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INTRODUCTION.

When my report on the Scyphomedusae of Madras was finished, Professor Ramunni Menon suggested to me that an investigation of the Hydromedusae of this coast would form a good sequel to the work on the larger jelly fishes. The present paper is the outcome of my observations on the Hydromedusae extending over a period of more than one year. The work was carried out in the University Zoological Laboratory under the direction of Professor Gopala Ayyar, the present Honorary Director, and I wish to express my sense of indebtedness to him and to Professor Ramunni Menon for much valuable help and sympathetic consideration. My grateful thanks are also due to Dr. F. H. Gravely for kin[redacted]undertaking to publish this paper in the Bulletin of the Madras Government M[redacted].

[redacted] medusae described here were obtained from the plankton brought to the la[redacted]ry where a systematic investigation of the Madras plankton is also being carried out. The methods of townetting adopted and other particulars concerning the mode of collection have been dealt with in a paper on the Plankton of the Madras Coast from this laboratory[1]. It should, however, be mentioned that only surface townettings within three miles of the coast were taken and the nets in use were either of fine mull or bolting silk. The fisherman employed for the purpose went out every alternate day early in the morning and the townet water was ready in the laboratory between 7 and 9 a.m. The medusae were picked out from the fresh plankton and it was possible, in most cases, to examine and sketch them in the living condition. The material, after preliminary examination, was preserved by the sea-water-formalin method which gave excellent results.

The collection contains 35 species of Hydromedusae belonging to 28 genera, of which one genus and six species are new to science. A few more are likely to prove new but in the absence of a sufficient number of specimens it has been considered advisable to leave them unnamed for the present. The number of species in the collection, considering that only ordinary surface townets were used, is remarkable. But the fact that the large majority of them belong to the Leptolinae (Anthomedusae and Leptomedusae) which are usually found in littoral waters, where they are liberated from their parent hydroids, is only what is to be expected. The few species belonging to the Trachylinae (Trachymedusae and Narcomedusae) were obtained at irregular intervals, the only exceptions having a more general occurrence being species of the genera, *Gonionemus* and *Olindias*, which are regarded as shallow water forms. *Gonionemus suvaensis*, Agassiz and Mayer, is common on the coast from January to June and appears to reach sexual maturity towards the end of the latter month. In these respects this medusa behaves exactly as some of the Leptolinae. *Olindias singularis* Browne, was collected only once at the end of June but

[1] " Plankton of the Madras Coast " by K. S. Menon, to appear shortly in the *Records of the Indian Museum.*

then they could be had in large numbers. Of the other species of Trachylinae, *Liriope tetraphylla* (Chamisso and Eysenhardt) and *Solmundella bitentaculata* (Quoy and Gaimard) are the commonest. *Cunoctantha octonaria* (McCrady) is represented only by two specimens. From the nature of their appearance in the plankton these oceanic medusae can only be regarded as occasional visitors to the coast brought by currents or strong wind.

Confining ourselves to the Anthomedusae and Leptomedusae certain preliminary observations can be made on the periods of occurrence of these forms. As a result of the study of the plankton, it has been noticed that the biological year begins on this coast in October, after a period of general dearth of organisms in the sea, which roughly corresponds to the hottest part of the year. A glance at the table in which are recorded the several species of medusae that were collected during the different months of the year shows that the Hydromedusae, barring the occurrence of stray specimens in a few cases, begin to appear in the plankton early in October and steadily increase in numbers till January, during which month the largest numbers of species are recorded. Febru[illegible]nd March show no appreciable change. Thereafter, there is a steady decline and t[illegible]es on during the hot months of June, July, and August. It is not to be understood [illegible]he above that none of the species shows a period of maximum during the months o[illegible]al scarcity. *Eirene malayensis* Stiasny, for instance, occurs in very large numbers during June. The biology of the different species of Hydromedusae must certainly depend on various factors, and it is not possible to draw any definite conclusions on the subject from the data available, although an attempt is being made to elucidate the life-histories of a few of the commoner forms of this coast. The only general conclusion that can be drawn from the present study is that the Hydromedusae seem to preponderate in the plankton, both in bulk and species, during the colder months of the year, which succeed the November monsoon. Speaking about the "Succession of Organisms in the Plankton", Sewell (1913) remarks that in Indian waters, "There would appear to be a general tendency for marine organisms to have their breeding season during the cold weather rather than during the hot months; it is possible that this may be to a certain extent the result of the south-west monsoon and the consequent disturbance of the waters in this region."

It may be pointed out in passing that in plankton collections made by Mr. Hornell from the Gulf of Kutch during December, 1905, and January, 1906, the Hydromedusae were almost absent. Hornell's suggestion (Browne 1916 *b*) that this might have been due to the fact that the collection was coincident with the period when the temperature of the surface water off the Kathiawar coast was at its lowest is not in accordance with what has been noticed in Madras. Though I have been unable to trace any definite records, there seems to be no reason to think that there is any great difference in temperature between the two coasts and one would have expected an equally good collection, unless it be that the Madras plankton is all brought to the shore entirely by the force of currents prevailing at this season. But most of the medusae concerned are littoral and there is every reason to think that they were generated on the coast. It may be, as Browne's alternative suggestion shows, that the scarcity of jelly fishes in the Kathiawar collection

was due to the collecting having been done at stations too close inshore, and this fact also accounts for the "unreasonable amount of very fine mud in the jars." Hornell thinks from his experience in the Indian waters, "That March and April together with September and October are the months when plankton is likely to be specially abundant both in species and in bulk in the Gulf of Kutch." Work done here on the plankton shows that at least for this coast zooplankton is most abundant from November to March inclusive and that September and October can in no sense be regarded as maximal months.

Our knowledge of the Hydromedusae inhabiting the littoral waters of the Indian coast is practically confined to the collections made by Professor Herdman from Ceylon. The two expeditions to the Maldives (Stanley Gardiner and Alexander Agassiz) have brought to light several interesting medusae. But the medusa fauna of the latter locality which is a group of coral-formed oceanic islands is not strictly comparable to a collection such as ours made very near the coast, in shallow waters. Similar reasons prevent us from carrying comparisons too far between the littoral medusae of Madras and medusae collected by other expeditions to the Indian Ocean. Judging from the number of genera and species so far recorded, the Madras coast seems to be richer in Hydromedusae than Ceylon. As is only to be expected, a large number of forms is common to both localities. The Madras collection is also essentially similar to other littoral collections of Hydromedusae made from the Indo-Pacific.

Bigelow (1919) has given an interesting account of the distribution of the Hydromedusae of the Indo-Pacific. He concludes that there is no separation between Malayasia and the Ceylon-Maldives-Chagos region so far as their medusae are concerned, and that the Malayan region cannot be separated geographically from the Philippines. The present collection adds to our knowledge of the medusa fauna of the Indo-Pacific. In this connection mention may be made that species like *Halitiara formosa*, Fewkes, and *Merga violacea* (Agassiz and Mayer), are recorded for the first time from the Indian Ocean. The presence of a few of the typical Atlantic species like *Amphinema dinema* (Péron and Lesueur) and *Staurodiscus tetrastaurus*, Haeckel, on this coast is interesting in that it throws fresh light on the distribution of these medusae.

The following is a list of the species described in this paper:—

ANTHOMEDUSAE.

Hybocodon sp.
Sarsia sp. 1.
Sarsia sp. 2.
Halitiara formosa, Fewkes.
Merga violacea (Agassiz and Mayer).
Amphinema dinema (Péron and Lesueur).
Leuckartiara octona (Flemming).
Cytaeis tetrastyla, Eschsholtz.
Bougainvillia fulva, Agassiz and Mayer.
Köllikeria constricta, n. sp.
Proboscidactyla ornata (Mc Crady).
Proboscidactyla conica, n. sp.

LEPTOMEDUSAE.

Staurodiscus tetrastaurus, Haeckel.
Eucope sp.
Obelia sp.
Phialucium multitentaculata, n. sp.

Eucheilota sp. 1.
Eucheilota sp. 2.
Eutima mira, Mc Crady.
Phortis sp.
Irenopsis hexanemalis, Göette.
Eirene malayensis, Stiasny.
Eirene madrasensis, n. sp.
Octocannoides ocellata, n.g., n.sp.
Octocanna solida, n. sp.
Octocanna polynema, Haeckel.
Aequorea macrodactyla (Brandt).
Aequorea pensile (Modeer).
Aequorea parva, Browne.
Zygocanna buitendijki, Stiasny.

TRACHYMEDUSAE.

Gonionemus suvaensis, Agassiz and Mayer.
Olindias singularis, Browne.
Liriope tetraphylla (Chamisso and Eysenhardt).

NARCOMEDUSAE.

Solmundella bitentaculata (Quoy et Gaimard).
Cunoctantha octonaria (Mc Crady).

The classification followed is mainly that adopted by Mayer in his "Medusa[redacted] the World." The deviations that have been made from Mayer's system are in acc[redacted]nce with the researches of Hartlaub, Maas, or Bigelow. In preparing this paper it [redacted]een my aim not only to work out the Hydromedusae of Madras but to supply the ne[redacted]he college student in his attempt to study the Madras plankton. This has necessitated the repetition of the descriptions of already known forms and also the introduction of short paragraphs explaining the classification. The descriptions of the families and genera have been adapted from published monographs with the same object in view.

HYDROMEDUSAE.

Medusae with a velum, with ectodermal gonads, and without gastric filaments. Development either direct or through alternation of generations from hydroids.

Order Anthomedusae.

The bell in this order is usually dome-shaped. The gonads are contained within the ectoderm of the manubrium. The margin of the bell is without otocysts or sensory clubs. The medusae are known to develop only through alternation of generations. Where known, the hydroids are of the Tubularian order. Asexual development of medusae is, however, found in some of the families. Medusae of this order are chiefly inhabitants of the coast and are rare in the open ocean far from the land.

Family CODONIDAE.

Codonidae are Anthomedusae in which the gonad is ring-like and encircles the manubrium. Prominent lips and oral tentacles are absent. Radial canals are simple and unbranched. Ocelli are often found on the outer sides of the tentacle bulbs. Tentacles are simple, being neither branched nor feathered.

