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The two Leptomedusae, *Aequorea coerulescens* and *Aequorea vitrina*[1)]

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(With 6 Text-figures)

The Pacific medusa, *Aequorea coerulescens* was first described by Brandt (1838) under the name of *Mesonema* (*Zygodactyla*) *coerulescens* from northern Central Pacific. In 1909 H.B. Bigelow reporting this medusa from the eastern Tropical Pacific mentioned as follows: "Both our specimens show the characteristic pigmentation described by Brandt, the tentacular bulbs being of a very deep bluish black, which now after preservation is black and very opaque. Otherwise the specimens are entirely colourless". Recently F.S. Russell (1953) who studied nematocysts of the Atlantic species, *A. vitrina*, writes as follows, "*A. vitrina* evidently comes very close to *A. coerulescens* (Brandt) as described by Bigelow (1909). In fact if it were not for the deep bluish black pigmentation in the tentacle bulbs, which appears to be as characteristic of *A. coerulescens*, there does not seem to be any character by which they can be distinguished. Bigelow's photograph of that species (1909, Pl. 4, Fig. 4) might well be a typical *A. vitrina*. An examination of the nematocysts of *A. coerulescens* might be helpful." The coloration of medusae is often changeable due to stages and localities, therefore, it is not the definite character to distinguish species. In regard to the hydroid of *Aequorea vitrina* Russell (1953) pointed out that *Campanulina acuminata* (Alder) is very probably the polyp stage and further described young medusae liberated from this hydroid.

The medusa, *Aequorea coerulescens*, was first recorded in Japan by Maas (1909) from Misaki as *Mesonema pensile* and 8 years afterwards the medusa was identified with the species by Uchida (1927) based on specimens obtained from Misaki and Asamushi. Since then it has been known that the species is very common on the Pacific coasts of Japan. In 1966 Dr. Y. Kakinuma published an important report on the life-history of the hydroid, from the hydropolyp to the matured medusa, describing the hydropolyp and young medusae. Through the kindness of Professor E. Hirai of the Asamushi Marine Biological Station the writer was able to get and rear living hydropolyps and young medusae in the Biological

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Laboratory of the Imperial Palace. He compared them in detail with those of *Aequorea vitrina*. Besides, Dr. Z. Nagao kindly helped the writer in giving his observations on the nematocysts of *A. coerulescens* caught at Akkeshi. Taking into consideration of the results obtained by the writer, it has been concluded that *Aequorea coerulescens* distinctly differs from *Aequorea vitrina*.

Aequorea coerulescens (Brandt)

Hydropolyp. The hydropolyp of *Aequorea coerulescens* is closely related to that of *Campanulina acuminata*, which possibly corresponds to the hydropolyp-stage of *Aequorea vitrina* as pointed out by Russell (1953). As to the hydropolyp of the

Fig. 1. Hydropolyp of *Aequorea coerulescens* (Brandt).

Japanese species Kakinuma (1966) gave a description, but some supplementary notes will be given here. The colony of hydropolyps is connected by stolon which grows on sea-weeds found on the sea-shore in front of the Station (*fide* Kakinuma).

The trophosome arises singely from stolon or is budded off from older one, reaching 5 mm or more in length, with tentacles slightly shorter than the polyp. The hydranth is colourless, slender and very extensile. Around the epistome of hydranth are armed with from 16 to more than 30 filiform tentacles which are radially arranged in a circlet and united at their base by a membranous web. This web contains conspicuous bean-shaped nematocysts approximately 0.01 to 0.015 mm in length. Hydrotheca cylindrical and smoothly tapering to the junctionpoint of hydrocaulus. The free-margin of hydrotheca ends in rather indistinct toothed opercular part. Several fine longitudinal striations are visible on the surface of hydrotheca. Hydrocaulus narrow and short, about 0.2 to 1 mm or more in length and imperfectly annulated throughout its length. When the polyp well extends, it far exceeds the length of hydrotheca plus hydrocaulus. The gonophore is large and cylindrical, growing from the hydrocaulus just below the hydranth or directly from the stolon.

As regards the development of medusa-buds and growth of hydranth, Kakinuma gave descriptions in figures. Even when the polyp within the hydrotheca once degenerates in unfavourable conditions, it was observed to regenerate again from a red residual mass.

