 28 mm. the numbers are 48, 41, 45, 42, and the total number is given by Hartlaub as about 150.

The only noticeable separation between examples from the two localities is that in those from Bering Sea the gonads begin close to the base of the peduncle, instead of at a slight distance from it, as in the Helgoland specimens, but the difference is so slight that it is probably a developmental feature. Unfortunately the formalin in which the specimens are preserved has destroyed most of the otoliths, in some otocysts all of them, so it is impossible to tell whether the number counted by Hartlaub is repeated here.

Color.—In formalin, stomach, gonads, and tentacular bulbs are pale yellowish-brown.

The previous records of the species are from Helgoland and the east coast of Scotland.

Genus TIMA Eschscholtz, 1829.

Up to the present time this genus has not been recorded from the Indo-Pacific; but the *Albatross* collection contains a single very large medusa, which is best referred to *Tima*, though it differs from the excellent specimens of the two Atlantic species, *lucullana* and *formosa*, with which I have compared it, in the extraordinary complexity of the lips, and in having a much shorter peduncle. These differences seem to warrant a new species.

TIMA SAGHALINENSIS, new species.

Station 5028, September 28, 241–0 fathoms (off Saghalin Island); 1 specimen, about 100 mm. in diameter.

Type.—Cat. No. 31055, U.S.N.M.

The peduncle is nearly cylindrical, only slightly narrowed distally, and only about 14 mm. long. But though small, it is perfectly evident, and quite as well marked off from the subumbrella as it is in the other Timas. In both *T. formosa* and *T. lucullana* the peduncle is long, hanging to, or below the opening of the bell.

Marginal organs.—Unfortunately there is not a single tentacle intact, so I was much surprised to find a large number of otocysts preserved. Tentacular knobs were likewise distinguishable, alternating with the otocysts, much as they do in *T. formosa*, and occa-

sionally I could make out the scar which marked the location of a tentacle. As to the numbers of the various organs, not much can be said. It is impossible to make any estimate of the tentacles, but the otocysts and bulbs, of which there are about as many of one as of the other, are evidently very numerous, for I counted 16 otocysts over about one-twentieth of the circumference. In this distance there was the scar of only one tentacle; the bulbs could not be counted, but each one that could be seen lay between two otocysts. These observations suggest a total of some 300 otocysts and knobs; that is, about the same number as in large specimens of *T. lucullana* which have 64 or more large tentacles and upward of 300 knobs; in *formosa* 39 is the largest number of tentacles I have counted [Mayer (1910) credits it with 32 only], and there are only about 100 bulbs (96, according to Mayer).

The otocysts of the Pacific specimen are large, and in two of the best preserved ones 8–10 otoliths could be seen, lying in a single series around the periphery of the vesicle, just as they do in *T. formosa* (Mayer, 1910, pl. 41, fig. 3). The gonads begin close to the manubrium, at the distal end of the peduncle, run over that organ and over the subumbrella nearly to the ring canal, being largest in the region of the peduncle and the central part of the subumbrella, and growing smaller toward the margin. Each gonad consists of a single fold or lamella, thrown into a close series of transverse folds. In their present condition the lamellae are more or less split over part of their lengths, so that each seems to be double, but this is clearly accidental.

Manubrium.—The manubrium is short (contracted), the lips much more complex than in either *lucullana* or *formosa*.

Color.—In formalin gonads, manubrium, and lips are pale, but opaque, ochre-yellow.

Family AEQUORIDAE Eschscholtz, 1829.

Genus AEQUOREA Péron and Lesueur, 1809.

I had hoped that the *Albatross* collection, together with the series in the Museum of Comparative Zoology, would afford the basis for a revision of this puzzling genus, but the gaps, both geographic and structural, are too serious to allow this.

The difficulty has been to find any character or combination of characters sufficiently stable to afford a basis for classification, the only two which seem to be precise, so far as we yet know, being the presence or absence of gelatinous subumbral papillae and of excretory papillae. The former has been made by Mayer the distinguishing character of *Zygodactyla*, but gelatinous papillae are not present in the type of *Zygodactyla, Z. coerulescens* Brandt, and another

Aequorid which has them is *Zygocanna* (of which I have studied specimens from the Philippines), with branched canals. All Aequorids with unbranched canals are referred here to *Aequorea*. One of them, *groenlandica*, has subumbral papillae; and only one, *pensile*, lacks excretory papillae.

Somewhat to my surprise a character which proves to be one of the least variable in *Aequorea* is a trivial one—that is, proportional diameters of stomach and bell, a very small stomach, only about one-fourth or one-fifth as wide as the bell, distinguishing *A. tenuis* and its close ally, *A. floridana*, from all other Aequoreas.

The forms remaining after the elimination of *tenuis* (+ *floridana*), *groenlandica*, and *pensile*, are all closely allied to one another. Vanhöffen (1911) considers the relative number of tentacles and canals sufficiently important to subdivide them, but the collection which I have studied shows that it can not be used as a specific character, because there is an unbroken series from specimens with many more canals than tentacles, to ones with many more tentacles than canals. The only tangible character for this purpose seems to be the shape of the tentacular bulbs, according as they do ("*macrodactylum*") or do not clasp the exumbrella ("*aequorea*"). But the Philippine series of *macrodactylum* shows that the clasps vary from being as pronounced as figured by Maas (1905) to a condition where it is difficult to say whether they are present or not. On the other hand, some of the tentacles in one of the specimens from Naples which I have studied clasp the exumbrella nearly as much as the less pronounced ones in *macrodactylum*, while others do not, but are constricted at the base. Thus no hard and fast line can be drawn separating the extremes. Nevertheless it is usually, if not always, possible to place a given specimen in one group or the other, at least I have never seen one absolutely intermediate, although a considerable number have been examined. Here, as in other instances among medusae, the relationship of the two can be best represented graphically by a dumb-bell shaped figure, not by two isolated circles. And although we do not know whether the groups, or species, have been differentiated phylogenetically, or by physiological or by environmental factors, we can say, from the known records, that members of any given swarm are usually all of one type or of the other, while all recent records of *macrodactylum* are from the Tropics (Pacific, and one Gulf Stream); none from the Mediterranean or colder waters. With our present limited knowledge of the two it is best to retain *macrodactylum* provisionally as a distinct species.

All remaining Aequoreas probably belong to a single species, *A. aequorea*. Most of the Pacific Aequoreas, like most of those from the Adriatic recorded by Claus, and the Naples specimens which I have examined, and those from the Tortugas studied by Mayer

(1910), have about as many tentacles as canals, varying to one side or the other to a greater or less degree, besides a large, though variable, number of tentacular rudiments, connected with fully formed tentacles by a series of developmental stages. But forms with three to five times as many tentacles as canals are represented in the Pacific (*"coerulescens"*) as well as in the Atlantic (*"albida"*). In the Atlantic the many-tentacled form is known only from cold waters (Labrador, Newfoundland, Norway), but this is not true of the Pacific.

In the present paper the form with many tentacles, and the one with about equal numbers of tentacles and canals, are treated provisionally as varieties of *Aequorea aequorea*.

AEQUOREA AEQUOREA (Forskål).

Medusa aequorea Forskål, 1775, p. 110; 1776, pl. 32.
Medusa patura Modeer, 1791, p. 32.
Aequorea forskalea Péron and Lesueur, 1809, p. 336.

For synonymy, see Mayer, 1910, p. 325; to which should be added—

Aequorea globosa Eschscholtz, 1829, p. 110, pl. 10, fig. 2.—Maas, 1905, p. 43, pl. 8, figs. 48–50.
Aequorea albida A. Agassiz, 1862, p. 359; 1865, p. 110, figs. 160–162.
Aequorea norwegica Browne, 1903, p. 19, pl. 5, figs. 1–5.
Mesonema victoria Murbach and Shearer, 1902, p. 72; 1903, p. 180, pl. 19, figs. 1–2; pl. 22, fig. 2.
Aequorea floridana Mayer, 1910, p. 330, pl. 43, figs. 6, 7 (*not* L. Agassiz, 1862, p. 361.—A. Agassiz, 1865, p. 67, fig. 139).

This species has universally been called *forskalea*, following Péron and Lesueur (1809), but this name was expressly given by them to the *Medusa aequorea* of Forskål (1775), and all modern authors are agreed that the animal in question is the same that Forskål described.

1. var. AEQUOREA.

I thus designate the variety in which there are about as many tentacles as canals, many of the knobs remaining rudimentary; that is, the form which has usually been described as *"A. forskalea."* There is, as pointed out above, no sharp line between it and the var. *"albida,"* which has several times as many tentacles as canals; but the extremes are so distinct that they are treated separately here for the sake of convenience.

Union Bay, British Columbia, surface; 7 specimens, 36–48 mm. in diameter; in excellent condition.

Friday Harbor, Puget Sound; 10 specimens, 38–72 mm. in diameter; excellent condition.

The series affords the following numerical data:

1. UNION BAY.

Diameter.	Diameter of stomach.	Number of canals.	Number of tentacles.	Number of bulbs.	Total number of tentacular organs.
48	25	52	72	53	125
52	about 26	63	71	39	110
45	about 22	53	67	69	146
47	22	47	66	66	132
43	21	54	80	39	119
44	22	59	68	55	123
36	19	39	62	46	108

2. PUGET SOUND.

72	36	83	91	108	199
55	24	74	71	88	159
50	25	93	70	80	159
45	21	59	90	76	166
38	about 20	57	53	73	126

3. SPECIMEN FROM NAPLES.

79	39	78	65	140	218

Thus the numerical proportion between tentacles and canals is variable according as more or fewer bulbs develop into tentacles.

In specimens up to 190 mm. in diameter Torrey found the tentacles more numerous than the radial canals (about 120), and in one 55 mm. in diameter from San Diego there were 90 canals; in the Puget Sound series studied by Murbach and Shearer (1903) there were about as many tentacles as canals (about 100 of each in specimens 70 mm. broad) besides numerous knobs.

The general "habitus" has often been described, and its chief variations have been tabulated by Mayer (1910).

The shape of the tentacular bulbs is important, because of its bearing on the status of *A. macrodactylum.* In most cases they are somewhat triangular, tapering, slightly narrower at their junction with the margin than just below, circular in cross section, and in side view we see that they cover very little, if any, of the exumbrella. On some of the largest tentacles, however, the bulbs are so much thicker that they do cover a considerable amount of the exumbrella, and it would take only a slight increase in this respect to equal the small tentacles in *A. macrodactylum;* but none have distinct clasps. The bulbs of half-grown tentacles are fusiform.

The excretory papillae are very prominent, one associated with every tentacle, and even with the youngest knob, from which it appears that in development knob and papilla are formed at about the same time. After preservation the mouth is wide open in all our specimens; nor does it give any clue to its normal ability to expand,

so graphically described by Murbach and Shearer (1903), because the lower gastric wall shows no signs of contraction.

The gonads afford another instance of variability, for in large specimens new canals are interpolated in an entirely irregular way. In the present specimens there is a varying number of young canals, some of which are still blind, while others have reached the ring canal. Preexisting canals, too, can bi- or tri-furcate, though this is less common, and occasionally two canals unite. But there is never as much anastomosis as is seen in large specimens of *A. pensile*. Gonads are formed on the young canals when they reach the margin, and according as more or fewer of the canals are of recent growth large or small gonads preponderate in a given individual. In all of the *Albatross* specimens most of the canals are old; for example, in an individual of 50 mm. with 73 canals there are 67 large gonads, and the remaining 16 canals have none.

2. var. ALBIDA.

Dutch Harbor, May 25, surface; 2 specimens, about 120 and about 165 mm. in diameter; in formalin.

These specimens are in fairly good anatomical condition, but they are much flattened, and the gelatinous substance is very hard, their appearance suggesting that they were first put in alcohol. Under the circumstances nothing can be said about general form further than to note that the subumbrella is smooth.

In the larger specimen there are 227 canals and about 675 tentacles of different ages, old and young roughly alternating. Several small segments of the margin are destroyed, but wherever it is intact, as it is over most of the circumference, the ratio between tentacles and canals is slightly more than 3:1. Thus, over 25 canals I counted 84 tentacles and 3 rudimentary knobs.

In the smaller specimen there are 171 canals and 549 tentacles—that is, a ratio of slightly more than 3:1—and about 10 rudimentary knobs. Specimens from Newfoundland and Grand Manan give the following data: diameter 85 mm., 81 canals, about 380 tentacles, and about 12 knobs (72 tentacles and 3 knobs over 15 canals); diameter 69 mm., 97 canals, about 370 tentacles, and 90 knobs (53 tentacles and 12 knobs over 14 canals); diameter 55 mm., 99 canals, 204 tentacles, and about 75 knobs. The tentacle-bulbs are fusiform, slightly flattened laterally, and narrower at their junction with the margin; they do not clasp the exumbrella. There is an excretory papilla at the base of each tentacle, though it might easily be overlooked in the Bering Sea specimens owing to distortion.

Stomach and mouth.—In the larger specimen the stomach is about 85 or 90 mm. in diameter; in the smaller about 63 mm.—that is, in each it is slightly more than half as broad as the bell as a whole; and in each the mouth is nearly closed by long pointed lips, which are

much less numerous than the canals; for example, in the larger specimen there were only 10 lips corresponding to 37 canals.

Gonads.—Each canal bears a well developed gonad.

Color.—No pigment is evident, but it may have been destroyed by preservation.

AEQUOREA PENSILE (Modeer) Haeckel.

Medusa pensile MODEER, 1791, p. 32.

(For synonymy, see Mayer, 1910, p. 333.)

Station 4961, 33–0 fathoms; 9 rather fragmentary specimens, 25–45 mm. in diameter.

The greater part of the margin is torn off in all of the specimens, so that it is impossible to count the tentacles; but on the portions which are intact there are 10–12 canals between every two tentacles, and the tentacular bases are broad, extending more or less along the bell margin. In these respects, as well as in having a large number of canals, a very thick lenticular disk, and in the absence of excretory papillae, which, of course, I specially sought, the specimens agree with better preserved examples of *pensile* from the Philippines.

Order TRACHOMEDUSAE.

Family PETASIDAE Haeckel, 1879. (Browne, 1904; Bigelow, 1909*a*.)

Genus OLINDIOIDES Goto, 1903.

OLINDIOIDES FORMOSA Goto.

Olindioides formosa GOTO, 1903, p. 3, pl. 1, figs. 1–9; pl. 2, figs. 14–16; pl. 3, figs. 17–20.—MAAS, 1909, p. 29.—MAYER, 1910, p. 358.

Station 4883, surface ?; 1 specimen, 50 mm. in diameter.

Station 4884, 53–0 fathoms; 11 specimens, 32–110 mm. in diameter.

Station 4885, 53–0 fathoms; 2 specimens, 45 and 125 mm. in diameter.

These few specimens agree very well with the excellent accounts of much larger series given by Goto and by Maas.

Family PTYCHOGASTRIDAE Mayer, 1910.

Genus PTYCHOGASTRIA Allman, 1878.

PTYCHOGASTRIA POLARIS Allman.

Ptychogastria polaris ALLMAN, 1878, p. 290.—BROWNE, 1903, p. 24, pl. 4, figs. 1, 2; pl. 5, figs. 6, 8.—BIGELOW, 1909*c*, p. 310.

Pectyllis arctica HAECKEL, 1879, p. 266; 1881, p. 11, pls. 3, 4.

(For full synonymy, see Mayer, 1910, p. 372.)

Station 4781 (Bering Sea), 30–0 fathoms; 7 specimens, 10–18 mm. in diameter; much contracted.

Station 3325 (Bering Sea), 109–0 fathoms, August, 1890; 1 specimen.

Unfortunately all of the specimens are in poor condition, the exumbrella being much damaged and the margin so nearly destroyed that there is not a single tentacle or sense-club intact. But specific identification rests on a comparison with a better series from Labrador (Bigelow, 1909*c*, p. 310). In two examples the subumbrella, gonads, and manubrium are in good condition, and show clearly that Browne (1903) was entirely correct in his description of the gonads as situated exclusively on the walls of the manubrium entirely independent of the radial canals. In both the specimens in question the gonads are discontinuous along the narrow line of attachment of the mesenteries to the manubrium just as they were in my Labrador specimens and those described by Browne, as well as in the interradii, so that there are 16 separate adradial sexual masses.

In one specimen the mouth is protruded in a tube of considerable length; in the other it is contracted; in both the lip is simple and circular.

Ptychogastria polaris is known from the coast of Nova Scotia, Labrador, Greenland, Spitzbergen, Norway, the north coast of Russia, and Barents Sea.

Family TRACHYNEMIDAE Gegenbaur, 1856.

Genus AGLAURA Péron and Lesueur, 1809.

AGLAURA HEMISTOMA Péron and Lesueur.

Aglaura hemistoma Péron and Lesueur, 1809, p. 351.

(For synonymy, see Bigelow, 1909*a*, p. 119, and Mayer, 1910, p. 398.)

Station 4896, surface; 10 specimens, 1.5–4 mm. high.

Sado Island, Sea of Japan, surface; 14 specimens, 1.5–3 mm. high.

Station 4955, surface; 2 specimens.

The specimens show variation in general form, some being higher and narrower, others lower and broader; but all are circular in cross section, and so were the Japanese specimens studied by Maas (1909). The smallest, 1.5 mm. high, have no gonads, but these organs are visible in some 2.5 mm. high, and are well developed in the larger specimens.

Genus AGLANTHA Haeckel, 1879.

The collection contains a considerable series of *Aglantha*, and though most of the specimens are in poor condition they show that they belong to a large form with more than four [probably normally eight] otocysts, and that the gonads first appear in specimens 8–10 mm. high. They thus agree with the larger of the two size-varieties of *Aglantha* which I recorded from Labrador (1909*c*), and these same characters distinguish a series collected by the *Michael Sars* in the

Faroe Channel in August, 1910, between 1,000 and 500 meters, for which I have to thank Doctor Broch.

In describing the Labrador collection I used the name *rosea*, following Browne (1903), Maas (1906*b*), and Hartlaub (1909*a*), who separate *rosea* with eight otocysts from *digitale* with four. But Mayer (1910) has found that there is no discontinuity in this character, because specimens may normally have 3, 4, 5, 6, or 8, and all the large specimens studied by me have 6–8 otocysts, if those organs are visible at all, which is very often not the case. The otocysts are so easily detached in *Aglantha* that the identification of many of the collections which have been recorded as *digitale* or as *rosea* rests on no more certain ground than size or geographic location; but there is certainly no correlation between size and number of otocysts, for I have seen specimens from 29–30 mm. high, as well as some with large gonads of only 10–15 mm. with eight of these organs (1909*c*). For these reasons it is probable that Mayer (1910) was justified in uniting the two species, and I therefore follow him, referring the present collection to *digitale*. But revision, which the genus is in urgent need of, will probably show that the latter has several size-varieties.

AGLANTHA DIGITALE (Fabricius) Haeckel.

Medusa digitale FABRICIUS, 1780, p. 366.

(For synonymy, see Mayer, 1910, p. 402.)

The species was taken at the following stations: 4758, 4759, 4760, Dutch Harbor, 4762, 4763, 4766, 4767, 4775, 4783, 4785, 4793, 4797, 4800, 4805, 4806, 4810, 4818, 4819, 4820, 4830, 4831, 4847, 4866, 5030, both on the surface and in hauls with open nets from 300 fathoms. The series consists of about 300 specimens ranging in height from 8–25 mm.

The few specimens which were in good enough condition to show the otocysts afforded the following data:

Locality.	Height.	Tentacles.	Otocysts.	Gonads.
	mm.			
Dutch Harbor	8	68	8	Medium.
Do	9	76	8	Do.
Do	9	86	7	Do.
4810	10	87	5+	Small.
Dutch Harbor	11	89	7	Large.
4673	15	153	6	Do.
4820	17	124	8	Do.

In all of these specimens, as in the Labrador series, the course of the radial canals is direct, instead of in an S curve, as it was in the specimens from the intermediate waters of the eastern tropical Pacific (var. *intermedia*, 1909*a*). There seems to be normally one otocyst to the octant; but some otocysts may lack them in specimens so good that we can not assume that they were present but are lost, and this same phenomenon is recorded by Mayer.

Genus RHOPALONEMA Gegenbaur, 1856.

RHOPALONEMA VELATUM Gegenbaur.

Rhopalonema velatum GEGENBAUR, 1856, p. 251, pl. 9, pp. 1–5.

(For synonymy, see Bigelow, 1909*a*, p. 129, and Mayer, 1910, p. 378.)

Station 4897, 150–0 fathoms; 3 specimens, about 7 mm. in diameter.
Station 4920, 300–0 fathoms; 4 specimens, 6–9 mm. in diameter.
Station 4978, surface; 6 specimens, 8–10 mm. in diameter.
Station 5064, 300–0 fathoms; 2 specimens, fragmentary.

The specimens are so battered that it is impossible to add anything to the earlier accounts of the species further than that all show a well-marked apical thickening or top knot.

Genus PANTACHOGON Maas, 1893.

Homoeonema VANHÖFFEN (1902*b*); Mayer (1910, part).
Isonema MAAS (1906*a*).
Not *Homoeonema* MAAS (1893).—BROWNE (1903).

Trachynemidae with numerous tentacles, in one row, and all alike; without peduncle.

The genus *Isonema* was instituted by Maas for two species, *amplum* Vanhöffen and *macrogaster* Vanhöffen, in which the gonads are spherical and lie close to the manubrium. But studies of a series of *P. haeckeli* have convinced me that the precise location of these organs on the canals is better used as a specific character. The genus, as here amplified, includes six species, *Homoeonema militare* Maas, *Homoeonema amplum* Vanhöffen, *Homoeonema macrogaster* Vanhöffen, *Pantachogon rubrum* Vanhöffen, *Pantachogon scotti* Browne, and *Pantachogon haeckeli* Maas, the last being the type. *Homoeonema platygonon* Maas is grouped with the preceding by Mayer (1910), but Maas (1906*b*) has pointed out that its type specimen belongs to a different family, the Halicreasidae.

The position of the gonads separates the members of *Pantachogon* into three groups, *amplum* and *macrogaster* in which they are close to the manubrium; *militare* in which they are limited to the distal half of the canals; and *haeckeli*, *scotti*, and *rubrum*, in which they occupy nearly the whole length of the canals. It is doubtful whether the first two are separable from each other, and the same is true of *haeckeli* and *rubrum*, which can be told apart only by the brilliant red color of the latter. *Scotti* is distinguished from the last two by its more numerous tentacles (about 120 instead of 64).

PANTACHOGON HAECKELI Maas.

Plate 3, figs. 4–8.

Pantachogon haeckeli MAAS, 1893, p. 17, pl. 1, fig. 2; 1904, p. 29.—MAYER, 1910, p. 389, fig. 239.

Station 4758, 300–0 fathoms; 7 specimens.
Station 4760, 300 fathoms; 7 specimens.

Station 4763, 300 fathoms; 18 specimens.
Station 4764, 1130–0 fathoms; 2 specimens.
Station 4766, 300–0 fathoms; 10 specimens.
Station 4767, 300–0 fathoms; 12 specimens.
Station 4774, 557–0 fathoms; 1 specimen.
Station 4775, 200–0 fathoms; 24 specimens; excellent condition.
Station 4800, 300–0 fathoms; 14 specimens.
Station 5030, 1800–0 fathoms; 4 specimens; fragmentary.

Most of the specimens are in good condition, except that the tentacles are broken short off. The series ranges in height from 5–19 mm. Up to the present time only two specimens of this species have been recorded, one young (Maas, 1893, 8 mm.), the other fragmentary (Maas, 1904*b*).

In general outline the specimens are thimble-shaped, with deep bell cavity, and thin gelatinous substance (pl. 3, fig. 4); most of them are about as broad as high, but several are proportionately broader, though in good condition. Probably the differences in this respect between different specimens are due to varying states of contraction.

The exumbrella is marked by a regular series of meridional furrows, running from apex to margin, thirty-two in every large specimen in which I could count them; the subumbrella is extremely muscular.

Manubrium.—The manubrium is flask-shaped, sessile, without a trace of peduncle, the mouth surrounded by four pointed lips (pl. 3, fig. 8).

In the original specimen of *haeckeli* the eight gonads extended the whole length of the radial canals, forming several irregular thickenings on each. Very much the same condition is to be seen also in our small specimens, 6–8 mm. high (pl. 3, fig. 5), in which each canal bears from 2–4 sexual swellings, connected or not according to their age. But the sexual centers do not remain independent, for as growth progresses, sex-tissue is developed along almost the entire length of each canal, connecting them in a continuous ridge (pl. 3, fig. 6), which finally takes on a wavy form (pl. 3, fig. 7). The development of the gonads is very irregular, not only in different specimens, but often in the different canals of a given specimen, and the largest gonads were found in a specimen only 14 mm. high. Another feature adding to their irregularity is that in all the large specimens the sexual products had been shed over the distal end of each gonad, as is made noticeable by a difference in color, the distal part being white instead of brownish-yellow.