Mayer divides the family into two subfamilies, Sarsianae with tentacles arising singly from the bell-margin, and Margelopsinae with marginal tentacles grouped into clusters.

The family name is used here in the sense Mayer (1910) has employed it.

Genus Hybocodon, L. Agassiz, 1862.

Codonidae with asymmetrical bell. One of the four radial canals is longer than the rest. There are one or more long tentacles at the foot of the long radial canal and three small or rudimentary tentacles, one at the foot of each of the three other radial canals. The hydroid is *Hybocodon.*

Hybocodon sp.

Pl. I, fig. 1.

The medusae budded off from specifically distinct hydroids are often found to be indistinguishable in this genus. The present collection contains only a single, immature specimen and therefore its specific identity cannot be settled, until more forms are examined.

The bell is pyriform and 2 mm. in height. Rows of nematocyst cells are present on the exumbrella. One of the tentacles is well developed, the others being reduced to mere bulbs. The manubrium has a broad base and hangs down to almost the level of the mouth opening. There is a well developed velum at the margin of the bell. Beautiful violet spots are present on the tentacle bulbs and at the tip of the manubrium. The single, well developed tentacle is also splashed with the same tint.

Genus Sarsia, Lesson, 1843.

Codonidae with four equally developed, perradial tentacles. Ectodermal ocelli are present upon the outer sides of the tentacle bulbs. The manubrium is tubular and surrounded by a ring-like gonad.

Hartlaub (1907) divides the genus into two groups, the "Eximia-gruppe" and the "Tubulosa-gruppe." The former includes medusae with a short manubrium which is entirely covered with the gonad and the latter with a long manubrium portions of which are free of the gonad.

Sarsia sp. 1.

Pl. I, fig. 2.

There is only a single representative of the species in the collection.

Bell 2 mm. high and has an oval outline. The jelly is somewhat thick at the top but becomes thinner towards the margin. The four tentacles are long and have characteristic swellings very near their tips. The basal bulbs of the tentacles carry reddish ocelli, there being one such ocellus on the outer side of each bulb. Bright pigment spots are

also found at the tips of the tentacles. The manubrium hangs down almost to the level of the bell opening and is spindle-shaped. A beautiful pigment spot is present at its base. The gonad surrounds the entire manubrium. The bell opening is circular and there is a narrow velum at the margin of the bell.

The medusa, though represented only by a single specimen, is distinguished from other described species of the same genus by the bulbous enlargement of the tentacle very near the tip. The presence of a pigment spot at the place where the four radial canals originate is another feature of this medusa.

Sarsia sp. 2.

Pl. I, fig. 8.

This medusa is also represented by a single specimen. The bell is more or less oval in appearance, 4 mm. high and 2 mm. broad. The top of the bell is drawn out into an apical projection and inside this there is an axial canal extending upwards from the stomach. In the preserved state the tentacles look very much contracted but even in the living condition they do not have any bulbous enlargements near their extremity as in the species described above. Ocelli were not noticed on the tentacle bulbs. The manubrium is narrow at the base but becomes broader towards its free end and is broadest a little above the mouth opening. The velum is narrow. Gonads are developed all round the manubrium. Four narrow radial canals are present.

Family TIARIDAE.

Tiaridae are Anthomedusae with four wide radial canals often with jagged edges or short side branches. The manubrium is four-sided. There are no oral tentacles at the mouth opening. Gonads may be in the form of simple sacs or intricately folded masses but never ring-like as in Codonidae. The tentacles are hollow and are not grouped into clusters. Ocelli are present on the abaxial sides of the tentacle bulbs.

Mayer (1910) treats the families of Haeckel, Tiaridae and Margelidae, as subfamilies of Oceanidae, sens. Vanhöffen, 1891. A third subfamily, Dendrostaurinae, is created under the same family to include the Bythotiaridae and the Williadae. Hartlaub (1913) has given an excellent revision of the family. He recognizes two main groups under the family, the first of which, "*Neoturris*", corresponds to the Tiaridae of Haeckel. Hartlaub's division of the family is based mainly on the structure of the gonads. The various genera fall into well defined groups. (See Hartlaub 1913, pp. 241–248.)

Genus Halitiara, Fewkes, 1882.

Four perradial tentacles with several short, solid, cirrus-like tentacles between them. Mouth only a simple, cruciform opening. Gonads four on the interradial sides of the stomach. The outer surfaces of the gonads smooth.

Mayer (1910) has included Fewkes' medusa in the genus *Protiara.* But, as Hartlaub has pointed out, the presence of solid cirri on the margin is a character of sufficient generic importance and therefore the medusa deserves separate generic rank.

Halitiara formosa, Fewkes.

Pl. I, fig. 4.

A single specimen of this medusa was collected along with numerous other Hydromedusae on January 21, 1930. It was not possible to study the medusa in the fresh condition and unfortunately it has lost its natural shape due to contraction. There cannot be any doubt, however, as to its generic identity.

The bell is 1 mm. high and has bulging sides and a solid apical projection. It is likely that the bell is slightly distorted in its present condition and it is very probable that fully grown medusae will have the pear-shaped appearance of *Halitiara formosa*, Fewkes. The four slender, tapering tentacles have large basal bulbs. The tentacles are many times as long as the height of the bell. Their distal portions are coiled. Between two large tentacles there are 3–5 short tentacles which are of the nature of marginal cirri. The shape of the manubrium has been slightly changed. Gonads can, however, be recognized as four interradial bulgings on the manubrium. They are not mature. The mouth opening appears to be simple.

Genus Merga, Hartlaub, 1913.

This genus has been created by Hartlaub to include *Pandea violacea* of Mayer (1910) in which the gonads are smooth. Bigelow (1918) refers *Pandea sp.* of Lo Bianco (1903) to the same genus, although Hartlaub has placed it in a separate genus. The present collection contains several specimens which cannot be separated from those described by Mayer, and Bigelow (1909). I have therefore described them as *Merga violacea* (Agassiz and Mayer).

As characters of the genus, *Merga*, Hartlaub mentions the thick jelly and rounded top of the bell which has no apical projection, the simple lips, the eight smooth, adradial, gonads, the presence of mesenteries connecting the radial canals with the stomach, the eight or more long tentacles with rudimentary ones between them, and the presence of ocelli.

Merga violacea (Agassiz and Mayer).

Pl. I, fig. 10.

In clean sea water the animal swims with the bell and tentacles fully extended. The bell then is about 9 mm. long and 7 mm. broad. Compared to the height of the bell, the subumbrella cavity is not deep being only 5 mm. The sides of the bell are parallel and the top rounded. There are 8 well developed tentacles, having long, hollow, basal bulbs tapering into lash-like filaments. The latter are twice as long as the bell height. Ocelli

are present on the outer sides of the tentacle bulbs. Between each pair of tentacles there are two rudimentary bulbs. Some of these seem to be merely growing tentacles. The manubrium hangs down to half the depth of the bell-cavity. There are four lips with simple margin. There are four straight radial canals ending in the ring canal. The gonads have a smooth surface and contain large ova. Small brownish pigment spots are present all over the gonads.

Tentacle bulbs, manubrium, radial canals and gonads have a light greenish tint. Ocelli are purple in colour.

The medusa is extremely sensitive to shocks. At the slightest disturbance the tentacles are drawn into the bell-cavity and the animal becomes motionless. Large numbers of this medusa were collected during the last week of January and the first week of March. But they were present in the plankton in varying numbers from October to May.

Genus Amphinema, Haeckel, 1879.

Tiaridae with two perradial tentacles placed diametrically opposite to each other. Rudimentary tentacles are present on the margin. The stomach is without a peduncle or mesenteries. Gonads are developed on the adradial sides of the stomach and in the species, *Amphinema dinema*, they are complexly folded.

Mayer (1910) has united this genus with *Stomotoca*.

Amphinema dinema (Péron et Lesueur).

Pl. I, fig. 7.

The shape of the bell is highly variable. One of the specimens, 3 mm. high and 4 mm. broad, has parallel sides and a solid, apical projection. The latter is subject to great individual variation in its size and shape. The two perradial tentacles have elongated basal bulbs. In life the tentacles are several times as long as the bell height. There are about 14 rudimentary bulbs on the margin of the bell. The subumbrella cavity is spacious and from its centre hangs down the four-sided manubrium. There are four lips whose margins are not markedly folded. When the animal pulsates, its manubrium comes down to the level of the narrow velum. There are four straight radial canals and a ring canal. Gonads are developed as adradial folds on the sides of the stomach and contain in most specimens mature ova.

The bell is transparent. Gonads and manubrium are light yellow. Tentacle bulbs are dark brown and the tentacles cream coloured. The manubrium is greenish but on the four sides it is shaded with a dark brown tint. Gonads are brownish yellow. In the plankton these small medusae can be easily recognized by their brilliant colouration. Sometimes they are caught with their bells turned inside out and struggling to attain their normal shape. They are voracious feeders. The medusa is fairly common from October to March. They appeared in large numbers during the first week of March.

Genus Leuckartiara, Hartlaub, 1913.

This genus differs from *Amphinema* in having eight or more tentacles and ectodermal ocelli. The manubrium is large but does not extend beyond the bell-opening. No peduncle. Radial canals are large and sometimes have short blindly ending side branches. Mesenteries in relation to the stomach are developed. Gonads are horse-shoe shaped.

For a discussion of the generic characters see Hatlaub (1913).

Leuckartiara octona (Flemming).

Pl. I, fig. 5.

This medusa has never been collected in large numbers on this coast. The few individuals in the collection were obtained in the middle of January. None of them is sexually mature. The gonads are in different stages of development. The identification of the medusa as *Leuckartiara octona* is therefore provisional.

