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ANATOMY OF TWO STALKED MEDUSAE WITH REMARKS ON THE DISTRIBUTION OF THE STAUROMEDUSAE IN JAPAN

BY

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(With 27 Text-figures and 1 Chart)

In connection with the biological survey carried out around the Akkeshi Marine Biological Station during July-August, 1933, we have been able to examine many living specimens of two stalked medusae which have as yet never been recorded from Japan. One of them is *Haliclystus steinegeri*, which has been known from North Saghalien and the Commander Islands; the other is *Haliclystus borealis*, which was recently preliminarily reported by UCHIDA (1933) as a new form. It appears to us that the specific identification of Stauromedusae is very difficult without examining living specimens and without cutting sections. As in the case of actinians, it is necessary, for definite identification, first to observe living specimens and secondly to investigate the internal anatomy. As a detailed description of the medusae above mentioned has not yet been given, their anatomy will here be reported upon. We wish to take this opportunity to give a note on the distribution of the Stauromedusae in Japan, basing our report on specimens received from several different localities of this country during recent years. For these specimens we are very much indebted to the following gentlemen: Messrs. T. HIKITA, K. BABA, M. IWASA, S. OKUDA, S. SATO and H. ISHIZUKA.

Contribution No. 59 from the Zoological Institute, Faculty of Science, Hokkaido Imperial University.

Haliclystus borealis UCHIDA Jap. name=¹⁾Shirasuji Asagaokuragé.

Calyx quadropyrimal, generally narrowing aborally and somewhat widened at the middle portion. Exumbrella generally smooth but finely granulated with nematocysts. Mesogloal layer rather thick and rigid. Margin of the bell produced into 8 adradial arms,

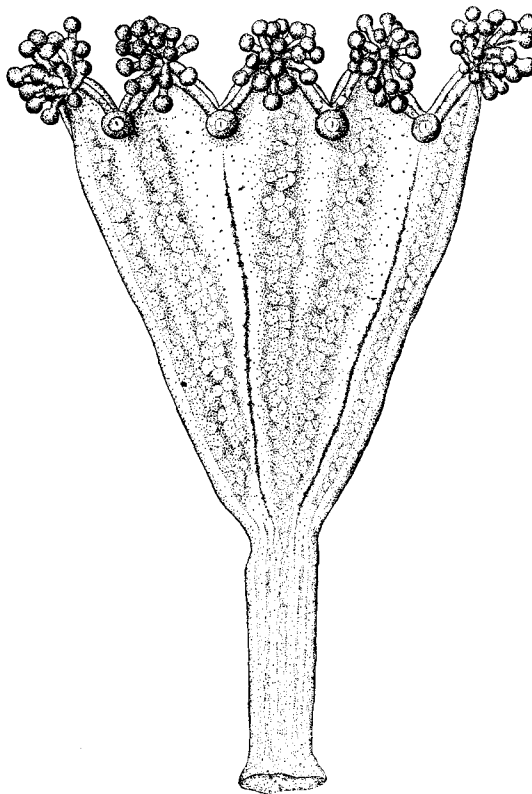


Fig. 1. *Haliclystus borealis* UCHIDA.

each with a tentacle cluster at the tip. The four perradial clefts between the arms are slightly wider than the four interrarial ones. Each tentacle cluster consists of about 20-30 tentacles with a hollow stem and a globular head covered with nematocysts, and arranged in 3-4 axial rows, with the younger ones inside. The eight marginal

1) Shirasuji = white-striped, asagao = morning glory, kuragé = medusa.

anchors, perradial and interradial, have each a short stalk and a round cushion-like disc, each of which is provided with a longitudinal furrow in the central portion. The diameter of the disc is a little less than a half that of the peduncle. Unlike other species of *Haliclystus*, there is no pigment fleck on the disc. White spots are arranged on the margin, generally two on both the sides of the anchors and two on the inner side of the arms. Four interradial white stripes, widest in the middle portion, are prominent, running

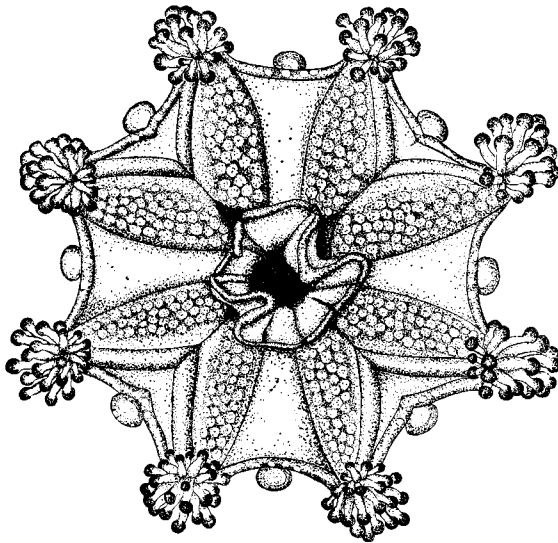


Fig. 2. *Haliclystus borealis* UCHIDA; oral view.

from the base of the anchor to the end of the calyx. Gonads in four interradial pairs, extending from just below the bell margin barely to the point of the junction of the calyx with the peduncle, consist of about 50 follicles thickly interlocated with each other and arranged generally in three or four rows in the widest portion of the gonads. Subumbrella generally smooth, with eight sac-like evaginations containing gonads. Manubrium four-sided, its free margin thin and folded several times. Gastral filaments numerous and in eight rows, one in each adradius. Four interradial infundibula reaching to the base of the calyx.

Peduncle four-chambered, broad, less than $1/3$ the length of the calyx, provided with a disc of a somewhat round form. The cross section of the peduncle is four-lobed on account of four perradial swollen portions corresponding to the canals. The peduncle is longer in younger individuals. The white stripes above mentioned are not extended into the interrarial portions of the peduncle.

The measurements of preserved specimens in different developmental stages are as follows:

Specimen	Length of calyx	Width of calyx	Length of peduncle	Number of secondary tentacles in each adradius
A	$5\frac{3}{4}$ mm	4 mm	$1\frac{1}{2}$ mm	17
B	6 mm	$4\frac{3}{5}$ mm	$1\frac{1}{2}$ mm	19
C	$7\frac{3}{5}$ mm	$5\frac{1}{2}$ mm	$1\frac{3}{4}$ mm	19
D	8 mm	6 mm	$1\frac{1}{2}$ mm	21
E	9 mm	$6\frac{1}{2}$ mm	2 mm	20
F	$10\frac{1}{2}$ mm	$8\frac{1}{2}$ mm	$2\frac{1}{3}$ mm	24
G	$11\frac{1}{4}$ mm	7 mm	$3\frac{1}{4}$ mm	24
H	12 mm	$8\frac{1}{2}$ mm	$2\frac{4}{5}$ mm	22

The colour of the calyx greenish brown or reddish brown. Anchors and secondary tentacles in reddish brown specimens slightly reddish brown, those in greenish brown ones yellowish brown. Peduncle reddish brown or brownish green. Conspicuous white stripes are generally present, rarely absent. In young specimens these stripes are comparatively narrow and indistinct.

Microscopical anatomy. The ectoderm of the exumbrella is generally similar in structure both in the calyx and in the peduncle, and consists of three kinds of cells: cubic or cylindrical supporting cells, ovoid nematocyst cells and ovoid granulated gland cells. The supporting cells are most numerous, while the other two cells are sparsely distributed in the former (Fig. 3). The ectodermal layer of the exumbrella is uniformly similar in thickness except in the eight arms and in the basal disc of the peduncle. On the abaxial side of the arms the ectoderm cells are arranged as if in two rows, making

a high ridge as shown in Fig. 4. The ectoderm cells of the basal disc are extremely modified, comprising high gland cells containing mucus well stained by aniline blue and fuchsin. The subumbrellar

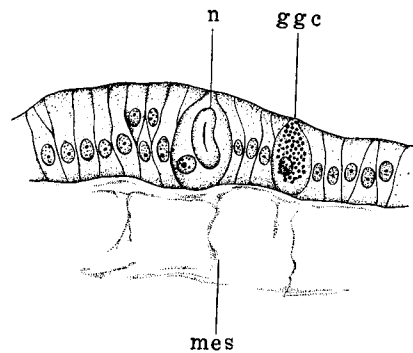


Fig. 3. *Haliclystus borealis*; section of exumbrella. $\times 3333$; ggc granulated gland cell, mes mesogloea, n nematocyst.