Marginal organs.—In every specimen, large and small, which was in good enough condition to show the stumps of the tentacles, there are 64, that is, 8 perradials and 7 subradials in each octant; and the same is true in *P. rubrum*. Between the bases of the tentacles the margin is thickened, forming rounded prominences crowded with

nematocysts, and there are 64 otocyst-clubs alternating with the tentacles, as in *P. rubrum*. Structurally the clubs agree with Vanhöffen's (1902*b*) figure of clubs of the latter species.

Color.—The specimens are colorless, the subumbrella highly iridescent. One specimen appeared, at first sight, to have a reddish tinge, but on examination it proved that the color was confined to the exumbrella surface, and was evidently an accidental stain. In *P. rubrum* subumbrella and manubrium are rosy red.

Genus COLOBONEMA Vanhöffen, 1902.

Colobonema Maas (1905).—Browne (1906).—Bigelow (1909*a*).
Homoeonema Mayer (1910) part.

The one species of *Colobonema* yet known is characterized by the order of development of its tentacles, of which the 8 perradial, the 16 adradial, and finally the 8 interradial appear successively, 32 being the final number in every specimen which has yet been examined. Though it is not yet certain that this type of succession is peculiar to *Colobonema*, it is certainly unusual, and there is no evidence that it occurs elsewhere.

Maas (1905) and Mayer (1910) use the name *typicum*, believing that *sericeum* Vanhöffen is identical with the form from the Gulf of California earlier described by the former as *Homoeonema typicum*, and for the sake of uniformity the same course is followed here.

C. typicum Vanhöffen is now known to be a mesoplanktonic form of very wide distribution (Bay of Biscay, west coast of Africa, Malaysian region, Philippines, eastern tropical Pacific, and northwestern Pacific).

COLOBONEMA TYPICUM (Maas).

Homoeonema typicum Maas, 1897, p. 22, pl. 3, figs. 1–3.

(For synonymy, see Mayer, 1910, p. 385.)

Station 4905, 369–0 fathoms; 1 specimen, about 32 mm. in diameter.

Station 4909, 300–0 fathoms; 2 specimens, 40 and 30 mm. in diameter.

Station 4917, 361–0 fathoms; 1 specimen, about 35 mm. in diameter.

Station 4920, 440–0 fathoms; 1 specimen, 28 mm. in diameter.

Station 5066, 211–0 fathoms; 1 specimen, 32 mm. in diameter.

The material is not good enough to add much to the earlier accounts, but it is interesting as further evidence of the invariable number 32, of tentacles, of which the interradial in each octant is always the smallest; and because one specimen shows the gonads, the two which are intact being nearly cylindrical, narrow and smooth, and extending from close to the apex nearly to the margin, much the condition observed by Maas (1905). No otocysts were preserved, but one is intact in a specimen from the Philippines. The manubrium usually hangs to about the mid level of the bell, but may be contracted.

Genus CROSSOTA Vanhöffen, 1902.

This interesting genus was founded by Vanhöffen for a Trachomedusa, conspicuous for its dense pigmentation, with 8 canals, 8 sausage-shaped gonads hanging from the canals at the top of the bell, a short, broad manubrium, and several rows of tentacles of different ages. It has since been recorded by me (1909*a*) from the eastern Pacific expedition of the Fisheries steamer *Albatross*. The original describer and Maas (1906*b*) grouped *Crossota* with *Ptychogastria* because of the arrangement of the tentacles, and I (1909*a*) followed the same course, though pointing out that it lacks the mesenteries of *Ptychogastria*, while the tentacles are not radially grouped. But my own studies on *Ptychogastria* (1909*c*) have convinced me that *Crossota* has no relationship with it, because the gonads in *Ptychogastria* are developed in the walls of the manubrium, whereas in *Crossota* they are borne on the radial canals. Mayer (1910) groups the genus with *Halicreas* and *Botrynema;* but in *Crossota* the manubrium is highly organized, with distinct digestive and labial portions, while the tentacles, as the present series shows, are of the usual Trachynemid type, instead of having a distal spine such as is characteristic of *Halicreas*. In the original species of the genus, *brunnea,* the tentacles are in several rows, but in a new species in the collection this arrangement is less developed, and in young stages (p. 49) the tentacles are in a single row.

With these facts in view, I have no doubt that the phylogenetic relationship of *Crossota* is with the Trachynemidae, and especially with such genera as *Aglantha* and *Aglaura*, which it resembles in its sense organs, its gonads, and its manubrium, and from which it differs only in the arrangement of tentacles in the adult.

Two species of *Crossota* were described by Vanhöffen, *brunnea*, the type, and *norvegica;* the only difference between the two being that the latter was of a brighter red color than *brunnea* and that it had gonads, though smaller; distinctions so slight that both Mayer (1910) and I (1909*a*) have classed *norvegica* as a synonym of *brunnea*. But the present collection shows that I went too far in uniting them unequivocally, for it contains a large and excellently preserved series from Bering Sea, all of the "*norvegica*" type; and though the differences between them and *brunnea* are slight, the characters separating them from the latter are exactly those to which Vanhöffen called attention; that is, rather brighter color and the presence of gonads in smaller specimens, to which I may add fewer tentacles at maturity. Now these differences are so slight that they may be evidence of nothing more important than swarm variation such as is so prevalent in *Aequorea*. But, on the other hand, the appearance of typical *norvegica* in cold waters far removed from its type locality seems rather to suggest that it may be a stable form. Before we can answer the question defi-

nitely one way or the other many more Crossotas from various localities must be studied with an eye to their variation. And as *norvegica* is very much closer to *brunnea* than is either of the two new species in the collection, the wisest course is to class it for the present as a variety of the former.

The two new species agree with *brunnea* in their general form, in the structure of the gonads, in the arrangement of the tentacles in several rows, and one of them at least in the structure of the sensory clubs; but the gonads in both are borne at or below the mid-level of the bell in the adult instead of near the apex, while one has a gelatinous peduncle. The presence of a peduncle is so important a character that it might be made the basis of a new genus. But it seems to me that to do so would tend to obscure the obvious affinity of the medusa in question to the other species of *Crossota*, and that it is therefore wiser to refer it to that genus. Pigmentation, too, helps to separate one of them in which it is restricted to the manubrium.

The four members of *Crossota* may be summarized as follows:

A. No peduncle.
1. Gonads hanging from canals close to apex. Subumbrella pigmented.
a. Gonads appear first when bell is about 16 mm. in diameter.....*brunnea*.
b. Gonads visible in specimens only 80 mm. in diameter
brunnea, var. *norvegica*.
2. Gonads hanging from radial canals at about the mid-level of bell. Manubrium heavily pigmented, but subumbrella unpigmented.....*alba*, new species.
B. Manubrium situated on a gelatinous peduncle; gonads at or below mid-level of bell; subumbrella pigmented .....*pedunculata*, new species.

CROSSOTA BRUNNEA Vanhöffen, var. NORVEGICA Vanhöffen.

Crossota norvegica Vanhöffen, 1902*b*, p. 75.—Mayer, 1910, p. 396, fig. 249.
Crossota brunnea (part) Bigelow, 1909*a*, p. 135.

Station 4758, 300–0 fathoms; 5 good specimens.
Station 4759, 300–0 fathoms; 7 fragmentary specimens.
Station 4760, 300–0 fathoms; 12 specimens.
Station 4763, 300–0 fathoms; 23 specimens.
Station 4764, 1,130–0 fathoms; 3 specimens.
Station 4766, 300–0 fathoms; 38 specimens.
Station 4767, 300–0 fathoms; 15 specimens.
Station 4793, 300–0 fathoms; 33 specimens.
Station 4797, 300–0 fathoms; 1 specimen.
Station 4800, 300–0 fathoms; 18 specimens.

The specimens range from 4 mm. to 22 mm. in diameter, and as a whole they are in a fair condition, while one, 18 mm. in diameter, is more nearly perfect than any example of *Crossota* previously recorded. They are thimble-shaped, with a deep bell and with the exumbrella marked by a large number of shallow meridional furrows just as in Vanhöffen's material, and I can definitely announce that the adult *Crossota* has sense clubs. Vanhöffen has already described them in a

young stage about 7 mm. in diameter; but they could not be found in the adults collected by the *Valdivia* nor in the eastern Pacific series. Several of the tentacles of the best specimen, too, are intact, though most of them are broken short off, as has been the invariable rule in all Crossotas yet described. The sense clubs, which are very small and difficult to find among the closely crowded tentacles, have a single terminal concretion; that is, they are of the usual Trachynemid type. I could not count them.

Tentacles.—In the best specimen there are about 43 tentacles to the octant, closely crowded together, in three or four irregular rows, with the oldest farthest from the margin, as described by Vanhöffen. It is impossible to distinguish the members of the successive series of development, but the ones most recently formed lie closest to the margin, and there are some so young that they are still mere cirri. In Vanhöffen's large specimens of *brunnea* (32 mm. in diameter), the tentacles were more numerous, up to 84 to the octant, and, of course, an equally large number may be attained in *norvegica*, for we have no right to assume that any of the specimens have reached their final dimensions. Structurally the few tentacles which remain intact are of the usual Trachynemid type, being solid, with a core consisting of chordate cells, and with the pigment confined to the entoderm. In a specimen 4 mm. in diameter the tentacles, though of different sizes, lie in a single row, 12, 13, 11, in three successive octants. The smallest specimen with gonads is 11 mm. in diameter; in specimens 15–20 mm. they are almost as long as the manubrium. In the eastern Pacific series of *brunnea* the smallest specimen with gonads is 17 mm. in diameter; and even in this one they are only minute swellings on the radial canals.

Color.—The entire subumbrella, manubrium, and gonads are so heavily pigmented with chocolate-brown as to be practically opaque. The tentacles, too, are reddish-brown, the tint being rather brighter than in the eastern Pacific specimens of *brunnea*, or in Vanhöffen's (1902*b*) figure of the latter. The manubrium agrees with Vanhöffen's account, being sessile and much contracted in all the specimens.

One of the interesting things which the series shows is that the pigmentation is as general and as dense in specimens 4 and 5 mm. in diameter as it is in larger ones.

CROSSOTA ALBA, new species.

Plate 3, figs. 9–12.

Type.—Cat. No. 31056, U. S. N. M.

Station 4920, 300–0 fathoms; 1 specimen, type.

Station 5050, 300–0 fathoms; 1 specimen.

The specimens are both about 22 mm. in diameter by 18 mm. high, with deep bell cavity and comparatively thin gelatinous substance.

While neither is perfect, the type having lost the musculature over most of the subumbrella, the two together give a good idea of the species. The exumbrella is furrowed by a large number of shallow meridional grooves, just as it is in *C. brunnea;* indeed, this seemingly trivial feature is characteristic of the whole genus. The entire subumbrella, as shown by the specimen from station 5050, is clothed with a powerful musculature of circular fibers, and the rather broad velum is also very muscular.

The manubrium in the type is about 9 mm. long by 1.5 mm. broad, cylindrical, sessile on the subumbrella (that is, without peduncle), and the mouth is surrounded by four pointed lips (pl. 3, fig. 9). Digestive and labial portions are sharply defined by the fact that the pigmentation is limited to the former. In the other specimen the manubrium is much contracted (pl. 3, fig. 11).

The eight sausage-shaped gonads, which hang free in the bell cavity, being attached only at one end, are situated on the radial canals only about one-third of the meridional distance above the margin (pl. 3, figs. 9, 11) and fortunately they are so well preserved that there is no doubt about their form and location.

Marginal organs.—Most of the tentacles are broken short off in both specimens, but their stumps are well preserved in both, and they are especially clear in the type, which is not contracted at all. The tentacles are arranged in three irregular rows (pl. 3, fig. 10) as in *C. brunnea,* the oldest being farthest from, the youngest closest to, the margin, and each tentacle root, of course, connects with the circular canal. In the type there are large stumps opposite five of the radial canals, but none to correspond with the other three. The number of tentacles per octant is 23, 24, 24, 17, 22, 25, 20, 24, a total of 179, that is, only about one-third as many as in *C. brunnea* of about the same size. The few tentacles which are not broken off are soft and so much damaged that there is nothing to say about them except that they evidently do not have any distal spine-like portion.

The sense clubs (pl. 3, fig. 12) are small, and each contains a single terminal concretion. They were seen in both specimens, but evidently most of them had been lost, so all I can say as to their number is that they were apparently not more than half as numerous as the tentacles.

Color.—The digestive portion of the manubrium is chocolate-brown, so densely pigmented that it is almost black. So far as can be seen from surface views (I did not wish to section either of the specimens) the pigmentation is purely entodermic. The lips are not pigmented. Except for the manubrium, the animal is colorless, though the subumbral musculature is highly iridescent.

CROSSOTA PEDUNCULATA, new species.

Plate 3, fig. 13.

Fisheries steamer *Albatross* station 3066, June 13, 1889, 46° 26′ N. 124° 26′ W. (just north of the mouth of the Columbia River), 50–0 fathoms; 4 specimens, respectively 14, 19, 24, and 25 mm. in diameter.

Type.—Cat. No. 31057, U. S. N. M.

These specimens, from the collection of the United States National Museum, had been in alcohol for over 20 years when they came into my hands, and they are not in good condition. But fortunately they show their more important anatomical features clearly.

In general form, and in the extent of their pigmentation, they resemble *C. brunnea* so closely that I had no doubt I was dealing with that species until I observed the location of the gonads and the peduncle on which the manubrium is borne. The exumbrella, as in *brunnea,* is ribbed with numerous fine meridional furrows, while both subumbrella and velum are very muscular.

Manubrium.—In the two specimens in which it is intact the manubrium is flask-shaped, situated at the end of a short cylindrical neck. On dissection it proved that the neck is a solid gelatinous peduncle, though it is not readily identifiable as such from a surface view, because it, like the rest of the subumbrella, is densely pigmented. On sectioning the digestive apparatus lengthwise it is evident that the peduncle, about 5 mm. long, is cylindrical, and the eight radial canals can be followed lengthwise over it, just as in *Aglantha.* The manubrium itself is much contracted, but, so far as can be seen, it resembles the corresponding organ in *C. brunnea.*

Gonads.—The gonads are sausage-shaped, attached by the upper end only, and hanging free in the bell cavity, as in other Crossotas. In the smallest specimen (14 mm.) they are attached to the canals about one-third of the meridional distance below the apex; in the 19 mm. specimen they are at about the mid-level of the subumbrella (pl. 3, fig. 13); and in the 25 mm. specimen they are about one-third of the meridional distance above the margin. Apparently, then, the gonads become progressively lower and lower with the growth of the bell.

Tentacles.—The tentacles are very closely crowded together, in three or four irregular rows, the oldest and largest being farthest from the margin, just as in *C. brunnea.* In the smallest specimen there are about 75 to the octant; in the 19 mm. one, upward of 80. In the largest they are too much damaged to count. In all of the specimens there are a few very young ones, on the margin. No sense-clubs could be detected.

Color.—The color is not very well preserved, but it apparently was of much the same reddish-brown as in *C. brunnea,* and the

pigmentation covered the entire subumbrella, though now it is intact over occasional patches only.

Family HALICREASIDAE Fewkes, 1886.

Family HALICREIDAE Vanhöffen, 1902*b*.

HALICREAS PAPILLOSUM Vanhöffen.

? *Halicreas minimum* Fewkes, 1882*b*, p. 306; 1886, p. 953, pl. 8.
Halicreas papillosum Vanhöffen, 1902*b*, p. 68, pl. 9, figs. 7, 8; pl. 11, fig. 30.—Maas, 1905, p. 57, pl. 10, fig. 70; pl. 11, fig. 71.—Bigelow, 1909*a*, p. 138, pl. 3, fig. 3; pl. 34, figs. 1–3, 5, 8, 10, 11.—Mayer, 1910, p. 391.
Halicreas papillosum, var. *antarcticum* Browne, 1908, p. 237.

Station 4774, depth ?; 1 specimen, 25 mm. in diameter; fragmentary.

Station 4780, 1046–0 fathoms; 3 specimens, 28–30 mm. in diameter; fragmentary.

Station 4797, 682–0 fathoms; 1 specimen, 30 mm. in diameter; fragmentary.

Station 4800, 300–0 fathoms; 1 specimen, 15 mm. in diameter; fragmentary.

Station 5064, 300–0 fathoms; 2 specimens, 35 mm. in diameter; fragmentary.

Although the specimens are all more or less fragmentary, they are interesting as corroborating my earlier account of the tentacles, several of which clearly show the soft proximal and stiff spine-like distal portion (1909*a*), and especially since they show that the characters on which Browne (1908) based his var. *antarcticum*—that is, presence of tubercles on the central projection of the exumbrella—is merely an individual variation, for the projection is smooth in two specimens, tuberculous in a third.

Genus BOTRYNEMA Browne, 1908.

Alloionema Hartlaub, 1909.

This genus, in which the tentacles are in groups, is so far known from a single specimen from the Antarctic, the type of *B. brucei* Browne (1908); and from 5 described almost simultaneously by Hartlaub (1909*b*) from the Arctic Ocean as *Alloionema ellinorae*.

Four specimens in the *Albatross* collection likewise belong to *Botrynema*, and are indistinguishable from *ellinorae*. The latter and *brucei* are closely allied to each other, the only apparent differences being that in *brucei* the margin is cleft into lobes and that the perradial tentacles lie in exumbral grooves. But until more specimens of the Antarctic *brucei* are studied, it is impossible to tell whether these slight differences are significant, or whether they are

merely evidence of contraction or of individual variation. In the meantime both species may be retained provisionally.

Plate 4, figs. 1–4.

BOTRYNEMA ELLINORAE (Hartlaub).

Station 4760, 300–0 fathoms; 3 specimens, 10–13 mm. in diameter.

Station 4763, 300–0 fathoms; 1 specimen, 11 mm. in diameter.

Station 4764, 1130–0 fathoms; 1 specimen, 8 mm. in diameter.

The specimens are more or less fragmentary except one, which is in fairly good condition except that most of the tentacles are broken short off.

A good account of this species, with excellent figures, has been given by Hartlaub.

Our best specimen (pl. 4, fig. 1) is 13 mm. in diameter by about 9 mm. high, the bell cavity moderately deep, the gelatinous substance thin at the margins, but thickened to form a rounded prominence or knob at the apex; in *brucei*, likewise, there is a gelatinous knob. Apparently the subumbrella is not especially muscular; but the velum, which is so broad that it fills the entire opening of the bell in the preserved state, is provided with an unusually well developed series of circular fibers.

The eight radial canals are broad and flat, as in other Halicreasidae, and the corresponding gonad is represented on each one by a broader region near the junction with the manubrium. Apparently the specimens are all immature, for the walls of the canals in the sexual regions are but little thickened as yet.

The manubrium is broad, shallow, and of the same general appearance as in other Halicreasidae; the mouth, wide open at present, is surrounded by a simple, unfolded, circular lip.

Marginal organs.—The margin is not lobed as it is in *brucei*, but is smooth, just as Hartlaub found it. There are 8 single perradial tentacles and 16 adradial tentacle groups (pl. 4, fig. 2), with from 7–11 tentacles in each group, and tentacles of different ages, as identified by the length of their stumps, being arranged in a continuous series, the oldest at one end of the group, the youngest at the other. In the groups of tentacles flanking four alternate radial canals, the oldest tentacles are next to the perradius; in the other four pairs of groups the youngest (shortest) tentacle stumps are nearest the perradius. Thus, following around the margin, the two groups in any octant show the one, those in the next octant the other arrangement. And this same arrangement was traced by Hartlaub. In *brucei* the longest basal ends are next the perradius in the group figured by Browne (1908), "but in some of the other groups the shortest basal end occupies this position" (Browne, 1908, p. 240). It was

Alloionema ellinorae HARTLAUB, 1909*a*, p. 8, pl. 76, figs. 3, 4, 6.

not clear, however, whether there was a regular alternation in this respect, such as is so evident in *ellinorae*. All of the tentacles are broken off.

Sensory clubs.—The sense clubs closely resemble those of *Halicreas*. They, like the tentacles, are grouped, lying in the perradial regions in the space between the two tentacle groups which flank each radial canal, three in each group (Hartlaub shows four). Each club consists of an ectodermic sheath, and a clear entodermic core (pl. 4, fig. 4), but the boundaries and nuclei of the entodermic cells which were visible in the clubs of *Halicreas* (1909*a*, pl. 33, fig. 8) could not be made out here, and none of them now contain otoliths.

Color.—In formalin the manubrium and canals are pale reddish-brown.

Family GERYONIDAE Eschscholtz, 1829.

Genus LIRIOPE Lesson, 1843.

The "species" of *Liriope*, like those of most other oceanic medusae common enough to find their way often into literature, have long been a fertile field for discussion. Various characters have been used as the basis for specific separation, but as a historical survey would be outside the field of the present paper, it will suffice to say that the only one which has stood the test of time is the shape of the gonads; and even this one must be used with due regard to the changes in form assumed by these organs during their growth.

All the Liriopes in the present collection belong to the type with triangular gonads which I have called *tetraphylla*, but for which Maas (1909) uses the name *rosacea* (he applies *tetraphylla* to a form with rounded or oval gonads close to the ring canal, which, as he points out, is the same as the eastern Pacific form with similar features, which I left unnamed).

In the eastern Pacific collection I found a growth series connecting specimens with triangular gonads with the large specimens in which the gonads are pentagonal (*compacta*, Maas), and as there is a continuous series of stages in growth from the triangular to the pentagonal form, correlated with a general increase in bodily size, it is fairly demonstrated that the latter is an older stage of the former. Maas, too, in his most recent communication on the Indo-Pacific Liriopes (1909), no longer distinguishes sharply between the two, if I read him aright.

The *Liriope* with triangular gonads is recorded from the Atlantic by Vanhöffen, Maas, and Mayer; and I myself have studied numerous specimens of this type from the West Indies, so it is evidently at home in the warm waters of all three great oceans, though, according to Maas, it is not yet known from the Mediterranean. As Vanhöffen pointed out (1902*b*), this triangular-gonad form merges into

the "heart-shaped," a fact which I have been able to corroborate on the eastern Pacific series. Therefore all Liriopes with triangular or heart-shaped gonads, which may finally become pentagonal, are best united in one species. Hartlaub (1909*b*), it is true, recognizes a second species with triangular gonads, under the name *L. haeckeli* Götte, but neither of the characters by which he characterizes it, i. e., long peduncle, and gonads close to the circular canal, seem to deserve the importance he gives them, because the first is subject to great individual variation (at least in preserved series), and the second is probably a growth character.

My use of the name *tetraphylla*, instead of *rosacea*, for the species with angular gonads, is warranted, I believe, by the fact that the figure of the former, the oldest *Liriope* (Chamisso and Eysenhardt (1821, pl. 27, fig. 2) has distinctly triangular gonads, the outline being fully as pronounced as it is in the Eschscholtz figure of *rosacea* (1829, pl. 11, fig. 2). It is therefore incorrect to use *tetraphylla* for a *Liriope*, the distinguishing character of which is that its gonads are not triangular.

This leaves the Indo-Pacific form with oval gonads, which both Maas (1905) and I (1909*a*) have studied, without a name; and I am content to let it remain so until some student can determine its relationship to the numerous Atlantic "species" of similar character, with some of which it is undoubtedly identical.

LIRIOPE TETRAPHYLLA (Chamisso and Eysenhardt).

Geryonia tetraphylla Chamisso and Eysenhardt, 1821, p. 357, pl. 27, fig. 2.

(For synonymy, see Bigelow, 1909*a*, p. 112, with the exception that *L. tetraphylla* Maas was wrongly included, as pointed out above.)

Station 4827, surface; 19 specimens, 2–7 mm. in diameter.
Station 4864, surface; 4 specimens, 2–7 mm. in diameter.
Station 4889, surface; 15 specimens, 4–10 mm. in diameter.
Station 4920, 300–0 fathoms; 5 specimens, 8–15 mm. in diameter.
Station 4927, surface; 7 specimens, 6–12 mm. in diameter.
Station 4955, surface; about 20 specimens.
Station 4978, surface; 9 specimens.
Station 5081, surface; 2 specimens, 13 and 16 mm. in diameter.

The series, which as a whole is in good condition, is of interest as illustrating the variability of the species and the impossibility of drawing any exact parallel between gonad-form and general size. Among the larger ones both triangular gonads and pentagonal ones, in contact with one another and consequently truncated, are to be seen. One specimen of 12 mm. has three pentagonal, one triangular. All of the specimens have gonads, as might be expected, for these organs appear when a diameter of 3–4 mm. is reached (Maas, 1909); and they

are angular in all, except a few of the smallest which are badly crumpled. This, too, was to be expected, because though they are oval when they first appear, both Maas (1909) and I (1909*a*) have found that they are already triangular in specimens of 5–6 mm.