The specimens are from 3 to 4 mm. high, and 2 to 3 mm. broad. The umbrella is bell-shaped and has a solid, apical projection, the shape of which is highly variable. There are eight well developed tentacles with tapering basal bulbs and hair-like filaments which are several times as long as the height of the bell. The tentacle bulbs have dark-red ocelli on their outer sides. In preserved specimens these ocelli appear to be located on abaxial projections of the laterally compressed tentacle bulbs. Alternating with the eight tentacles there are eight rudimentary bulbs, also with ocelli. These bulbs appear to be permanently rudimentary structures for they do not show any indication of growing up to normal tentacles. The manubrium never reaches to the level of the velum which is very narrow. The mouth-opening has four indistinct lips with folded margin. The radial canals are straight and do not have jagged margins. Gonads are typically horse-shoe shaped structures with radiating fold-like outgrowths on their sides and top.

Bell transparent, manubrium and gonads yellowish green. Basal bulbs of the tentacles slightly greenish.

Family MARGELIDAE.

Anthomedusae with oral tentacles or nematocyst knobs at the mouth opening which may be simple or provided with lips. Marginal tentacles solid, often arranged in clusters. Four simple radial canals. Gonads mostly adradial or perradial.

Mayer (1910) divides the family, "Margelinae", into three tribes (p. 131) according to the nature of the tentacles, both marginal and oral. Hartlaub (1911) takes into consideration the structure of the mouth-opening and the manner in which the oral appendages are inserted. He distinguishes two main groups in the family based mainly on the above characteristics. For further details see Hartlaub (1911, pp. 137—139).

Genus Cytaeis, Eschscholtz, 1829.

Unbranched oral tentacles inserted just above the mouth-opening. Four, perradial, marginal tentacles.

Cytaeis tetrastyla, Eschscholtz.

Pl. I, fig. 3.

This medusa is now known to occur in all the three great oceans. Though it has been described under different names, several recent authors believe that there is only a single species which has an extensive distribution. The present collection contains a moderately large number of specimens in different stages of development. The largest example is 3 mm. high. On the top of the bell there is a small depression. The shape of the bell conforms to that of the tropical pacific examples, photographs of which are given by Bigelow (1909, plate 6, fig. 3). When the animal pulsates, the manubrium with the oral tentacles is thrown out of the bell-cavity. The four stiff, marginal tentacles are normally bent upwards towards the top of the bell. The basal bulbs of the tentacles contain dark brown pigment in them. The manubrium has a short peduncle. The number of oral tentacles surrounding the circular mouth opening never exceeds 20 in the specimens examined. Gonads are developed on the interradial sides of the stomach. They stand out as slightly greenish outgrowths on the manubrium which by itself is brownish yellow.

The medusa is common in the middle of January. Swarms were collected during March. Thereafter they became rare in the plankton.

Genus Bougainvillia, Lesson, 1836.

Unlike *Cytaeis* the oral tentacles are branched in this genus. There are four radially placed culsters of marginal tentacles. Four radial canals. Gonads on the interradial or adradial sides of the stomach.

Bigelow (1918) is of opinion that the species recognized by Mayer (1910) and by Hartlaub (1911) may be conveniently divided into two groups, those with many (8 or 9) marginal tentacles per bundle and in which the oral tentacles branch dichotomously five or more times, and those in which either marginal tentacles or dichotomous branchings of the oral tentacles or both, are few. The first group includes among other species *Bougainvillia fulva*, Agassiz and Mayer, *B. britannica*, Forbes, and *B. niobe*, Mayer, which are closely allied to one another. Bigelow observes that his studies have convinced him of such a close similiarity of *B. niobe* and *B. fulva* that he would have united the two but for the occurrence of medusa buds on the walls of the manubrium in *B. niobe*, a feature separating it from *B. fulva* and all other species of *Bouginvillia*.

Bougainvillia fulva, Agassiz and Mayer.

This medusa is widely distributed over the Pacific and Indian oceans. The Madras specimens resemble those described by Maas from the "Siboga" and "Amboine" collections (1905, 1906).

The bell of the largest example is only 4 mm. high and 3 mm. broad. The top is flatly rounded. Each marginal cluster has nine tentacles in it. The tentacles are short being less than half as long as the bell-height. Ocelli are present at the bases of the tentacles. Four radial canals. Manubrium is broad at the base and is without a peduncle. The whole structure reaches to more than three-fourths the depth of the bell-cavity. The oral tentacles branch dichotomously several times and their ultimate branches have knob-like structures bristled with nematocyst clusters. Gonads contain large eggs.

Like many other medusae, *Bougainvillia fulva* is very common in the plankton during January. It occurs in moderate abundance in October and there is hardly any month that does not show records of this medusa.

Genus Köllikeria, L. Agassiz, 1862.

Oral tentacles are branched as in *Bougainvillia*. Marginal tentacles in eight bundles. The bulbs carrying these tentacles are simple. Centripetal canals are absent.

Mayer (1910) unites all *Bougainvilleidae* with eight groups of marginal tentacles and uses the generic name, *Rathkea*, in a broad sense. But Maas and Hartlaub separate the different genera on the structure of the labial appendages and Bigelow follows suit. Three genera can thus be recognized, *Rathkea* with simple nematocyst knobs, *Lizzia* with unbranched labial tentacles, and *Köllikeria* with branched labial tentacles. According to this classification the common Mediterranean species becomes *Köllikeria fasciculata*. The Malayan species, *R. octonemalis* Maas, and *Rathkea elegans* Mayer, likewise come under the same genus (see also Bigelow, 1913).

Köllikeria constricta, n. sp.

Pl. II, fig. 11.

There is only a single specimen in the collection.

Bell pyriform and 4 mm. high. Where it is widest the diameter is the same as the height. There is a constriction on the bell at about one-third the distance from the top. This separates the solid, gelatinous apex of the bell from the hollow lower portion. The marginal tentacles are grouped into four radial and four interradial clusters. The bulbs carrying the tentacles are brown. Reddish brown pigment spots are present on the bases of the tentacles. The number of tentacles in a single cluster is the same in both the radial and interradial groups. In the only specimen examined, the number is eight. The tentacles are very contractile. When expanded, they are longer than the diameter of the bell.

The subumbrella cavity is spacious. The manubrium hangs down from the level of the apical constriction to about half the depth of the bell-cavity. The peduncle is short. The four oral tentacles branch dichotomously several times and their ultimate branches are very short and carry nematocyst knobs. The radial canals are narrow. The gonads are V-shaped and placed perradially with the arms of the V touching one another at the top. The gonads are distinctly folded. The location of the gonads on the perradial sides of the stomach is rare in the Anthomedusae. *K. fasciculata* shows a similar condition.

The medusa is undoubtedly related to *K. fasciculata* but differs from it in the shape of its bell which has a characteristic constriction at the top and in having fewer (?) tentacles in the marginal clusters.

Family WILLIADAE.

The primary radial canals give rise to one or more side branches during the growth of the medusa. The stomach has 4–6 lobes upon the interradial sides of which the gonads are situated. The simple, hollow tentacles are situated at the ends of the main radial canals and their branches. There are clusters of nematocysts upon the exumbrella above the margin between the tentacles, and there is no ring canal.

Two genera can be recognized under this family, *Proboscidactyla* with four primary radial canals leaving the stomach, and *Willia* with six or more primary radial canals leaving the stomach.

Genus Proboscidactyla, Brandt, 1838.

With four primary radial canals.

The collection contains two species of these very interesting medusae. Both of them show only the sexual stage of development.

Proboscidactyla ornata (McCrady).

Pl. II, fig. 18.

Bell fuller than a hemisphere, 3 mm. high and 2½ mm. broad. When the animal swims, it has parallel sides and a conical top. Gelatinous substance is thick only at the top and the bell-cavity is considerably deep. The number of tentacles vary from 16 to 19, just as they do in the specimens described by Maas (1905) and Bigelow (1909). The basal bulbs of the tentacles are pigmented. The tentacles are longer than the diameter of the bell. In preserved specimens, however, they appear as short, stumpy structures. Rings of nematocysts are present on the entire lengths of the tentacles. Alternating with the tentacles there are short centripetal canals with nematocyst clusters in them. These travel from one end of the canal to the other in the living medusae. This phenomenon has been described by Browne (1904, p. 725). The mode of branching of the 4 radial canals conforms essentially to that shown by Bigelow (1909, plate 41, figs. 1

and 7). The main canals bifurcate at about one-fourth the distance from their origin to the bell margin. There is a broad velum at the margin. The manubrium is flask-shaped and hangs down to very near the bell-opening. There are four lips surrounding the mouth and these have a crenate margin. The gonads are confined to the sides of the stomach.

Jelly transparent, lips and manubrium light yellow with splashes of green and brown. Tentacle bulbs brownish.

This medusa was collected on several occasions between October and April. They appeared in large numbers during January.

Proboscidactyla conica, n. sp.

Pl. II, figs. 12 and 13.

Bell has the appearance of a cone, 4 mm. high and 3½ mm. in diameter. The gelatinous substance is very thick and the subumbrella cavity extremely shallow. There are 35–45 tentacles on the bell margin. These appear as short, stumpy structures, in all preserved specimens. Some of the tentacles are only just developing and these are not associated with any of the radial canals. Nematocyst clusters and short centripetal canals are present as in other species. The velum is remarkable for its narrowness. The manubrium is short compared to the height of the bell. There are four lips with a wavy margin. The gonads are developed on the sides of the stomach and on the proximal branches of the four main radial canals. Viewed from above, the stomach appears to be four-rayed at the centre. The branching of the four main radial canals does not conform to the same plan always. Distally a large number of canals are formed and these end at the bases of the several tentacles.

The tentacle-bases are coloured brown. Gonads are light greenish-yellow. The manubrium is yellowish.

This medusa appeared only once (March 7, 1930) in the plankton during the course of my studies. It is interesting to note that *P. ornata* was entirely absent during March.

The medusa is described as a new species due to the peculiar shape of its bell and the shallow nature of its bell-cavity, and due to the presence of a large number of radial canals and tentacles. The association of the gonads with the proximal part of the radial canals is another interesting feature of this species.

Order Leptomedusae.

Hydromedusae with gonads upon the radial canals. When present, the otoliths are of ectodermal origin. The medusae arise through alternation of generations from Campanularian hydroids.