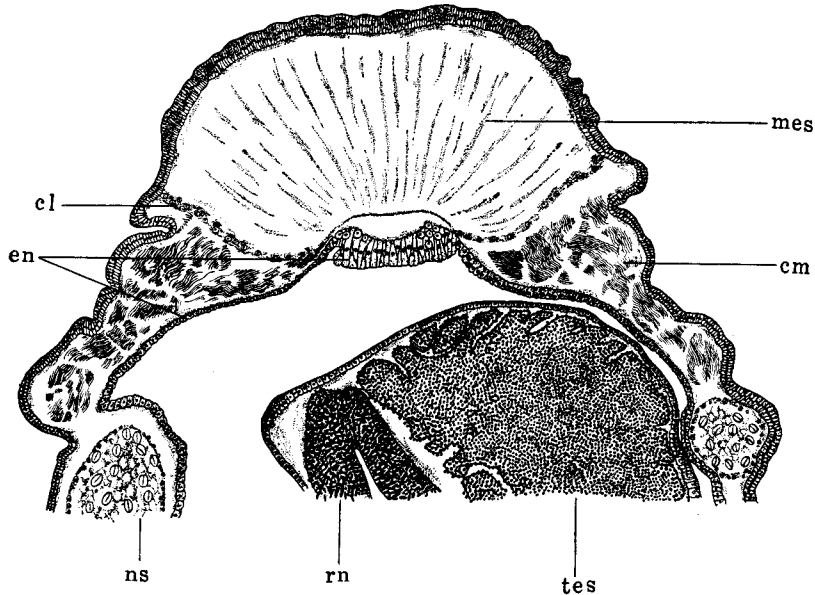


Fig. 4. *Haliclystus borealis*; horizontal section of arm. $\times 150$; cl cellular lamella, cm circular muscle, en endoderm, mes mesogloea, ns nematocyst sac, rn rod-shaped nematocysts, tes testis.

ectoderm is generally thicker than that of the exumbrella and contains many granulated cells, few vacuolated cells and scarce ovoid nematocysts. The ectoderm bordering the four interradial infundibula is especially characterized in having a few glandular cells well-stained by aniline blue, considerably numerous rod-shaped nematocysts and

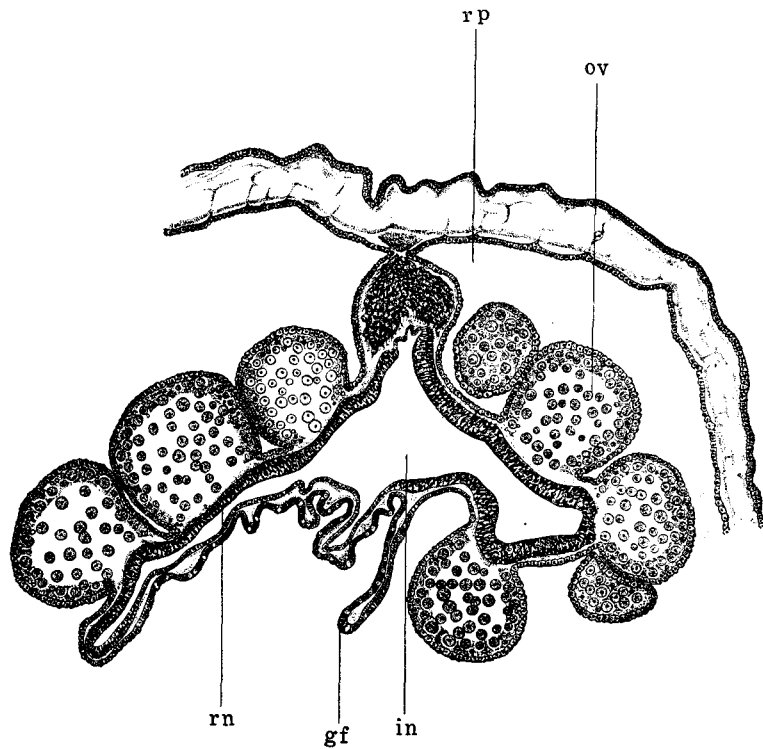


Fig. 5. *Haliclystus borealis*; horizontal section of a quadrant of calyx. $\times 150$; gf gastral filament, in infundibulum, rn rod-shaped nematocyst, rp radial pocket, ov ovary.

a few ovoid nematocysts. These cells form a thick layer in the portions corresponding to the gonads, but are scarcely found in the interradial small parts adjacent to the longitudinal muscle in cross sections of the calyx and also in the axial portion forming the stomodaeum wall (Fig. 5).

The mesogloea is rigid and fairly thick, especially massive in the exumbrellar part of the arms and in the peduncle. The mesogloea is uniformly beset with minute fibres which are imbedded in the mesogloea and are well-stained by Haematoxylin and aniline blue. These fibres are also present around the exumbrellar endoderm layer, making a circular region in the mesogloea. The conspicuous coiling fibres in the mesogloea running perpendicularly to the ectoderm layer are formed by these minute fibres through their twining together. The white stripes generally present in the interradial are well-stained by Haematoxylin and eosin, and are represented by a fine fibrous structure. The mesogloea surrounding the infundibula is thin and that of the axial part is provided with diffused muscles. The circular muscle in the bell margin is well-developed and subumbrellar. The interradial longitudinal muscles are in cross section diffused in the basal portion of the peduncle but become gradually circumscribed towards the calyx. They are mostly bilobed in transverse sections of the calyx but are divided into two circumscribed muscles near the bell margin. The cell lamella (Zellplatte) is present in the mesogloea near the bell margin, generally situated just below the circular muscle, but is undulating, giving rise to processes into the stem of the anchors, perradial and interradial, and the adradial arms. The nematocyst sacs containing ovoid nematocysts are rather few and are only found in the limited portions near or at the base of the arms.

The endoderm cells are generally higher than the ectoderm cells and are mostly glandular, granulated or vacuolated. Besides them, there are some wedge-shaped gland cells with a widened base containing a well-stained coagulum and a slender canal opening into the cavity. The endoderm surrounding the gonads comprises rather a large number of vesiculated cells, and the endoderm cells in the basal disc of the peduncle are extremely granulated. The abaxial side of the arm cavity is lined with a thick endoderm layer composed of granulated cells irregularly arranged in two rows.

As in other species belonging to the genus, the peduncle is four-chambered throughout the whole length and is furnished with

four interradial longitudinal muscle strands (Fig. 6, 7). The four infundibula are fairly long and reach to the base of the calyx, but are united in transverse sections of the marginal portion into a

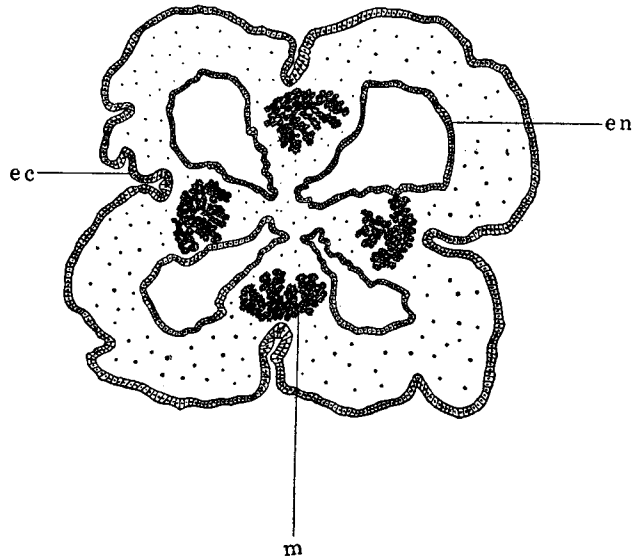


Fig. 6. *Haliclystus borealis*; horizontal section of peduncle. $\times 150$; ec ectoderm, en endoderm, m muscle.