Genus GERYONIA Péron and Lesueur, 1809.

GERYONIA PROBOSCIDALIS (Forskål) Eschscholtz.

Medusa proboscidalis FORSKÅL, 1775, pl. 36, fig. 1, 1776, p. 108.

(For synonymy, see Bigelow, 1909*a*, p. 116, and Mayer, 1910, p. 425. To the latter add *Geryones elephas* Haeckel, 1879, p. 294, pl. 18, fig. 7.)

Station 4948, 650–0 fathoms; 1 specimen, 25 mm. in diameter; fragmentary.

Station 4952, surface; 1 specimen, 22 mm. in diameter; fragmentary.

Both of the specimens are hexamerous; that is, they have the normal number of radial canals. This is worth noticing only because the species is very variable, examples with 5 or 7 canals often being observed.

Order NARCOMEDUSAE.

Family CUNINIDAE[1] Bigelow

Family CUNANTHIDAE Haeckel (1879) (Maas 1904*a*, Bigelow 1909*a*.)

Genus SOLMISSUS Haeckel, 1879.

Solmissus MAAS (1904), BIGELOW (1909*a*), MAYER (1910).

Genus SOLMARIS Vanhöffen (1908) [part].

This genus, and Vanhöffen's treatment of the forms involved, is discussed in detail in my account of the Philippine Medusae, collected by the Fisheries steamer *Albatross*, and as that paper will probably appear before this one does, it would be a needless repetition to go into the matter here further than to point out that Vanhöffen has combined two totally distinct genera under the name *Solmaris*, and that his statement that all Solmarids have gastric pockets is based on misapprehension. That there are Solmarids without gastric pockets is now well established. Such forms, that is, those with neither otoporpae nor gastric pockets, have been described by Maas (1909, p. 34); and both Mayer (1910) and I have substantiated his account from excellent specimens of the well-known *Solmaris flavescens* from the Mediterranean.

The present collection contains several specimens of *Solmissus*, all more or less fragmentary, but still well enough preserved to show

[1] The name Cunanthidae, used by Maas (1904) and by me (1909*a*) is untenable, because *Cunantha* Haeckel is almost certainly larval *Aegina*.

that they probably belong to the form which I described from the eastern Pacific as *S. incisa* Fewkes. It is distinguished from the better known *marshalli* and *albescens* by its much more numerous antimeres and less numerous otocysts, as well as by its rounded gastric pockets and very large size. Probably *S. faberi* and *S. bleekii* of Haeckel are synonyms of *incisa* (Bigelow, 1909*a*, p. 64), and the *Solmaris rhodoloma* of Vanhöffen (1908), which likewise has a large number of tentacles, can not be distinguished from *incisa*, so far as his brief account of rather fragmentary specimens shows.

SOLMISSUS INCISA (Fewkes).

Solmaris incisa Fewkes, 1886, p. 954, pl. 9.—Bigelow, 1909*a*, p. 67, pl. 21, figs. 1–3, 5.—Mayer, 1910, p. 483

Solmissus faberi Haeckel, 1879, p. 350.

Solmissus bleekii Haeckel, 1879, p. 351.

?*Solmaris rhodoloma* Vanhöffen, 1908, p. 60, pl. 1, fig. 5 (not Brandt, 1838).

The series gives the following data:

Station.	Depth, fathoms.	Number of specimens.	Diameter, mm.	Number of tentacles.
4759	2708–0	1	48	22
4760	300–0	1	50	23
4763	300–0	2	40 and 103	20 and 35
4775	300–0	1	44	23
4785	300–0	1	45	19
4793	300–0	5	76, 60, 65, 75, 112	40, 31, 34, 35, 35
5058	300–0	1	43	24
5063	300–0	1	43	19

Fragments probably belonging to this species were taken at stations 4758, 4766, 4767, 4774, and 4797, in the trawl or in "intermediate" hauls.

The specimens are all in poor condition, being variously torn and distorted, with the entire lower wall of the gastric system torn away, except around the margins of the gastric pockets and in the septal regions separating them. Consequently I can add little to my previous account.

The most valuable thing about the series is the data which it affords as to the number of antimeres and tentacles. In the eastern Pacific series they ranged from 16 to 31 in specimens 10–68 mm. in diameter, all the large ones (17 mm. or upward) having upward of 20. And Vanhöffen's specimens of 71, 75, and 82 mm., which probably belong here, had 30, 28, and 29, respectively.

These numbers, together with those listed above, show that the tentacles increase irregularly with growth (a specimen of 45 mm. has 19, another smaller one, of 43 mm., has 24), and that in large specimens there are always many more tentacles than in either *marshalli* or *albescens*, for both of which 16 is the maximum yet recorded.

No otocysts were found, but the pads on which these organs were situated are preserved in a few antimeres of the largest specimens, the

number varying from 2–4 to the antimere. This is the same number which I counted in the eastern Pacific specimens (2–3 to the antimere, 1909*a*, p. 69), and Haeckel's specimens, too, had very few (1–3 to the lappet). In *marshalli* and *albescens* there are many more otocysts in each antimere, up to 15 having been recorded for the former and 10 for the latter.

Genus CUNINA Eschscholtz, 1829.

CUNINA PEREGRINA Bigelow.

Cunina peregrina Bigelow, 1909*a*, p. 59, pl. 1, fig. 6; pl. 15, figs. 1, 2; pl. 28, figs. 1–7; pl. 45, fig. 8.

Station 4978, surface; 1 specimen, in fair condition.

C. peregrina has been recorded from Japan by Maas (1909).

Family AEGINIDAE Gegenbaur, 1856.

Genus AEGINA Eschscholtz, 1829.

Sensu Maas (1904, 1905), Bigelow (1909*a*).

Recent studies by Vanhöffen (1908) and by Maas (1909), and my own examination of the Fisheries steamer *Albatross* Philippine collection have shown that my union (1909*a*) of *A. rosea* with *A. citrea* was incorrect, because the former is separated from the latter both by color and by the important fact that the eight gastric pouches (four double pouches) are not further subdivided even in large specimens, whereas in *citrea* each is deeply notched at the margin at maturity. And the difference has been established on sufficiently large numbers of specimens to show that it deserves recognition.

The eastern Pacific collection was all of the *citrea* type except for one specimen which had four gastric pockets alternating with the four peroniae, and which I made the basis of a new species, *A. alternans*. But the present series shows that this specimen was merely an abnormal, or perhaps regenerated, *rosea*, and the name must therefore be abandoned. It is probable that all the Aeginas yet described belong either to *rosea* or to *citrea*, for *A. rhodina* Haeckel, recently redescribed by Mayer (1910), agrees with *rosea* in its gastric pouches; the large specimens recorded by Haeckel were no doubt *rosea;* the small one, of 7 mm., studied by Mayer, might equally well be the young of *rosea* or of *citrea*. Vanhöffen's *lactea* is separated from *rosea* only by the absence of color over the gastric system, and his *brunnea* by the brown color of the stomach. These are known from one specimen each; far too little material to show that these color differences have any phylogenetic meaning. Even if we leave these three forms out of account, *rosea* and *citrea* are both known from the Atlantic as well as from the Indo-Pacific (Maas, 1909; Vanhöffen, 1908).

AEGINA ROSEA Eschscholtz.

Aegina rosea Eschscholtz, 1829, p. 115, pl. 11, fig. 4.—Vanhöffen, 1908, p. 48, pl. 7, figs. 1, 2; pl. 9, figs. 16–19.—Maas, 1909, p. 35.
Aegina alternans Bigelow, 1909*a*, p. 74, pl. 17, fig. 1.

Station 4761, 1973–0 fathoms; 1 specimen, 35 mm. in diameter.
Station 4774, 557–0 fathoms; 1 specimen, 40 mm. in diameter.
Both are rather fragmentary.

The large specimen agrees so well with my *A. alternans*, except that it has five antimeres, that I had no doubt at first that I was dealing with a second representative of that species, and consequently that its validity was fairly well assured. But when I examined the smaller one I saw at once that this was not the case. The distinctive feature of *alternans* was that it had four gastric pouches alternating with the canals, and not divided at all in the interradii, and this is exactly the condition in the specimen from station 4761. But in the other, which has six tentacles, two of the antimeres have two pouches each, discontinuous in the interradii exactly as in the other Aeginas, three have a single undivided pouch, as *alternans;* but the sixth gives us the clue, for in this one the interradial septum separating the two pouches has broken down distally, putting the two cavities into communication with each other, though its proximal portion remains intact. The specimen is so large that the exact state of affairs is easily traced, and the fact that in the antimeres in which the pouches are confluent there is no visible evidence that a septum formerly existed explains my failure see an indication of anything of the sort in the original specimen of "*alternans.*"

AEGINA CITREA Eschscholtz.

Aegina citrea Eschscholtz, 1829, p. 113, pl. 11, fig. 4.

(For synonymy, see Mayer, 1910, p. 451.)

Station 4757, depth?; 1 specimen, 29 mm. in diameter, with four antimeres, rather fragmentary; in alcohol.
Station 4978, surface; 1 specimen, 15 mm. in diameter, with four antimeres.

The specimens add nothing, except the record of occurrence, to our knowledge of the species. The identification rests on the fact that the 8 gastric pockets are subdivided into 16 by deep marginal notches, exactly as in the eastern Pacific examples (1909*a*).

AEGINA, species?

Station 4762, 50–0 fathoms; 2 specimens, 7 and 9 mm. in diameter.
Station 4785, 300–0 fathoms; 3 specimens, 6 and 7 mm. in diameter.
Station 4793, 300–0 fathoms; 4 specimens, 5–8 mm. in diameter.
Station 4797, 300–0 fathoms; 2 specimens, 6 and 10 mm. in diameter.

Station 4805, 200–0 fathoms; 2 specimens, 7 and 10 mm. in diameter.

Station 4806, 200–0 fathoms; 1 specimen, 6 mm. in diameter.

In these young Aeginas the 8 gastric pouches (all have 4 antimeres) are not divided secondarily, and in our present comparative ignorance of the growth-stages of the genus, it is impossible to be certain whether they belong to *rosea* or to *citrea*.

None of them are in good enough condition for me to count the otocysts.

Genus AEGINURA Haeckel, 1879.

Aeginura Maas (1904*b*; 1905).—Bigelow (1909*a*).—Mayer (1910).
Cunoctona Haeckel (1879).—Vanhöffen (1908).

Aeginidae with 8 tentacles and 16 gastric pockets: with secondary tentacles on the margin of the lappets.

There is no need to repeat the history of this genus here. Maas's (1904*b*) choice of *Aeginura* as the generic name for the deeply pigmented mesoplanktonic Aeginids with 8 tentacles, which have been brought to light by the recent deep-sea explorations of the Prince of Monaco, the *Siboga*, and the *Albatross*, seems to be justified by a strong probability that they are congeneric with Haeckel's *A. myosura*. A different stand is taken by Vanhöffen (1908), who refers them to Haeckel's *Cunoctona*, on the ground that the latter has no peripheral canal system, whereas his *Aeginura* had. It is true that Haeckel's figures of the latter apparently show a well developed system of canals, though Maas (1905, p. 79) has pointed out that the "canals" in Haeckel's section (1881, pl. 13, fig. 7) are in reality portions of the gastric pockets themselves, such as are to be seen in a corresponding figure of one of the *Siboga* specimens (Maas, 1905, pl. 14, fig. 92).

Vanhöffen (1908) found no canals in the sections of the margin which he studied, and though Maas (1905) observed and figured spaces in the entodermic lamella in exactly the region where canals would be expected, these probably did not indicate the existence of canals, because there was no definite endothelial layer surrounding them. On the other hand, Haeckel's figure of *Cunoctona* certainly suggests the presence of canals, though whether or not it actually had them is not certain. Under these circumstances it seems idle to try to derive a generic character from the presence or absence of canals in Haeckel's specimens. Another objection to referring the Aeginuras of modern authors to *Aeginura* Haeckel is the fact that he saw no secondary tentacles, while he figures very large otocyst-clubs. But his figure is obviously more or less reconstructed, and the

secondary tentacles may well have been lost in his specimen, or he may have mistaken them for otocysts.

As to Haeckel's *Cunoctona*, I must point out that if we are to unite it with *Aeginura* we must suppose that its otoporpae, which he shows so clearly, were imaginary. And it is not clear whether its gastric pouches were actually of the bifid, Aeginid type, for though they are so shown in the side view (Haeckel, 1879, pl. 20, fig. 2), in the oral view (1879, pl. 20, fig. 1), which is much the more detailed, they are hardly notched at all in the perradii, that is, they are more nearly of the *Cunina* type.

The modern Aeginuras are *grimaldii* and *weberi* of Maas, and *grimaldi* var. *munda*, *guinensis*, and *obscura* described as new by Vanhöffen from the collections of the *Valdivia*. I have already given my reasons (1909*a*) for uniting the first two, as does Mayer also (1910), and for calling the eastern Pacific specimens *grimaldii*. Vanhöffen's species are based on the number of secondary tentacles and on slight differences in color. But the present series shows that the first of these characters is too variable, even from octant to octant of a given individual, to be of any value in classification, at least within the narrow limits laid down by Vanhöffen; and it also affords evidence that the second is of no greater importance.

All of these forms are therefore united here as *grimaldii*.

AEGINURA GRIMALDII Maas.

Aeginura grimaldii Maas, 1904*b*, p. 38, pl. 3, fig. 19–28.—Bigelow, 1909*a*, p. 80, pl. 9, fig. 4.—Mayer, 1910, p. 470.
Aeginura weberi Maas. 1905, p. 77.
Cunoctona grimaldi, var. *munda* Vanhöffen, 1908, p. 53, pl. 2, fig. 6.
Cunoctona guinensis Vanhöffen, 1908, p. 53, pl. 3, fig. 29.
Cunoctona obscura Vanhöffen, 1908, p. 52, pl. 2, fig. 7; pl. 3, figs. 25–28, 30.

Station 4764, 1130–0 fathoms; 3 specimens, 26, 27, and 30 mm. in diameter.

Station 4766, 300–0 fathoms; 1 specimen, 32 mm. in diameter.

Station 4768, 764–0 fathoms; 1 specimen, 20 mm. in diameter.

Station 4780, 1046–0 fathoms; 7 specimens, 20–30 mm. in diameter, fragmentary.

Station 4953, 1350–0 fathoms; 1 specimen, 15 mm. in diameter.

Station 5058, 300–0 fathoms; 1 specimen, 22 mm. in diameter.

Station 5084, 300–0 fathoms; 1 specimen, 15 mm. in diameter; fragmentary.

In their general organization these specimens agree so well with Maas's (1905) excellent account of the *Siboga* material, and with the eastern Pacific series (1909*a*, p. 80) that an extended account is unnecessary. The most important point which they illustrate is the futility of trying to base several species on the number of secondary tentacles per octant. The largest example is in good condition, and

though the others are all more or less battered, their margins are well enough preserved to afford the following data:

Diameter, mm.	Antimeres.	Secondary tentacles in successive antimeres.
32	7	4, 4, 3, 4, 5, 5, 5
27	8	3, 3, 3
22	8	3, 3, 4, 3, 3, 5, (?), (?)
15	8	2, 3, 3

The previous records are:

23 (?) mm., 3 secondary tentacles per octant (Maas, "Monaco").

35–45 mm., 3 secondary tentacles per octant (Maas, *Siboga*).

16–21 mm., usually 3 secondary tentacles per octant (Bigelow, 1909*a*, *Albatross*).

8 and 16 mm., 3 secondary tentacles per octant (Vanhöffen, 1908, var. *munda*).

Diam. ?, 5 secondary tentacles per octant (Vanhöffen, 1908, *guinensis*).

34 mm., 4 secondary tentacles per octant (Vanhöffen, 1908, *obscura*.

The value of these records must be modified by the statement that the margin in the "Monaco" specimen, and most of the *Albatross* eastern Pacific ones, was in such poor condition that the counts given are only approximate. Some of the octants of the latter could not be counted at all, and in others some of the secondary tentacles may have been lost.

Vanhöffen's definition of the various species is: with 3 secondary tentacles to the octant, *grimaldii;* with 4, *obscura;* with 5, *guinensis*. But the present series shows that it is impossible to draw any such lines, because a single specimen may show all three conditions on different parts of the margin; that is, its individual antimeres, on this system, would belong to different species. The number of secondary tentacles increases with growth, but very irregularly. Thus the largest number observed for any antimere, 5, occurs in a specimen of only 22 mm., as well as in the largest, while the only one which has 3 in 3 successive octants is 27 mm. in diameter. Nor is it safe to assume that more than 5 may not be developed.

The general rule, according to both Maas and Vanhöffen, is that there is an otocyst on either side of each secondary tentacle; and that is the case in the present series wherever the otocysts are intact. But in no specimen could I count them even over the whole of a single antimere.

In the largest specimen, one in which the central gastric system is well preserved, the interradial incisions between the gastric pockets are fully twice as deep as the incisions in the perradii, a discrepancy

even greater than that observed by Maas (1905) and by me (1909*a*). As pointed out elsewhere, this fact is probably of phylogenetic importance, showing that the pockets are primarily radial, as in *Cunina.*

This specimen is a female with large eggs, and it shows that the reason that the eggs in the large eastern Pacific example showed white (1909*a*, pl. 9, fig. 4) was that the overlying tissue was torn, or at least that the pigment was destroyed. In the present case they are made visible only by the swellings which they cause, exactly as in *Solmissus marshalli* (1909*a*, pl. 21, fig. 7).

Color.—In the best preserved specimens the central stomach and gastric pouches are very dense, opaque, chocolate-brown, with more or less pronounced reddish tinge, with the marginal region of the subumbrella pale reddish; i. e., of about the same color as the specimens of the species previously recorded.

In the two specimens named by Vanhöffen var. *munda*, the marginal region was white; and this was their sole distinguishing character. But there is no sharp line between them and specimens with pale reddish margin and his own *obscura* in which the marginal region was densely pigmented.

Genus SOLMUNDELLA Haeckel, 1879.

Solmundella MAAS (1904*b*, 1905).—BROWNE (1905*b*).—BIGELOW (1909*a*).

This genus has been so thoroughly discussed by Maas (1905), Browne (1905*b*), Mayer (1910), Vanhöffen (1908), and me (1909*a*), that all that is necessary here is to record the 17 specimens contained in the collection.

SOLMUNDELLA BITENTACULATA (Quoy and Gaimard).

Charybdea bitentaculata QUOY and GAIMARD, 1834, p. 295, pl. 25, figs. 4, 5.
(For synonymy, see Bigelow, 1909*a*, p. 77; Mayer, 1910, p. 455.)

Station 4800, 300–0 fathoms; 3 specimens, fragmentary.
Station 4896, depth ?; 2 specimens, 3 and 5 mm. in diameter.
Station 4920, 300–0 fathoms; 10 specimens, 6–10 mm. in diameter.
Station 4952, surface; 2 specimens, 1.5 mm. in diameter.

None of the specimens are in good enough condition for me to count the otocysts.

Class SIPHONOPHORAE.

Order CALYCOPHORAE.

Family SPHAERONECTIDAE Huxley, 1859.

Genus NECTOPYRAMIS Bigelow, 1911.

NECTOPYRAMIS DIOMEDAE Bigelow.

Nectopyramis diomedae BIGELOW, 1911*b*, p. 191, pl. 1, fig. 1–6.

Station 4759, 300–0 fathoms; 1 eudoxid, good condition.
Station 4806, 200–0 fathoms; 1 eudoxid; fragmentary.

These eudoxids, in both of which the bract is 25 mm. long, agree very well with one of corresponding size from the eastern Pacific. The best one is somewhat younger than the one I have figured (1911*b*, pl. 1, fig. 5), its apical canal giving off only four branches instead of six, the odd basal canal three instead of four. But these differences are only indications of differences in development. Its tentacles and gonophores are not in good enough condition to add anything to my previous account.

The polygastric state is not represented in the collection.

Family PRAYIDAE Kölliker, 1853.

Genus ROSACEA Quoy and Gaimard, 1827.

ROSACEA PLICATA Quoy and Gaimard.

Plate 5, figs. 10, 11.

Rosacea plicata Quoy and Gaimard, 1827, p. 147, pl. 4 B.

(For discussion and synonymy of this species, see Bigelow, 1911*b*, pp. 197, 201.)

Station 4764, 1130–0 fathoms; 2 loose nectophores.

Station 4766, 300–0 fathoms; 1 complete specimen, 9 loose nectophores.

Station 4767, 300–0 fathoms; 2 complete specimens, 2 loose nectophores.

Station 4775, 200–0 fathoms; 1 complete specimen, 3 loose nectophores.

Station 4785, 300–0 fathoms; 1 complete specimen, 19 loose nectophores.

Station 4785, 300–0 fathoms; 2 loose nectophores.

Station 4800, 300–0 fathoms; 1 complete specimen, 16 loose nectophores.

Station 4865, 200–0 fathoms; 9 loose nectophores.

Station 4902, 432–0 fathoms; 2 loose nectophores.

Station 4920, 300–0 fathoms; 2 loose nectophores.

Forty-five of the loose nectophores are younger (superior), and 21 older (inferior). The largest nectophores are about 30 mm. long.

The series is tantalizing, for although the nectophores are in good condition, the stems are invariably broken off short, so that the most important question, that is, whether there are special nectophores in the cormidia, must remain unanswered. The evidence that *R. plicata* does have such organs is not as conclusive as might be supposed, for nothing of the sort is shown by Keferstein and Ehlers (1861, "*P. diphyes*") or by Kölliker (1853*b*, "*P. diphyes*"), and the special nectophore in Vogt's figure (1854, "*P. diphyes*") might be a

gonophore which had lost its spadix. In the Biscayan series of *plicata* (1911*b*), I found what appeared to be a typical special nectophore, in addition to gonophores, in one cormidium. But we must remember that such a structure might be interpreted as an abortive gonophore in which the spadix had failed to develop. A single specimen with the whole stem intact would settle the question at once; and until some student can examine such material further discussion is idle. But it must be observed that if it should prove that *R. plicata* has no special nectophores, but only gonophores, there would be no generic distinction between it and *Praya cymbiformis*.

The nectophores in the present series (pl. 5, fig. 10) agree with the Biscayan and eastern Pacific ones in their short broad outlines and in the very deep hydroecium, and it is on the strength of these features that I have united the Biscayan, eastern Pacific, and northwestern Pacific specimens.

In the only other species with which they could be confused, *Praya cymbiformis*, the nectophores are proportionately narrower, with hydroecium shallower, and of almost equal depth from end to end, and as the difference seems to be constant, it would separate the two forms specifically, even if it does eventually prove that they belong to a single genus. The older (inferior) nectophores of *plicata* can not be distinguished from those of *cymbiformis* (1911*b*).

Stem and appendages.—Only young siphons, gonophores, and bracts remain attached, and none of these are sufficiently advanced to show whether there is any important difference between them and the corresponding organs in *cymbiformis*, nor did the eastern Pacific series prove any more helpful.

In none of the eastern Pacific specimens was the somatocyst terminally dilated, whereas in the Biscayan series it varied from being slightly thickened at the tip to having an egg-shaped terminal swelling (pl. 5, fig. 11). But the present series shows that the difference is due either to contraction or to individual variation, for one specimen has a well-marked dilation, some are slightly thickened, and others retain an even caliber to the tip.

Genus NECTODROMA Bigelow, 1911.

NECTODROMA RETICULATA Bigelow.

Nectodroma reticulata Bigelow, 1911*b*, p. 206, pl. 1, figs. 7, 8; pl. 3, figs. 1–7.

Station 4928, 300–0 fathoms; 2 nectophores, which probably belong together, though now separate, 42 and 50 mm. long; 4 bracts.

The nectophores, though not perfect, are in sufficiently good condition to show that they agree in all their essentials, as well as in

general form, with the type specimen. Fortunately the apical portion of the subumbrella of each is intact, and shows the network of subumbral canals, which is the chief characteristic of the species. The only point in which they differ from the eastern Pacific material is that in the smaller nectophore the descending arm of the somatocyst has no branches and the ascending one only 6, instead of about 18, short transverse branches. The lateral branches of the dorsoventral extension, too, are fewer, and even shorter. But there is no reason to suppose that these differences are anything but evidence of an earlier stage in development. In the larger nectophore the somatocyst is largely destroyed.

The four bracts *captured* with the nectophores agree very well with the ones collected with the type specimen (1911*b*, pl. 3, fig. 6), and the fact that the bracts of this type have now been taken twice with the nectophores is almost proof positive that they belong together.