Family THAUMANTIADAE.

Leptomedusae without lithocysts.

Genus **Staurodiscus**, Haeckel, 1879.

Each of the four radial canals gives rise to two blindly ending side branches. The gonads are developed upon the canals and their branches. Marginal sense clubs may or may not be present.

Staurodiscus tetrastaurus, Haeckel.

Pl. II, figs. 14 and 19.

Haeckel established the genus for *Staurodiscus tetrastaurus* collected from the Canary Islands. Mayer got large numbers of them from Tortugas. Two specimens of the medusa were collected from the plankton of this coast on January 22, 1930. Both are of the same size and have mature gonads on the radial canals and their side branches. It is interesting, however, that in one of them there are only 4 tentacles, while the other has eight equally well developed ones. The four tentacles of the former are of the same size and there are no traces of other tentacles developing in the interradii. The eight tentacles of the latter are also of the same size. It is not possible to say from a study of these two specimens alone that they represent two races of the medusa, one with four and the other with eight tentacles. Also, it cannot be assumed that the four-tentacled example is only a stage in development because both are of the same size. It must, however, be mentioned that the specimen with the lesser number of tentacles is a male.

The bell is hemispherical, 3 mm. high and 5 mm. broad. Tentancles are long and lash-like. In the living condition, they are twice as long as the diameter of the bell. Tentacle bulbs are hollow and have dark ocelli on them. There are 5 or 6 sense clubs in each quadrant of the four-tentacled specimen. The total number of sense clubs, however, is the same in the two, there being 2 or 3 of them between a pair of tentacles in the other example. The ocelli are located at the bases of the sense clubs. A marginal velum is present. The subumbrella cavity is not deep. The manubrium has four large lips. The four radial canals form the arms of a cross with the manubrium at the centre. About the middle of their course the radial canals give rise to side branches, one on each side. The specimen with eight tentacles had an extra side pouch. The gonads are developed on these side pouches and the distal portions of the radial canals.

Jelly transparent. Tentacle-bases greenish. Gonads greyish white.

Family EUCOPIDAE.

Leptomedusae with lithocysts, and with less than eight radial canals upon which the gonads are developed.

Genus **Eucope**, Gegenbaur, 1856.

Basal bulbs of the tentacles are simple and hollow and do not project inward into the gelatinous substance of the bell. Eight adradial lithocysts on the bell margin. Four sac-like gonads. No marginal cirri.

Eucope sp.

Pl. II, fig. 17.

A single specimen of this medusa without any trace of gonads is contained in the collection. Bell, dome-shaped in life, about 1 mm. in diameter. The four perradial tentacles have large, basal bulbs and long, coiled filaments. The interradial tentacles are only just developing. Situated on either side of the main tentacles there are eight lithocysts with one or two concretions in them. The manubrium is without a peduncle and hangs down to half the depth of the bell-cavity. There are four prominent lips. The radial canals do not show any trace of gonads on them. Evidently the medusa is at a very early stage of development.

Genus Obelia, Péron and Lesueur, 1809.

Endodermal cores of tentacles project inwards into the gelatinous substance of the bell. Otocysts on bases of tentacles. Hydroid, *Obelia*.

Obelia sp.

Pl. II, fig. 22.

This is a fairly common medusa in the Madras plankton. It appears at irregular intervals during the year and seems to be absent in the plankton only during July and August, when there is a general poverty of organisms in the sea.

The mature medusae belonging to distinct species of hydroids closely resemble one another. The identification of the medusae without a knowledge of the hydroids is therefore likely to result in an unnatural grouping of medusae belonging to clearly defined species of hydroids. The mature medusae of this coast are a little more than 1 mm. in diameter. The bell is flat and disc-like. There are about 54 straight, stiff tentacles at the bell margin. Their number in each of the four quadrants is not the same. The endodermal cores of the tentacles project inwards into the gelatinous substance of the bell and form the so-called roots. Each tentacle is as long as the radius of the bell and is covered entirely with nematocyst cells. The velum is very narrow. There are eight adradial lithocysts at the margin. Each lithocyst has a single concretion. The stomach is without a peduncle. The manubrium is less than half as long as the bell-radius, cylindrical, and with four lips. The gonads are developed very near the ring canal on the four radial canals. They are spherical in shape and contain large ova in them.

Genus Phialucium, Maas, 1905.

Sixteen or more tentacles. More than sixteen lithocysts. Four radial canals. No cirri. This genus differs from the closely allied *Phialidium* in having permanently rudimentary tentacle bulbs on the bell margin.

Bigelow (1919) believes that previous divisions of this genus based on the relative numbers of tentacles, rudimentary bulbs, and otocysts are purely arbitrary. He shows that the relation between the numbers of otocysts and tentacular organs, both large and rudimentary, has some real value in distinguishing the different species (see Bigelow, 1919, pp. 293–294). Considered from this standpoint the Atlantic species, *P. carolinae* Mayer, has as many otocysts as tentacles, while the Indo-Pacific species have many more tentacular structures than lithocysts. The specimens described below have about 150 lithocysts and almost the same number of tentacular structures.

Phialucium multitentaculata, n. sp.

Pl. II, figs. 15 and 16.

The bell is somewhat fuller than a hemisphere, 11 mm. high and 14 mm. in diameter, in the largest specimen examined. The gelatinous substance of the bell is 5 mm. thick at the top. The subumbrella cavity, therefore, has a considerable depth. The largest number of tentacles present on the margin is 32. As a rule this number varies from 25 to 32. The tentacles have hollow basal bulbs. Even in the living medusae the tentacles look very much contracted. They do not, however, seem to be longer than the radius of the bell. The rudimentary bulbs are found to vary from three to four between a pair of the large tentacles. None of the specimens had less than 150 lithocysts. Each one of them usually contains two concretions, but sometimes three or even four of them are found in a single lithocyst. The velum is broad. The stomach is rectangular and is without any peduncle. The four recurved lips have fimbriated margins. Gonads are developed on the four radial canals and occupy almost the entire lengths of the canals, leaving only the two ends free. In the young specimens they appear first on the distal portions of the radial canals and gradually extend on towards the centre. In a speciman, 8 mm. in diameter, the gonads are straight, spindle-shaped structures. Further growth makes them flat and ribbon-like, until in the mature individuals they become tucked up alternately to one side and the other of the radial canals.

The jelly is transparent. Tentacle bulbs brown, tentacles and lips splashed with the same tint. Gonads light brownish yellow.

When only 6 mm. high, the bell is somewhat conical and the bell-cavity very shallow. There are 16–18 tentacles with a few rudimentary bulbs between them. Lithocysts, 32. Traces of gonads are present on the radial canals very near the bell margin.

This species is characterized by having a large number of tentacles, rudimentary bulbs, and lithocysts.

Young specimens of this medusa were noticed in the plankton at the end of January. A few individuals slightly more grown up were collected during February and March. Medusae that were nearing sexual maturity appeared in shoals during the third week of April. The plankton collected on those days and again on the 5th May, contained

these medusae to the exclusion of all other forms. Probably it is about this time that these medusae attain their sexual maturity.

Genus Eucheilota, McCrady, 1857.

Four or more closed vesicular lithocysts. Four radial canals. Marginal or lateral cirri or both present on the bell margin.

Two distinct species are present in the collection, one of which is represented by a single specimen and the other by two specimens.

Eucheilota sp. 1.

First specimen: Bell 2 mm. high and 1½ mm. broad, with rounded top and straight sides. Even though there is a thick development of jelly at the top, the subumbreilar cavity is not shallow. The four perradial tentacles are larger than the interradial ones which seem to be only just developing. The tentacles have prominent basal bulbs and rather short filaments. Short, coiled cirri are present on the sides of the tentacle bulbs. In addition to these structures there are present on the bell margin eight adradial rudimentary bulbs and eight lithocysts each with a single concretion in it. The velum is narrow. The stomach is without a peduncle. There are four lips at the mouth opening. The four narrow, radial canals are without any trace of gonads on them. The jelly is transparent.

Second specimen (Pl. I, fig. 6): This seems to represent an earlier stage of development of the medusa. The bell is flatter than a hemisphere and is only 1 mm. in diameter. Four perradial tentacles are developed and these are as long as the radius of the bell. Traces of the interradial tentacles are present in the form of small bulbs on the bell margin. Cirri are developed both on the perradial and interradial bulbs. There are eight lithocysts, two in each quadrant of the bell. The radial canals do not show any trace of the gonads.

The jelly is transparent. The tentacle bulbs and manubrium have a beautiful, green colour.

Eucheilota sp. 2.

Pl. I, fig. 9.

The collection contains a single specimen.

The bell has a broad base, sloping sides, and flat top. Its diameter is only 1 mm. The four large perradial tentacles have prominent bulbs, flanked by cirri. Interradial tentacles are represented by mere bulbs without any cirri on their sides. There are in each quadrant of the margin two lithocysts, each with a single concretion. The velum is very broad and practically closes up the bell opening. The manubrium is short and without a peduncle. Four radial canals are given out from the stomach. Gonads are

developed just on the middle portions of the radial canals as globular outgrowths. Large ova are present in them.

Genus Eutima, McCrady, 1857.

Four or more tentacles on the bell margin. Eight lithocysts, two in each quadrant. Numerous rudimentary tentacles or marginal cirri. The stomach mounted upon a gelatinous peduncle. The gonads developed upon the sides of the peduncle, or upon the subumbrella, or upon both places at one and the same time.

The collection contains a single species which resembles *Eutima orientalis* Browne, described from Ceylon. But following Vanhöffen who has shown (1913) that *E. orientalis* is not different from *E. mira*, I have described the Madras medusa as *E. mira* McCrady.

Eutima mira, McCrady.

Bell in some examples is deeper than a hemisphere, 6-8 mm. in diameter. When the animal swims, the bell looks four-sided with the marginal tentacles disposed at the four corners. The tentacles are long and have elongate, hollow, basal bulbs. There are about 68 rudimentary bulbs on the margin, each of which is flanked by cirri. Two lithocysts are present in a quadrant of the bell. They have 6–10 concretions in each one of them. The peduncle hanging from the centre of the subumbrella is about two times as long as the diameter of the bell. The gonads are developed both on the peduncle and the subumbrella.

