THE DANISH
INGOLF-EXPEDITION.

VOL. V, PART 8.

CONTENTS:

P. L. KRAMP: MEDUSÆ.

PART I. LEPTOMEDUSÆ.

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THE DIRECTION OF THE ZOOLOGICAL MUSEUM OF THE UNIVERSITY.

COPENHAGEN.

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THE DANISH INGOLF-EXPEDITION.

VOLUME V.

8.

MEDUSÆ.

PART I.

LEPTOMEDUSÆ.

BY

P. L. KRAMP.

WITH 5 PLATES, 17 FIGURES IN THE TEXT, AND 14 MAPS

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CONTENTS

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Introduction.

In the present paper as also in one or two more to be published later on, the Medusæ from the northern Atlantic and adjacent waters will be dealt with. Owing to various casual circumstances the group of the Leptomedusæ has been worked up as the first. The geographical area, dealt with in the said works, comprises: the Atlantic Ocean north of Lat. 50° N., the Davis Strait, the western part of the North Sea, the Norwegian Sea, and the Polar Sea as far eastwards as the Kara Sea. The choice of the southern limit is rather gratuitous. The medusæ from the British Channel are going to be mentioned in the "Report on the Danish Oceanographical Expeditions 1908—1909 to the Mediterranean and adjacent Waters", dealing with the fauna of the Mediterranean and the Atlantic from the coast of Morocco to the British Channel. Moreover I am preparing a work on the medusæ of the Danish waters; in the present paper, therefore, I have only included some few summary remarks on the medusæ from that area.

The present paper is based particularly on the collections in the Zoological Museum of the University of Copenhagen. Besides I have made use of a smaller collection of medusæ belonging to the Plankton Department of the Danish Commission for Investigation of the Sea. For the admission to that collection I owe my best thanks to Professor C. H. Ostenfeld, the Director of the Plankton Laboratory. Moreover, during a stay in Bergen in the summer of 1916 I studied the exceedingly interesting material of medusæ collected during the first cruise of the M. S. "Armauer Hansen" in the Atlantic west of Rockall in 1913; some of the specimens were sent to me to Copenhagen for further investigation. With the permission of Professor A. Brinkmann the results of my studies have been included in the present paper. I wish to express my best thanks to Professor Brinkmann for that permission.

Some years ago I was commissioned to work up the Anthomedusæ and Leptomedusæ from the "Michael Sars" North Atlantic Deep-Sea Expedition 1910. The paper was finished in 1915, and the printing was nearly accomplished, when the great fire in Bergen on January 15th 1916 destroyed the matter in type; the printing has not yet been resumed, and as certain parts of the material dealt with in that paper are of considerable interest with regard to the problems discussed in the present work, I have made use of that material to such an extent as I found suitable.

Some of the material in the Zoological Museum of Copenhagen has previously been worked up and mentioned in the literature. Some older material has been examined by E. Haeckel and mentioned in his System der Medusen. The museum possesses a list of that material, to which Haeckel himself has added the identifications of the species. The numbers in the list are refound in the labels of the specimens. The said list is of considerable interest, as far as it has rendered it possible to correct some of Haeckel's identifications. The medusæ from Greenland were dealt with by G. M. R. Levinsen in "Meduser, Ctenophorer og Hydroider fra Grønlands Vestkyst" 1892, and, later, by the present author in "Medusæ collected by the "Tjalfe" Expedition" (1913), and "Meduser og Siphonophorer" in Conspectus Faunæ Groenlandicæ (1914). The last-mentioned paper includes a complete account of the literature relating to the medusæ of the waters of Greenland.

Besides the older material, the collections of the following expeditions have been employed in the present paper:

Wm. Lundbeck, 1892 (Iceland).

Danish "Ingolf" Expedition, 1895 and 1896 (Faeroe Islands, Iceland, and Greenland).

Inspecting-ship "Diana", A. Ditlevsen, 1902 (Iceland).

"Michael Sars", Ad. S. Jensen, 1902 (Norway and Iceland).

"Michael Sars", 1903 (Norwegian Sea).

Inspecting-ship "Beskytteren", C. V. Otterstrøm 1903, K. J. Gemzoe 1904, and F. Johansen 1905 (Iceland).

"Thor", fisheries-investigations 1903, 1904, 1905, 1906, and 1908 (British Isles, Norway, Faeroe Islands, Iceland).

"Tjalfe", 1908 and 1909 (West-Greenland).

"Armauer-Hansen", Norwegian research motorship, 1913 (West of Rockall).

The state of preservation of the material has partly been very satisfactory (formalin), particularly as far as the collections of the "Thor" and the "Tjalfe" are concerned. The material of the "Diana" is likewise generally well preserved, though it has only been treated with alcohol; the same testimony is partly applicable to the material from the "Beskytteren" collected by Gemzoe. The material from the "Ingolf" Expedition, on the other hand, is as a rule very badly preserved. Especially a great lot of specimens have been spoiled owing to the usage of osmic acid or Flemmings solution. As a matter of fact, these substances have quite a ruinous effect on medusæ, particularly so if the dissolution is too concentrated and the specimens are exposed to the influence of the fluid during a too long space of time. Not merely the pigmentation is concealed, but the animals become intransparent and very much fragile, and must be handled with the utmost care not to break during the examination. Indeed, still during the transportation in the glasses a great part of the material has been shaken into small fragments. Neither are the single organs better hardened for investigation by this method of preparation; I have tried sectioning on microtome different organs of specimens treated with Flemmings solution, and the tissues are by no means better preserved, rather more badly if anything, than in the case of animals merely preserved in common alcohol or formalin. The method of treating medusæ with fluids containing osmic acid seems to have been very favourite during a certain period; on account

of sad experiences, I take this opportunity to warn against the use of these substances for preparation of medusæ.