Family HIPPOPODIIDÆ Kölliker, 1853.

Genus HIPPOPODIUS Quoy and Gaimard, 1827.

HIPPOPODIUS HIPPOPUS (Forskål).

Gleba hippopus FORSKÅL, 1775, p. 14; 1776, pl. 43, fig. E.

(For synonymy, see Bigelow, 1911*b*, p. 208.)

Station 4951, 300–0 fathoms; 1 small specimen with 4 nectophores.

As was to be expected, this example shows nothing to separate it from the tropical Pacific or Atlantic specimens, with which I have compared them.

Genus VOGTIA Kölliker, 1853.

VOGTIA PENTACANTHA Kölliker.

Plate 5, figs. 7–9; plate 6, fig. 6.

Vogtia pentacantha KÖLLIKER, 1853*b*, p. 31, pl. 8.—KEFERSTEIN and EHLERS, 1861, p. 23, pl. 5, figs. 12–15.—CHUN, 1897*b*, p. 35, pl. 1, figs. 11–14.—BIGELOW, 1911*a*, p. 351; 1911*b*, p. 210.

Hippopodius pentacanthus CLAUS, 1863, p. 551, pl. 47, figs. 23–25.—SCHNEIDER, 1898, p. 84.

Station 4763, surface; 2 colonies with 3 and 5 nectophores and 39 loose nectophores.

Station 4766, 300–0 fathoms; 1 colony with 11 nectophores, in excellent condition.

Station 4785, 300–0 fathoms; 1 colony with 3 nectophores and 7 loose nectophores.

Station 4797, 300–0 fathoms; 2 colonies with 3 and 6 nectophores and 9 loose nectophores.

Station 4800, 300–0 fathoms; 3 colonies with 5, 5, and 6 nectophores and 16 loose nectophores.

Station 4897, 300–0 fathoms; 6 loose nectophores.

Station 4928, 300–0 fathoms; part of a colony with 3 nectophores.

Station 4951, 300–0 fathoms; part of a colony with 3 nectophores.

Station 5030, 300–0 fathoms; 3 colonies with 6, 6, and 7 nectophores and 14 loose nectophores.

As a whole, the material is in good condition, but the stem is invariably so strongly contracted that it is difficult to disentangle the prolonged "knospungzone," which bears the nectophores, from it.

These specimens are especially interesting, because comparison between them and the eastern Pacific series of *V. spinosa* shows that the difference in the conformation of the nectophores which has been used to separate the two specifically (1911*b*) is visible from a very early stage in development. In *spinosa* the nectophores are spinous on the lateral and dorsal facets, as well as on the margins of the facets. This type of spinosity is seen in very young nectophores as well as in older ones (1911*b*, pl. 15, figs. 9–11), but in *pentacantha* the surfaces of the facets are smooth at all ages (pl. 5, fig. 7).

It appears that there is a good deal of variation in the degree to which spines are developed on the ridges limiting the facets. Chun (1897*b*) shows numerous pointed spines in these regions, and the Biscayan specimen recorded by me was likewise slightly spinous on the margin of the facets. But in the present series the older nectophores have no spines at all. The ridges, like the facets, are perfectly smooth (pl. 5, fig. 7), though in very youngest nectophores the margins of the facets are always (?) more or less irregular (pl. 5, fig. 8), and I found one in which they are distinctly spinous.

The nectophores of the two species likewise differ in details of form, but this is more clearly shown by figures (pl. 5, fig. 7, 1911*b*, pl. 15, figs. 9, 10) than verbally.

Another feature which proves to be diagnostic is the "ventral sinus," into which the ventral subumbral canal is expanded. In *spinosa* this cavity covers nearly the whole of the upper surface of the subumbrella in very young nectophores, and as growth progresses it becomes gradually obliterated, the coalescence progressing from the dorsal side and from the margins, in such a way that the sinus is finally narrowed to two lateral wings, which are narrowest next the canals (1911*b*, pl. 15, figs. 9, 12); and in this form it is to be seen in the largest nectophores which I examined.

In the youngest nectophores of *pentacantha* the sinus is smaller (pl. 5, fig. 8) than in *spinosa* at a corresponding stage, and with the growth of the bell it becomes narrower and narrower, taking on a heart-shaped (pl. 5, fig. 9) and finally a linear outline (pl. 5, fig. 7),

and in the largest nectophores it is represented merely by a slight thickening of the ventral canal.

In the general structure of the colony, in the arrangement of the nectophores, and in size, *pentacantha* very closely resembles *spinosa*. One of the specimens is in good enough condition to show that the nectophores are borne on an elongate "Knospungzone" (pl. 6, fig. 6), just exactly as in *Hippopodius*, and the same is true of *V. spinosa* (fig. 1), as I have previously pointed out (1911*b*, p. 211). Chun (1897*a*) has given a very good figure and an account of the relation of nectophores to stem in *Hippopodius*, and as the two genera are built on exactly the same plan in this respect, no further account is needed here. Each cormidium, as in *spinosa*, consists of siphon with its tentacles, and gonophores, both female and male, but not bract. Palpons are absent, as indeed in all Calycophores.

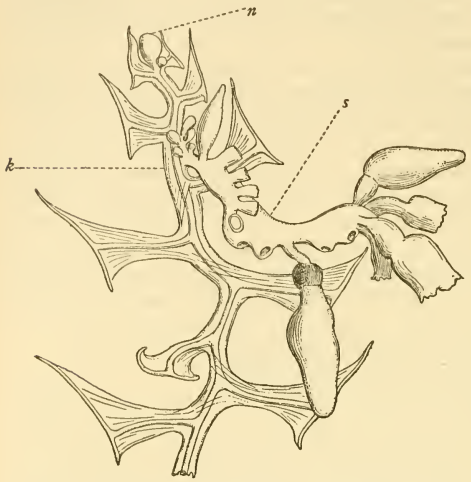

FIG. 1.—VOGTIA SPINOSA. MOST OF THE APPENDAGES AND NECTOPHORES ARE STRIPPED OFF, TO SHOW THE RELATIONSHIP OF THE STEM *s* TO THE ELONGATED "KNOSPUNGZONE" *k* WHICH BEARS THE NECTOPHORES. *n*, YOUNG NECTOPHORE.

Family DIPHYIDAE Eschscholtz, 1829.

Subfamily ABYLINAE L. Agassiz, 1862.

Genus ABYLOPSIS Chun, 1888.

ABYLOPSIS TETRAGONA (Otto) Bigelow.

Pyramis tetragona OTTO, 1823, p. 306, pl. 42, figs. 2*a*–2*c*.

(For synonymy, see Bigelow, 1911*b*, p. 224).

Station 4906, 369–0 fathoms; 1 entire colony.
Station 4928, 300–0 fathoms; 8 entire colonies.
Station 4930, 300–0 fathoms; 3 entire colonies.

Station 4951, 300–0 fathoms; 1 entire colony.

Station 5064, 300–0 fathoms; 4 entire colonies.

The proportions of the smallest are, superior nectophore 5 mm. long, inferior one 11 mm.; of the largest, superior nectophore 6 mm., inferior 16 mm.

These few specimens, not in very good condition, agree very well with the previous accounts of this well-known species. The distinctions between *tetragona* and *eschscholtzi* are given elsewhere (1911*b*, p. 216), the most important being the course of the canals of the posterior nectosac (1911*b*, pl. 14, fig. 7).

ABYLOPSIS ESCHSCHOLTZII (Huxley).

Aglaismoides eschscholtzii Huxley, 1859, p. 60, pl. 4, fig. 2.

(For synonymy and description, see Bigelow, 1911*b*, p. 226.)

Station 4928, surface; 1 specimen with both nectophores.

Genus BASSIA L. Agassiz, 1862.

BASSIA BASSENSIS (Quoy and Gaimard) Bigelow.

Diphyes bassensis Quoy and Gaimard, 1834, p. 91, pl. 7, figs. 18–20.

(For synonymy, see Bigelow, 1911*b*, p. 229.)

Station 4921, surface; 1 superior and 6 inferior nectophores.

Station 4952, surface; 3 superior and 9 inferior nectophores.

The material is not in good condition, being more or less crumpled, and all the nectophores are detached and stems and appendages lost; but the nectophores, particularly the posterior ones, are sufficiently well preserved to show their identity.

Subfamily GALEOLARINAE Chun, 1897.

Genus GALEOLARIA Blainville, 1834.

GALEOLARIA AUSTRALIS Quoy and Gaimard,

Plate 5, fig. 6.

Galeolaria australis Quoy and Gaimard, 1834, p. 42, pl. 5, figs. 29–31.
(For a discussion of the history and synonymy of this species, see Bigelow, 1911*b*, pp. 233, 238.)

Station 4952, surface; 45 anterior and 13 posterior nectophores; the largest of the former is 16 mm. long, of the latter 12 mm.

Station 4955, surface; about 40 superior nectophores.

Station 4978, surface; 16 superior nectophores.

The material is in good condition and has been compared with more extensive material from the eastern Pacific. The anterior nectophore is characterized by having two large ventral wings, but no dorso-basal or latero-basal teeth; the posterior nectophore by

the absence of basal teeth and by the presence of an undivided basal wing. Unfortunately the stems, with their appendages, are lost in all cases.

GALEOLARIA MONOICA (Chun).

Epibulia monoica CHUN, 1888, p. 1157.
(For synonymy, see Bigelow, 1911*b*, p. 239.)

Station 4955, surface; 2 anterior, 4 posterior nectophores.

Station 4978, surface; about 30 anterior and 30 posterior nectophores.

Identification rests on comparison with the more extensive series from the eastern Pacific.

CLAUSOPHYINÆ, new subfamily.

Genus CLAUSOPHYES Lens and Van Riemsdijk, 1908.

Diphyes KEFERSTEIN and EHLERS, 1861 (part).
Galeolaria CHUN, 1897*b* (part).

In 1861 Keferstein and Ehlers described a peculiar Diphyid, *Diphyes ovata*, taken in the Straits of Messina, in which the posterior as well as the anterior nectophore had a well-developed somatocyst, as in the Prayids, although the two bells were of different outlines and one superposed upon the other, as is the case in all Diphyids. Chun (1897*b*) has suggested that *D. ovata* is actually intermediate between the two groups, but since no one since 1861 has seen a siphonophore answering to the original account of *D. ovata*, it has remained a more or less problematical form. For this reason I thought it wisest not to lay much stress upon it in my discussion of the relationships and classification of the Calycophorae (1911*b*, p. 179).

It is now my good fortune to announce the discovery of three complete specimens and a loose posterior nectophore which agree with the account of Keferstein and Ehlers in all their main features. The most interesting feature of the animal is, of course, the fact that the posterior nectophore has a well-developed somatocyst, and the material is in good enough condition to allow this statement to be made without hesitation. In this it differs from all Diphyids, for though Chun (1897*b*) states that he was able to distinguish the rudiments of a somatocyst in all the posterior bells of *Galeolaria* studied by him, there is good reason to believe that what he saw was a part of the common muscular lamella to which both the nectophores are attached, or the dorsal extension of the pedicular canal beyond the point at which it joins the lamella (pl. 5, fig. 6). This prolongation of the canal is likewise to be seen in the anterior nectophore, in which the somatocyst arises from it. But there is no trace of anything corresponding to a somatocyst in any of the many posterior bells of

Galeolaria which I have examined. This being the case, *D. ovata* is not a *Galeolaria;* and at first I thought a new genus must be instituted for it, but the figure by Lens and Van Riemsdijk (1908) of their problematical genus *Clausophyes* agrees so well with the posterior bell of the *Albatross* specimens that no doubt they are identical; especially since my series includes specimens from the Philippines.

The *Albatross* specimens of *Clausophyes* show that the genus has no real connection with the Prayidae. In the first place, though each nectophore has a somatocyst, the two bells are wholly dissimilar in form; and, more important is the fact that the somatocyst of the posterior one occupies a totally different position from that of the anterior bell. Furthermore, the somatocyst of the anterior bell is a special organ deeply embedded in the gelatinous substance, and that of the posterior one is structurally like it, whereas in all Prayids the somatocyst, or branching system which represents it (as in *Nectodroma*), is merely a slightly thickened extension of the canal system, structurally much simpler than the somatocyst in Diphyds, though fundamentally homologous with it.

These facts point to the conclusion that *Clausophyes* is not a link connecting the two families, but an offshoot of the Diphyidae, in which the canal system of the posterior nectophore has secondarily developed a somatocyst. General form suggests that its affinities are with the Galeolarinae; but it is so aberrant that it seems wisest to make it the type of a new subfamily.

It seems necessary to separate the *Siboga* and *Albatross* specimens specifically from the Mediterranean *ovata,* because the base of the posterior nectophore is provided with two large and noticeable teeth, whereas in *ovata* this region is represented as rounded (Keferstein and Ehlers, 1861, pl. 5, fig. 1), and because the basal teeth have proved to be valuable specific characters in the Diphyidae in general on account of their constancy. But fresh Mediterranean material must be examined before the matter can be settled definitely.

CLAUSOPHYES GALATEA Lens and Van Riemsdijk.

Plate 6, figs. 1, 2.

Clausophyes galatea LENS and VAN RIEMSDIJK, 1908, p. 12, pl. 1, figs. 6–8.

Station 4909, 300–0 fathoms; 2 upper and 2 lower nectophores; fragmentary.

Station 4954, south of Shikoku Island, Japan; 850–0 fathoms; 1 complete specimen and 1 loose posterior nectophore.

Station 5064, 300–0 fathoms; 1 upper and 1 lower nectophore.

Also Philippine Islands, *Albatross* station 5320, 1908; 1 upper and 1 lower nectophore.

The northwestern Pacific specimens have been flattened out more or less, the subumbral surfaces of the nectosac are largely destroyed, and

all but the basal portion of the stem lost; but the essential features of the somatocysts and nectophores are intact, while the Philippine specimen (with the bells separated) is in excellent condition. In the complete specimen the anterior nectophore is 13 mm. long, the posterior one 28 mm.

Anterior nectophore.—The surface of the anterior bell is rounded, with no ridges, either dorsal, lateral, or ventral, and with no basal teeth; its apex bluntly pointed; its general form that of an obliquely truncate cone (pl. 6, fig. 1). There is a shallow hydroecium, open along the ventral side for its whole length, and reaching nearly to the mid-level of the bell; the nectosac is large, reaching over two-thirds of the length of the bell, and the pedicular canal joins it at one-third of its height. Only the proximal ends of the subumbral canals can be traced. The somatocyst reaches almost to the apex; its proximal half is narrow, and in one specimen it continues thus, though wrinkled and twisted; but in another it dilates near its tip (pl. 6, fig. 1). This part of the somatocyst is injured, but its outlines can still be traced.

Posterior nectophore.—The surface is rounded, without ridges; the opening of the nectosac oblique, the flaps which inclose the hydroecium are separate from end to end, though the left-hand one overlaps the right hand. Below the level of the opening of the nectosac the dorsal wall of the hydroecium is prolonged in two large triangular, smooth-edged teeth, of about equal length (pl. 6, fig. 1), and these are shown by Lens and Van Riemsdijk (1908).

The pedicular canal joins the nectosac at about its mid-level; the subumbral canals are largely destroyed. The most interesting feature of the posterior nectophore is, of course, its somatocyst. This structure (pl. 6, figs. 1, 2) is a pear-shaped outgrowth of the pedicular canal close to the apex of the bell, and it lies close to the dorsal surface of the hydroecium, which reaches to the apex. Lens and Van Riemsdijk likewise observed it and suspected its true nature.

The relationship of the two bells to each other and to the stem differs in detail from what is found in *Galeolaria*, the two bells being less intimately connected, and the stem arising from the common pedicular canal after the latter has joined the ventral surface of the posterior nectophore (pl. 6, fig. 2). The result of this is that when the two nectophores are forcibly separated the stem remains attached to the posterior one, instead of to the anterior as in the Diphyopsinae. This phenomenon makes it improbable that there is a succession of nectophores in this genus, because the anatomy of the parts concerned suggests that if either bell were cast off it would be the anterior one.

Stem and appendages.—Unfortunately only the basal part of the stem is preserved in any specimen, and it is invariably so contracted

that all that is to be seen is a crowded mass of young siphons and gonophores. I could not find any bracts, but the material is not good enough to lay any stress on their apparent absence.

Subfamily DIPHYOPSINAE Haeckel, 1888.

Genus CHUNIPHYES Lens and Van Riemsdijk, 1908.

CHUNIPHYES MULTIDENTATA Lens and Van Riemsdijk.

Chuniphyes multidentata Lens and Van Riemsdijk, 1908, p. 13, pl. 1, figs. 9–11; pl. 2, figs. 12–15.—Bigelow, 1911*a*, p. 348; 1911*b*, p. 262, pl. 8, fig. 9; pl. 10, fig. 7; pl. 12, fig. 6.

Station 4759, 300–0 fathoms; 1 superior and 1 inferior nectophore, respectively 23 and 29 mm. long.

Station 4917, 361–0 fathoms; 1 inferior nectophore, about 20 mm. long.

Station 4920, 300–0 fathoms; 1 superior and 1 inferior nectophore.

The two nectophores from station 4920 and the pair from station 4759 are now separate, but as the members of the pairs were taken together it is probable that they are the components of two colonies.

The material is in good condition, and as it shows the characteristic conformation of the two nectophores in a typical fashion (Bigelow, 1911*b*) it can be identified with certainty. The superior nectophores are interesting, because they illustrate the variability of the somatocyst. I have already pointed out (1911*b*) that this structure is dilated shortly above its point of origin, and then contracts once more to run as a narrow tube nearly to the apex. In one eastern Pacific specimen the dilation was spherical (1911*b*, p. 263); in the Biscayan examples it consisted of two short transverse horns, one on either side, varying in size in different specimens (1911*a*, p. 349). In one of the present examples, likewise, the dilation projects on either side as a horn, one of which is almost twice as long as the other, but in the other the swelling is an irregular rhomboid, its lateral corners merely somewhat prolonged. This nearly bridges the gap between specimens with "horns" and one from the eastern Pacific with a spherical dilation. Unfortunately the stem is broken short off.

Genus DIPHYES Cuvier, 1817.

DIPHYES TRUNCATA Sars.

Plate 6, figs. 3, 4, 5.

Diphyes truncata Sars, 1846, p. 41, pl. 7, figs. 1–12.
Galeolaria truncata Huxley, 1859, p. 38.
Diphyes subtiloides Lens and Van Riemsdijk, 1908, p. 46, pl. 7, figs. 59–61.
Muggiaea kochii Bigelow, 1911*a*, p. 340; 1911*b*, p. 188, pl. 12, figs. 2–4.

The series described below is especially interesting because it shows that the siphonophore described by me from the Bay of Biscay (1911*a*) and from the eastern tropical Pacific (1911*b*) as "*Muggiaea kochii*" is not a Monophyid but a Diphyid, and the structure of the inferior nectophore as well as of the superior one identifies it positively with the *Diphyes truncata* of Sars (1846).

The *Diphyes subtiloides* of Lens and Van Riemsdijk (1908) is almost certainly identical, for their figures of its superior nectophore agree very well with small specimens in the *Albatross* series, especially in the shallowness of the hydroecium and length of the somatocyst. They did not find its inferior nectophore. Sars's species has usually been called a *Galeolaria;* but the structure of the upper nectophore suggests that it belongs to the Diphyopsinæ, though further data on the appendages (that is, whether or not they are set free as eudoxids) is needed to settle the question.

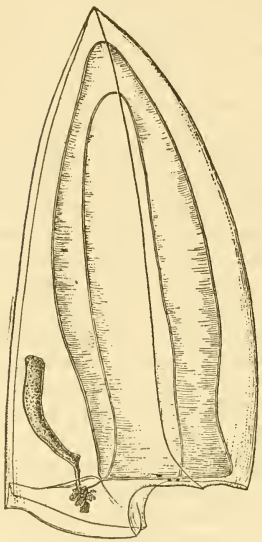

FIG. 2.—DIPHYES TRUNCATA, ANTERIOR NECTOPHORE, X 5.

It is not clear whether or not I was correct in believing that my Biscayan and eastern Pacific specimens belonged to the same species as the *Muggiaea kochii* of Chun, for the latter is insufficiently described, and the same is true of *Diphyes kochii* Will (1844). Should all finally be united, Will's name would, of course, take precedence.

Diphyes truncata is represented in the collection by 3 pairs of nectophores (now separated, but connected when taken), 32 loose superior nectophores, and 1 loose posterior one, all in fairly good condition, from stations 4759, 4760, 4763, 4766, 4767, 4775, 4785, 4793, 4797, 4896, 4955; and by a considerable number of nectophores, both superior and inferior, from station 4757, which were preserved in alcohol, and are now so flattened and distorted that they are useless for description, though their identity is evident.

Superior nectophore.—Nectophores 3–4 mm. long were taken at stations 4896 and 4955; the others range in length from 13 to 28 mm. The distinctive characters of the superior nectophore, as I have pointed out elsewhere (1911*b*), are the presence of five ridges from the apex; the very shallow hydroecium lying wholly below the opening of the nectosac; the fact that the dorsal wall of the hydroecium

is divided into two wings, and the considerable length of the somatocyst. The latter organ is fusiform (never globular and transverse as in *D. fowleri* Bigelow) and usually about one-third as long as the nectosac, but it may be variously contracted (fig. 2) with preservation, and in two specimens it reaches to about the mid-level of the nectosac; its normal length must be sought in living material.

The five ridges are usually perfectly smooth (fig. 2), as are the margins of the hydroecial opening, but in a few specimens slightly wavy, and in some the lateral ridges terminate just above the basal margin. But this is not invariable, as I formerly supposed, for in others the ridges can be followed to the margin. The shape of the hydroecium shown better in the figures (pl. 6, fig. 5) than by verbal description, is extremely characteristic.

The specimens agree very well with Sars's figures (1846, pl. 7, figs. 1–12). Thus he shows the five ridges and concave facets, and the moderately long fusiform somatocyst, and his figure (fig. 2) of the detached superior nectophore is especially important because it shows a very shallow hydroecium entirely below the opening of the nectosac, just as in our specimens (in his figure of the complete colony, the hydroecium is obscured).

Inferior nectophore.—The lower nectophore (pl. 6, fig. 3) is shorter than the upper one (superior 18 mm., inferior 12 mm.; superior 24 mm., inferior 17 mm.), somewhat quadrate in outline, with well-marked dorsal and lateral ridges; the hydroecium, open from end to end, indeed merely a furrow, deep near the apex, very shallow at the base, as in the genus *Galeolaria*. It resembles that genus, too, in the presence of a single basal hydroecial wing, incised in a characteristic way in its mid line, the right-hand lobe being the larger (pl. 6, fig. 4). The apex of the bell, too, recalls *Galeolaria*, for the pedicular canal joins the nectosac some little distance below its apex.

One specimen shows that the vascular system is of the usual Diphyid type.

Sars's (1846) figures of the lower nectophore agree with the above in general form and give a very clear account of the hydroecial groove, and it is especially important that he shows that his specimen agreed with ours in the outline of the basal wing (particularly in his side view, fig. 3), and apparently in the course of the lateral canals of the nectosac.

The present records are from the coasts of British Columbia, the Bering Sea region, and the Eastern Sea near the Goto Islands. The previous records are from Norway (Sars), the Bay of Biscay (1911*a*), the eastern tropical Pacific (1911*b*), and the Malaysian region (Lens and Van Riemsdijk).

The temperatures at which it has been taken range from 42° (or less?) to upward of 80° (Eastern Sea, Malaysia).

DIPHYES APPENDICULATA Eschscholtz.

Diphyes appendiculata Eschscholtz, 1829, p. 138, pl. 12, fig. 7.

For synonymy, see Bigelow, 1911*b*, p. 248.

Station 4757, surface; 1 anterior nectophore, 14 mm. long.
Station 4920, 300–0 fathoms; 1 anterior nectophore, 10 mm. long.
Station 4928, 300–0 fathoms; 4 anterior nectophores.
Station 4955, surface; 1 anterior nectophore.
Station 5064, 300–0 fathoms; 1 anterior nectophore.

I have discussed this species at such length elsewhere (1911*b*) that I need only note that the identification of these specimens rests on actual comparison with specimens from the tropical Pacific, the Philippines, the West Indies, from the Mediterranean, and from the north Atlantic (Bay of Biscay). They clearly show the arrangement of the ridges at the apex, and the hydroecium, both of which are characteristic.

DIPHYES CONTORTA Lens and Van Riemsdijk.

Diphyes contorta Lens and Van Riemsdijk, 1908, p. 39, pl. 6, figs. 48–50.—Bigelow, 1911*b*, p. 254, pl. 7, figs. 7, 8; pl. 11, fig. 2.