The Japanese hydropolyp is clearly different in possession of shorter hydrocaulus from that of *Campanulina paracuminata* described by Rees (1938) which was identified with the polyp-stage of *Aequorea forskalea* by Russell (1953). So far as described, the Japanese hydropolyp is very similar to that of *A. vitrina*, though the number of tentacles is more numerous in the former.

Hydromedusa. The young medusa just liberated from the hydropolyp is bell-shaped and slightly wider than high as is seen in the table of measurements given below, which was kindly made by Dr. E. Hirai at the beginning of May, 1968.

No.	Bell-height	Bell-diameter
1	0.8 mm	1.2 mm
2	0.8 mm	1.0 mm
3	1.0 mm	1.3 mm
4	0.7 mm	1.0 mm
5	0.8 mm	0.9 mm
6	1.1 mm	1.5 mm

The jelly is rather thin. There is an apical depression at the apex of subumbrella. There are numerous nematocysts scattered all over the surface of the exumbrella. The velum is broad. The manubrium is short and the mouth has 4 simple lips. The 4 radial canals are straight and the ring canal is slightly narrower than the former. There are 2 opposite perradial marginal tentacles with large bases and 2 small opposite perradial marginal tentacle bulbs have no tentacles. There are 8 adradial marginal vesicles, each with a single or two concretions. There is no sign of gonads. The perradial tentacle bulbs are pale brown in colour.

Tentacles are whitish on account of the presence of numerous nematocysts. So far known, the young medusa just liberated has 2 opposite perradial tentacles and 8 adradial statocysts in the genus *Aequorea*.

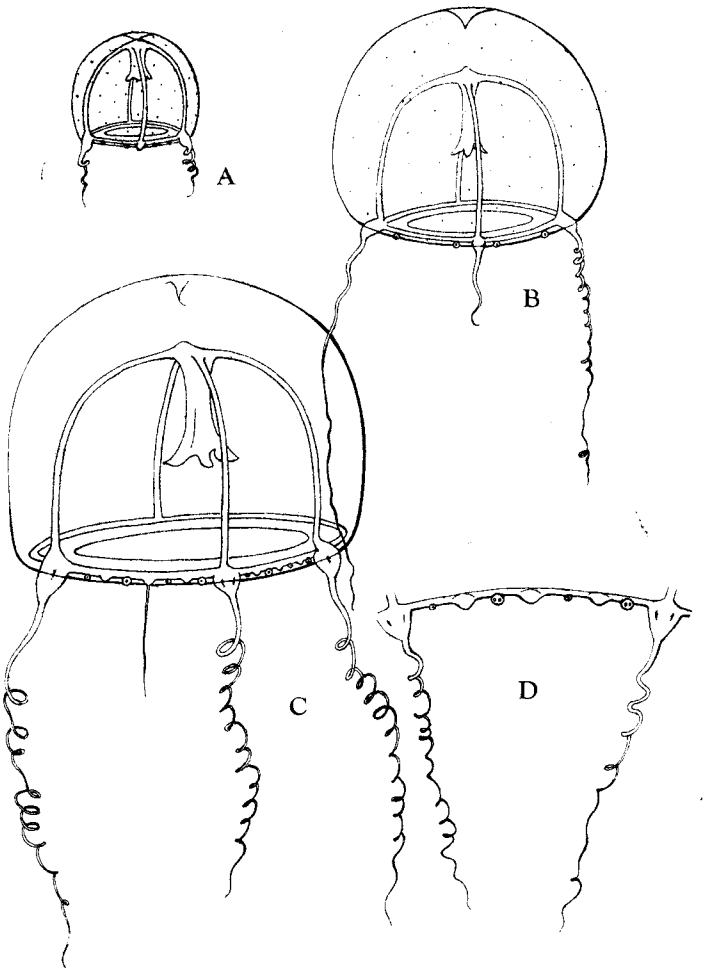

Fig. 2. Young medusae of *Aequorea coerulescens*;
A. Medusa just liberated, 0.8 mm high and 0.9 mm in diameter; B. Medusa, 2 mm high and 2.25 mm in diameter, 12 days old; C. Medusa, 2.5 mm high and 2.75 mm in diameter, 18 days old; D. Quadrant of marginal part of the medusa.