The jelly is transparent. Tentacle bulbs and lips are splashed with a greenish tint. The tentacle filaments are light rose.

Genus Phortis, McCrady, 1857.

Eucopidae with numerous lithocysts and numerous simple tentacles. There are neither lateral nor marginal cirri. The stomach is mounted upon a gelatinous peduncle.

There is only a single species in the collection.

Phortis sp.

The largest individuals are not more than 7 mm. in diameter. Bell flat and with sloping sides which in some cases have a tendency to flange outwards at the margin. There are about 48 tentacles at the bell margin and these have large, hollow, basal bulbs without any excretion papillae. The tentacles are as long as the diameter of the bell. Rudimentary tentacle bulbs are entirely absent. Lithocyst vesicles containing one or more concretions in them are present on the margin, there being always one and sometimes two between a pair of tentacles. The velum is narrow. The peduncle is not particularly broad at the base and narrows towards the tip. The mouth has four prominent lips

with folded margin. The whole structure does not extend very much beyond the bell-opening. The gonads are developed on definite portions of the radial canals and the space occupied by them is highly variable. Large ova are found projecting out of the gonads in the specimens collected during February.

The medusa is one of the commonest forms of the coast, being found in the plankton from October to March. Shoals of mature medusae appeared in February.

This species differs from *Phortis ceylonensis* (Browne) in its smaller size, in having fewer tentacles and in the nature of its gonads. It resembles *P. kambara* (Agassiz and Mayer) of the Fiji Islands in many respects but stands aloof in having ordinarily only a single lithocyst between a pair of tentacles.

Genus **Irenopsis**, Goette, 1886.

Eucopidae with six radial canals, six gonads and six lips. No cirri. Numerous lithocysts. Stomach mounted upon a peduncle.

Vanhöffen (1913) regards *Irenopsis hexanemalis*, Goette, as a variety of *Phortis pellucida*, Will, formed as a sport from the typical four-radiate forms.

Irenopsis hexanemalis, Goette.

The few specimens in the collection are fairly well preserved, although the margin has been damaged in most cases. The medusae agree so thoroughly with Browne's description of the Ceylon specimens (1905) that any detailed account of them here would only be a repetition.

Bell, in the largest specimen, is about 15 mm. in diameter. The top of the umbrella is very thick and slightly arched. There seems to be 30–40 slender, coiled tentacles on the bell margin. Between a pair of tentacles there are about three rudimentary bulbs and four lithocysts. The peduncle is prominent in all the specimens and looks like an inverted cone. It is about 7 mm. broad at the base and extends a little beyond the bell margin. The stomach is rather small but the six lips are large and have a folded margin. The gonads are confined to the distal portions of the narrow radial canals. Variation in the number of radial canals was found in two cases. One specimen had seven radial canals and seven lips, while the other had eight radial canals and seven lips.

The medusae were first collected during the first week of May. They continued to be present in the plankton during the remaining days in May, and in June.

Genus **Eirene**, Eschscholtz, 1829.

The genus is closely related to *Phortis* but differs from it in having marginal cirri.

Two distinct species are contained in the collection, one of which is not different from *Eirene malayensis*, Stiasny, of the Java Sea. The other is described as a new species.

Eirene malayensis, Stiasny.

Pl. III, fig. 23.

The umbrella is typically watchglass-shaped, 25 mm. in diameter. There are about 50 tentacles at the margin. They have large cone-shaped basal bulbs and prominent excretion papillae. Between a pair of the tentacles there are 1–3 rudimentary bulbs and one or two lithocysts each with two concretions. The rudimentary bulbs are also provided with excretion papillae. Short, coiled cirri are present on the sides of the tentacle bulbs. The gonads are developed on the four radial canals and have a wavy outline. They extend from near the bell margin to some distance down the peduncle. The peduncle is a little longer than the bell radius. The 4 lips have a folded margin.

A few specimens of this medusa were collected in October and November. They appeared in large numbers in May. The largest and sexually mature individuals were collected in June.

Eirene madrasensis, n. sp.

Pl. III, fig. 24.

The bell is more or less of the same shape as that of *E. malayensis*. The gelatinous substance is thin. The diameter of the largest specimen is 20 mm. This has about 100 tentacles at the bell margin. Rudimentary bulbs between the tentacles are absent. There are a few marginal bulbs without tentacles in some of the younger examples but these are merely developing tentacles. Cirri are present on the sides of the tentacle bulbs of both kinds. It may be noted that the rudimentary bulbs in *E. malayensis* do not carry any cirri. The nature of the cirri is the same in both the species. They are short, slender structures. Excretory papillae were not observed in any of the specimens. They seem to be absent in this species. There is only a single lithocyst between a pair of tentacles. The velum is narrow. The peduncle is comparatively shorter than that of *E. malayensis*. The stomach is short. The mouth is provided with four lips having a folded margin. Gonads are wavy in outline and flat like a narrow ribbon.

These medusae were collected during October and November in 1930 and during March in 1931.

Eirene madrasensis resembles *Phortis (Irene) ceylonensis* described by Browne from Ceylon (1905). Comparing the Madras species with the description of Browne it is noticed that the only character separating the two is the presence of cirri in *Eirene madrasensis*. The relationship between the two medusae becomes all the more interesting, when we note that *Eirene malayensis* comes very near to *Phortis (Irene) palkensis*, also described from Ceylon by Browne. As in the case of *Phortis ceylonensis* the only specific character, if that can be of sufficient specific importance, separating *Eirene malayensis* from *Phortis palkensis* is the presence of cirri in the former.

Subfamily OCTOCANNIDAE Haeckel, 1879.

Sens. emend. Maas (1905).

Eucopidae with eight radial canals.

The subfamily is represented by two genera and three species, of which one genus and two species are regarded as new.

Genus Octocannoides, n.g.

This genus is constructed to include three interesting medusae contained in the collection. They resemble the typical Octocannids in having eight radial canals and eight lips but differ from them in that their tentacle bulbs have large abaxial ocelli in addition to a number of sense clubs developed on the bell margin. The genus may be defined as follows :—

Octocannidae with eight simple, radial canals which arise separately from the periphery of the stomach ; eight tentacles (four perradial and four interradial) carrying ocelli on the abaxial sides of their basal bulbs. A varying number of sense clubs on the bell margin. Lithocysts without ocelli. Manubrium without a peduncle. Eight lips.

Octocannoides ocellata, n. sp.

Pl. III, figs. 27 and 28.

The bell is flatter than a hemisphere, 5–7 mm. in diameter. The jelly is not thick even at the top of the umbrella. There are eight slender, coiled tentacles which, when expanded, are as long as the diameter of the bell. The tentacles have large conical basal bulbs with conspicuous ocelli developed on their abaxial sides. Excretory papillae in relation to the tentacle bulbs seem to be entirely absent. In each octant of the bell margin there are 2–4 short, sense clubs tipped with dark ocelli. Interspersed between the sense clubs, there are about five lithocysts in an octant of the bell margin. Each lithocyst contains 2 or 3 concretions. The velum is not particularly broad. The stomach occupies the central half of the subumbrella. The manubrium is short and the lips appear to be simple in these preserved forms. The eight radial canals are arranged 45 degrees apart and carry on their middle portions large gonads. Each gonad consists of two halves developed on the two sides of the radial canal.

The jelly is transparent. The stomach contains a lot of food material and looks greenish yellow.

Genus Octocanna, Haeckel, 1879.

The eight simple, radial canals arise separately from the periphery of the stomach. Eight lips. Lithocysts without ocelli. Manubrium without a peduncle.

Haeckel founded this genus for two medusae, *Octocanna octonema* and *Octocanna polynema*, which were later on shown by Maas (1905) and Browne (1905) to be not

specifically different from each other. Maas is responsible for removing the genus from the Aequoridae to the Eucopidae. It is interesting to note that all species of *Aequorea* pass through an "*Octocanna*" stage in their ontogeny. Mayer (1910), therefore, holds the view that *Octocanna* may be regarded as a special form of *Aequorea* which becomes sexually mature with eight radial canals.

The present collection contains two distinct species of *Octocanna*, one of which seems to be the same as that described by Browne from Ceylon (1905). This species is described here as *O. polynema*, Haeckel, although it has been suggested by Vanhöffen (1911, 1912) and Bigelow (1919) that it is merely an octoradial variety of some Eucopid, like *Phialidium* or *Phialucium*. The other species resembles, in the shape of its bell, the peculiar forms of *Octocanna*, described as *O. polynema* Haeckel, by Bigelow from the Tropical Pacific (1909). The number of tentacles in the Madras medusae has undergone considerable reduction, there being only four perradial ones on the bell margin. The tentacle bulbs have developed exumbrellar clasps more or less resembling those found in *Aequorea macrodactyla* (Brandt). The nature of the rudimentary bulbs between the tentacles is also different from those of the other known species of *Octocanna*.

Octocanna solida, n. sp.

Pl. III, fig. 26.

The bell is hemispherical and about 10 mm. in diameter. The gelatinous substance is so thick that the subumbrella cavity is very shallow. In the younger examples the bell is higher than broad but this seems to be only a temporary stage in the growth of the medusa, because all the larger specimens have attained the typical hemispherical condition. There are only four tentacles on the bell margin. These have large basal bulbs and short, coiled filaments which are as long as the radius of the bell. The tentacle bulbs have excretory papillae on their oral sides and characteristic exumbrellar clasps. Rudimentary tentacle-like structures are present in varying numbers on the bell margin. The four interradial ones among these develop first and are the largest of the series. The others are formed in regular succession until there are about 11 of them in each octant of the bell. These structures have no excretory papillae or exumbrellar clasps similar to those found in the case of the four perradial tentacles. The tips of the bulbs are coloured dark-brown. The clubs are thus made conspicuous by their colouration and stand in contrast to the normal tentacles which are devoid of any pigmentation. The number of lithocysts and the number of concretions in each one of them could not be accurately determined from the specimens which are all preserved in formalin. But there seems to be one lithocyst between a pair of the marginal bulbs. The stomach is as broad as the radius of the bell. There are eight short lips which are capable of closing the mouth when the animal is in life. From the stomach are given off in all the examples eight radial canals which often have a wavy course on the subumbrella. The gonads occupy almost the entire lengths of the radial canals, only the two extremities being free. The gonads are much convoluted and contain large eggs.