Station 4896, surface; 38 anterior nectophores, 4–5 mm. long.
Station 4928, 300–0 fathoms; 5 anterior nectophores, 4 mm. long.

These small specimens agree very well with the larger ones taken by the Fisheries steamer *Albatross* in the eastern Pacific, except that none of them show the bud for an inferior nectophore.

DIPHYES SPIRALIS Bigelow.

Diphyes spiralis Bigelow, 1911*b*, p. 249, pl. 7, fig. 4; pl. 8, figs. 1, 2; pl. 9, fig. 3; pl. 11, fig. 4.

Station 4954, 300–0 fathoms; 1 anterior nectophore.
Station 4955, surface; 1 anterior nectophore.

DIPHYES ARCTICA Chun.

Diphyes arctica Chun, 1897*b*, p. 19, pl. 1, figs. 1–10.

For synonymy, see Bigelow, 1911*b*, p. 347.

Station 4760, 300–0 fathoms; 6 anterior nectophores.
Station 4763, 300–0 fathoms; 6 anterior nectophores.
Station 4767, 300–0 fathoms; 5 anterior nectophores.
Station 4785, 300–0 fathoms; 13 anterior nectophores.
Station 4793, 300–0 fathoms; 22 anterior nectophores.
Station 4797, 300–0 fathoms; 6 anterior nectophores.
Station 4800, 300–0 fathoms; 3 anterior nectophores.
Station 4805, 200–0 fathoms; 15 anterior nectophores.
Station 4806, 200–0 fathoms; 1 anterior nectophore.
Station 4820, 300–0 fathoms; 7 anterior nectophores.

These anterior nectophores range in length from 5 to 11 mm., and in four cases there is a young bud for an inferior nectophore.

Chun's account and figures of this species are so satisfactory that I can add little further than to note that the rounded apex, the peculiar hydroecium opening along the mid-ventral line, the fact that the dorsal hydroecial wall below the level of the bell opening is undivided, and the absence of basal teeth are all illustrated by our specimens. The hydroecium, especially, is so characteristic (Chun, 1897*b*, pl. 1, fig. 1–3) in its outlines as to identify the specimens at a glance. The somatocyst is rather long, reaching slightly above the mid-level of the bell cavity, and in our specimens it is abruptly truncate basally, connecting with the hydroecium at its dorsal edge (Chun, 1897*b*, pl. 1, fig. 1); but it may be rounded basally (Chun, 1897*b*, fig. 3), the difference being probably due to contraction.

In my Key to the Diphyopsinae (1911*b*, p. 247) this species was omitted, because I had never seen it and because Chun mentioned no details as to the number of ridges. In the present series the apex is evenly rounded, as Chun shows it (1897*b*, pl. 1, fig. 1), and there are no distinct ridges, either dorsal, lateral, or ventral, at any level; indeed, in this respect *D. arctica* suggests the allied genus *Galeolaria*, from which, however, it is separated by its deep hydroecium, and by the fact that its cormidia are set free as eudoxids.

All of the specimens are more or less contracted along the middle lateral line on either side, but as Chun's figures do not show this, it may be the result of contraction.

Inferior nectophores.—As noted above, four specimens have the bud for an inferior nectophore, but these are so young that they give no hint of their future form. Their presence, however, is important, because they corroborate Chun's (1897*b*) account, and are sufficient demonstrations that the species is a Diphyid, not a Monophyid. Only the basal parts of the stems are intact, and the siphons, gonophores, and bracts which are intact are so young that they add nothing to Chun's account.

Genus DIPHYOPSIS Haeckel, 1888.

DIPHYOPSIS DISPAR (Chamisso and Eysenhardt) Haeckel.

Diphyes dispar Chamisso and Eysenhardt, 1821, p. 365, pl. 33, fig. 4.

(For synonymy, see Bigelow, 1911*b*, p. 257.)

Station 4896, surface; 4 anterior nectophores, 6 mm. long.

Station 4952, surface; 6 anterior nectophores, 8–11 mm. long.

Station 4955, surface; 1 anterior nectophore.

Station 4978, surface; 20 anterior nectophores and about 20 posterior nectophores.

Station 5064, 300–0 fathoms; 4 anterior nectophores.

I have already suggested (1911*b*, p. 265) that the *Doromasia picta* of Chun (1888, 1892) is not a monophyid, but perhaps identical with this species, and Moser (1911) definitely asserts that it is merely the young of *D. dispar*. The small specimens listed above agree very well with Chun's figure; the larger ones are broader; and specimens from the Philippines show that there is an increase in breadth with growth, though it is decidedly irregular.

DIPHYOPSIS CHAMISSONIS (Huxley).

Diphyes chamissonis HUXLEY, 1859, p. 36, pl. 1, fig. 3.

(For synonymy, see Bigelow, 1911*b*, p. 347.)

Station 4896, surface; 2 anterior nectophores, 8 and 9 mm. long.

Station 4955, surface; about 30 anterior nectophores.

Station 5064, 300–0 fathoms; 1 anterior nectophore.

I have also studied several specimens from the Philippines.

The species recently described by Lens and Van Riemsdijk (1908) as *Diphyopsis weberi* is undoubtedly the *D. chamissonis* of Huxley (Bigelow, 1911*b*, p. 244).

None of the present examples is in good enough condition to add anything to the previous accounts; but all of them show the five ridges at the apex, deep hydroecium reaching to the mid-level of the nectosac, short somatocyst, prominent dorso-basal and latero-basal teeth, and narrow form characteristic of the species. This is an appropriate place to point out that by some error in composition, overlooked in proof reading, the characterization of this species in my Key to the Diphyopsinae (1911*b*, p. 247) reads "somatocyst short, reaching only to the opening of the nectosac; hydroecium deep;" instead of "somatocyst short; hydroecium deep, reaching to the middle of the nectosac." As printed, the clause is obviously self-contradictory.

DIPHYOPSIS MITRA (Huxley) Bigelow.

Diphyes mitra HUXLEY, 1859, p. 36, pl. 1, fig. 4.

(For synonymy, see Bigelow, 1911*b*, p. 258.)

Station 4955, surface; 1 anterior nectophore.

Order PHYSOPHORAE.

Family FORSKALIIDAE Haeckel, 1888.

Genus FORSKALEA Kölliker, 1853.

FORSKALEA, species?

Station 4810, 100–0 fathoms; many fragments.

The material consists of parts of several specimens so contracted and fragmentary that nothing can be said about them further than that they belong to the genus *Forskalea*. At the locality of capture, off Cape Sirakimi, the surface temperature was 70°.

Family AGALMIDAE Brandt, 1835.

Genus AGALMA Eschscholtz, 1825.

AGALMA OKENI Eschscholtz.

Agalma okeni Eschscholtz, 1825, p. 744, pl. 5, fig. 17.

(For synonymy, see Bigelow, 1911*b*, p. 277.)

Station 4920, 300–0 fathoms; a large colony (50 mm. long) with 9 cormidia. The siphosome is in excellent condition; but the nectophores are all detached and loose in the bottle.

Station 4978; a fragmentary colony.

O-Shima Harbor; an example 30 mm. long, with 5 cormidia, in fair condition.

This widely distributed and easily recognized species has usually been known either as *Crystallomia polygonata* Dana or *Crystallodes vitreus* Haeckel. It has been described in detail by the latter author, by Lens and Van Riemsdijk (1908), and by me in a previous paper (1911*b*), where its relationship and history are discussed.

The outlines of the nectophores and bracts of this species are so characteristic that it is not likely to be confused with any other Agalmid, and the identity of the present series rests further on comparison with large series from the tropical Atlantic, tropical Pacific, and Philippine waters.

Family RHODALIIDAE, Haeckel, 1888.

Family RHODALIIDAE Bigelow, 1911*b*.

Genus ARCHANGELOPSIS Lens and Van Riemsdijk, 1908.

ARCHANGELOPSIS TYPICA Lens and Van Reimsdijk.

Plate 6, figure 7.

Archangelopsis typica Lens and Van Riemsdijk, 1908, p. 91, pl. 17, pl. 18, figs. 137–140.—Bigelow, 1911*b*, p. 350.

Station 4903, 139–0 fathoms; 1 specimen, in good condition except that all the nectophores but the youngest have been detached.

I mentioned this specimen in my report on Eastern Pacific Siphonophores (1911*b*, p. 303), but it came to hand too late for me to give an account of it in that work.

Lens and Van Riemsdijk (1908) have given a good account of the general anatomy of this interesting genus, particularly of the aurophore, but as their specimens were all more or less fragmentary, especially with regard to the cormidia, a description of the present example will not be amiss.

The general structure of the specimen, with large pneumatophore, nectosome with longitudinal muscular lamellæ which bore the nectophores in life, and siphosome in the form of a thin-walled bag, agrees

with the original account. The pneumatophore is about 9 mm. long. The aurophore is covered with papilliform appendages (pl. 6, fig. 7), and closely resembles the corresponding organ of *Dromalia* (1911*b*, pl. 23, fig. 7) in external appearance; the serial sections studied by Lens and Van Riemsdijk (1908) show that in its internal anatomy it differs, though not essentially, from that genus.

The present example was not sectioned, partly because it was not in very good histological condition, partly because it was desirable to preserve it intact, but optical sections of the appendages of the aurophore, cleared in glycerine, show that each has a terminal pore, as in *Dromalia*. The older nectophores were all detached, and there were none in the bottle, but one very young one is still in place.

The zone of proliferation, as in *Dromalia* and *Angelopsis*, lies directly opposite the aurophore on the nectosome close to its junction with the pneumatophore (pl. 6, fig. 7). Unfortunately, this region is damaged, there being only one young nectophore, and two young siphons with their tentacles, so that it is impossible to work out the successive stages in the growth of the various appendages, as I was able to do in *Dromalia* (1911*b*). On the opposite side of the nectosome, just below the aurophore, there is a naked zone, just as in *Dromalia*.

Cormidia.—The basal surface of the siphosome is covered with cormidia. In my preliminary reference to this specimen (1911*b*, p. 308) I said that they were apparently arranged in a spiral, as they certainly are in *Dromalia*. But a more careful examination shows that they are so crowded, owing to the contraction of the siphosome as a whole, that it is impossible to make sure whether the arrangement is fundamentally spiral or not. In their present condition they are all closely in contact with one another.

The cormidia themselves resemble those of *Dromalia* (1911*b*, pl. 23, fig 9) in structure. The appendages of each group, as in that genus, are situated on a stout gelatinous stalk, considerably longer in *Archangelopsis* than in *Dromalia*, which is traversed by a canal putting the siphons and gonophores in connection with the general vascular system of the siphosome (that is, the hypocystic cavity).

Each cormidium consists of siphon with its tentacle, and usually two gonodendra which are variously branched. In one case, however, there are four separate gonodendra, each with its own independent stalk. Unfortunately most of the older gonophores are lost, but the few large enough to show their sex are all males, which suggests, though it does not prove, that all the gonophores of a given example are of one sex, as Brooks and Conklin (1891) found them in the specimen of *Rhodalia* (?) studied by them. In *Dromalia* this point could not be determined. In *Rhodalia* Haeckel (1888) describes both male and female gonophores for a single specimen.

Each gonodendron bears several long thin-walled palpons in addition to the gonophores.

In their present condition all the cormidia have dropped their siphons, but the scar left by this mutilation is invariably very noticeable just proximal to the point at which the gonodendra branch out. The one siphon loose in the bottle is of the usual type, but its tentacle, as Lens and Van Riemsdijk observed, is unusually stout, and it has a well-developed suspensional membrane as in *Dromalia*. The only tentilla intact are so young that they as yet give no indication whether an involucre is formed later, or how many terminal filaments they are fated to have.

In many cases the gelatinous stalks bear accessory stalks near their bases, and these accessory stalks develop gonophores and palpons. But I have found none with a siphon, and am in doubt whether any of them normally bore such organs.

One of the most interesting features of the specimen remains to be mentioned; this is that the stalks of the cormidia near the upper end of the bag-like siphosome usually bear from one to three small wing-like muscular lamellae on their outer sides, close to the base. At present there is nothing attached to any of these lamellae, but they are reminiscent, both in structure and in position, of the lamellae to which the bracts are attached in various Agalmids, as, for instance, *Stephanomia bijuga* (1911*b*, pl. 20, fig. 1), and therefore suggest the possibility that *Archangelopsis* may have bracts as well as nectophores.

Suborder CHONDROPHORAE.

Family PORPITIDAE Brandt, 1835.

Genus PORPITA Lamarck, 1801.

PORPITA PACIFICA Lesson.

Porpita pacifica Lesson, 1826, pl. 7, figs. 3, 3′.

(For synonymy, see Bigelow, 1911*b*, p. 333.)

Station 4883, surface; 7 specimens, 23 to 40 mm. in diameter.
Station 4884, surface; 4 specimens, 30 to 35 mm. in diameter.
Station 4909, surface; 2 specimens, 25 and 30 mm. in diameter.
Station 4917, surface; 1 specimen, 2 mm. in diameter.
Station 4921, surface; 49 specimens, 1.5 to 9 mm. in diameter.
Station 4952, surface; 3 specimens, 4 to 11 mm. in diameter.

The specimens, all from Japanese waters, are interesting chiefly because they supplement the rather large examples collected by the Fisheries steamer *Albatross* in the eastern Pacific (1911*b*, p. 333). The characters which separate *pacifica* from all specimens of the Atlantic *umbella* yet described, and all the ones which I have studied, are the tubercles on the superior surface of the disk, the greater num-

ber of stalked nematocyst knobs on the tentacles, the more complexly branched limbar canals, and the fewer open stigmata.

In the eastern Pacific specimens 50–55 mm. in diameter, the tubercles were extremely prominent and covered all the upper surface of the disk except a narrow marginal ring (1911*b*, pl. 28, fig. 1). In the present specimens of 25–40 mm. they are smaller and restricted to the central part of the disk. But the fact that in one of 28 mm. the region which they cover is only as broad as half the radius of the disk, whereas in one of 35 mm. it is as broad as the radius, shows that they extend farther and farther toward the margin with growth, a later stage in this process being illustrated by the large specimens from the eastern Pacific. Specimens of 11 mm. or less have no tubercles, and there is a gap in the series between them and those of 23 mm.

The number of tentacular nematocysts in each row, in five tentacles taken at random from three specimens, is: 25 mm. in diameter—30, 19, 19; 27, 19, 19; 29, 19, 19; 31, 19, 19; 31, 18, 19; 31, 17, 16; 30 mm. in diameter—25, 15, 16; 30, 19, 18; 27, 15, 16; 26, 18, 18; 27, 16, 17; 40 mm. in diameter—32, 16, 16; 29, 14, 15; 34, 15, 15; 30, 17, 16; 31, 17, 16.

At first sight it seems surprising that the smallest specimens should have more knobs than the next larger one, but it has a goose-barnacle parasitic upon it, and is perhaps stunted in consequence. The numbers in all three are rather larger than in the eastern Pacific specimens, in which they were from 25–29 in each of the long and 11–14 in each of the short rows.

Umbella has been described as having 9–12 in the long, 6–8 in the short rows (A. Agassiz, 1883; Chun, 1897*b*). In two specimens the numbers are: 22 mm. in diameter, Naples—12, 6, 7; 11, 6, 6; 12, 7, 7; 10, 6, 6; 11, 5, 6; 26 mm. in diameter, Tortugas—13, 9, 7; 11, 6, 7; 15, 7, 8; 11, 9, 9; 12, 6, 8. Unfortunately, I have no large specimens with the tentacles intact.

The limbar canals in the Japanese specimens agree very well with the conditions in the eastern Pacific series (1911*b*), being very much branched and irregular, and the limbus itself is narrower than in any *umbella* which I have seen, though it would take a large series of each to show whether this difference is really important. In the specimens of *pacifica* upward of 25 mm. in diameter there are no open stigmata in the central region, but in the peripheral parts of the disk the stigmata are rather more numerous than in the corresponding region in large eastern Pacific examples, from which it appears that they are successively closed as growth progresses. In *umbella* many more are permanently open (1911*b*). The very small specimens 1.5–2 mm. broad are all further advanced than the larva which I have already described, though no larger, for all of them have more than eight gastrozooids, and the velum is already noticeable in all.

Class SCYPHOMEDUSAE.

Order CORONATA.

Family PERIPHYLLIDAE Haeckel, 1880.

Genus PERIPHYLLA Steenstrup, 1837.

For accounts of the anatomy and histology of this genus, see Haeckel (1881), Maas (1897, 1903, 1904*b*), and Vanhöffen (1902*a*).

The present collection contains a large and excellently preserved series of typical *P. hyacinthina*, ranging from very young, in which the gonads have not appeared, to an example 70 mm. in diameter, thus affording a good opportunity to trace the development of the endodermic pigment. This is of interest because this character is used by Maas (1904*b*) and by Vanhöffen (1902*a*) to separate *hyacinthina* from *dodecabostrycha*, the former, according to their diagnoses, being so densely pigmented over the entire subumbrella that the gonads are invisible from without, the latter having the pigment limited to the gastric cavity and upper part of the subumbrella, allowing the gonads to show through. In my account of the eastern Pacific medusae (1909*a*) I gave a survey of the published evidence on this question, and pointed out that the specimens so far described with the *dodecabostrycha* pigmentation were all rather small; but this statement needs correction because Vanhöffen has called my attention to the fact that I overlooked a *dodecabostrycha* 56 mm. broad described by him, and which, as he writes me, had no trace of pigment in the ring-sinus. It appears from this that the *dodecabostrycha* condition is not necessarily transitory, though the present series shows that specimens which assume the *hyacinthina* pigmentation when adult pass through a *dodecabostrycha* stage. And it also shows that in the adult there is a good deal of variation in the density of the pigmentation of the peripheral regions. This suggests, of course, that there is no sharp line between *hyacinthina* and *dodecabostrycha;* that if the two are distinguishable at all they are at most varieties of one species. But to settle the relationship of the two will require more data than is available at present. We need, especially, series of growth stages of the *dodecabostrycha* type, and large series of the adults of both, to show whether or not intermediates occur. Without this information further speculation can not lead to any definite result.

The status of *P. regina* is also unsettled. Like *hyacinthina* it is so densely pigmented that the gonads are concealed; and it is separated from that species only by large size and perhaps by a brighter red color. I have not been able to study any good material of this form, so do not feel qualified to express a definite opinion.

PERIPHYLLA HYACINTHINA Steenstrup.

Periphylla hyacinthina STEENSTRUP, 1837.

(For full synonymy, see Bigelow, 1909*a*, p. 26, and Mayer, 1910, p. 544.)

Station 4758, 300–0 fathoms, south of Alaska Peninsula; 2 specimens.

Station 4759, 300–0 fathoms, south of Alaska Peninsula; 3 specimens.

Station 4760, 300–0 fathoms, south of Alaska Peninsula; 2 specimens.

Station 4761, 1973–0 fathoms, south of Alaska Peninsula; 1 specimen.

Station 4765, 1217–0 fathoms; 1 specimen.

Station 4766, 300–0 fathoms, Bering Sea; 4 specimens.

Station 4767, 300–0 fathoms, Bering Sea; 4 specimens.

Station 4773, 334–0 fathoms, Bering Sea; 3 specimens.

Station 4774, 557–0 fathoms, Bering Sea; 2 specimens.

Station 4775, 585–0 fathoms, Bering Sea; 3 specimens.

Station 4781, 482–0 fathoms, Bering Sea; 1 specimen.

Station 4785, 300–0 fathoms, Bering Sea; 7 specimens.

Station 4793, 300–0 fathoms, off Kamchatka; 2 specimens.

Station 4797, 300–0 fathoms, Sea of Okhotsk; 2 specimens.

Station 4928, 1008–0 fathoms, Japanese waters; 1 specimen.

Station 4951, 703–0 fathoms, Japanese waters; 1 specimen.

Station 4956, 720–0 fathoms, Japanese waters; 1 specimen.

Station 4958, 405–0 fathoms, Japanese waters; 1 specimen.

Station 5063, 300–0 fathoms, Japanese waters; 1 specimen.

Also—

Station 3070, 685–0 fathoms, off the coast of Oregon; 3 specimens.

Station 3222, 50–0 fathoms, Bering Sea; 1 specimen.

Out of the total of 46 specimens, 29, illustrating the whole range of development from 10 to 70 mm. in diameter, are in beautiful condition; the remainder may be described as fair.

From the systematic standpoint the most important thing illustrated by this series is the extension of the entodermal pigmentation with growth. In the specimens up to about 15 mm. in diameter the pigment is entirely restricted to the stomach, as in the young specimens from the eastern Pacific. The gonads are first visible in a specimen of about 10 mm; and in the examples of 12–15 mm., they are of considerable size; so these specimens, if captured alone, would probably have been recorded as *dodecabostrycha*. As growth proceeds, the pigmentation extends from the stomach out over the subumbrella. The beginning of the process is to be seen in a specimen of 16 mm., and in those of 20 mm. the pigment is fairly dense as far as the proximal ends of the gonads in the radii of these organs, while between them it reaches to about the middle of their length, corresponding to the corner of the stomach.

In a slightly older specimen, 23 mm. in diameter, the ring sinus, lappet canals, and the surface of the gonads themselves are faintly reddish; in other words, the pigmentation has now attained practically its final extent, though in the distal regions it is still so faint that the gonads are visible from without.

Though all the large specimens are so heavily and extensively pigmented that their identity, as *hyacinthina*, is at once apparent, it is not correct to say that the gonads are always rendered invisible from without by the pigment. This may be the case; for example, in two perfect specimens about 25 and 45 mm. in diameter they are entirely hidden. But in another of 40 mm. in equally good condition the gonads show plainly from without, the pigment in this case being less dense, though equally extensive. Again, in a much smaller specimen (27 mm.), they are entirely hidden; in one of 36 mm. their distal ends plainly visible, though the pigment has attained its final extent. These irregularities show that there is considerable individual variation in the density of the pigment, though in all large specimens it extends over the ring sinus and peripheral canal system.

General form, another character which has been supposed to separate *hyacinthina* from *dodecabostrycha*, but in which, as I have pointed out (1909*a*), no sharp division line can be drawn, likewise shows much individual variation. The very small specimens are all low and broad, the medium-sized ones proportionately higher, usually with the pointed outlines, with pronounced "stiel canal." But there is much variation, the extremes being a specimen 40 mm. in diameter and 50 mm. high; that is, with proportions in terms of the diameter, of 1.25 : 1, and one 40 mm. high and 40 mm. in diameter. None of these specimens are proportionately so high as some previously recorded; for example, Vanhöffen mentions examples of 1.9 : 1, and 1.7 : 1 (Bigelow, 1909*a*, p. 25).

The form of the upper part of the gastric cavity, whether rounded or conical, seems to be largely a question of contraction. In the best specimens, which, to judge from their condition, must have been alive when put into the preservative, it is of the latter, in the more damaged ones, of the former type. And *hyacinthina* with low, rounded stomach has already been recorded (1909*a*; Vanhöffen, 1902*a*).

Family NAUSITHOIDAE Bigelow.

Family EPHYROPSIDAE[1] Claus.

Genus NAUSITHOË Kölliker, 1853.

NAUSITHOË PUNCTATA Kölliker.

Nausithoe punctata KÖLLIKER, 1853*a*, p. 323.

(For synonymy, see Bigelow, 1909*a*, p. 35; Mayer, 1910, p. 554.)

Station 4927, surface; 2 specimens, 12 mm. in diameter.

[1] Untenable, because *Ephyropsis* Claus is a synonym of *Nausithoë* Kölliker.

Family ATOLLIDAE Bigelow.

Family COLLASPIDAE[1] Haeckel.

Genus ATOLLA Haeckel, 1880.

The general anatomy of this peculiar genus is now well known, thanks to Maas (1897, 1903, 1904*b*) and Vanhöffen (1902*a*); but the specific relationships of its members are still unsettled, because the characters which have been used to separate the various closely allied "species," are all more or less subject to individual variation.

The characters used by Vanhöffen to separate species are the presence or absence of radial furrows in the central disk; whether the furrows, if present, are broad or narrow; the presence or absence of exumbral warts; and the size of the septal nodes. But I have found that it is impossible to draw any sharp line between specimens with broad and those with narrow radial furrows; and the present series shows that the size of the septal nodes is so variable that it can not be a specific character. There remain then only the presence or absence of radial furrows, and of exumbral knobs. Mayer notes that the former is not a sharp difference, because there may be faint sinuosities on the margin of the central disk, without any true radial furrows; so that he suggests that the two forms, *wyvillei* with furrows and *bairdii* with a smooth disk may be merely varieties of a single species.