The young medusa of *Aequorea coerulescens* seems to be smaller than those of the Atlantic two species, *A. vitrina* and *A. forskalea*, and seems to be wider than high, differing from the latter. It is clearly distinct from that of *A. vitrina* in having the

apical depression and from that of *A. forskalea* in the distribution of exumbrellar nematocysts.

The metamorphosis of the young medusa thenceforwards proceeds always regularly but the process seems to be variable according to individuals and environmental conditions. Except increase of size and change of shape of the bell, the main changes lie in increase of marginal tentacles, statocysts and centripetal radial canals, and also subdivision of oral lips. Gonads appear on radial canals consequently. These changes will be summarized in separate headings as shown below.

1) *Bell-shape.* The bell is at first slightly wider than high, with a distinct apical depression. It becomes higher than wide in the four-tentacled stage for a while. In this stage the apical depression disappear completely. After that the bell becomes gradually flatter and consequently disc-like in full-grown specimens (about 150 mm in diameter).

2) *Tentacles, statocysts and centripetal canals.* The youngest medusa is equipped with 2 opposite perradial tentacles and 8 adradial statocysts. From 7 to 10 days afterwards 2 other perradial tentacles arise. In this stage tentacle-bulbs are pale brown. In medusae 18–28 days after liberation, 2.25–2.5 mm high and 2.75–3.5 mm in diameter, 12 more tentacle bulbs, 4 interradial and 8 adradial, develop. Some of interradial bulbs often bear short tentacles. Between the tentacles and tentacle-bulbs are situated each a statocyst. Out of these 16 statocysts, 4 near the perradial tentacles and 4 near the interradial tentacle-bulbs are larger than the other 8. The larger statocysts are the 8 primary and the 8 smaller are the secondary ones. The 4 perradial tentacle bulbs are larger than others and light brown in colour, with dark brown streaks on lateral sides. In this stage the lips are 4 but some of medusae become to have 4 short branches of interradial centripetal canals. The sequence of appearance of tentacle bulbs and statocysts does not coincide each other: in some specimens tentacle-bulbs proceed to appear to statocysts, while in some specimens statocysts appear earlier than tentacle-bulbs. The perradial tentacle-bulbs are light brown in colour, with dark brown pigment on both lower lateral sides. On the surface of the shaft of tentacles nematocysts are thickly set in coiled state, but separately distributed in extended state. In this stage 4 interradial centripetal radial canals begin to elongate. When the medusa reaches 4.5 mm in diameter and 3.25 high, the interradial radial canals become connected with the circular canal at bell margin, and 4 interradial tentacles become developed, though slightly shorter than the perradial ones. In this stage the manubrium comes to have 4 well-developed lips.

In a medusa, 48 days old after liberation and 5.75 mm in diameter and 4.25 high, 8 short adradial tentacles become developed, along with elongation of 8 short adradial centripetal radial canals, which extend less than half way to the margin. This specimen has a narrow ring canal and still wider radial canals. In each octant of this medusa 2 or 3 tentacle-bulbs are seen and they seem to be slightly less in number than marginal statocysts. In a medusa, 60 days old after liberation and