As distinguishing characters of this species, may be mentioned the shape of the tentacle bulbs which have exumbrellar clasps, the small number of tentacles, and the nature of the bell.

These medusae were collected during February and March.

Octocanna polynema, Haeckel.

Pl. III, fig. 25.

Bigelow (1919) has separated *O. polynema* collected from Amboine (Maas, 1906) from other representatives of the species and describes it under the new name, *O. aphrodite.* The Madras specimens resemble the medusae described from Ceylon (Browne, 1905) even in minute details of their structure.

The bell has a flat top, 22 mm. broad and 10 mm. high. The margin is curled inwards. The subumbrella cavity is shallow. There are about 30 large, and several small, growing tentacles on the bell margin. Rudimentary tentacle bulbs are also present on the bell margin and their number is either three or four between a pair of the well-developed tentacles. Both normal tentacle bulbs and the rudimentary ones have large excretion papillae. Between a pair of the normal tentacles there are four lithocysts, each containing two concretions in it. The stomach is octagonal, 4 mm. in diameter. There is a short manubrium and eight recurved lips with fimbriated margin. The radial canals have gonads on the outer one-thirds of their lengths. The gonads increase in thickness towards their distal ends but do not touch the ring canal at the margin.

The jelly is transparent and thick. Tentacle bulbs are brown. In many examples the stomach is found to be asymmetrically placed on the subumbrella. The number of radial canals may be more or less than eight.

O. polynema is one of the commonest of the Hydromedusae of this coast. They can be had in good numbers from the middle of December to the end of June.

Family AEQUORIDAE.

Leptomedusae with lithocysts and with numerous simple or branched radial canals upon which the gonads are developed.

Genus Aequorea, Péron and Lesueur, 1809.

Aequoridae with more than eight simple, unbranched, radial canals which arise separately from the margin of the stomach, and with more than four lips. Subumbrella smooth, without wart-like protuberances. Tentacles, lithocysts, and excretion papillae numerous.

Aequorea macrodactyla (Brandt)

The few preserved specimens of this medusa in the collection are considerably flattened and in this condition the bell resembles a large plano-convex lens, 100 mm. in

diameter. The bell margin is very interesting in the Madras specimens, because the rudimentary marginal bulbs observed in the examples from the Maldives and other localities appear to be absent in them. There are about 100 large tentacles which are long and filamentous and several smaller ones in the course of development. The tentacle bulbs have the characteristic exumbrellar clasps. Excretory papillae are very prominent on the tentacle bulbs. The development of a large number of tentacles might have been responsible for the entire absence of rudimentary bulbs on the margin. In the largest example described by Browne (1904) there was one rudimentary bulb between every two tentacles, while the smaller medusae had 3–5 bulbs between a pair of tentacles. Browne himself expresses the opinion that some of the marginal bulbs probably develop into tentacles at a later stage in the growth of the medusa. Lithocysts were not accurately counted but they seem to be numerous. The stomach is about half as broad as the bell diameter. The mouth has about 51 lips which have a finely crenate margin. The number of radial canals is somewhere about 63. The gonads are bilamellar and occupy almost the entire lengths of the radial canals.

The medusae can be distinguished from other species of *Aequorea* by the peculiar exumbrellar clasps of the tentacle bulbs.

Aequorea pensile (Modeer).

Browne (1904, 1905) has given a good description of this medusa. It can be easily distinguished by its large size and thick transparent jelly which gives it the appearance of a biconvex lens.

The largest example collected on this coast has a diameter of 55 mm. There are about 27 tentacles at the margin of the bell. Rudimentary bulbs and lithocysts are numerous. The stomach has a diameter of 35 mm. The mouth is almost as broad as the stomach. There are about 150 radial canals given off from the stomach and the gonads are not equally well developed on these canals.

Aequorea parva, Browne.

Pl. III, figs. 29–33.

Mature specimens of this medusa were collected on two occasions during the course of my studies. They were first noticed in the plankton, early in September but these disappeared after November during which month the first lot of sexually mature individuals were obtained. Then, after a period of absence, they began to appear in large numbers towards the last week of February, but mature specimens could be had only in March. The sexually ripe individuals collected on these two occasions differed considerably in size, the March medusae being the larger of the two.

The bell is plano-convex in shape, 10–12 mm. broad and 6–8 mm. high. The gelatinous substance is very thick. There are always eight tentacles at the margin. The number of marginal bulbs in an octant of the bell margin varies from 5–7 and the

number of lithocysts is eight or nine. The lithocysts have two or three concretions in them. The diameter of the stomach is about one-third to one-half of that of the subumbrella. There are 16 lips which are capable of closing the mouth opening. The gonads occupy almost the entire lengths of the radial canals.

An interesting feature noticed in the canal system of some examples of this medusa is that a number of radial canals have lost their connexion with the stomach and have developed on their ventral surfaces openings surrounded by minute lips, which are capable of functioning as accessory months. Speaking about *Mesonema pensile*, Browne (1904, p. 723, pages 734–735) observes that the canal system has taken on the function of the stomach in that species which has the lower wall of its stomach quite rudimentary. He has also suggested that this may apply to other Aequoridae and account for the large number of radial canals and excretory pores on the circular canal. The discovery of a functional mouth provided with motile lips on the radial canals of *A. parva* fully justifies Browne's suggestion that "the function of the stomach has been removed to the canal system." In *Aequorea parva*, there are fewer radial canals than in other species of the same genus and the mouth is capable of being closed. The development of the accessory mouths on the radial canals might have been due to the fact that the canals have lost their connexion with the stomach. It is difficult to account for this condition, until more forms are examined.

Genus Zygocanna, Haeckel, 1879.

This genus is characterized by having branched radial canals. The maubrium is without a peduncle and there are eight or more lips.

Zygocanna buitendijki, Stiasny.

Pl. III, figs. 34 and 35.

This medusa, recently described by Stiasny (1928) from the Java Sea, is fairly common on this coast. Comparing the Madras specimens with the description and figures given by Stiasny, I find that the only character not common to the two is the presence of subumbrellar papillae at the ends of the radial canals in the Javanese medusae.

The largest example in the present collection is more than 100 mm. in diameter. In the living medusa the bell is hemispherical in outline and the jelly is fairly thick and transparent. When the animal is 15 mm. in diameter, it has eight long and eight short tentacles. The former are more than twice as long as the diameter of the bell. There are about 128 lithocysts each with two concretions. The number of ridges on the exumbrella is 120 but only half of these reach the summit of the bell, the others ending blindly at varying distances from the bell-margin. The stomach is about half as broad as the subumbrella. There are only 16 radial canals in the specimen under consideration and these divide into 2–4 branches very near the periphery of the stomach. The manubrium is much folded up and curtain-like and has a funnel-shaped appearance in the living medusa. Its

margin is broken up into several short lips. Gonads are developed on the branches of the radial canals.

Order Trachymedusae.

The lithocyst concretions in this order are of endodermal origin. The simple, entire bell-margin is not cleft into lappets. The gonads are developed upon the radial canals. In development an alternation of generations with a fixed hydroid stage is absent.

There is reason to believe that the Trachymedusae and Narcomedusae have attained the medusiform shape and appearance from Actinulae which are not homologous with Anthomedusae and Leptomedusae.

Two genera, *Gonionemus* and *Olindias*, belonging to the family, Petasidae, and one genus, *Liriope*, belonging to the Geryonidae are contained in the collection.

Genus Gonionemus, A. Agassiz, 1862.

The tentacles all project from the sides of the exumbrella above the margin and have adhesive discs on their aboral sides near the outer ends. There are four radial canals with gonads on them. Centripetal canals are absent.

In this genus the tentacles have been observed to make sharp bends near their free ends just beyond the sucking discs. The specimens described below were found to possess this quality in a remarkable manner but I have not been able to locate even a rudimentary adhesive pad on the tentacles. Considering what Bigelow (1904) has observed in *Gonionemus pelagicus* collected from the Maldives, I have ventured to place these medusae under *Gonionemus*. It might be possible that the rudimentary sucking discs of *G. pelagicus* have become still more reduced in the specimens under consideration. They belong to the " Suvaensis " group and cannot be separated from *G. suvaensis*. (See Bigelow, 1909, pp. 105–106.)

Gonionemus suvaensis, Agassiz and Mayer.

Pl. II, figs. 20 and 21.

The bell is hemispherical, about 9 mm. in diameter. The gelatinous substance is fairly thick at the top but thin at the sides and margin of the umbrella. There are about 40 tentacles at the bell-margin, in different stages of development. The four perradial, the four interradial and the eight adradial are the oldest of the series and are longer than the diameter of the bell. The basal bulbs of the tentacles are globular and carry brownish pigment spots which are conspicuous in the living medusae when the tentacles are directed towards the exumbrella. A very conspicuous pigment spot of the same tint is also present at the centre of the stomach. The tentacles are ringed with nematocyst bands. There are 16 otocysts on the bell-margin, four in each quadrant. In specimens less than 2 mm. in diameter, there are only two of them in a quadrant and of these one is

distinctly smaller than its mate. There is a broad velum. The manubrium extends to half the depth of the bell cavity, and lacks a peduncle. It is cruciform in cross section. The gonads are developed on the distal two-thirds of the radial canals but in the larger medusae they extend further towards the centre. The gonads have the typical ribbon-like appearance.

The bell is transparent. Gonads, radial canals and the proximal portions of the tentacles have a light greenish tint, while the lips have a touch of crimson. Near their extremities the tentacles are light brownish red.