Vanhöffen recognized five species, *bairdii, valdiviae, verrillii, chuni,* and *wyvillei;* but Mayer reduces these to three, *bairdii* with smooth disk, *wyvillei* with radial furrows, and *chuni,* in which the lappets are sprinkled with exumbral papillae; a reduction which seems warranted. *Chuni* has now been recorded by Browne (1910) from the Antarctic, and Hartlaub (1909*a*) has recently described another species, *A. tenilla* from the Greenland Sea; but this is probably the young either of *bairdii* or of *wyvillei.*

ATOLLA WYVILLEI Haeckel.

Atolla wyvillei Haeckel, 1880, p. 488; 1881, p. 113, pl. 29, fig. 1–9.—Vanhöffen, 1902*a*, p. 13, pl. 5, fig. 22.—Bigelow, 1909*a*, p. 39, pl. 8, fig. 1; pl. 9, fig. 3; pl. 10, figs. 8, 9.
Collaspis achilis Haeckel, 1880, p. 489.
Atolla alexandri Maas, 1897, p. 81, pl. 11, fig. 2; pl. 14, fig. 4, 5.
(For full synonymy see Mayer, 1910, p. 566.)

Station 4758, 300–0 fathoms; 1 specimen.
Station 4759, 300–0 fathoms; 2 specimens.
Station 4760, 300–0 fathoms; 3 specimens.
Station 4764, 1130–0 fathoms; 1 specimen.
Station 4765, 300–0 fathoms; 1 specimen.

[1] Untenable, because *Collaspis* is a synonym of *Atolla.*

Station 4766, 300–0 fathoms; 7 specimens.
Station 4767, 300–0 fathoms; 4 specimens.
Station 4773, 300–0 fathoms; 2 specimens.
Station 4780, 1046–0 fathoms; 1 specimen.
Station 4917, 361–0 fathoms; 1 specimen.
Station 5058, 300–0 fathoms; 3 specimens.
Station 5063, 300–0 fathoms; 2 specimens.
Station 5064, 300–0 fathoms; 3 specimens.
Station 5079, 300–0 fathoms· 1 specimen.
Also—
Station 3009, Gulf of California, 857–0 fathoms; 2 specimens.
Station 3070, off the coast of Oregon; 636–0 fathoms; 1 specimen.
Station 3071, off the coast of Oregon, 685–0 fathoms; 2 specimens.

These specimens are all in such good condition that it is easy to see that they belong to *wyvillei;* but 22 damaged Atollas, taken at stations 4767, 4774, 4906, 4907, 4908, 4909, 4917, 4919, 4957, 5063, in the trawl, show no furrows clearly; though judging from their general condition it is probable that the absence is due to rubbing in the net.

Several of the undoubted *wyvillei* are in beautiful condition.

In the eastern Pacific specimens there was considerable variation in the breadth of the furrows, which were usually broad in large, narrow in small, specimens. And in a general way the same is true of the present series. But the furrows vary so much in the large specimens, and even in a given specimen, that no sharp line can be drawn between specimens in which they are broad and those in which they are narrow.

The size of the septal nodes has been used as the chief distinguishing character between *valdiviae* and *bairdii* (Vanhöffen, 1902*a*); and it is therefore interesting that these organs vary in size and proportions in the present series. Thus in a specimen 70 mm. in diameter the nodes are 9 mm. long and 5 mm. broad, while in another of about the same size (71 mm.), they are 12 mm. long by 3 mm. broad; that is, proportionately only about half as broad in the latter as in the former. In other examples intermediates are to be seen. In *valdiviae,* according to Vanhöffen's figure (1902*a*, pl. 6, fig. 41), the septal nodes are about two-thirds as broad as long; that is, only slightly broader than in our 70 mm. specimen.

A new character was described for *bairdii* by Maas (1904*b*), namely, the occurrence of septal regions subdividing the tentacular canals, and in many of our specimens there are clear oval regions in the tentacular canals which look like septa. But it is easy to demonstrate that there is no discontinuity in the cavity; and the copepods which are so often seen in the canals are as apt to lie in these false septa

as anywhere else. The true explanation of these clear spaces is afforded by the fact that the dense entodermal pigmentation of the aboral surfaces of the canal walls is lacking in the clear spaces. When the pigmented ectoderm of the subumbrella is rubbed off the spaces are noticeable; and this has happened more or less in most of the specimens, even when they are otherwise in excellent condition. There is one specimen in which the subumbrella pigment is intact, and in this one the false septa are only very faintly visible.

The general structure of the peripheral canal system has been described by Vanhöffen (1902*a*) for *valdiviae*, by Maas (1904*b*) for *bairdii* and by me (1909*a*) for *wyvillei*.

Order DISCOPHORA.

Suborder SAEMAEOSTOMATA.

Family PELAGIDAE Gegenbaur, 1856.

Genus PELAGIA Péron and Lesueur.

The revision of this genus would be of great value to the zoogeographer as well as to students of pelagic coelenterates; but it must be postponed until some one has access to large series from all oceans. For the present, the chief duty of any one who can examine a small series of Pelagias is to give the details of the two characters which, according to Maas (1903) and Mayer (1910) separate the "species," i. e., proportions of manubrium and mouth arms, and form of the exumbral nettle knobs.

The specimens in the collection agree very well with the eastern Pacific examples, with the *Siboga* material described by Maas (1903), with the *Valdivia* collection which Vanhöffen described as *P. phosphora*, and with specimens from the Hawaiian Islands, the Philippines, and from Australia. I have given elsewhere (1909*a*) the reasons for the choice of the name *panopyra* Péron and Lesueur for this form.

PELAGIA PANOPYRA (Péron and Lesueur).

Medusa panopyra Péron and Lesueur, 1807, pl. 31, fig. 2.

(For synonymy, see Bigelow, 1909*a*, p. 43.)

Station 4910, surface; 1 specimen.
Station 4920, surface; 7 specimens.
Station 4921, surface; about 15 specimens.
Station 4926, 165 fathoms; 1 specimen.
Station 4932, surface; 25 specimens.
Station 4950, surface; 1 specimen.
Station 4952, surface; 15 specimens.
Station 4954, 850–0 fathoms; 3 specimens.

Station 4970, 300–0 fathoms; 4 specimens.

Station 5079, surface; 7 specimens.

Station 5081, surface; 1 specimen.

The localities are all in Japanese waters with surface temperatures of 75°–86° F.

Measurements of 10 specimens, 21–60 mm. in diameter, are:

Diameter.	Length of manubrium.	Length of mouth arms.
21	9	27
25	15	23
30	15	31
36	14	50
40	25	31
42	16	38
50	22	74
50	21	60
56	20	90
60	23	97

These measurements show that there is a good deal of variation in the proportional lengths of manubrium and mouth arms, so much so that it is doubtful whether Maas's (1903) suggestion that *panopyra* and *perla* are separated by great length of the manubrium in the former, its almost entire suppression in the latter, is justified. The present series as a whole seems to have a rather longer manubrium than the specimens recorded by Vanhöffen, in which it ranged from 5–25 mm. in specimens 18–54 mm. in diameter. But in deciding how much weight this difference deserves, I may point out that this particular measurement is not a reliable one, because it depends very largely on whether the manubrium is extended or contracted; and also on whether it is stretched when the measurement is taken. To make the measurements of the present series comparable with one another, they were taken with the manubrium and mouth arms stretched out straight.

The shape of the exumbral nettle knobs is the main feature employed by Mayer for specific diagnosis, but as Vanhöffen (1902*a*) has pointed out, the types intergrade. In the first place there is not a single specimen, nor have I ever seen one, in which the knobs are all alike; but in every one round knobs, oval ones, linear or sausage-shaped ones, and linear ones subdivided by transverse furrows are to be seen. In specimens from Australia and from Naples the same variety occurs; but in the three large specimens of the Mediterranean form, "*noctiluca*," which I have studied, long narrow knobs largely predominate, whereas in the present series the various types are more equally represented. In our small specimens 14–20 mm. in diameter most of the knobs are round or oval, and they are much higher proportionately than in the larger ones. This suggests that the

large ridge-like knobs are characteristic of advanced stages in growth, which would explain their predominance in the large Mediterranean examples.

Color.—In the large specimens, as in those from the eastern Pacific (1909*a*), gonads, tentacles, subumbrella, and the four perradial ridges of the mouth arms are pink-violet, varying in strength in different specimens. Some are almost colorless, but these are poorly preserved. The small ones are colorless except that the manubrium and gonads are pinkish, or, in some, pale yellowish.

Mayer separates *P. flaveola* Eschscholtz (including *P. tahitiana* Agassiz and Mayer) on account of its yellow color, but Vanhöffen (1902*a*) found that color changes with growth from yellowish to violet.

Genus SANDERIA Götte.

SANDERIA MALAYENSIS Götte.

Sanderia malayensis Götte, 1886, p. 835.—Vanhöffen, 1902*a*, p. 38, pl. 3, fig. 12; pl. 8, fig. 69–74.—Mayer, 1910, p. 590, fig. 375.
Neopelagia eximia Kishinouye, 1910, p. 14, pl. 3, fig. 15.

Station 4841, surface, Sea of Japan; 1 specimen.

Station 4845, surface, Sea of Japan; 1 specimen.

Station 4921, surface, off Kagoshima Bay, Japan; 1 specimen.

The temperatures at these stations range from 76° to 84°.

The specimens range from 40 mm. to about 70 mm. in diameter.

Such good accounts of *S. malayensis* have been given by Vanhöffen (1902*a*) and Mayer (1910) that it is not necessary to describe it in detail here. The large specimen agrees with Vanhöffen's excellent figures of the species, except that the gonads are more advanced, and the smaller ones differ from it only in the more primitive state of development of the gonads and tentacles.

Genus CHRYSAORA Péron and Lesueur.

The collection contains a single large *Chrysaora* which is probably the *C. melanaster* of Brandt, but it has lost its mouth parts and most of the margin, besides being otherwise so badly damaged that its identity is not certain.

? CHRYSAORA MELANASTER Brandt.

Chrysaora melanaster Brandt, 1838, p. 385, pl. 16, 17.

(For synonymy, see Mayer, 1910, p. 582.)

Station 4781, 300–0 fathoms; 1 fragmentary specimen, 130 mm. in diameter.

Genus DACTYLOMETRA L. Agassiz.

This genus has usually been defined as having five tentacles to the octant (as for example, by Vanhöffen, 1902*a*, Maas, 1909, Mayer, 1910,

p. 583), but Mayer (1910) has already pointed out that the number of tentacles to the octant in the type species *lactea* L. Agassiz may be more than five, and in a considerable number of *lactea*, and as the following table shows, it is the rule, not the exception, to find more than five tentacles to the octant.

Dactylometra lactea, Santiago, Cuba.

Diameter, mm.	Tentacles per octant.	Total tentacles.
26	5, 5, 5, 4, 4, 5, 5, 4	37
31	4, 4, 3, 3, 3, 3, 4, 3	27
38	5, 5, 5, 6, 6, 5, 6, 6	44
39	3, 5, 4, 4, 5, 5, 4, 3	33
48	8, 7, 6, 6, 8, 7, 7, 8	57
55	6, 5, 6, 4, 6, 7, 6, 7	47
58	7, 7, 7, 7, 8, 6, 8, 6	56
62	6, 7, 5, 6, 5, 6, 5, 5	45
66	7, 7, 8, 7, 6, 7, 7, 6	55
79	9, 7, 7, 8, 7, 9, 8, 7	62

On examining the individual octants it was at once evident that when there were only five tentacles, the ones nearest the ocular lobes were usually the youngest; but when there were more, the others were irregularly interpolated. This, of course, shows that it is impossible to distinguish *Kuragea* with seven, from *Dactylometra* with five tentacles to the octant; and as we do not yet know what the limit to tentacle formation is in *D. lactea*, we may define *Dactylometra* as Pelagidae with five or more tentacles to the octant.

The various species of *Dactylometra* are distinguished from one another only by such minor characters as color, number of tentacles, and form of the marginal lappets, features all more or less variable. The Pacific forms, *ferruginaster* Kishinouye and *pacifica* Götte, are undoubtedly merely successive stages in the development of one species (Maas, 1909), in which, as the present collection shows, five tentacles per octant are attained in specimens of about 40 mm. in diameter. In large specimens of this species accessory tentacles appear (*D. longicirrha* Kishinouye), and in its final condition there are seven tentacles per octant (*Kuragea depressa* Kishinouye).

According to Kishinouye, the tentacles are short in *ferruginaster*, long in *pacifica* (=*longicirrha* Kishinouye), but my series of *lactea* and the Japanese Dactylometras in the present collection show that there is too much variability in this respect and that it is too subject to contraction to be used in classification. *D. africana* Vanhöffen, which has five tentacles per octant when very large, seems to be allied to *quinquecirrha*, in which there are never more than five, often less; indeed, the only thing definitely separating it from the latter is its brilliant coloration. For an excellent survey of the genus and of the variation of *D. quinquecirrha*, see Mayer (1910).

DACTYLOMETRA PACIFICA Götte.

Dactylometra quinquecirrha, var. *pacifica* Götte, 1886, p. 834.
Dactylometra ferruginaster Kishinouye, 1892, p. 264, pl. 3.—Mayer, 1910, p. 588.
Dactylometra longicirrha Kishinouye, 1892, p. 261, pl. 2.
Kuragea depressa Kishinouye, 1902, p. 9, pl. 1, fig. 7.
Dactylometra pacifica, var. *ferruginaster* Maas, 1909, p. 44, pl. 2, fig. 14.

Tsuruga Gulf, Japan, surface, July 23; six specimens, 38–81 mm. in diameter; in good condition.

The smallest specimen has 4, 4, 5, 5, 5, 5, 3, and 4 tentacles in the eight octants; all others have five in each octant; the central are often, but not always, the largest, the two on either side slightly smaller, i. e., younger. In Maas's specimens (40 and 90 mm.) the lappets next the rhopalar lappets were the smallest (Maas, 1909, pl. 2, fig. 14); and this is true of our smallest specimen. But in the large ones the tentacular lappets are all about the same size, though distinctly smaller than the rhopalar lappets.

The rhopalia resemble those of *quinquecirrha* so closely that I can find nothing to separate them.

Color.—In the largest specimen the reddish-brown exumbral star, which suggested the name *ferruginaster*, is faintly visible; the others have lost their color in the preservative.

Family CYANEIDAE L. Agassiz, 1862.

Genus CYANEA Péron and Lesueur, 1809.

At present it seems impossible to distinguish more than one species in this genus, for although several forms have been described which are so unlike, especially in color, as to be recognizable at a glance, they are all connected by intermediates. A revision of the Cyaneas, with a study of their exact geographic ranges is much to be desired; but to be of value it will require a much larger series of well-preserved material than I have at my command. Mayer (1910, p. 597) has given an excellent synopsis of the various varieties.

The present collection contains two forms; one from the Bering Sea, apparently identical with *C. ferruginea* of Eschscholtz; probably also with the *C. postelsii* of Brandt. Comparison between it and a "*lamarckii*" from the North Sea and an "*arctica*" from New England, shows that it agrees with the former, and with the figures of "*capillata*" (Vanhöffen), in the size and shape of the rhopalar lappets, with the latter in yellowish color, and in the arrangement of the lappet canals.

It is so doubtful whether there is anything to distinguish the var. "*ferruginea*" from *capillata* that the specimens are referred to the latter.

The second form, from southern Japan, is undoubtedly the *C. nozakii* of Kishinouye (1891). It is distinguished by the entire lack of color,

by the fact that the rhopalar lappets are scarcely marked off, by the structure of the rhopalia, and by the structure of the circular musculature of the subumbrella, which is separated into 16 blocks by broad gelatinous ridges, a condition different from that in *capillata*, *arctica*, and *lamarckii*, where the 16 muscular trapezia are separated from one another by very narrow gaps, if at all. But the two extremes are not discontinuous, for in specimens from Puget Sound and from Sakhalin Island the outer part of the circular musculature is broken by 16 gaps of medium breadth, though the inner part is continuous all around its circumference.

CYANEA CAPILLATA, var. CAPILLATA (Linnaeus) Eschscholtz.

Plate 4, figs. 8, 9.

Medusa capillata LINNAEUS, 1758, vol. 1, p. 660.

(For synonymy and synopsis of varieties, see Mayer, 1910, pp. 596, 597.)

Dutch Harbor, May 26, surface; 3 medium-sized specimens, 75, 120, 170 mm. in diameter; 7 small ones, 22–40 mm.

Station 5005, surface; 1 specimen, 70 mm.; disk only.

Station 5024, surface; 1 specimen, 160 mm.

CYANEA CAPILLATA, var. NOZAKII Kishinouye.

Plate 4, figs. 5–7.

Cyanea nozakii KISHINOUYE, 1891, p. 1, pl. 1.

Kobe, Japan, August 24, surface; 1 specimen of about 150 mm.; in excellent condition.

This specimen is particularly interesting, as showing how much *nozakii* differs from *capillata* in its extreme type. As pointed out above, the characters of importance in this respect are the form of the marginal lappets, the structure of the musculature and the color. The interrhopalar notches are not so deep as the rhopalar, and the margin follows an uninterrupted curve, between the two, so that there are no distinct rhopalar lappets.

The subumbrella musculature consists of series of radial and circular bands (pl. 4, fig. 5), the latter broken into 16 groups separated by broad, rounded gelatinous ridges, the interrhopalar groups being about twice as long as the rhopalar. And they differ from those of *capillata* not only in this respect but also in the fact that the individual muscle bands are fewer in number (only 9–10 in each group instead of 15–20), and much stouter.

The rhopalia, likewise, separate *nozakii* (pl. 4, fig. 6) from *capillata* (pl. 4, fig. 9), for in the former they lack the rounded prominences on the subumbral side near the base, which are prominent features in the latter.

The specimen is colorless.

CYANEA, variety?

Station 5008, near Sakhalin Island, surface; 1 fragmentary specimen, 140 mm. in diameter.

This specimen has lost part of the margin, and all the tentacles and mouth-arms, but what remains shows that it was almost exactly intermediate between var. *capillata* and var. *nozakii*. The sense organs agree with those of the latter; the rhopalar lappets are marked off by very shallow notches, that is, they are intermediate, and the circular musculature is especially instructive, as the 9 or 10 outer bands are separated into 16 groups by broad spaces, while the 4 or 5 inner ones are unbroken, and it is interesting that it is intermediate in geographic occurrence, as well as anatomically.

Family AURELIIDAE L. Agassiz, 1862.

Family ULMARIDAE[1] Haeckel (1879).

Genus PARUMBROSA Kishinouye, 1910.

Aureliidae with 8 sense organs; with 24 tentacles; with blind canals extending from the ring canal outward into the marginal lappets.

Parumbrosa is closely allied to *Discomedusa* and *Undosa;* but it differs from the type species of both of these in the occurrence of blind branches from the ring canal into the marginal lappets, such as are present in *Phacellophora*. Mayer (1910) does not consider this character of generic importance, but separates *Parumbrosa* from *Discomedusa* solely on the ground that there are twice as many marginal lappets, i. e., two instead of one, between every two marginal organs (that is, tentacles or rhopalia). In the present case it seems clear that the number of lappets has less phylogenetic meaning than the presence of canals, because, as Mayer himself points out, the two lappets between every two tentacles of *Parumbrosa polylobata* are merely the result of the fission of single lappets.

The features separating *Parumbrosa philippina* Mayer from *P. polylobata* are that in the former there is only one lappet between every two canals, and that the branching and anastomosis of the per- and interradial canals is rather more complex than Kishinouye (1910) represents it for the latter.

PARUMBROSA POLYLOBATA Kishinouye.

Parumbrosa polylobata KISHINOUYE, 1910, p. 19, pl. 4, fig. 20–23.

Station 4898, 207–0 fathoms; 1 specimen, 65 mm. in diameter.

Station 4899, 207–0 fathoms; 1 specimen, 110 mm. in diameter, and fragments of another.

Both of these stations are off the Goto Islands.

The specimens have both lost most of their mouth parts and are otherwise damaged, but fortunately they still show the canal system,

[1] Untenable, because *Ulmaris* Haeckel is a synonym of *Discomedusa* Claus.

the marginal lappets, tentacles and rhopalia, and the gonads, so clearly that there is no doubt of their identity with *P. polylobata.* Kishinouye (1910) has given a good account of the species (summarized by Mayer, 1910).

In our smaller specimen the canal system is in about the same stage as in Kishinouye's figure, except that one of the adradial canals anastomoses near its distal end with the perradial on one side, the other adradials being unbranched. But in the large one the branching and anastomosis of the per- and interradials is considerably more complex than he shows it, though less so than it is in *philippina* (Mayer, 1910). No two octants, however, are exactly alike. In this specimen all of the adradials anastomose more or less with the neighboring per- and interradials near their outer ends, though the exact conditions vary from octant to octant, just as in *Discomedusa lobata* Claus. The margin, with its narrow lanceolate lappets, agrees very well with Kishinouye's figure, except that he does not show the eight otocysts, though their positions are indicated.

Kishinouye's specimens were taken in Toyama Bay, and according to the local fishermen it is never found on the surface.

Genus PHACELLOPHORA Brandt, 1838.

An excellent account of the general structure of this genus has been given by Mayer (1910), but it is so far known from so few specimens that it is difficult to decide how much importance should be attached to the supposed distinctions between its four members, *camtschatica* Brandt, *ambigua* Brandt, *ornata* Verrill, and *sicula* Haeckel. The only tangible differences between them are afforded by the degree of scalloping or subdivision of the marginal lappets, for although a considerable range has been recorded for the number of tentacles and canals, this is subject to individual variation, as well as to progressive changes with growth.

In *P. camtschatica,* which is necessarily the type species of the genus, each of the tentacular lappets is cleft into seven, and the sense organ is apparently covered by a large projecting scale, flanked on either hand by a narrow lappet, the three together making a tridentate organ. In *ambigua* each tentacular lappet is divided into two, while each sense organ lies at the bottom of a deep cleft flanked on either hand by a rounded rhopalar lappet. In the Mediterranean *P. sicula* the rhopalar lappets are rounded and separated by notches from the tentacular lappets, which are entire (Mayer, 1910, p. 614, fig. 392). Just what the condition is in the specimens of *P. ornata* collected at Eastport by Verrill (1869) and afterwards by Fewkes (1888) is not clear, for while Mayer (1910) represents each of the tentacular lobes of one of the former as subdivided by deep

notches into two or three, in Fewkes's figures the tentacular lobe is merely slightly undulating in outline, his characterization of the lobes as "indented, incised, or scalloped," evidently referring to the notches separating the rhopalar lappets from the tentacular. As Fewkes's figures were drawn from life, and are evidently carefully made, and not at all diagrammatic, and as Verrill's specimen had been in alcohol upward of 20 years when Mayer examined it, it is likely that Fewkes's representation more clearly represents the normal condition.

Within recent years the genus has been recorded from the South Atlantic by Browne (1908) as *ornata* and from Japan and the Kurile Islands by Kishinouye (1910) as *sicula*. In Browne's specimen the tentacular lobes were not subdivided, but merely somewhat wavy in outline, and so are the specimens in the present collection. In Kishinouye's material they were entire. To summarize, then, specimens with entire or slightly wavy lappets—that is, all the recently described specimens of the genus—are known from the Mediterranean, the Bay of Fundy, the South Atlantic, Japan, the Kurile Islands, while the present collection contains two of this type from Bering Sea. Phacellophoras are also recorded from the west coast of the United States by A. Agassiz (1865) and Fewkes (1889), but without details as to their margins.

There seems to be nothing whatever to separate Browne's and Kishinouye's specimens specifically from the Mediterranean *sicula*, and I believe that the same is true of the Eastport form, *ornata*, for though Mayer's figure (1910) shows the mouth arms as *Aurelia*-like, he says in his characterization of the species that they are like those of *dubia*—that is, *Cyanea*-like—while in Fewkes's figure from life they are large, curtain-like, just as in *sicula*. The differences in the number of canals in the various recorded specimens also suggest nothing more than geographic varieties, if that. My own studies show that a little rough treatment is all that is needed to make the lappets split, for the gelatinous substance is very thin at the margin, and when this happens it might easily be mistaken for the normal condition, which suggests that no line can be drawn between Phacellophoras with entire and those with subdivided tentacular lobes. There is nothing to show that *ambigua*, *sicula* and *ornata* are not all one species. The case of *camtschatica* is not clear, because its marginal sculpture is so peculiar.

PHACELLOPHORA AMBIGUA (Brandt).

Plate 4, fig. 10; plate 5, fig. 5.

Haccaedecomma ambiguum BRANDT, 1838, p. 380, pls. 27, 28.—A. AGASSIZ, 1865, p. 43.

Callinema ornata VERRILL, 1869, p. 117.—FEWKES, 1888, p. 235, pl. 6, fig. 1–4.