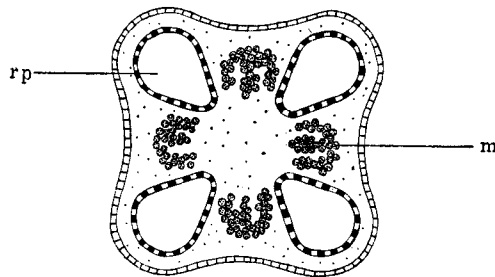


Fig. 7. *Haliclystus borealis*; schema of horizontal section through peduncle; rp radial pocket, m muscle.

cross-shaped chamber (Fig. 8, 9). The four radial pockets are approximately of the shape of a low isosceles triangle, and are, in the lower portion, communicated with each other through the central stomach cavity.

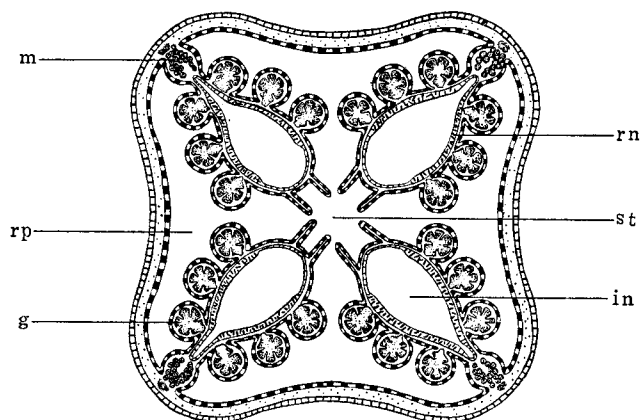


Fig. 8. *Haliclystus borealis*; schema of horizontal section through middle portion of calyx; g gonad, in infundibulum, m muscle, rn rod-shaped nematocyst, rp radial pocket, st stomach cavity.

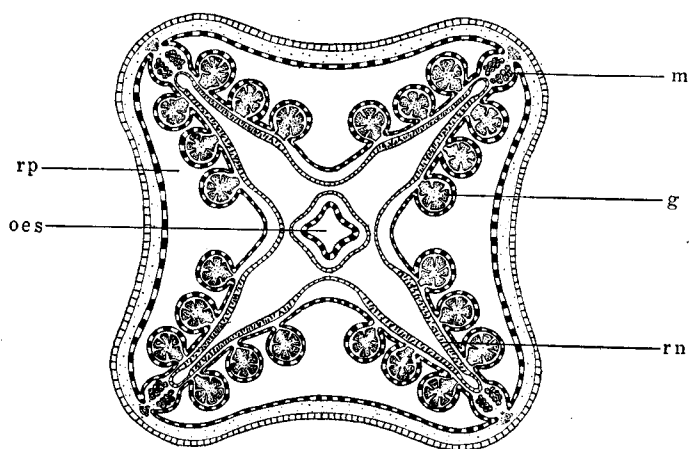


Fig. 9. *Haliclystus borealis*; schema of horizontal section of calyx much higher than Fig. 8; g gonad, m muscle, oes oesophagus, rn rod-shaped nematocyst, rp radial pocket.

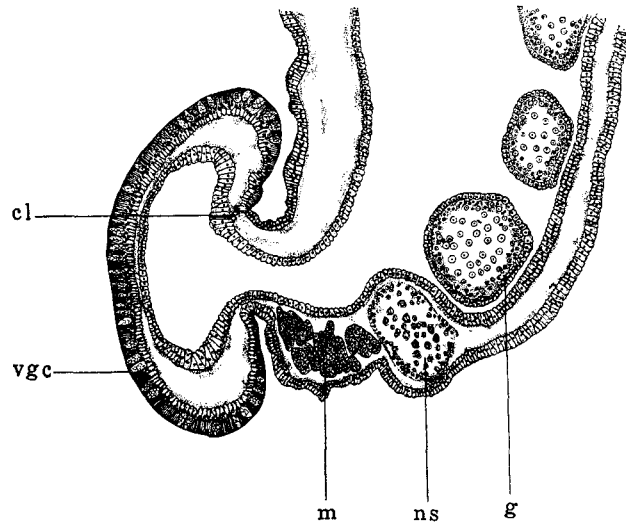


Fig. 10. *Haliclystus borealis*; sagittal section of anchor. $\times 150$; cl cellular lamella, g gonad, m muscle, ns nematocyst sac, vgc vesiculated gland cell.

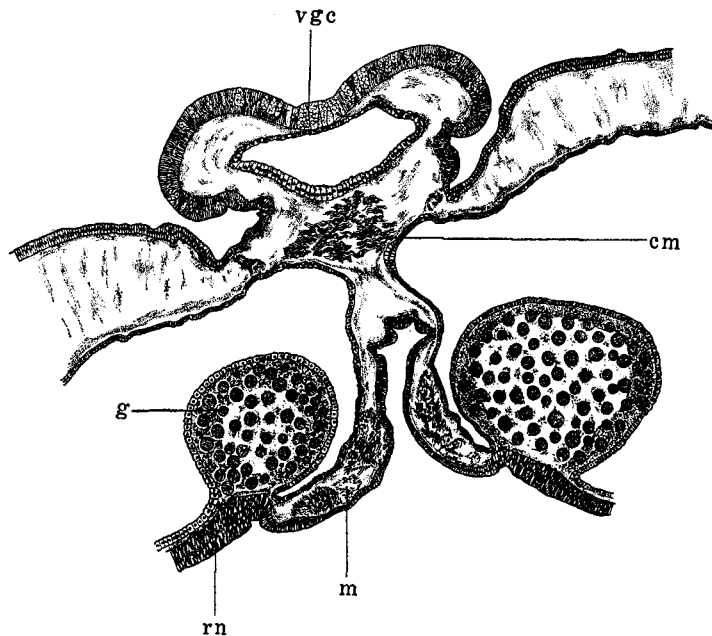


Fig. 11. *Haliclystus borealis*; horizontal section of anchor. $\times 150$; cm circular muscle, g gonad, m muscle, rn rod-shaped nematocyst, vgc vesiculated gland cell.