The medusa is common on the coast from January to June. The largest number was noticed in the plankton during June.

Genus Olindias, F. Müller, 1861.

There are two sorts of tentacles, those arising from the bell-margin and those projecting from the sides of the bell above the margin. The tentacles bear adhesive pads. There are four radial canals and between them numerous centripetal canals.

Olindias singularis, Browne.

On June 21, 1930, a good number of these medusae appeared in the plankton. The largest among them is 25 mm. in diameter and more or less hemispherical. There are about 32 primary tentacles projecting from the exumbrella just above the margin of the bell and 16 secondary tentacles. The primary tentacles are longer than the bell diameter and carry an irregular series of nematocyst rings which are not complete. They have sucking discs at their tips. Secondary tentacles are more than 40 mm. long, and are thinner than the primary ones. The nematocyst rings on them are in regular series and are more or less complete ventrally. Each tentacle is tipped with a cap of nematocysts. The tentacles do not have any basal bulbs as mentioned by Browne (1904). There are 10–12 marginal bulbs in each quadrant of the bell. The primary tentacles have one or two lithocysts at their base. Each lithocyst contains a single concretion. Between the four radial canals there are a varying number of centripetal canals. In the specimens under consideration there are usually three of them in a quadrant. Gonads are developed on the outer halves of the radial canals. They are papilliform and have branching tree-like processes. The stomach is small and the manubrium does not reach down to half the depth of the bell-cavity. There are a few brown streaks on the four sides of the manubrium. The velum is broad.

The bell is perfectly transparent, gonads and manubrium are light brown.

Genus Liriope, Lesson, 1843.

The gonads are leaf-like and developed on the four radial canals. Blindly ending centripetal canals are present between the radial canals. The stomach is mounted on a gelatinous peduncle.

Liriope tetraphylla (Chamisso and Eysenhardt).

Bell strongly arched being somewhat fuller than a hemisphere. In the largest example it is 18 mm. broad and 12 mm. high. The length of the peduncle is highly variable. In specimens measuring 8–9 mm. in diameter the peduncle is 13 mm. long, while in others with a bell-diameter of 14 mm. it is only 11 mm. long. The tentacles, when expanded, are considerably longer than the manubrium. The gonads are bluntly triangular and in all the larger examples they touch one another at the top. Between the main radial canals there are sometimes as many as seven centripetal canals. The velum is broad.

The jelly is transparent. The animal has the curious habit of everting the stomach and attaching itself to the glass dish with the lips spread.

Order Narcomedusae.

As in Trachymedusae the lithocyst concretions are of endodermal origin, but the bell-margin in this Order is cleft into lappets. The gonads are developed in the ectoderm of the subumbrella under the central stomach or upon its subumbrellar pouches. The tentacles project stiffly from the sides of the bell at the upper ends of the clefts between the lappets.

Mayer divides the Order into two families, Solmaridae without peripheral stomach pouches, and Aeginidae with marginal stomach pouches in the radii of the tentacles. Two genera, *Solmundella* and *Cunoctantha*, belonging to the latter family are contained in the collection.

Genus Solmundella, Haeckel, sens. Maas.

Aeginidae with two tentacles, eight gastric pouches, and without any peripheral canal system.

Solmundella bitentaculata (Quoy et Gaimard).

This medusa, now known to occur all over the world, was collected on several occasions. Detailed descriptions of this medusa and the closely allied species *S. mediterranea* Haeckel, will be found in Mayer's "Medusae of the World," pp. 455–458. In one of the specimens collected from this coast the mouth was found at the tip of a funnel-like outgrowth from the centre of the stomach. The region of the mouth is beautifully coloured with a greenish tint. The surrounding stomach pouches are light rose. None of the specimens showed more than eight sense clubs.

Genus Cunoctantha, Haeckel, 1879.

Aeginidae with eight tentacles alternating with eight marginal lappets; with eight simple gastric pouches in the radii of the tentacles.

Cunoctantha octonaria (McCrady).

This widely distributed species is represented in the collection only by two specimens. The umbrella is 5 mm. in diameter and 3 mm. high. The eight tentacles are almost as long as the diameter of the bell. They are very stiff, only their distal portions being capable of bending. The margin is cleft into eight lappets and each of these carries five otocysts. There is a well developed velum at the margin. The stomach gives rise to eight, rectangular, peripheral pouches in the tentacular radii. The mouth is a circular opening. The gonads are immature.

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INDEX TO GENERA AND SPECIES.

Names in *italics* are synonyms.

Page numbers printed in Roman type refer to the main references (including all descriptive ones), those in *italics* to subsidiary ones.

PLATE I.

Fig. 1. *Hybocodon sp.*—Side view.
„ 2. *Sarsia sp.* 1 Do.
„ 3. *Cytaeis tetrastyla* Do.
„ 4. *Halitiara formosa.*—Side view.
„ 5. *Leuckartiara octona* Do.
„ 6. *Eucheilota sp.* 1—Oral view.
„ 7. *Amphinema dinema.*—Side view.
„ 8. *Sarsia sp.* 2 Do.
„ 9. *Eucheilota sp.* 2—Oral view.
„ 10. *Merga violacea.*—Side view.

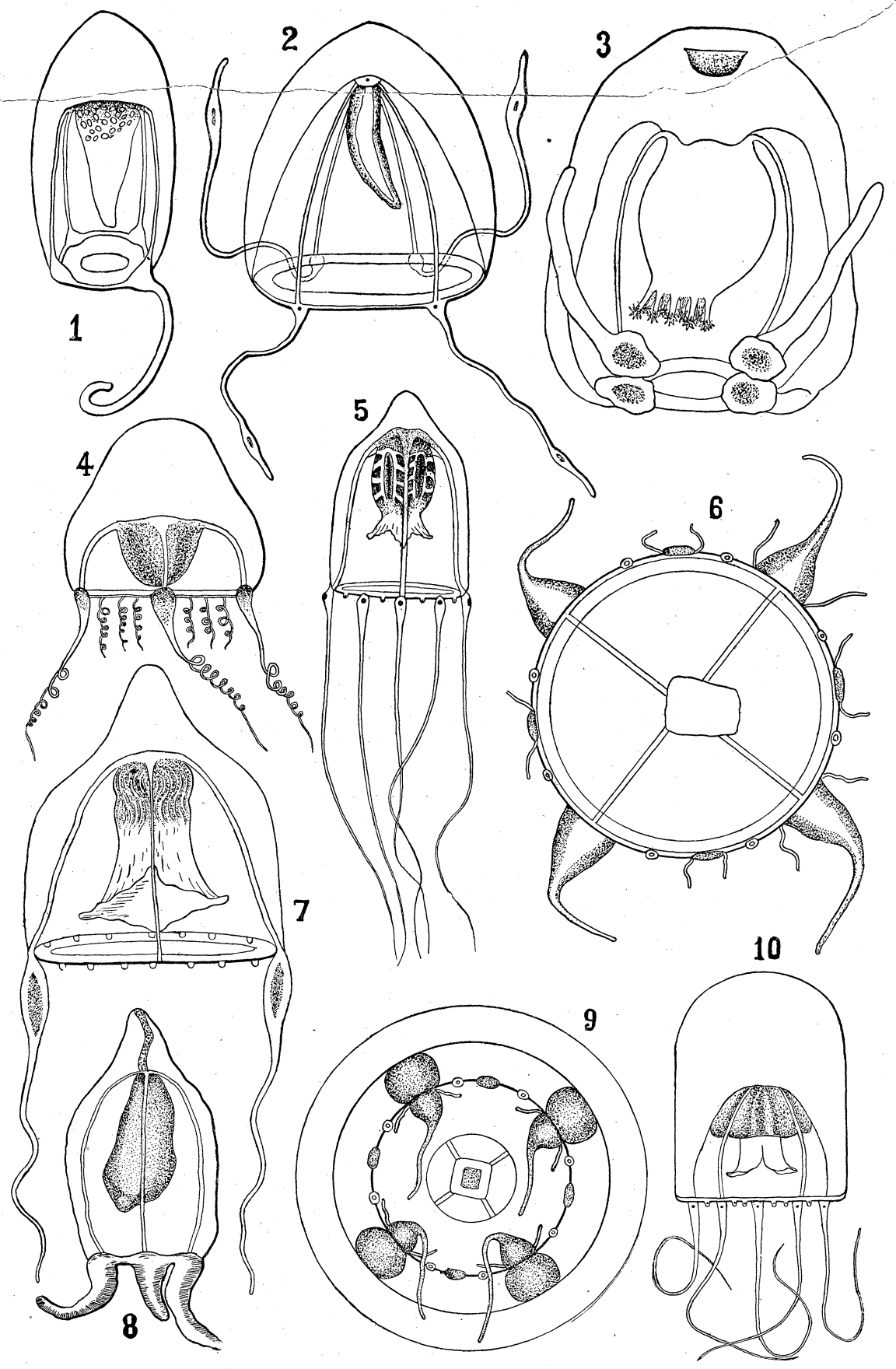
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PLATE II.

Fig. 11. *Köllikeria constricta.*—Oral view.
„ 12. *Proboscidactyla conica.*—Gonads and radial canals seen from above.
„ 13. *Do. do.* Entire specimen—Side view.
„ 14. *Staurodiscus tetrastaurus.*—Eight tentacled form. Aboral view.
„ 15. *Phialucium multitentaculata.*—Margin.
„ 16. *Do. do.* Entire specimen. Side view.
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„ 18. *Proboscidactyla ornata.*—Oral view.
„ 19. *Staurodiscus tetrastaurus.*—Four tentacled form. Oral view.
„ 20. *Gonionemus suvaensis.*—Side view.
„ 21. *Do. do.* Tentacle.
„ 22. *Obelia sp.*—Oral view.