Phacellophora ornata HAECKEL, 1880, p. 643.—HARGITT, 1904, p. 68.—VANHÖFFEN, 1906, p. 59.—BROWNE, 1908, p. 247, pl. 2, fig. 3, 4.—MAYER, 1910, p. 617.

Phacellophora ambigua HAECKEL, 1880, p. 550.—VANHÖFFEN, 1906, p. 58.—MAYER, 1910, p. 615.

Phacellophora camtschatica HERTWIG, 1878, p. 113, 114, pl. 9, fig. 15; pl. 10, fig. 16 (not Brandt, 1835).

Phacellophora sicula HAECKEL, 1880, p. 551.—MAYER, 1910, p. 613, fig. 392.—KISHINOUYE, 1910, p. 21, fig. 2.

Station 4779, 54–0 fathoms, Bering Sea; 1 specimen 95 mm. in diameter.

Agattu Island, surface; 1 specimen, 170 mm. in diameter.

Also 3604, Bering Sea, August, 1895; fragments.

The smaller specimen is in fair, the larger one in perfect condition.

The smaller specimen agrees so well with Mayer's figure of a Mediterranean example that the latter might almost have been taken from it; the larger differs only in having more canals and tentacles and more complex mouth parts. As in Mayer's figure, each rhopalium is flanked on either side by a rounded lappet, separated from the tentacular (velar) lappet, which is likewise rounded, or slightly wavy, by a shallow notch (pl. 4, fig. 10), and practically the same condition is figured by Kishinouye (1910) and by Browne (1908), except that according to the former the rhopalar lappets are rather more pointed, while the latter represents the lappets as proportionately longer and narrower.

Two antimeres are irregular in having the rhopalar lappets unusually large, and the tentacular lappet entirely suppressed.

Canal system.—In the large specimen 91 canals leave the stomach, but by the branching of the rhopalar canals there are about 140 at the margin. In the smaller specimen there are 70 at the stomach, 149 at the margin; that is, there is individual variation, apart from size. In Mayer's Mediterranean specimen there were 64 canals at the stomach, and his figure shows about 110 at the margin; in Browne's South Atlantic specimen there were 42 at the stomach. The number of blind canals extending into each of the tentacular lobes varies from 2 large and 4 very minute in an antimere in which the place of the tentacular lappet is usurped by the rhopalia of lappets on either hand, to 10 or 11, the 5 or 6 in the middle being much the largest and obviously the oldest, those at either end very small indeed.

In the small specimen there are usually 5 or 6 canals to the lobe. Kishinouye (1910) shows 10, Browne (1908) 8, Mayer 5 to 8 for his Mediterranean, but only 2 to 5 for his Eastport specimen.

Mouth parts.—Each of the four mouth arms is about 100 mm. long, of the same general type as in *Cyanea*, though not so large; i. e., practically the condition figured by Mayer for *sicula*. In the smaller specimen the marginal folds of the mouth arms are largely torn away, leaving the stiff aboral axes, which in this mutilated state suggest the mouth arms of *Aurelia*, and in Mayer's figure of his Eastport specimen they seem to be in the same condition.

The rhopalia (pl. 5, fig. 5) have no ocelli and agree very well with Hertwig's figure. According to Mayer (1910, p. 614) there is "no

sensory pit in the exumbrella above the sense club," but in our specimen there is a distinct pit above each rhopalium.

Color.—In formalin the specimens are pale yellowish.

Genus AURELIA Péron and Lesueur.

The collection contains two easily distinguishable species of *Aurelia*, the well-known *aurita*, and the Arctic *limbata* first described by Brandt (1838) from the Bering Sea region. As Vanhöffen has pointed out, *limbata* is characterized by the complex branching and anastomosis of its canal system and by pigmentation; and these characters taken together give the medusa a general appearance so characteristic that it is identified at a glance.

The considerable series of the *aurita* group which I have studied, taken off the coasts of New England, in British waters, the North Sea, Cuba, Puget Sound, and Japan, all incline me to accept Vanhöffen's view that they can not be divided even into varieties, certainly not by the precise arrangement of the canals. According to Mayer (1910, p. 628) "*labiata*" is separable from *aurita* by the fact that its margin is cleft into 16 instead of 8 lappets, by the small diameter of the subgenital openings, and because the bell margin "projects downward from the subumbrella side as 8 plain-edged, velum-like folds spanning between the sense organs." But our 8 specimens from Puget Sound and Japan show very clearly that whether there are 8 or 16 marginal lobes is a question of contraction. In some few preserved specimens the margin is more or less retracted in the adradii, giving the "*labiata*" outline; in others the contraction has taken place in some of the adradii only; and one specimen from Cuba is especially instructive because there are four such false lappets in one octant.

The size of the subgenital openings seems to be subject to great variation—Mayer himself has shown very small ones in an *aurita* from the Tortugas—and they are very small in our Japanese specimens and in others from Cuba. In New England specimens they are large as a rule.

As to the structure of the margin, I may point out that it is exactly the same in *aurita* as it is described by Mayer (1910) for *labiata;* in both the tentacles arise some distance from the bell margin, and the intertentacular lobes are not discontinuous, as they are shown in L. Agassiz's beautiful figures, but are connected with one another below the tentacles by a continuous "shelf" which is the true margin. Below this, again, the velarium is situated.

There are two Aurelias besides *aurita* and *limbata*, which may perhaps deserve specific rank, *solida* Browne and *maldivensis* Bigelow, the former characterized by the vertical position of the rhopalia, the latter by the extreme development of the mouth-arms. But both of these demand further study.

AURELIA AURITA (Linnaeus) Lamarck.

Medusa aurita LINNAEUS, 1758, p. 660.

(For synonymy, see Mayer, 1910, pp. 623, 628.)

Tsuruga, Japan, July 23, surface; 3 specimens, 65, 90, and 130 mm. in diameter.

I can find nothing to separate these specimens from the Aurelias of the New England coast, except that they have smaller subgenital pits than is usually the case among the latter; but in this respect they agree with Cuban specimens. The branching of the canals is rather regular, just as in the Japanese specimens recorded by Maas (1909, var. "*colpota*"), but no more so than I have seen it in some Atlantic specimens; in fact an example of almost exactly the same type (though with only seven rhopalia) has been figured by Hargitt (1905*c*) from Massachusetts.

AURELIA LIMBATA Brandt.

Plate 5, figs. 1–4.

Aurelia limbata BRANDT, 1835, p. 26.—VANHÖFFEN, 1902*a*, p. 43; MAAS, 1906*b*, p. 507.

Diplocraspedon limbata BRANDT, 1838, p. 372, pl. 10.

Dutch Harbor, surface, May 25; 16 young specimens, 16–22 mm. in diameter.

Agattu Island, surface, June 7; 1 specimen, now in fragments, about 200 mm. in diameter.

Mororan, Hokkaido, Japan, surface, July 5; 2 specimens of about 100 mm.; 1 very fragmentary, the other with subumbrella, part of margin, gonads, subgenital pits, and two mouth-arms intact.

Station 5008; surface, 1 specimen, 43 mm. in diameter.

This species resembles *aurita* in general form as well as in the fact that the exumbrella is thickly set with minute tubercles, giving a hoary appearance. The subgenital openings are of moderate size.

No one of the large specimens is perfect; but the two most important features from the systematic standpoint, canal system and margin, are well preserved over at least a part of the periphery, in all.

Canal system.—In the large specimens the canal system is so characteristic that it identifies them at a glance (pl. 5, fig. 1). The interradial groups rise as one trunk, the perradials usually as three trunks; in either case the original trunks soon divide and subdivide, while the resultant branches anastomose among themselves and with the outer portions of the adradials, until the entire subumbrella is occupied by an exceedingly close-meshed and complicated canal-net, in which the adradials are conspicuous by the fact that they are independent for the inner two-thirds of their length.

In the smallest specimen (16 mm.) the adradials are unbranched, and each per- and interradial group arises as a single trunk, which

shortly bifurcates; and close to the margin there is some further branching. In a specimen of 20 mm. the per- and interradials still start as a single trunk; but the peripheral branching and anastomosis is already much more extensive, and the outer third of the adradials is now involved in it (pl. 5, fig. 4), and the margins of all the canals are jagged. By the time a diameter of 32 mm. is reached there is a marked advance in the complexity of the branching.

Mouth parts.—Unfortunately the mouth parts are damaged in all the specimens; but so far as can be seen they are of the usual *Aurelia* type. In one example of about 100 mm. two of the mouth-arms are intact; they are slightly longer than the bell radius.

Margin.—The velarium is much broader than in *aurita*, and the oldest of the intertentacular lobes longer and pointed, but there are all stages in the development of the latter and of the tentacles. As in *aurita* (p. 98), the tentacles arise some distance above the margin, the lobes not being discontinuous, but connected with one another below the tentacles.

The rhopalia (pl. 5, figs. 2, 3) resemble those of *A. aurita* in general, there being a broad, shallow, radially corrugated exumbral pit above the sense club, and below it a narrow, tubular one opening into the notch at the bottom of which the latter is situated. The club itself stands in an oblique position, neither horizontal, as is usual in *aurita*, nor vertical, as in the form described by Browne (1905) as *solida*.

The most striking feature of the margin is that velarium, margin, and lappets are heavily pigmented. In the preserved specimens they are amber-brown, and one of Mertens's figures from life (Brandt, 1838) shows this same color, but in his other figure they are deep sepia-brown. The color is as dense in our specimen of 30 mm. as it is in the larger ones; but in the specimen of 60 mm. observed by Mertens (Brandt, 1838, *A. hyalina*) there was no pigment.

Suborder RHIZOSTOMATA.

Genus MASTIGIAS L. Agassiz, 1862.

MASTIGIAS PAPUA (Lesson) L. Agassiz.

Cephea papua Lesson, 1826, p. 122, pl. 11, figs. 2, 3.

(For synonymy, see Mayer, 1910, p. 678.)

Nagasaki, Japan, surface, August 8; 3 specimens, 20–35 mm. in diameter.

These specimens are apparently identical with the Japanese material described by Kishinouye (1895) as *M. physophora*, except that like the Japanese specimens studied by Maas (1909) they have lost all color in the preservative. As Maas (1903, 1909) has shown, *physophora* is at most a variety of *papua*, with which Mayer (1910) has unequivocally united it. I believe the latter is correct.

Genus CEPHEA Péron and Lesueur, 1809.

Mayer (1910) has given an excellent account of this genus, and has pointed out that since in all known species of *Cephea* the mouth-arms "give rise to secondary dichotomous or dendritic branches and all are laterally compressed" there is no distinction between it and *Netrostoma*. The several members of *Cephea*, though differing widely from one another in their extremes, are connected by so many intermediate conditions that the separation of the species is difficult and probably largely artificial.

The collection contains a single well-preserved *Cephea* which agrees very well with the *C. setouchiana* of Kishinouye, especially in having a rather high dome with numerous protuberances, and a unitary four-lobed subgenital cavity, a character which it shares with *C. coerulescens* Maas. According to Mayer, *setouchiana* is a variety of *C. cephea*, *coerulescens* of *C. octostyla*, the two species being separated by the conformation of the central exumbral dome. This character is a variable one, as Mayer himself has found; but as I have studied only a single specimen of the genus, his classification is adopted here for the sake of uniformity. Kishinouye's account (quoted by Mayer, 1910, p. 657) applies so well to our specimen that no description is called for here.

CEPHEA CEPHEA (Forskål), var. SETOUCHIANA (Kishinouye) Mayer.

Microstylus setouchianus KISHINOUYE, 1902, p. 11, pls. 1, 2.
Netrostoma setouchianus BROWNE, 1905*a*, p. 967.
Cephea cephea, var. *setouchiana* MAYER, 1910, p. 657, fig. 409.

Nagasaki Harbor, August 5; 1 specimen, 80 mm. in diameter.

Genus RHOPILEMA Haeckel, 1880.

RHOPILEMA ESCULENTA Kishinouye.

Rhopilema esculenta KISHINOUYE, 1891*b*, p. 53; 1899, p. 20, pl. 13, figs. 1–5.—MAYER, 1910, p. 705, fig. 423.
? *Rhopilema rhopalophora* HAECKEL, 1880, p. 596.

Kagoshima Gulf, Japan, August 16, surface; 1 excellent specimen, about 140 mm. in diameter.

Kishinouye's (1899) account of this species, quoted by Mayer, is so good that no description is necessary here.

GEOGRAPHICAL DISTRIBUTION.

The chief interest of the collection, from the zoogeographic standpoint, is that it throws fresh light on the relationships of the medusa fauna of Bering Sea to that of other parts of the north Pacific on the one hand, and to that of the Arctic Ocean and north Atlantic on the other: and it affords our first information of the siphonophore fauna of the northwestern Pacific.

Some 40 species of medusae are now recorded from the region including Bering Sea, the Aleutian chain, the neighborhood of the Shumagin Islands, and the east coast of Kamchatka, the known

occurrence of which, in other regions, is shown on the table with the exception that two species are omitted, *Aequorea aequorea*, because our knowledge of its several varieties is still so chaotic that it is not advisable to make any use of them as yet in discussions of zoogeography, and the "species *incerta*" of Murbach and Shearer (1903), a peculiar codonid, because known from a single poorly preserved specimen.

Distribution of Bering Sea species.

	Tropical Indo-Pacific.	East coast Nipon-Hondo.	East coast Hokkaido.	Sea of Japan.	Kurile Islands.	Sea of Okhotsk.	California.	Puget Sound-Alaska.	Bering Sea.	White Sea, Barents Sea.	Spitsbergen.	Norway.	Greenland-Iceland.	Labrador Current.	New England.	North Sea, etc.	United States south of 42° N.	Europe south of 50° N.	Tropical Atlantic.
1. MEDUSAE.																			
Sarsia princeps									×	×	×	×	×						
Sarsia eximia							×	×	×	?	?	×	×	×	×	×		×	
Sarsia japonica			×			×			×	?	?		?						
Hybocodon prolifer							×		×		×	×	?		×	×			
Bougainvillea superciliaris							?	?	×		×	×	×	×	×	×	×		
Bougainvillea bougainvillei							×	×	×		?	×	×	×	?	×	×	×	
Rathkea blumenbachii		×							×	×		×	×	×	×	×			
Meator rubatra									×										
Pandea rubra								×	×										
Catablema vesicaria									×	×	×		×	×	×				
Catablema multicirrata					×			×	×										
Calycopsis nematophora									×										
Heterotiara anonyma	×							×	×										
Proboscydactyla flavicirrhata							×	×	×										
Tiaropsis diademata									×	×				×	×	?			
Eutonina indicans									×							×			
Staurophora mertensii	?				×			×	×	×		×	×	×	×	×	×		
Ptychogena lactea			×			×			×	×			×	×	×				
Gonionemus vertens var. *depressum*		×						?	×				×						
Aglantha digitale			×	×	×	×		×	×	×	×	×	×	×	×	×	×		
Crossota brunnea var. *norvegica*						×		×	×				×						
Ptychogastria polaris									×	×	×	×	×	×					
Pantachogon haeckeli						×		×	×		×		×						
Botrynema ellinorae									×				×						
Halicreas papillosum	×	×				×			×								?	?	×
Aegina rosea	×	×							×								?		×
Aeginura grimaldii	×	×							×									×	×
Solmissus incisa	×								×								×		?
Aeginopsis laurentii				×					×	×	×		×	×	?	?			
Haliclystus stejnegeri									×		?	?	?				?		
Periphylla hyacinthina	×	×				×	×		×			×	×		×		?	?	×
Atolla wyvillei	×	×							×								?		?
Cyanea capillata var. *capillata*					×	×			×	×	×	×	×	×	×	×			
Chrysaora helvola	?				×		×	×	×										
Chrysaora melanaster						×			×										
Pelagia species	×	×							×								×	×	×
Aurelia aurita	×	×	×		×		×	×	×	×		×	×	×	×	×	×	×	×
Aurelia limbata			×		×	×			×				?						
2. SIPHONOPHORAE.																			
Rosacea plicata	×			×		×			×									×	
Vogtia pentacantha		×				×			×									×	
Diphyes arctica			×	×	×	×			×	×	×	×	×			×			
Diphyes truncata	×	×						×	×			×						×	

The most striking thing illustrated by the table is the paucity of a peculiar Bering Sea fauna, if indeed there be any. Thus there are only two Craspedotae so far known from Bering Sea, the neighborhood

of the Aleutians, and the Sea of Okhotsk alone, that is, *Meator rubatra* and *Calycopsis nematophora*, both described here for the first time. And though the second may fairly be assumed to be restricted to the Bering Sea region, because it is a surface species and has not been taken elsewhere although the genus to which it belongs is widely distributed, the first is certainly a member of the mesoplankton, for which reason it is unsafe to assume that it will not prove to be much more widely distributed than now appears, when the bathymetric province to which it belongs is better known. The same is true of *Pandea rubra*, recorded from Bering Sea and from off the coast of British Columbia, and it is questionable whether the single Scyphomedusae peculiar to the Bering Sea region, *Haliclystus stejnegeri* Kishinouye, is really separable from *H. auricula*.

The remaining species are easily classified as to their relationships, systematic and geographic. In the first place, there are four "intermediate" cosmopolitan species, belonging that is, to the mesoplankton, *Halicreas papillosum*, *Aeginura grimaldii*, *Periphylla hyacinthina*, *Atolla wyvillei*, and one cosmopolitan surface form, *Aurelia aurita*, while two others, *Solmissus incisa* and *Aegina rosea*, if not cosmopolitan, are at least widely distributed both in the Atlantic and in the Indo-Pacific. Then one, *Bougainvillea bougainvillei*, is probably identical with the other member of the same genus mentioned in the list, *B. superciliaris*. *Sarsia princeps*, *S. eximia*, *Hybocodon prolifer*, *Bougainvillea superciliaris*, *Rathkea blumenbachii*, *Catablema vesicaria*, *Tiaropsis diademata*, *Eutonina indicans*, *Staurophora mertensii*, *Ptychogena lactea*, *Aglantha digitale*, *Pantachogon haeckeli*, *Botrynema ellinorae*, *Aeginopsis laurentii*, *Haliclystus*, and *Cyanea capillata* var. *capillata*, are characteristic members of the medusa fauna of the boreal Atlantic, or of the Arctic Ocean; *Aurelia limbata* probably occurs in Greenland waters (Vanhöffen, 1902*a*) and *Sarsia japonica* may be identical with an Arctic species, *S. flammea*, while *Catablema multicirrata* is a member of a genus which, as here defined, is known only from the boreal Atlantic and from the Arctic Ocean. Six species, on the other hand, clearly have an Indo-Pacific origin. These are *Heterotiara anonyma*, which is widely distributed in the intermediate depths of the Indo-Pacific, but is not known from the Atlantic; *Proboscydactyla flavicirrata*, a Pacific species which finds its closest ally in the only other member of the genus, *ornata*,[1] one or other variety of which is recorded from various localities in the tropical Atlantic and the Pacific and Indian Oceans; *Gonionemus vertens* var. *depressum*, which is represented in the north Atlantic by a close ally; and *Chrysaora helvola*, which is so far known only from the two sides of the northwestern Pacific, though it is certainly

[1] I have recently examined two excellent specimens of *flavicirrata* from Puget Sound, finding that the mode of branching of the canal agrees very well with Brandt's (1838) figure; this separates them, as I supposed (1909*b*), from *ornata*.

very close to the Atlantic *C. hysoscela*, if indeed it is separable from it at all. *C. melanaster*, too, is so far known only from the northwestern Pacific; and the *Pelagia* is a representative of a tropical and subtropical genus, a casual visitor from the south.

Thus, as might have been expected on oceanographic grounds, it is evident that the medusa fauna of the Bering Sea region has been recruited from two directions, there being a constituent from the warmer waters of the Pacific on the one hand and, on the other, a more important one, numerically, from the cold Arctic waters, which must have entered Bering Sea by way of Bering Straits.

Most of the leptoline species of northern origin are known from the region extending from Cape Cod to southern Labrador, while one, *Eutonina socialis*, occurs in the North Sea; that is, they are boreal rather than purely Arctic, though several are known from Arctic stations; and this is what we might have expected, for in summer the temperature of the surface waters of the southern part of Bering Sea is from 50° to 57°; that is, about as warm as the waters of the northern parts of the Gulf of Maine on the New England coast and considerably warmer than the surface waters of the Labrador current off Labrador. And for this same reason it is probable that collections made during the late summer would contain a greater number of southern species, for the Fisheries steamer *Albatross* records are limited to May and the early part of June.

The Bering Sea list includes four siphonophores, all long-known species. One of them, *Diphyes arctica*, previously recorded only from Arctic and boreal regions (1911*b*), was taken regularly on the present cruise in cold waters, but was entirely absent in the warm waters of the Eastern Sea and of Kuro shiro. Like the Arctic and boreal medusae, it probably reached the Bering Sea region from the north, i. e, by way of Bering Straits. But, as Doctor Moser, who is now working on the siphonophores of the German South Polar Expedition, writes me that the *Gauss* took it in many localities, further discussion of its distribution is best postponed until her data is published.

The three other siphonophores are all species of wide distribution in both Atlantic and Indo-Pacific, *Rosacea plicata* and *Diphyes truncata* being known from tropical as well as from temperate stations and *Vogtia pentacantha* from the Bay of Biscay and from the Mediterranean. But as none of them has ever been recorded from Arctic temperatures, it is safe to assume that they colonized Bering Sea from the south. They were all taken there so regularly that they are to be considered characteristic members of its pelagic fauna.

The collection suggests the probability that certain species of medusae belonging to intermediate depths may be confined to Arctic-boreal regions; a generalization of great zoogeographic interest if it

proves to be well founded. This tentative conclusion (of course it may have to be modified) is based on the occurrence of *Pantachogon haeckeli* and of *Crossota brunnea* var. *norvegica.* If these species had been represented by only a few scattered captures, we might well hesitate to use them as instances of geographic range; but both were taken in considerable numbers at 10 stations each, and the regularity of their distribution is striking when we observe that only 14 hauls with the intermediate net from 300 fathoms were made south of the Shumagin Islands, in Bering Sea and in the Sea of Okhotsk, in 11 of which one or other of the two species was taken (in six hauls the two were taken together; each was likewise taken in the trawl). On the other hand, both were conspicuously absent in the intermediate hauls made in Japanese waters, nor are they represented in the extensive collections made by the *Albatross* off the coasts of California, British Columbia, and southern Alaska, which have passed through my hands. In the Atlantic, too, these two species have been taken only at far northern stations, though the expeditions of the *National*, of the *Valdivia*, and of the Prince of Monaco might have been expected to reveal them in the warmer parts of the Atlantic were they as common there as in Bering Sea, or as are such genera as *Halicreas*, *Periphylla*, and *Atolla*. And the fact that *P. haeckeli* is represented by a distinct, though allied, species, *scotti*, in the Antarctic and *C. brunnea* var. *norvegica* by a recognizable variety in tropical regions, is also strong evidence that the two are restricted to northern regions. The collection made by the *Michael Sars*, now being studied by Doctor Broch, may throw further light on this subject, but we are probably safe in assuming that both *Pantachogon* and *Crossota* entered Bering Sea from the north.

Botrynema ellinorae is likewise known only from "intermediate" hauls in Bering Sea and in the Arctic Ocean; but the records of its captures are too few to warrant the assumption that it is confined to high latitudes, while the fact that its close ally, *brucei*, is Antarctic, suggests that the genus, at least, will be found in the deeper water layers of low latitudes. It is not improbable that the two new "intermediate" species, *Pandea rubra* and *Meator rubatra*, may belong to the same category, for their occurrence in the northwestern Pacific closely parallels that of *Pantachogon* and *Crossota;* but, as pointed out above, it is best to suspend judgment on this point for the present.

We can not trace the cold water medusae southward along the west and east sides of the northwestern Pacific as well as we could wish, because we know very little about the medusae of the American coast between the Aleutians and Puget Sound. But the collections from the latter region, recorded by A. Agassiz (1865) and by Murbach and Shearer (1903), and a series in the Museum of Com-

parative Zoology collected by Professor Kincaid, give a fair idea, though certainly far from a complete survey, of its medusa fauna. The combined list from Puget Sound, coast of Washington, and southern British Columbia, is as follows:

Sarsia rosaria.
Sarsia eximia.
Stomotoca atra.
Neoturris brevicornis.
Catablema multicirrata.
Bougainvillea bougainvillei.
Proboscydactyla flavicirrhata,
Polyorchis penicillatum.
Polyorchis minuta.
Melicertum georgicum.
Staurophora mertensii.
Halistaura cellularia.
Phialidium gregarium.
Aequorea aequorea.
Gonionemus vertens.
Aglantha digitale.
Cyanea arctica (colorless var.).
Dactylometra species?
Chrysaora helvola.
Phacellophora species?
Aurelia aurita.