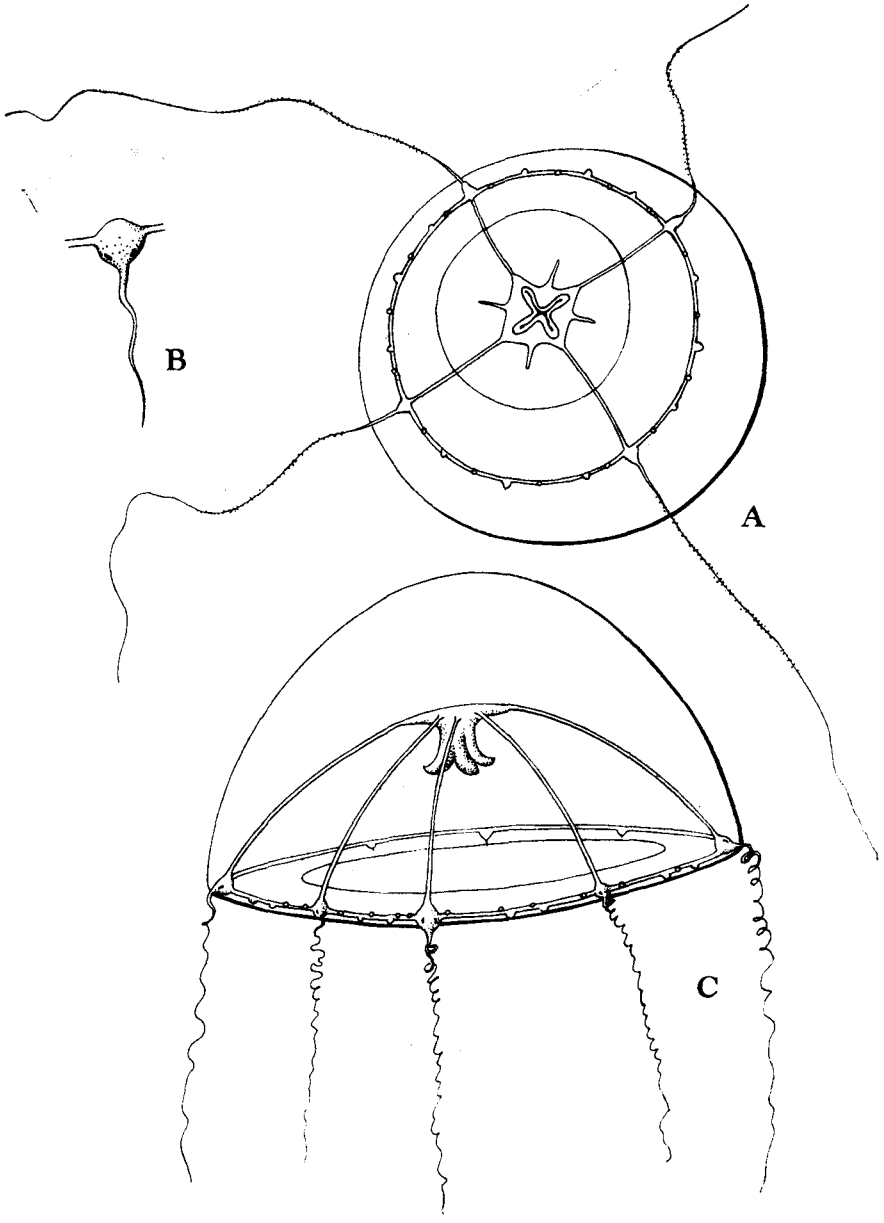

Fig. 3. A. Oral view of medusa, 2.25 mm high and 3.5 mm in diameter; B. Tentacle bulb of the medusa; C. Side view of medusa, 3.25 mm high and 4.5 mm in diameter.

9.5mm in diameter, the stomach is eight-sided, with 8 large and 8 smal lips. The radial canals are 16 in number, of which 14 reaching the bell-margin and 2 of them are blind-canals. At the junctionpoint of these canals with the circular canal is