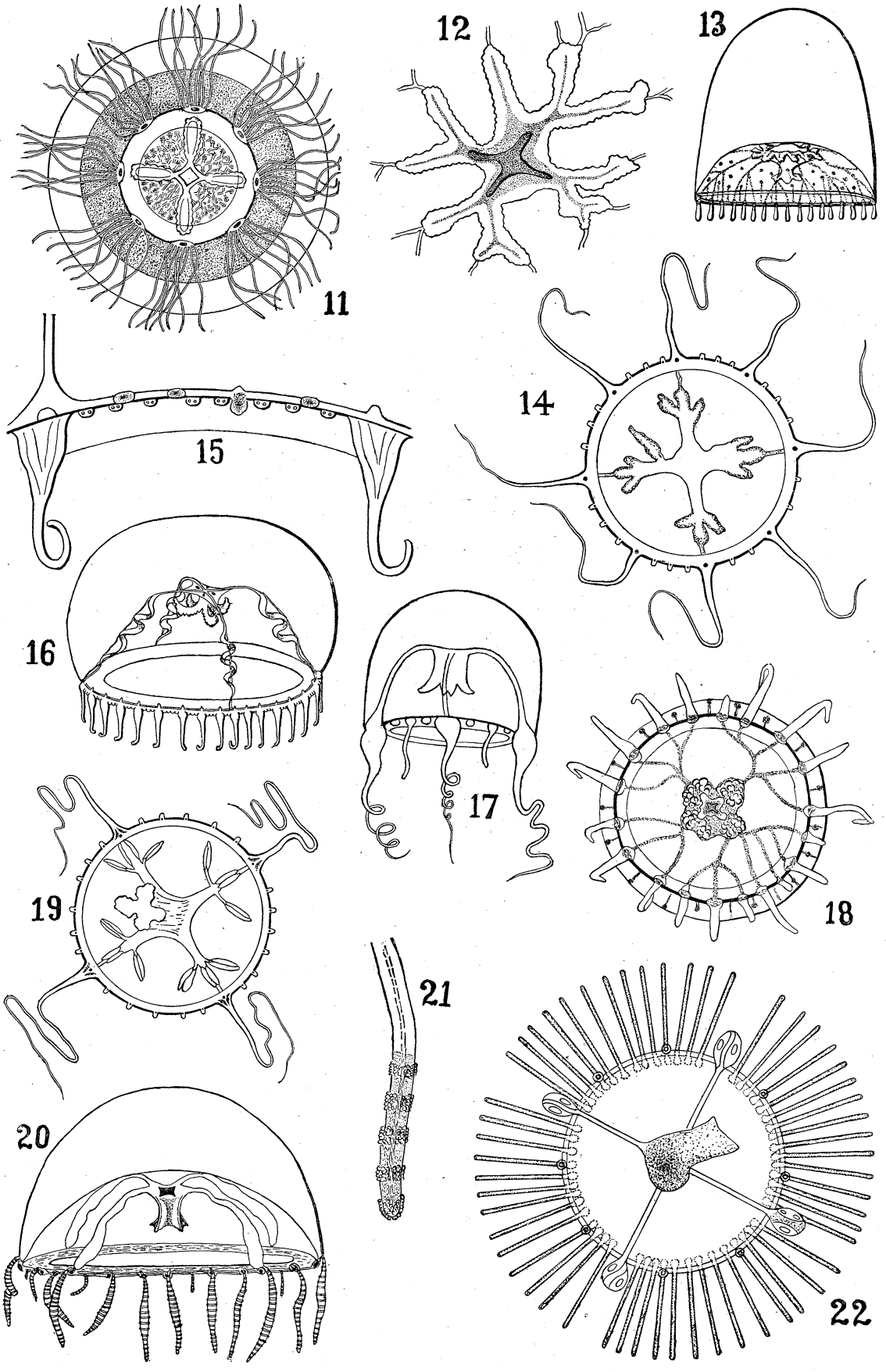
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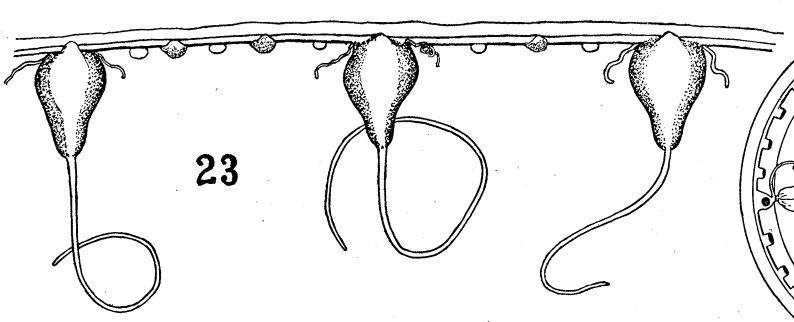
PLATE III.

Fig. 23. *Eirene malayensis.*—Margin.
„ 24. *Do. madrasensis* Do.
„ 25. *Octocanna polynema* Do.
„ 26. *Octocanna solida* Do.
„ 27. *Octocannoides ocellata.*—Oral view.
„ 28. *Do. do.* Margin.
„ 29. *Aequorea parva.*—Oral view.
„ 30. *Do. do.* Side view.
„ 31. *Do. do.* Margin.
„ 32. *Do. do.* Accessory mouth.
„ 33. *Do. do.* Eggs.
„ 34. *Zygocanna buitendijki.*—Oral view.
„ 35. *Do. do.* Margin.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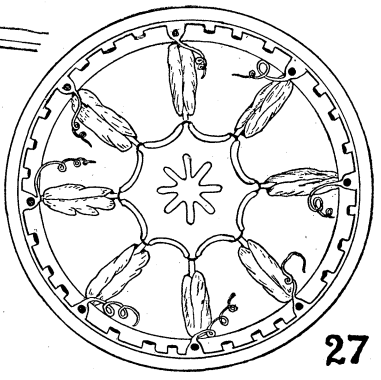
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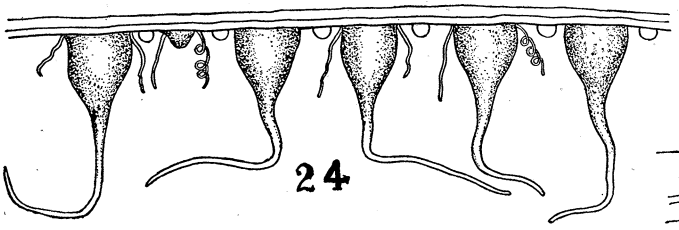
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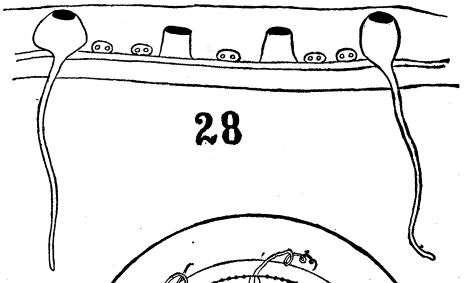
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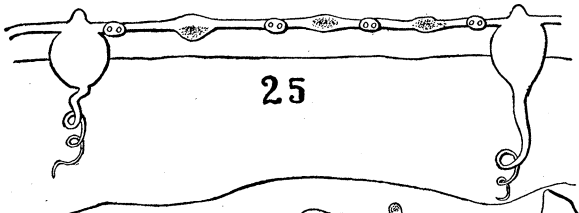
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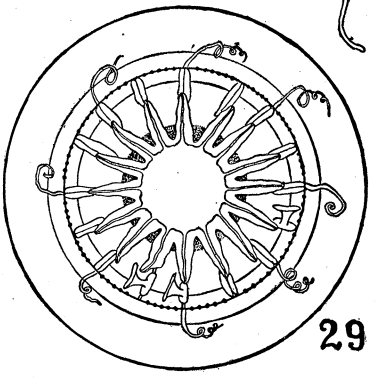
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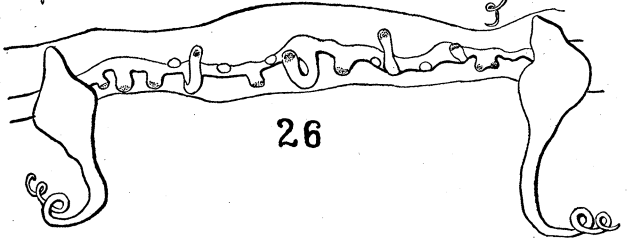
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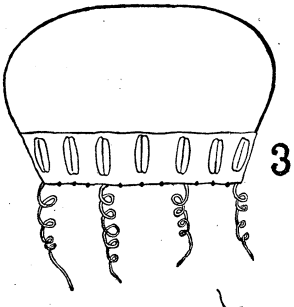
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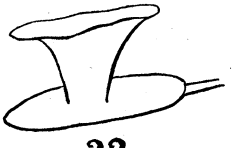
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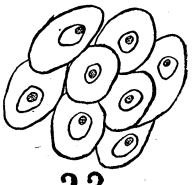
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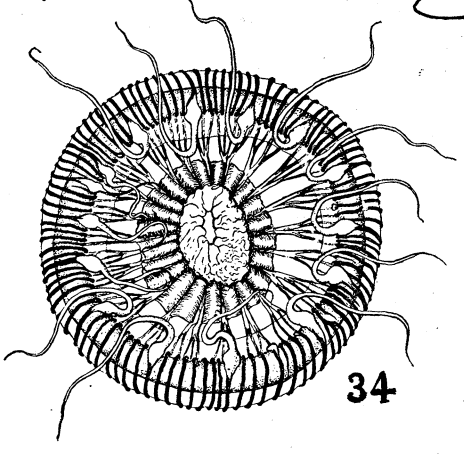
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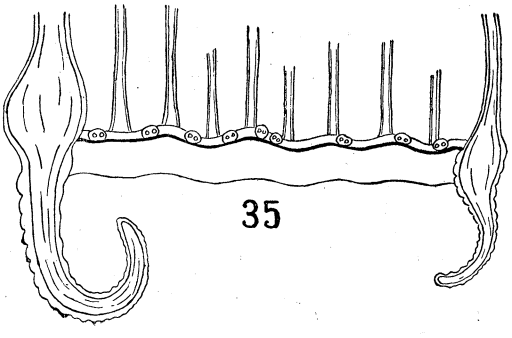
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