Likewise the siphonophores, *Diphyes appendiculata, Physalia, Porpita,* and *Velella;* and the present collection contains specimens of *Heterotiara anonyma* and *Crossota pedunculata* taken in intermediate hauls off British Columbia.

The general character of this list differs from that of Bering Sea by the appearance of the very noticeable genera *Polyorchis, Halistaura, Dactylometra,* and by the tropical siphonophores *Physalia, Porpita,* and *Velella,* while the dark-colored *Cyanea* of the north is replaced by a colorless variety, of which I have seen examples. At the same time seven of the Bering Sea species are also known from the Puget Sound region, while it would not be surprising to find *Sarsia rosaria* (? *tubulosa*), *Melicertum,* and *Phialidium* in Bering Sea, judging from the occurrence of these genera in the north Atlantic.

As we pass southward from the Puget Sound region, we find only a few scattered records of medusae until we reach San Diego. And somewhere in this long stretch the cold-water species which compose the great bulk of the medusa fauna of Bering Sea entirely disappear, the most southerly record for any of them on the surface being Fewkes's (1889) capture of *Hybocodon prolifer* at Santa Barbara, though the northern *Aglantha digitale* is represented by a distinct variety in the intermediate depths of the tropical Pacific (1909*a*). The only Leptomedusa known to be common to San Diego and to Bering Sea is the cosmopolitan *Aequorea aequorea,* and even in this case it is doubtful whether it is represented by the same variety.

On the western side of the Pacific the available data is more extensive, thanks to the collections from Japan recorded by Maas (1909) and by Kishinouye (1902, 1910), and to the Fisheries steamer *Albatross* series from the southern part of the Sea of Okhotsk, a virgin field, and the Eastern Sea south of Japan. The species taken in the Sea of Okhotsk are *Sarsia japonica, Calycopsis nematophora, Ptychogena lactea, Tima saghalinensis, Aglantha digitale, Crossota brunnea,*

var. *norvegica, Pantachogon haeckeli, Halicreas papillosum, Periphylla hyacinthina, Aurelia limbata,* and the siphonophore *Vogtia pentacantha;* all, except the *Tima,* also taken in Bering Sea; and the one exception may be expected to turn up there, as it is a new species known only from one record.

Cyanea capillata, Aurelia limbata, Staurophora mertensii, and the genus *Chrysaora* are also known from the southern end of Sakhalin Island, besides the genera *Urashimea, Nemopsis,* and *Polyorchis,* recorded by Kishinouye.

Eight of the Bering Sea medusae are known from the Kurile Islands, among them the typical cold-water forms *Staurophora mertensii, Aglantha digitale,* the dark-colored variety of *Cyanea capillata, Aurelia limbata,* and *Diphyes arctica;* but on the other hand, the eudoxid of *Nectopyramis diomedae,* a species previously recorded only from the tropical Pacific, was likewise taken off the Kurile Islands, but it is known from so few captures that it can not be assigned to any definite temperature zone. *Catablema multicirrata, Chrysaora helvola, Sarsia tubulosa, Phacellophora ambigua,* and the peculiar Stauromedusa *Thaumatoscyphus* have likewise been recorded from the Kuriles by Kishinouye.

In examining the records of the *Albatross* from the Sea of Japan we are confronted by the rather surprising fact that although the intermediate 5-foot net and the small plankton nets were used at 15 of the 86 trawling stations occupied, medusae were taken in only 3 hauls. Only four species of medusae were taken; i. e., *Liriope tetraphylla, Aglaura hemistoma, Aglantha digitale, Dactylometra pacifica,* and three siphonophores, *Rosacea plicata, Diphyes arctica,* and *D. truncata;* while the only previous records which I have been able to find are that of *Aeginopsis laurentii,* by Haeckel (1879) and *Parumbrosa polylobata* by Kishinouye (1910).

The apparent absence of the smaller surface medusae might perhaps be credited to their being overlooked in the mixed plankton; but we can not account in this way for the failure to find any of the larger red "intermediate" genera, as for example, *Atolla, Periphylla, Aeginura,* because they are made exceedingly conspicuous by their color. And as none of them were taken, it is fair to assume that the scarcity of the medusae on the Sea of Japan is a real, not an apparent phenomenon.

The short list includes three warm water members, *Aglaura, Liriope, Dactylometra,* and two cold water ones, *Aglantha* and *Diphyes arctica,* with two, *Rosacea plicata* and *Diphyes truncata,* which are probably cosmopolitan; and data of the specimens shows that *Aglaura* and *Liriope* were taken on the surface, while *Aglantha* and *Diphyes* were encountered only in intermediate hauls, the difference in bathymetric range being well illustrated by the coincidence that *Aglaura*

was taken on the surface close by the spot where the two cold water species were brought up from the deeper waters, the surface temperatures being 77°–80°, that at 245 fathoms 33.1°. Haeckel's record of *Aeginopsis* unfortunately gives neither the date, whether winter or summer, nor the exact locality. And both of these are of importance, because in summer the surface temperatures of the Sea of Japan range from about 60° (northern end) to about 80° (Korea Channel); while in winter the surface waters of its northern half, between Hokkaido and the Siberian coast, are cooled to 45° or less.

In the portion of the Eastern Sea south of the Straits of Korea traversed by the *Albatross*, the hauls brought to light an abundant harvest of medusae, the species taken near the Goto Islands, off Kagoshima Gulf, and off Kyushiu Island being—

1. Medusae.

Turritopsis nutricula.
Aequorea pensile.
Olindioides formosa.
Aglaura hemistoma.
Rhopalonema velatum.
Colobonema typicum.
Crossota alba.
Liriope tetraphylla.
Geryonia proboscidalis.
Solmundella bitentaculata.
Periphylla hyacinthina.
Nausithoë punctata.
Atolla wyvillei.
Pelagia panopyra.
Sanderia malayensis.
Parumbrosa polylobata.

2. Siphonophorae.

Rosacea plicata.
Nectodroma reticulata.
Hippopodius hippopus.
Vogtia pentacantha.
Abylopsis tetragona.
Bassia bassensis.
Clausophyes galatea.
Galeolaria australis.
Galeolaria monoica.
Chuniphyes multidentata.
Diphyes truncata.
Diphyes appendiculata.
Diphyes contorta.
Diphyes spiralis.
Diphyopsis dispar.
Diphyopsis mitra.
Diphyopsis chamissonis.
Agalma okeni.
Archangelopsis typica.
Porpita pacifica.

The list is essentially tropical, as might have been expected from the surface temperatures (83°–85°) at the season the collection was gathered, all the surface medusae being known from the tropical parts of the Pacific or Indian Oceans, except *Turritopsis nutriculata, Olindioides,* and *Parumbrosa polybata,* the last two known only from Japan. All the siphonophores, except *Vogtia pentacantha,* are known from the tropical Pacific, or from the Malaysian region, while most of them are characteristic of the warmer regions of all three great oceans.

During the summer months, when the southeastern coasts of Japan are bathed by the warm Kuro Shiro current, the tropical holoplanktonic coelenterate fauna extends northward along the coast of Nipon, at least as far as Suruga and Sagami Bays, where

the combined records of Kishinouye (1902, 1910), Maas (1909), Doflein (1906), and the Fisheries steamer *Albatross,* have revealed the following tropical species: *Cytaeis vulgaris, Clavula papua, Proboscydactyla ornata, Phialidium pacificum, P. discoida, Aequorea pensile, Liriope tetraphylla, Geryonia proboscidalis, Rhopalonema velatum, Aglaura hemistoma, Solmundella, Cunina peregrina, Charybdea rastonii, Pelagia panopyra, Sanderia malayensis, Dactylometra pacifica, Thysanostoma thysanura* and *Mastigias papua,* with the following siphonophores, *Abylopsis tetragona, Diphyes appendiculata, Diphyopsis dispar, Diphyopsis chamissonis, Forskalea, Physalia, Porpita,* and *Velella;* all of them being widely distributed in the tropical parts of the Indo-Pacific.

This list suggests that the pelagic coelenterate fauna of the southeast coast of Japan in summer is overwhelmingly tropical; but such a conclusion is correct only for its holoplanktonic constituent—that is, for the inhabitants of the warm waters of the Kuro Shiro, and for certain scyphomedusae. With the leptoline forms quite a different state of affairs is to be seen, because the list does not include any of the leptoline hydromedusae which are the most characteristic members of the medusa fauna of the Philippines, the Malaysian region, or of the Maldives and tropical Pacific, such as *Bougainvillea fulva, Laodice fijiana, Tiaropsis rosea, Phialucium mbengha, Irenopsis hexanemalis, Eutima levuka, Octocanna polynema, Gonionemus suvaensis,* or the genera *Euphysora, Phortis,* or *Olindias.* A full list of the Philippine, Malaysian, and tropical West American hydromedusae, and their distribution, will be found in my report on the *Albatross* Philippine medusae.

In Japanese waters the place of *Olindias* is taken by *Olindioides,* of the tropical *Gonionemus suvaensis,* by *G. vertens,* var. *depressum,* which is a close ally of the *Gonionemus* of the cold waters of Puget Sound, and of New England. Other Japanese leptoline forms recorded by Kishinouye (1910) and by Maas (1909), such as *Nemopsis dofleini, Willia pacifica, Spirocodon saltatrix,* are peculiar to Japan, so far as we know yet. The absence of the typically tropical leptoline species, which are so common among the Philippines, is probably not an accidental failure in collection, but is an actual condition, due to the low temperature of the waters off the east coast of Japan in winter, which they, or their hydroids, can not survive. But in the case of the holoplanktonic species, this bar is operative only in winter, for they are brought to Japan in summer by the Kuro Shiro, when the latter spreads toward the north.

Unfortunately we have almost no data on the medusa fauna of the east coast of Nipon, north of Yokohama Bay; indeed I have not been able to find a single definite record; but we can safely assume that before Tsugaru Strait is reached the tropical contingent

of the medusa and siphonophore fauna swings away from the coast, with the easterly trend of the Kuro Shiro current, because the few species previously known from the east coast of Hokkaido, and those found there by the *Albatross*, that is, *Sarsia japonica*, *Ptychogena lactea*, *Aglantha digitale*, *Haliclystus auricula*, *Aurelia aurita*, *Aurelia limbata*, and *Diphyes arctica*, are of a distinctly northern cast.

In summer the warm Kuro Shiro water, with its characteristic fauna, is periodically driven out from the shore off Tsuruga Gulf, by northwest winds, and its place taken by much colder water (Doflein, 1908); and the few available winter records, for example, *Rathkea blumenbachii* and *Phacellophora ambigua* from Misaki (Kishinouye), show that some northern species reach the coasts of Nipon at that season; whether any of them do so in summer is not yet known.

An interesting parallel may be drawn between the pelagic coelenterate fauna of the northeastern coasts of Asia and that of the northeast coast of the United States. It has, of course, been long recognized that the east coast of Japan and the southern shores of New England share certain striking oceanic phenomena, both being bathed in winter by cold, almost Arctic waters of northern origin, which in summer are periodically displaced by the northerly swing of a very warm current, the Kuro Shiro in the Pacific, the Gulf Stream in the Atlantic. On the Japanese coast the warm stream holds almost continuous sway in summer; but on the south coast of New England its full effect is felt only occasionally, though it tempers the surface waters to a marked degree throughout the warm months. Off the coast of Nipon, in the region of Sagami and Suruga Gulf the annual range of temperature is from about 50° to about 80°; off Narragansett Bay, in New England, from about 38° (it occasionally freezes in the bay) to about 76°; and of course even greater extremes and various anomalies are observed in partially enclosed waters.

To both of these regions the warm current brings an abundant tropical oceanic pelagic fauna in summer; but this deserts New England, and probably Japan, in autumn, when the warm waters to which it belongs recede. And in neither region is the leptoline medusa fauna tropical; thus there are very few leptoline species common to Narragansett Bay and to the West Indies, though the former receives a number of characteristic tropical oceanic medusae every summer; and the same is true of Japan; nor indeed would we expect to find litoral tropical species taking permanent foothold in regions where they would have to survive boreal temperatures at some stage of development.

In New England tropical medusae seldom penetrate north of Massachusetts Bay, beyond which point, in summer, we find boreal species such as *Melicertum campanula*, *Staurophora mertensii*, *Catablema*

vesicaria, which appear only in winter south of Cape Cod; and in Japan the Tsugaru Strait marks a similar division. But both in the Atlantic and in the Pacific there are records of the occurrence of tropical coelenterates from far north of their usual range, such as *Physalia* in the Bay of Fundy, *Pelagia* in Bering Sea.

In the cold season the process of dispersal is reversed, the warm-water species receding, the cold-water ones advancing toward the south. We do not know just how far southward boreal medusae extend along the coasts of the United States in winter, but several appear regularly at that season at Woods Hole and in Narragansett Bay, and I have myself seen the waters of Pamlico Sound (only a few miles north of Cape Hatteras) crowded with the dark red northern *Cyanea*, in January, after prolonged northeast storms. In Japan, as pointed out above, boreal species appear in Sagami Bay during the cold season, and it is probable that they advance even farther southward.

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EXPLANATION OF PLATES.

PLATE 1.

Meator rubatra.

Fig. 1. Side view of type. ×3.
2. Oral view of same.
3. Side view of manubrium of another specimen.

Catablema multicirrata.

Fig. 4. Side view of specimen, 29 mm. high, with the bell opened and its walls turned aside to show the manubrium.
5. Radial canal and portion of margin.
6. Dissection of margin, showing bases of an old and a young tentacle in side view.
7. Portion of margin.

Catablema vesicaria, var. *nodulosa.*

Fig. 8. Side view of specimen 21 mm. in diameter, with part of the bell wall dissected away to show manubrium and gonads.
9. Similar dissection of a young specimen 10 mm. in diameter.

PLATE 2.

Pandea rubra.

Fig. 1. Side view of type, 47 mm. high.
2. Upper part of another specimen, with part of the bell wall cut away to show manubrium and gonads.
3. Radial canal and portion of margin.
4. Side view of base of a tentacle.
5. Portion of radial canal.
6. Young specimen, 27 mm. high.
7. Manubrium of same.

Calycopsis nemataphora.

Fig. 8. Type, with part of bell wall cut away to show manubrium. ×3.

PLATE 3.

Calycopsis nematophora.

Fig. 1. Margin.
2. Aboral view of subumbrella, with manubrium largely cut away to show its relation to the canals.
3. Portion of lip.

Pantachogon haeckeli.

Fig. 4. Side view of specimen, 17 mm. in diameter.
5-7. Successive stages in the development of the gonads.
8. Manubrium and proximal part of gonads of a large specimen.

Crossota alba.

Fig. 9. Side view of type. × about 3.
10. Portion of margin of same, showing stumps of tentacles of different ages.
11. Portion of inner surface of bell of another specimen to show manubrium and gonads.
12. Sense-club of same. ×75.

Crossota pedunculata.

Fig. 13. Portion of type showing manubrium with its peduncle, and one gonad. ×3.

PLATE 4.

Botrynema ellinorae.

Fig. 1. Slightly oblique side view of specimen, 13 mm. in diameter.
2. Portion of margin of same to show stumps of tentacles.
3. Portion of same, more highly magnified, to show sense-clubs.
4. Sense-club.

Cyanea capillata, var. *nozakii.*

Fig. 5. Portion of subumbrella, about natural size.
6. Rhopalium of same, in side view.
7. Aboral view of rhopalium.

Cyanea capillata var. *capillata.*

Fig. 8. Portion of subumbrella.
9. Rhopalium of same, side view.

Phacellophora ambigua.

Fig. 10. Portion of subumbrella and margin.

PLATE 5.

Aurelia limbata.

Fig. 1. Portion of subumbrella of large specimen, 200 mm. in diameter, showing the canal system.
2. Aboral view of rhopalar folds and niche of same.
3. Dissection of margin, showing the rhopalium in side view.
4. Segment of subumbrella of a young specimen, 20 mm. in diameter.

Phacellophora ambigua.

Fig. 5. Dissection of margin, showing rhopalium in side view.

Galeolaria australis.

Fig. 6. Apex of lower and base of upper bell, with base of stem, to show the method of association. ×10.

Vogtia pentacantha.

Fig. 7. Mature nectophore, 16 mm. broad.
8. Young nectophore, 4 mm. broad.
9. Nectophore, 8 mm. broad at a stage intermediate between figs. 7 and 8.

Rosacea plicata.

Fig. 10. Side view of nectophore and contracted stem of specimen from the northwestern Pacific. ×2.5.
11. Extremity of somatocyst of specimen from the Bay of Biscay.

PLATE 6.

Clausophyes galatea.

Fig. 1. Entire animal. ×3.
2. Base of superior and apex of inferior nectophore of another specimen to show their relationship to the stem.

Diphyes truncata.

Fig. 3. Inferior nectophore; the course of the lateral subumbral canals is partly reconstructed (dotted). ×7.

4. Ventral view of base of same to show basal wings and open hydroecial groove bounded by two ridges.

5. Ventral view of base of superior nectophore. (See text fig. 2, p. 74.)

Vogtia pentacantha.

Fig. 6. Part of a colony with the nectophores torn off to show the relationship between the muscular stalk or "Knospungzone," which bears the latter to the stem. At its tip are four young nectophores. Only the basal part of the stem, with a few siphons and gonophores, is shown.

Archangelopsis typica.

Fig. 7. Side view. ×4. From a photograph.

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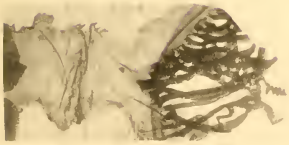

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ANTHOMEDUSAE

FOR EXPLANATION OF PLATE SEE PAGE 117

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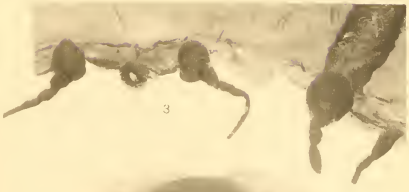

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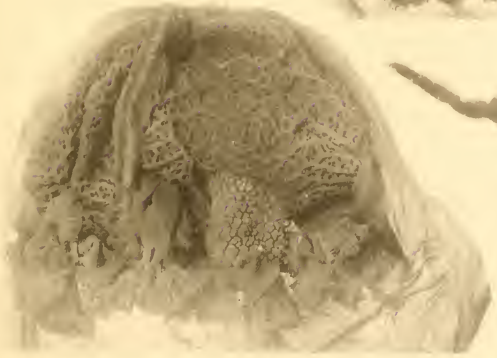

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ANTHOMEDUSAE

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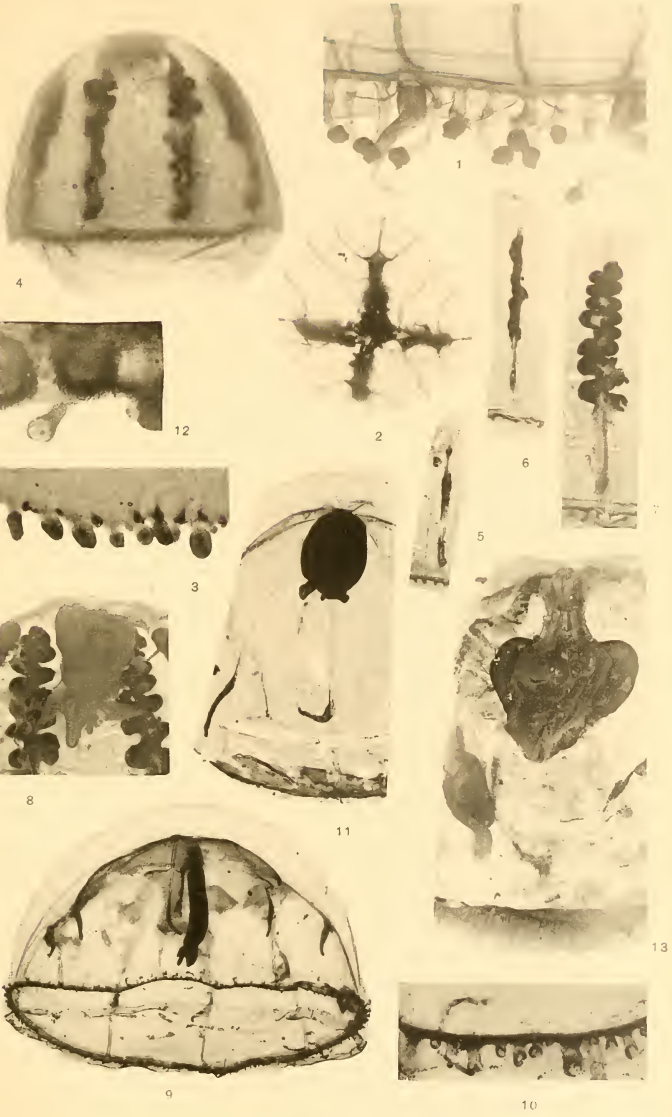

ANTHOMEDUSAE AND TRACHOMEDUSAE

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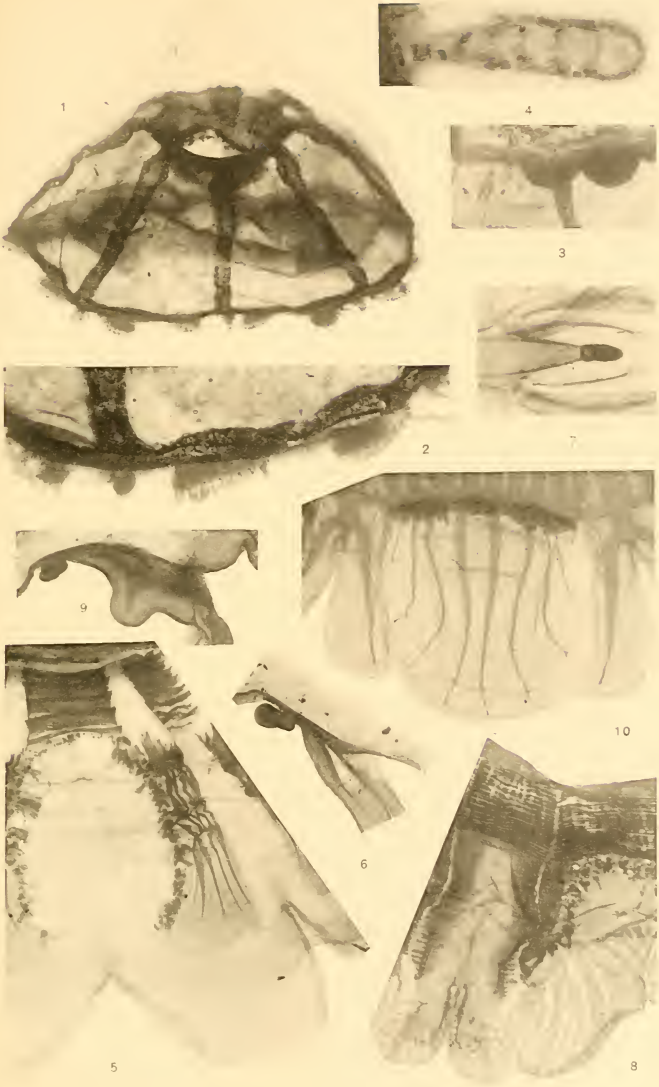

TRACHOMEDUSAE AND SCYPHOMEDUSAE

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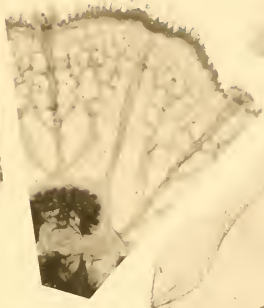
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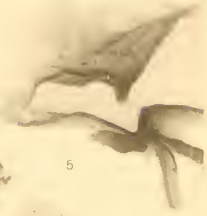
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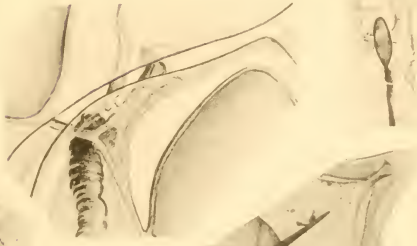
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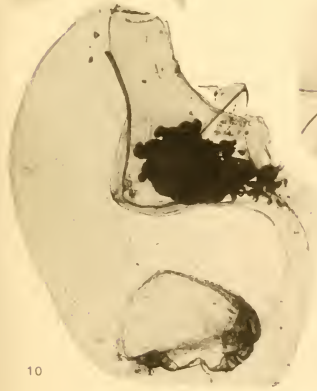
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11

Scyphomedusae and Siphonophorae

For explanation of plate see page 118

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SIPHONOPHORAE

FOR EXPLANATION OF PLATE SEE PAGES 118 AND 119

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