The anchors are large, spherical, with a longitudinal furrow on the abaxial side, and are made up of high supporting cells and vesiculated gland cells. The nematocysts could not be found. The supporting cells are arranged in roughly two radial rows, each cell with a nucleus in its middle portion. The vesiculated cells are especially numerous in the abaxial longitudinal furrow and some also

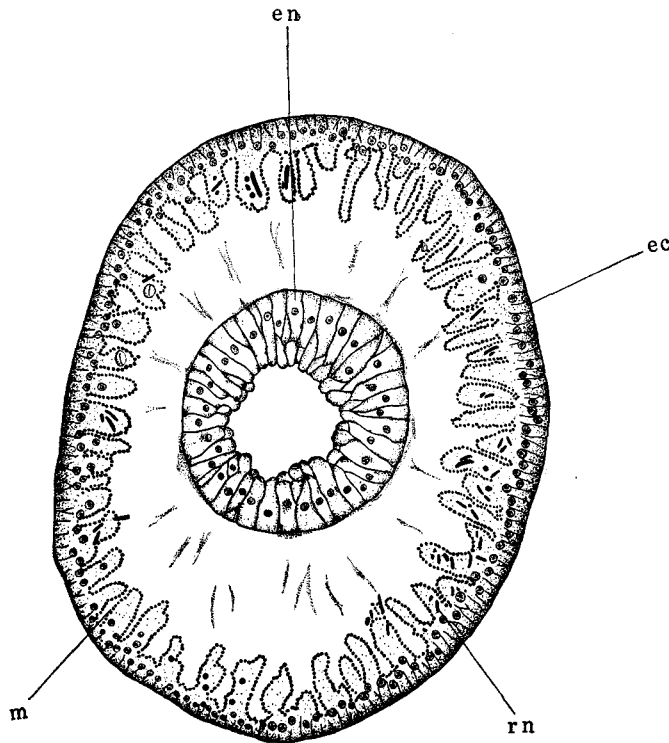


Fig. 12. *Haliclystus borealis*; cross section of tentacle stalk.
ec ectoderm, en endoderm, m muscle, rn rod-shaped
nematocyst.

are found in the axial side of the anchors. The mesogloea is slightly fibrillated and is thinner in the abaxial portion. The endoderm cells are glandular, granulated, and low on the abaxial portion corresponding to the vesiculated region of the ectoderm.

The secondary tentacles are composed of a tentacle knob and a stalk. The tentacle knob consists of four kinds of cells: supporting cells, finely granulated cells, rod-shaped nematocysts and ovoid nematocysts. The supporting and granulated cells forming most of the inner part of the tentacle knob are exceedingly narrow and are constricted at several levels. The rod-shaped nematocysts are numerous and thickly set on the periphery of the knob, intermixed with a few ovoid nematocysts, but some are found in the inner portion among the supporting cells. They have been derived from the ectodermal wall of the infundibula and have wandered upwards (orally) to the tip of the tentacle. We often found many rod-shaped nematocysts wandering in the ectoderm of the secondary tentacles, sometimes forming round clusters in the mesogloea attached to the ectoderm of the tentacles. The muscles of the tentacle stem are well-developed, making many foldings in cross section, but they are absent in the portion imbedded in the mesogloea. The tentacles situated in the abaxial portion have on their abaxial side in place of these muscles many ovoid vesicular gland cells, each with a deeply stained fleck at the bottom. The mesogloea is slightly fibrous. The endoderm cells are higher than the ectoderm cells and generally vacuolated; there are a few glandular cells with widened base containing a well stained coagulum and a slender neck leading to the tentacular lumen.

The lips are four-sided, showing several foldings. The subumbrellar ectoderm cells, higher than the exumbrellar ones, are thickly granulated, having a few ovoid nematocysts. In the abaxial mesogloea several diffused muscles are present.

The gastral filaments are asymmetrical and somewhat elliptical in cross section, with a mesogloea core surrounded by vacuolated or granulated cells arranged in a row, with the cells on one side higher than those on the other.

The gonads are formed by ellipsoidal evaginations from the endoderm layer of the subumbrella and are arranged in 1-5 (generally 3) rows, with the younger ones near the interradii. In the female, small ova are situated near the periphery and large ones in the central

cavity. In the male, the abaxial periphery is divided into several lobes, each lobe containing young male cells, and the axial cavity contains full grown sperm.

Abnormality. Among over a hundred specimens we found a single abnormal specimen with a typical hexamorous symmetry having

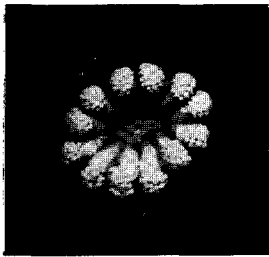


Fig. 13. *Haliclystus borealis*; abnormal specimen with hexamorous symmetry. \times ca. 2; oral view.

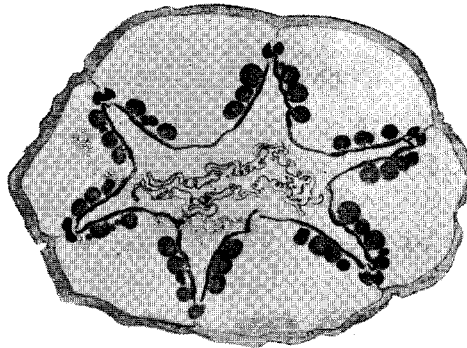


Fig. 14. *Haliclystus borealis*; horizontal section through marginal portion of calyx of hexamorous specimen. $\times 7$.

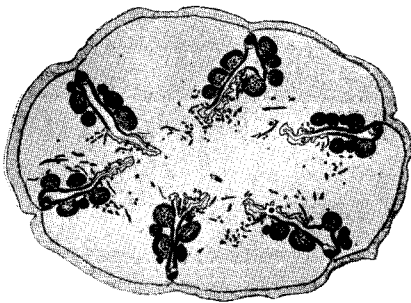


Fig. 15. *Haliclystus borealis*; horizontal section through middle portion of calyx of hexamorous specimen. $\times 7$.



Fig. 16. *Haliclystus borealis*; horizontal section through peduncle of hexamorous specimen. $\times 9$.

12 arms and 12 anchors (Fig. 13). The cross sections of the specimen show the hexamery of the internal structures, with 6 muscle strands, 6 infundibula and 6 radial pockets in the calyx, and 6 muscle strands and 5 radial canals (reduction of a canal on account of the confusion

of two opposite canals into a large canal) in the peduncle (Fig. 14-16). The specimen lacks the interrarial white stripes.

Localities. Many individuals were found attached to the sea-algae, *Laminaria longissima* and *Kjellmaniella gyrata* in the vicinity of the Akkeshi Marine Biological Station in August, 1933. Mr. T. HIKITA collected many specimens from the sea-weed *Phyllospadix scouleri* at Urakawa, Hokkaido, in August, 1933.

Remarks. The species is externally distinguished from others by the usual occurrence of the four interrarial white stripes and the shape of the anchors. In long-preserved specimens, the identification would be somewhat difficult, because the white stripes would be gradually faded out, while the shape of the anchors would become more or less deformed as seen in other species. Though this species bears some resemblances to *Haliclystus auricula*, it is easily distinguishable from the latter by the presence of white stripes, the shape of anchors, broadness of the peduncle, smaller number of white spots (nematocyst sacs) on the bell margin, and thicker layer of rod-shaped nematocysts in the wall of the infundibula. The figure of *Haliclystus tenuis* made by KISHINOUE (1910) is somewhat akin to this species. But from his brief description it is difficult to identify the specific name. Though the shape of marginal anchors is somewhat similar in both species, he gives no description of the white stripes. Moreover, he seems to have cut no section. So far as known, *Haliclystus auricula* is very common in these localities from which KISHINOUE's specimens were obtained, but there has never been found a single specimen of *Haliclystus borealis* in our collections from the localities.

Haliclystus steinegeri KISHINOUE Jap. name=¹⁾ Higasa-kuragé.