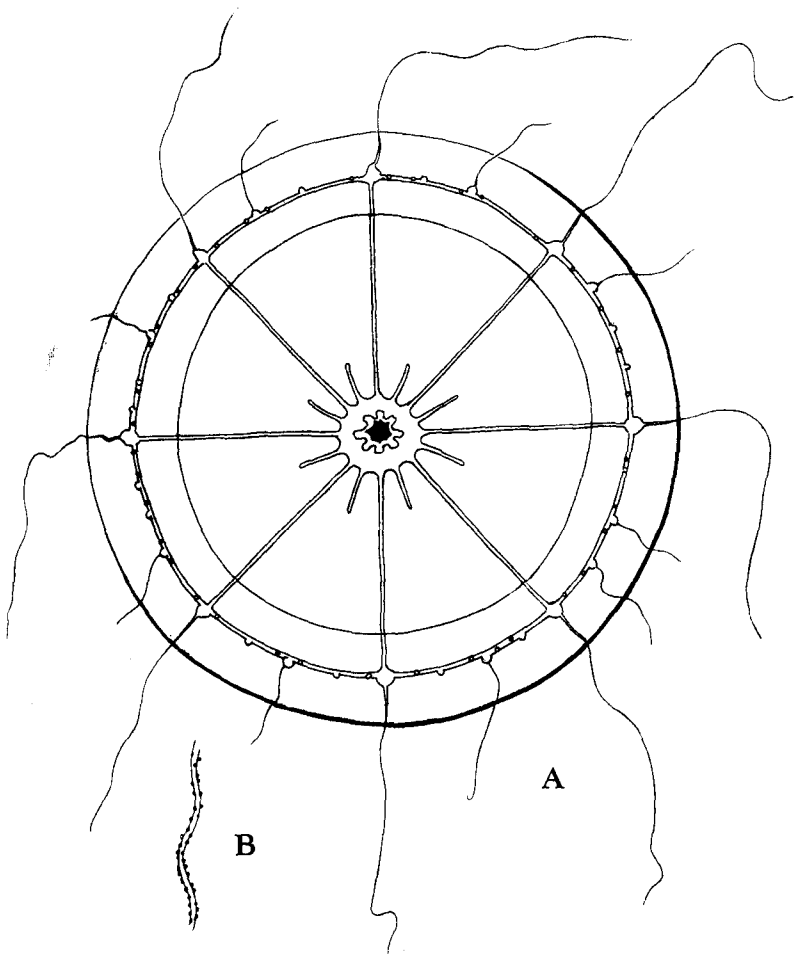

Fig. 4. A. Oral view of medusa, 4.25 high and 6.25 mm in diameter, B. Part of tentacle.

present a brown tentacle-bulb which bears a long filamentous tentacle. The marginal tentacles of the same series do not develop synchronously as shown in Fig. 4. Between these 16 tentacle-bulbs are found the 16 tentacles of the 4 series and small tentacle-bulbs. Statocysts, nearly located between tentacles and

tentacle-bulbs, are slightly more numerous than them. As to more developed stages Kakinuma (1966) gave figures. She reported that linear gonads began to develop along almost the whole length of the radial canals in a medusa, 30 mm in

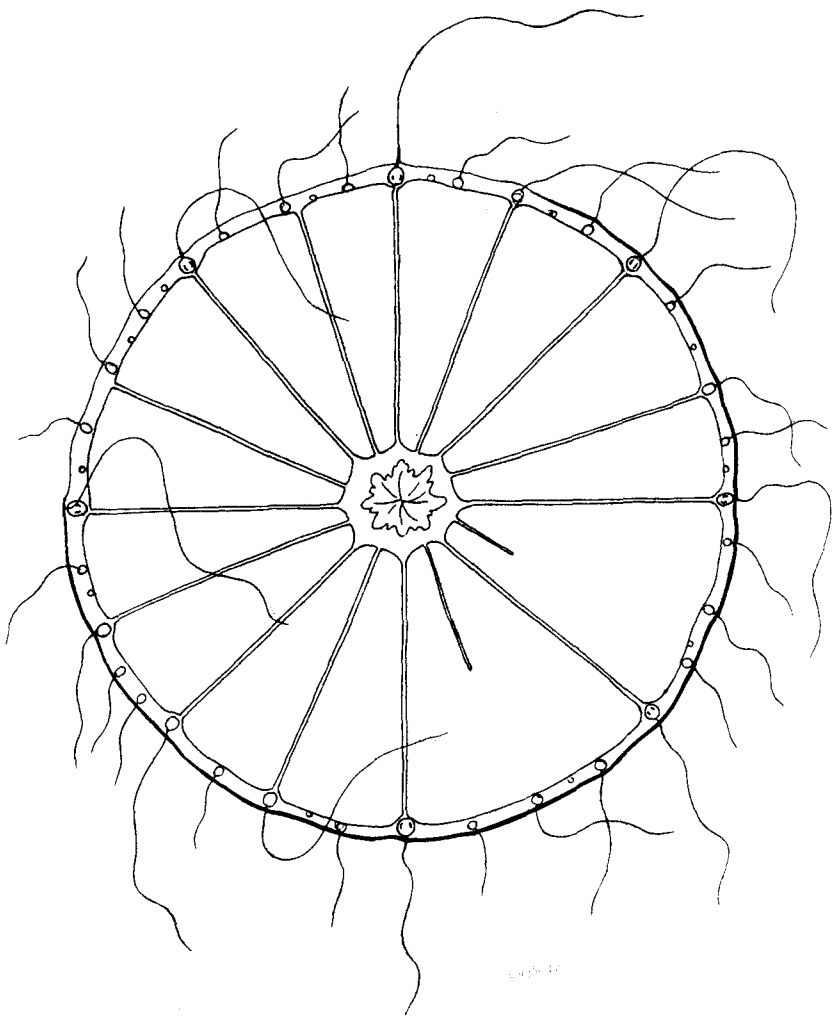

Fig. 5. Oral view of medusa, 9.5 mm in diameter.