Body funnel-shaped with a rather short peduncle. Exumbrella well-expanded, smooth, and devoid of prominent clusters of gland or nematocyst cells. The mesogloea is fairly thick and rigid, especially in the calyx. Calyx conical and shorter than wide, gradually expanding towards its bell margin, showing almost a straight line from the

1) Higasa = parasol, kuragé = medusa.

base to the margin of the calyx in the living state, generally measuring 7-8 mm high and 10-12 mm wide. Umbrella margin divided into 8 adradial arms almost equally distant from the perradii and the interradii, and separated by comparatively shallow and wide notches as deep and broad in the interradii as in the perradii. Each arm with a terminal cluster of very numerous hollow tentacles, with younger ones in the axial portion, each provided with a stem and a

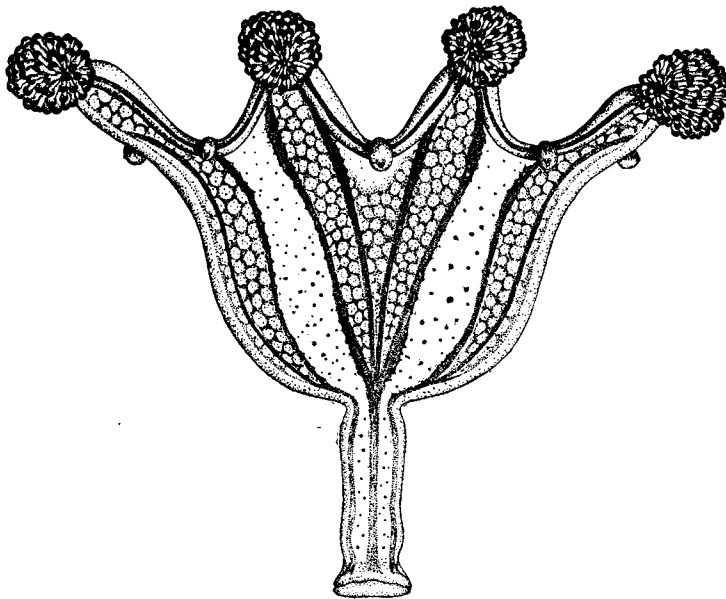


Fig. 17. *Haliclystus steinegeri* KISHINOUE; preserved specimen.

globular knob covered with nematocysts and gland cells at the distal end. The eight marginal anchors in the perradii and interradii are comparatively large, elliptical or oval, and a little higher than wide, measuring about one half as long as the diameter of the peduncle and having a short stem and a small spherical protuberance at the basal portion of the aboral side. The protuberance is indicated by the presence of a pigment fleck in the living state. The shape of these anchors is often shrunk in preserved specimens to form a small

tubercle at the upper (marginal) portion and a small invagination in the lower portion. White spots on the bell margin are very few in this species and are found only on the lateral sides of the base of the adradial arms. Subumbrella radially folded in preserved specimens, with four perradial swellings and eight adradial furrows, with a small number of conspicuous nematocyst sacs. Gonads eight in number, one in each adradius, extending from the arms to the base of the stomach, consisting of 90-120 comparatively small vesicles,

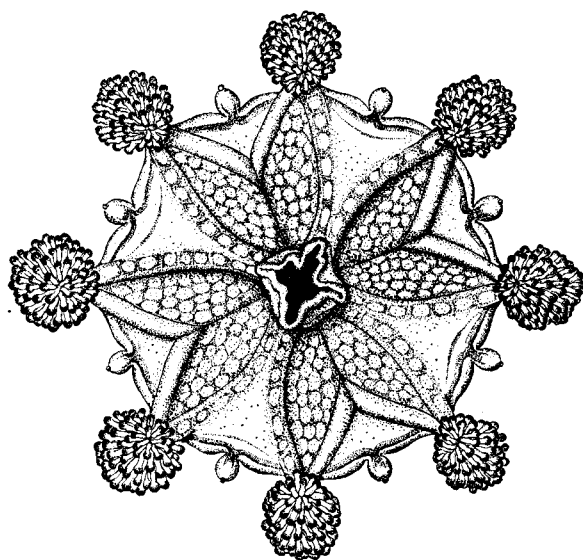


Fig. 18. *Haliclystus steinegeri* KISHINOUE; oral view of preserved specimen.

arranged in 3-10 (generally 3-6) irregular rows. These adradial rows of the vesicles are widest in the middle portion and are connected two by two in the interradii along the proximal half of their length, but are completely separated in the perradii. Manubrium four-sided, its free margin thin and folded several times. The gastral filaments are numerous and are arranged in eight vertical rows, one in each adradius. Four interradiial infundibula very short in this species. Peduncle rather short, quadrate in cross section, with four perradial

longitudinal chambers and four well-developed interradial muscle strands. The basal disc is expanded and nearly quadrate, with four round edges and four perradial constrictions. The measurement of preserved specimens is given in the following table.

Specimen	Length of calyx	Width of calyx	Length of peduncle	Number of secondary tentacles in each adradius
A	1 $\frac{2}{3}$ mm	$\frac{3}{2}$ mm	$\frac{1}{2}$ mm	0
B	2 mm	1 $\frac{1}{2}$ mm	$\frac{2}{3}$ mm	1-3
C	2 mm	2 $\frac{1}{3}$ mm	$\frac{2}{3}$ mm	16
D	3 mm	4 mm	$\frac{2}{3}$ mm	50
E	5 mm	7 $\frac{1}{2}$ mm	1 $\frac{2}{3}$ mm	60
F	6 $\frac{1}{3}$ mm	10 mm	2 $\frac{1}{3}$ mm	93
G	9 $\frac{1}{2}$ mm	10 mm	2 mm	about 100

Colour of the body generally reddish brown and prominently marked with eight vertical pairs of deep brown stripes running nearly on the margin of the gonads. Each interradial stripe of these brown pairs is separated in the upper half (near margin) but unites with the others along the lower half into an interradial stripe which extends into the peduncle. The brown stripes near the perradii are generally wider and more conspicuous than the interradial ones. The peduncle is similar in colour to the calyx. Secondary tentacles more reddish than the calyx and deeply coloured in their head. Anchors white with a reddish brown fleck on the outer side of each aboral part. In long-preserved specimens the stripes are faded out and the whole body is dull brown and semi-transparent.

Internal anatomy. The ectoderm cells of the exumbrella are generally similar and cylindrical, comprising a few ovoid nematocysts. The subumbrellar ectoderm cells are slightly granulated but are in general similar to the exumbrellar ones. The basal disc of the peduncle is composed of high cylindrical cells which are very modified, glandular and fibrous. The ectoderm bordering on the infundibula is high and granulated, containing numerous rod-shaped nematocysts and some ovoid nematocysts.

The mesogloea is thin in the calyx but thick in the peduncle, both rigid and fibrillated. Adjacent to the exumbrellar endoderm layer is found a circular fibrous layer well-stained by haematoxylin. The circular muscle in the bell margin is diffused but well-developed in the subumbrella. The interrarial longitudinal muscles are in cross section circumscribed or heart-shaped in the lower part of the peduncle, while they are elliptical and smaller near the pyloric region where the jelly is much more massive. The transversal section of these

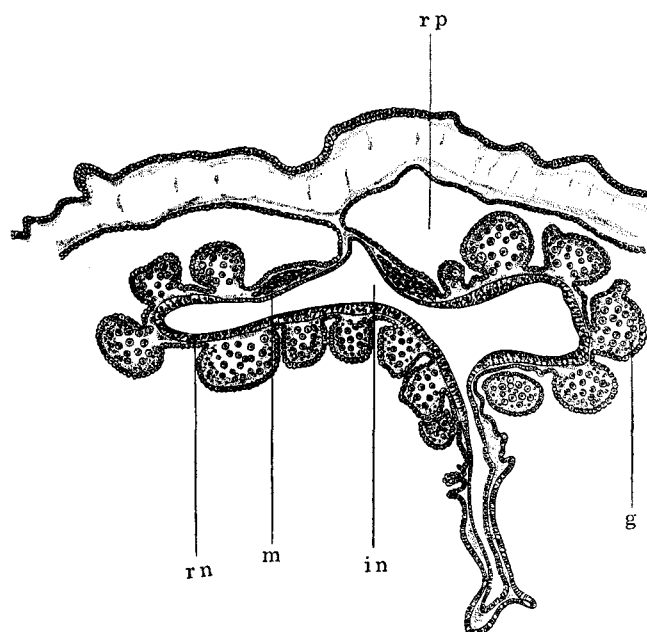


Fig. 19. *Haliclystus steinegeri*; horizontal section of a quadrant of calyx. $\times 150$; g gonad, in infundibulum, m muscle, rn rod-shaped nematocyst, rp radial pocket.

muscles in the calyx is small in the basal part but becomes gradually bilobed. The muscles are soon divided into two portions in the calyx and each part extends into the mesogloea in the inner wall of the four perradial pockets, forming eight adradial bands of some length, so that the mesogloea is very thin and is wholly destitute of muscles at the interradii near the margin (Fig. 19). The

longitudinal muscles of such type are known in European species *Haliclystus octoradiatus*, but are not present in the Japanese species, *H. auricula* and *H. borealis*. The nematocyst sacs containing ovoid nematocysts are few in number and are found only near the base of the arms.

The endoderm cells are slightly higher than the ectoderm cells and are mostly granulated, especially in the peduncle. In the endoderm layer surrounding the gonad are found several vesiculated and pigmented cells.

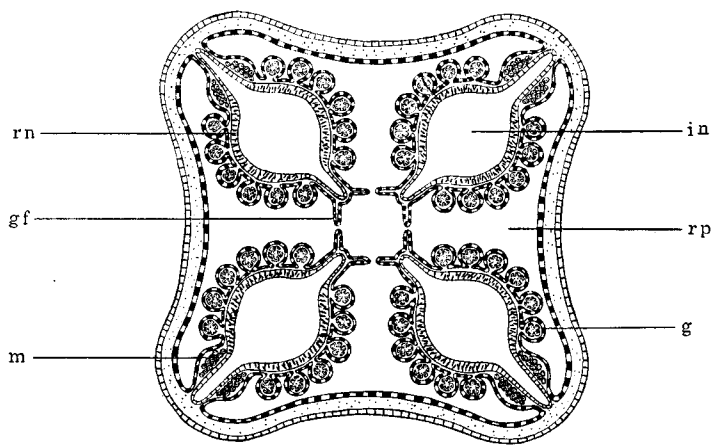


Fig. 20. *Haliclystus steinegeri*; schema of horizontal section through lower part of calyx; g gonad, gf gastral filament, in infundibulum, m muscle, rn rod-shaped nematocyst, rp radial pocket.

As shown in cross section of the calyx, the well-extended adradial muscles and the genital succules arranged in comparatively numerous rows are the remarkable characters in this species (Fig. 20). Besides them, the infundibula are very short and wide, compared with those of *H. auricula* and *H. borealis*, and are terminated a little lower down than the buccal cavity. The four chambers in the peduncle are very small in transversal section.

The structure of the anchors is particularly characterized by the presence of the abaxial protuberance. The ectoderm is generally

composed of narrow supporting cells arranged in 2-3 vertical rows (Fig. 21) and large vesiculated gland cells which are especially arranged in succession on both sides of the protuberance (Fig. 22). The protuberance is spherical and is composed of supporting cells, granulated gland cells and a few ovoid nematocysts. In the mesogloea just below the anchor there are found several endodermal cells thickly granulated, making several longitudinal rows. The endodermal

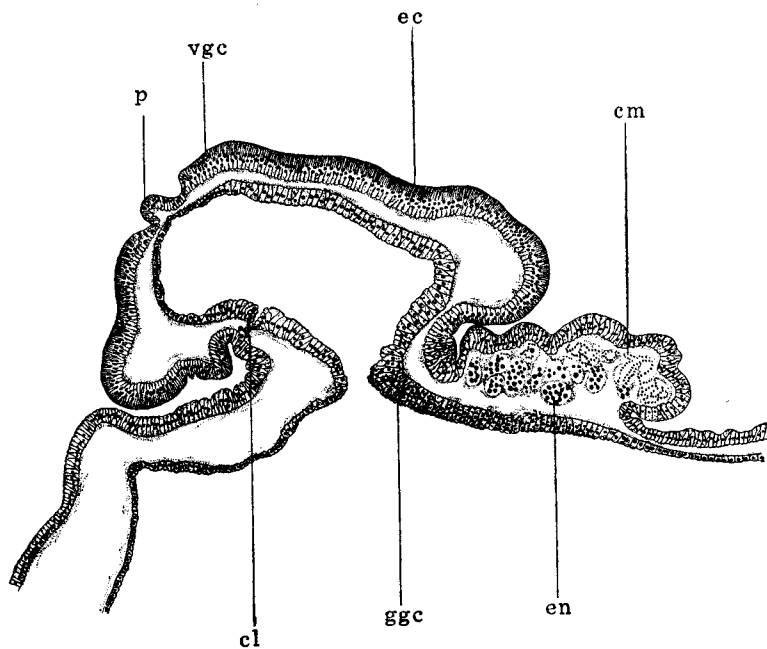


Fig. 21. *Haliclystus steinegeri*; sagittal section of anchor. $\times 266$; cl cellular lamelle, cm circular muscle, ec ectoderm, en endoderm, p protuberance of anchor, vgc vesiculated gland cell.

cells are those of the future secondary tentacles. The mesogloea is a little fibrous. The endoderm cells are generally high and granulated, but are in the part corresponding to the protuberance low and vesiculated.

The knob of the secondary tentacles consists of supporting cells, granulated cells, rod-shaped nematocysts and ovoid nematocysts. The

structure of the tentacle stem agrees in the main part with that of the former species.

The manubrium is four-sided. The outer ectodermal cells are generally low and similar in structure to those of the exumbrella. The mesogloea is very thick and slightly fibrous. The inner ectodermal layer is four sided, consisting of supporting cells and many vesiculated cells. The perradial corners, destitute of vesiculated cells, are furnished with granulated cells which are higher than the former and sometimes sprinkled with pigment.

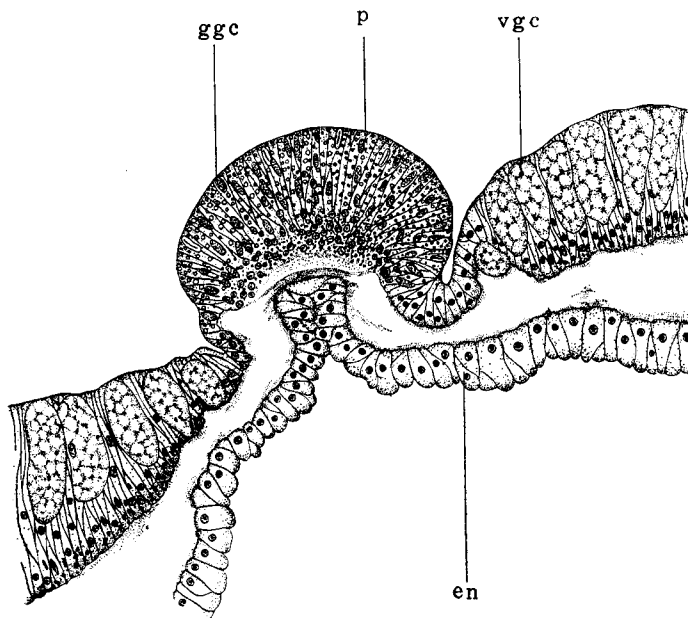


Fig. 22. *Haliclystus steinegeri*; horizontal section of anchor with protuberance. $\times 1500$; en endoderm, ggc granulated gland cell, p protuberance, vgc vesiculated gland cell.

The gastral filaments are elliptical and lined on one side with high granulated and on other side with low granulated cells.

The gonads are formed of many ellipsoidal succules which are arranged in generally 3-6 irregular longitudinal rows. The structure of each succule is in general equal to that of other species.