diameter, with 32 radial canals and 120 tentacles. The medusa was two and a half months old and the tentacles became blue, surrounded outside by black granules. Statocysts were found one or two between each 2 adjacent tentacles. As to the number of radial canals, tentacles and tentacle-bulbs, Kramp (1961) describes about 100

radial canals, 3-6 times as many tentacles as radial canals and numerous small bulbs in the medusa, 145 mm in diameter.

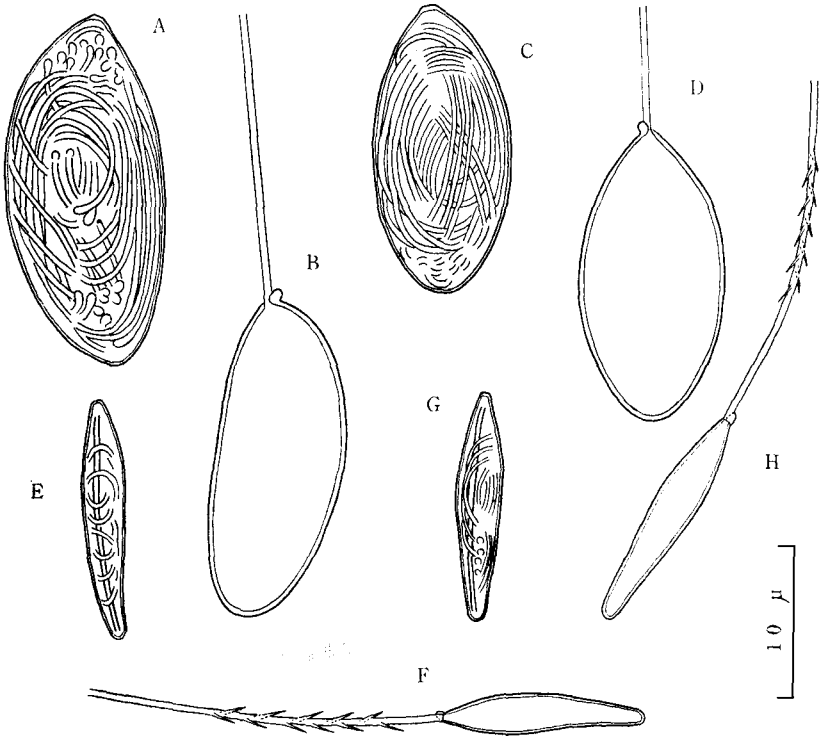

Fig. 6. Nematocysts of *Aequorea coerulescens*.
A-D: atrichous haplonemes, (A.B. from tentacles; C.D. from mouth lips); E-H: basitrichous haplonemes, (E.F. from tentacles; G.H. from mouth lips)

Nematocysts. There were found 2 kinds of nematocysts in *A. coerulescens*: basitrichous haplonemes and atrichous haplonemes in marginal tentacles and mouth lips of this species. The measurement of them is as follows:

Basitrichous haplonemes: 13–16×2.5–3μ (undischarged)

Atrichous haplonemes: 19–24×8–12μ (undischarged)

Atrichous haplonemes are slightly different in localities; those in mouth lips seem to be more or less smaller than those in marginal tentacles, though not distinct. As are given in Fig. 6, these nematocysts of the Pacific species are different in form from those of the Atlantic species described by Russell (1939).

Remarks. As was pointed out by Bigelow (1909) and Russell (1939), *Aequorea coerulescens* and *Aequorea vitrina* are closely related in their adult stages

and their polyp stages are also quite similar each other, but these two species are distinguished clearly by the young medusae just liberated and the form of the nematocysts.

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