Young forms. We were fortunate enough to be able to examine a young specimen in which the eight anchors are already present but the secondary tentacles do not as yet make their appearance. The measurement of this specimen (A) is given in the table on page 227. The peduncle of the specimen is still in the lowest portion single-chambered, with undifferentiated endoderm cells surrounding the

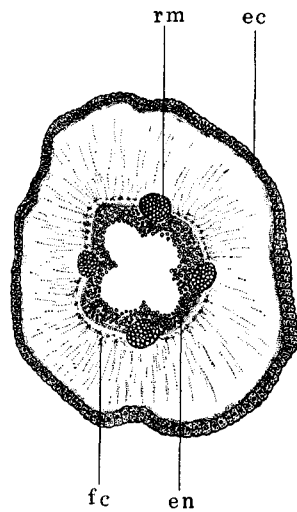


Fig. 23

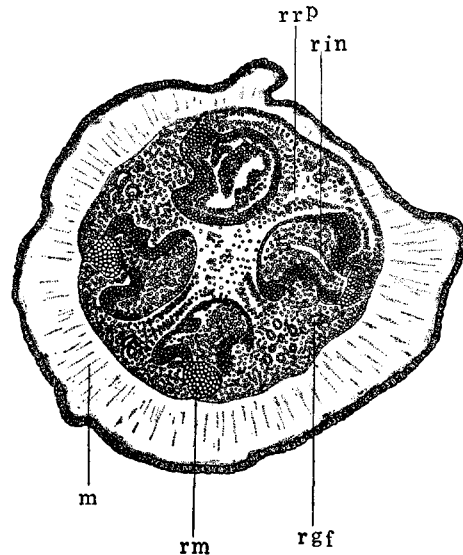


Fig. 24

Fig. 23. *Haliclystus steinegeri*; horizontal section through lower part of calyx of young specimen (A). $\times 150$; ec ectoderm, en endoderm, fc fiber cell, rm rudimentary muscle.

Fig. 24. *Haliclystus steinegeri*; horizontal section through calyx of the same specimen (A). $\times 150$; m mesogloea, rgf rudimentary gastral filament, rin rudimentary infundibulum, rm rudimentary muscle, rrp rudimentary radial pocket.

chamber, semi-differentiated muscle cells making four large interradian groups. In the middle portion the peduncle is four-chambered in a short length and becomes again single-chambered, with round narrower muscle strands and thick hyaline mesogloea which still contains fibrous cells sparsely distributed around the endoderm cells (Fig. 23). In cross section through the median part of the calyx, the stomach

cavity and the rudimentary infundibula are found filled with many undifferentiated cells, but the four rudimentary interradial muscles and gastral filaments are already distinguishable (Fig. 24). In this stage the mesogloea is very thick. The transverse section near the margin is provided with eight processes containing many vesiculated

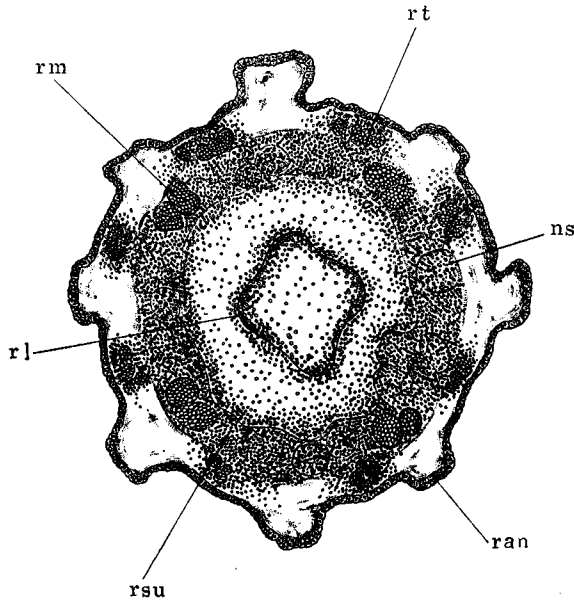


Fig. 25. *Haliclystus steinegeri*; horizontal section near marginal portion of calyx of the same specimen (A). $\times 150$; ran rudimentary anchor, rm rudimentary muscle, rl rudimentary lip, rsu rudimentary subumbrella, rt rudimentary tentacle, ns nematocyst sac.

cells, which correspond to the anchors. Alternate in position with these processes, the rudimentary secondary tentacles are seen as undifferentiated endoderm cells making eight adradial clusters (Fig. 25). The fact reminds us of the arms of *Lipkea* in which the secondary tentacles are rudimentary even in the adult and are represented by only the endoderm layer imbedded in the gelatinous substance, as pointed out by Carlgren (1933). The rudimentary interradial muscles are already divided into two and the nematocyst sacs are formed at

the base of the secondary tentacles. The subumbrella and the manubrium are now in the process of the formation by clustering of undifferentiated cells in their corresponding places. In the specimen (B) with one or three secondary tentacles in the bell margin, the peduncle is for the most part already furnished with four obscure narrow chambers made by undifferentiated cells. In the basal portion, however, it is single-chambered with a cross-shaped lumen and be-

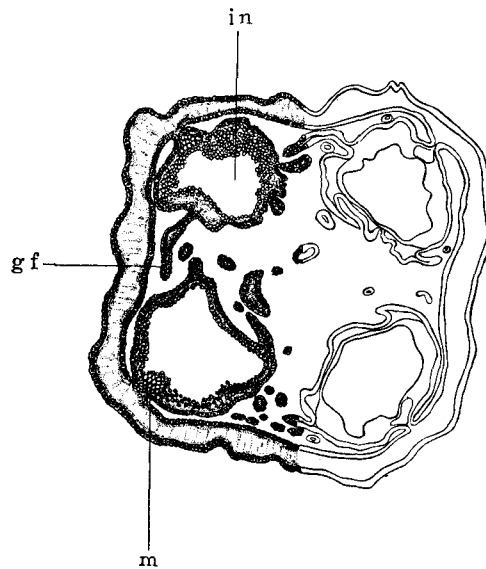


Fig. 26. *Haliclystus steinegeri*; horizontal section through middle part of calyx of young specimen (B). $\times 150$; gf gastral filament, in infundibulum, m muscle.

comes gradually upwards two- and three-chambered by the confusion of one or two canals with the central canal. The infundibula of the calyx are, though not completed, clearly formed (Fig. 26), and evagination of the rudimentary genital succules has already taken place (Fig. 27). In the specimen (C) with 16 secondary tentacles in each arm, the peduncle is four-chambered except for the very lowest portion. The subumbrellar ectodermal and endodermal cells are not yet well-differentiated but the general form of the adult is already made.

Localities. KISHINOUE (1887) was the first to describe the species basing his observations on specimens obtained from the Commander Island, and BIGELOW (1920) afterwards reported two specimens from Port Clarence, Alaska. In 1929 UCHIDA recorded the species from Cape Moshia, North Saghalien. The species is not uncommon in

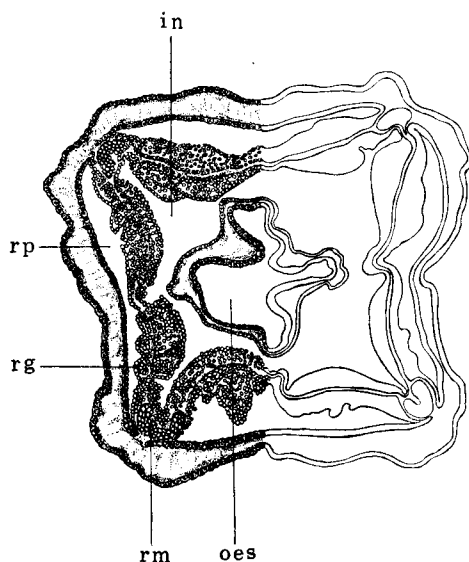


Fig. 27. *Haliclystus steinegeri*; horizontal section of the same specimen (B) through calyx much higher than Fig. 26. $\times 150$; in infundibulum, m muscle, oes oesophagus, rg rudimentary gonad, rp radial pocket.

Akkeshi in July-August, attaching to the sea-algae together with former species. Specimens in our collection involve those collected by S. SATO together with *Haliclystus auricula* and *Thaumatoscyphus distinctus* from Abashiri in August, 1933, those obtained by S. OKUDA in July, 1933 in Muroran and those caught by T. HIKITA with *Haliclystus borealis* from Urakawa in August, 1933. The three latter localities are in Hokkaido.

Remarks. The species is easily distinguishable from other species by its wide calyx, short peduncle, shape of anchors, presence of a protuberance in anchors, numerous secondary tentacles, many genital

succules arranged in comparatively numerous rows, and the longitudinal muscle strands, which are circumscribed in the peduncle and are divided into eight adradial well-expanded bands in the calyx.

Distribution of the Stauromedusae in Japan

The Stauromedusae are known as one of the animal groups of which the distribution is limited to the arctic or antarctic regions. In UCHIDA's last paper (1929, p. 186) it is stated that the southern limit of their distribution in the northern hemisphere in the Atlantic, as known at present, is the Canary Islands (ca. 28° N) where *Depastrum cyathiforme* occurs, and in the Pacific Gogoshima near Matsuyama (ca. 33° N) where *Kishinouyea nagatensis* and *Haliclystus auricula* were recorded. Recently Mr. K. BABA kindly sent me a specimen of *Stenoscypus inabai* collected in the vicinity of the Amakusa Marine Biological Station in Tomioka ($32^{\circ} 32'$ N). Tomioka has, therefore, been the southern limit of the stalked medusae hitherto known in the Pacific of the Northern hemisphere.

The distribution of the Japanese species of the Stauromedusae is as follows:

Stenoscypus inabai; Tomioka, Gogoshima, Kataura, Misaki, Asamushi, Oshoro.

Haliclystus auricula; Gogoshima, Gokasho, Asamushi, Muroran, Oshoro, Rishiri, Abashiri; in America, Norton Sound (Alaska), New England; in Europe, northern coasts.

Haliclystus steinegeri; Muroran, Akkeshi, Abashiri; in North Saghalien, Cape Moshia; in Alaska, Port Clarence.

Haliclystus borealis; Urakawa, Akkeshi.

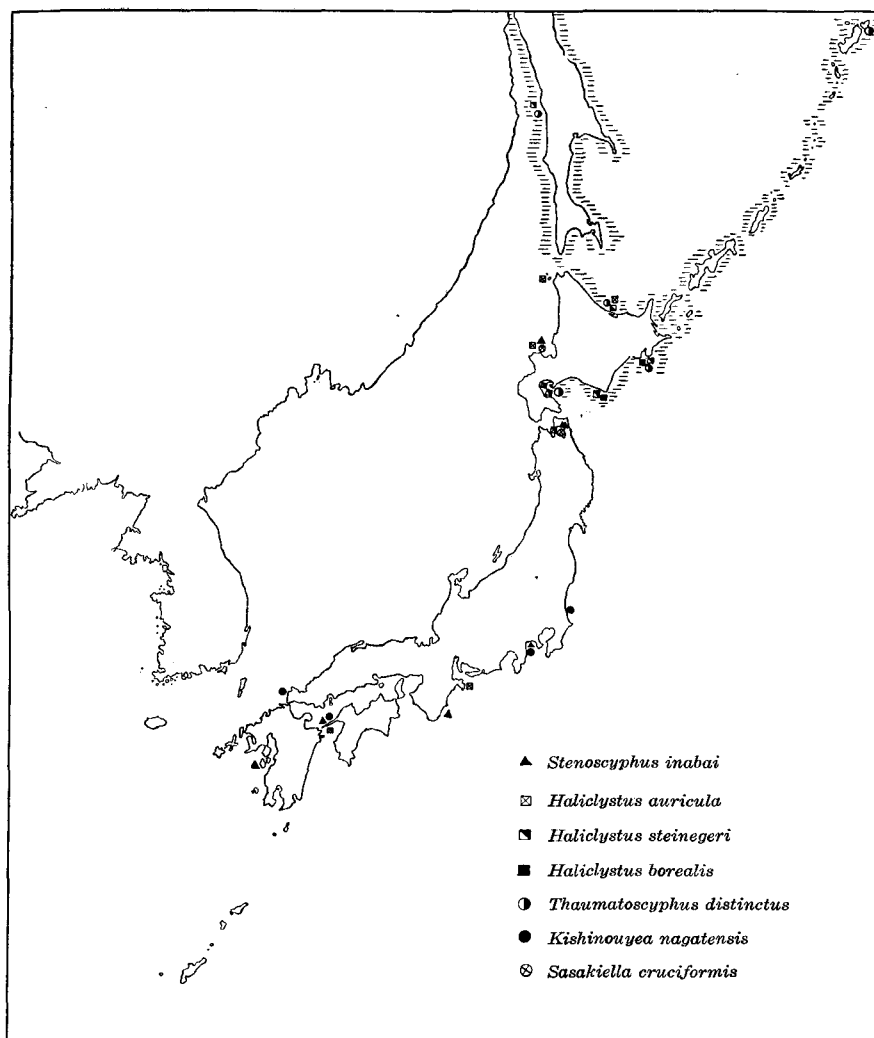
Thaumatoscyphus distinctus; Muroran, Akkeshi, Abashiri; in the Kuriles, Shumushu; in North Saghalien, Cape Moshia.

Kishinouyea nagatensis; Gogoshima, Kogushi, Misaki, Mito.

Sasakiella cruciformis; Asamushi, Oshoro.

Influenced by the two main currents, the Kuroshio (warm current) running from south to north and the Oyashio (cold current)

from north to south, the fauna of Hokkaido coasts is very different in the different localities. On the western coasts (e.g. Oshoro) several temperate animals are found, which are common on the coasts of



Map showing the distribution of Stauromedusae in Japan.

Honshu, especially the north-western coasts and Mutsu Bay. For instance, the scyphomedusae, *Aurelia aurita* and *Charybdea rastonii*, which are very common around Honshu, Kyushu and Shikoku, occur in

Oshoro. However, the north-eastern and south-eastern coasts of Hokkaido are rather similar in their fauna to those of Saghalien and the Kurile Islands. In Muroran, which is situated southward from Oshoro, such a tropical form as *Charybdea* is not found. Moreover, in place of the temperate species *Aurelia aurita* there occurs *Aurelia limbata* which is widely distributed in the North Pacific such as the Okhotsk and Bering Seas.

In respect to their geographical distribution, we can distinguish three groups of Stauromedusae: cosmopolitan, temperate and boreal. For the first time, *Halicyclustus auricula*, which is widely distributed in the Atlantic and the Pacific, ranging from ca 32° N to ca 64° N, seems to be a rather cosmopolitan species. *Kishinouyea nagatensis* is a typical temperate form and its distribution is limited only to warm middle or southern coasts of Japan. The distribution of *Stenoscaphus inabai* is generally paralleled with that of *K. nagatensis*, but the former species occurs also in Mutsu Bay and Oshoro, both belonging to rather temperate regions. Though *Sasakiella cruciformis* is found only in Mutsu Bay and Oshoro, it is probably a temperate inhabitant. *Halicyclustus steinegeri* and *Thaumatoscyphus distinctus* indicate the parallelism in distribution; they have never been found in Mutsu Bay and Oshoro but are known on the north-western and south-western coasts of Hokkaido, Saghalien, the Kurile Islands and northwards through the Commander Islands to Alaska (*H. steinegeri* only). It is, therefore, to be assumed that these two, probably together with *Halicyclustus borealis*, are boreal in their distribution.

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