In the case of such species, of which no modern descriptions have been given, I have carried out thorough examinations of the morphology, as far as the state of preservation has rendered such examination possible. Also in the case of well-known species I have in some cases discovered interesting structures, hitherto unobserved. It is really astonishing, how most medusæ are deficiently known with regard to their morphology. It is a well-known fact, that the classification of the Leptomedusæ is extremely difficult. I am quite aware, that a correct understanding of the systematical problems must be searched for not only through hatching experiments, by means of which we get knowledge of the connection between the hydroids and the medusæ, but also through thorough comparative-morphological investigations. As a matter of course, I cannot, in the present paper, enter into a discussion of the great and complicated systematical problems; my present knowledge of other forms of medusæ than the northern species is too deficient yet for such an undertaking. But it is my hope, that my investigations, when in course of time they are followed by others, may contribute to that understanding which, we may hope, must be reached once in the future.

In some cases I have discussed the history of a species or genus in order to remove existing confusion or to state the correct name of the species or genus in question.

The number of species of Leptomedusæ, identified with certainty, and occurring in the north-atlantic area here dealt with, amounts to a little more than 25. In the material examined by me 15 species are represented, excluding the non-identified species of *Obelia*. They belong to the families *Laodiceidæ*, *Thaumantiadæ*, *Mitrocomidæ* and *Eucopidæ*. The family of the *Equoridæ* is not represented. In order to give a picture, as complete as possible, of the north-atlantic fauna of medusæ, I have included the species of which no material has been at my disposal, but which, according to the literature, occur within the area in question. For such species, I give a short diagnosis, mainly derived from A. G. Mayer, Medusæ of the World, 1910, together with summary remarks on their distribution.

The following 15 species have been examined:

Chromatonema rubrum Fewkes
Laodicea undulata (Forbes & Goodsir)
Ptychogena lactea A. Agassiz
Staurophora mertensii Brandt
Melicertum octocostatum (M. Sars)
Mitrocoma polydiademata (Romanes)
Cosmetira pilosella Forbes
— megalota (Maas)
Halopsis ocellata A. Agassiz
Tiaropsis multicirrata (M. Sars)
Obelia nigra Browne
Phialidium hemisphæricum (Gronovius)
— islandicum nov. spec.
Eutonina indicans (Romanes)
Tima bairdii (Johnston)

Moreover the following species have been included (printed with Petit):

Dipleurosoma typicum Boeck
Agastra mira Hartlaub
Eucope globosa (Forbes)
Eucheilota maculata Hartlaub
Saphenia gracilis (Forbes & Goodsir)
Eutima insignis (Keferstein)

Eutima elephas (Haeckel)
Octorchis gegenbauri (Haeckel)
Eirene viridula (Péron & Lesueur)
Æquorea forskålea Péron & Lesueur
Zygodactyla groenlandica (Péron & Lesueur)

Family Laodiceidæ Browne.

"Leptomedusæ with cordyli, commonly called sensory clubs, on the margin of the umbrella" (Browne 1907, p. 459).

Browne has, no doubt correctly, ascribed the significance as a family-character to the peculiar organs called cordyli. Before I enter into a further discussion of these interesting organs, I will, for the sake of comparison, shortly call attention to the structure of another kind of marginal appendages, occurring in several Leptomedusæ: *viz.* the Cirri. A cirrus is lengthened, thread-shaped, and is always inserted directly on the margin of the umbrella without possessing a basal bulb. The entoderm of the cirrus is in connection with the entoderm of the circular vessel, and it is solid (not hollow), consisting of a single series of cylindrical or disk-shaped entoderm-cells. The ectodermal epithelial cover is very delicate, consisting of flattened polygonal cells. The cirri carry nematocysts, usually in considerable number, and particularly towards the distal end. The distal part of the cirrus may, as a rule, be spirally curled up.

A typical, fully developed Cordylus is club-shaped with a thin stalk and a swollen distal part; it may or may not be mounted upon a small tubercle on the bell margin. In opposition to the cirrus, it possesses a hollow central space which, however, may be more or less obliterated; particularly the lumen has often entirely disappeared in the narrow part, the lumen of the distal thick part thus being separated from that of the circular vessel. The entoderm consists of a single layer of large, usually cubical cells surrounding the central lumen. The ectoderm is fairly thin, but not so thin as the ectoderm of a cirrus. There are no nematocysts. This is the shape of a typical cordylus. A very interesting kind of cordylus, not so highly developed, has been observed by Browne in *Ptychogena antarctica* Browne (Browne 1910). The cordyli of that species, as figured by Browne (Plate 2, figs. 7—9) do not possess the well-marked club-shaped appearance as in the case of the typical cordyli, but are only slightly more thickened distally than proximally; moreover, in some of them nematocysts were found.

I am of opinion, that the small marginal appendages in *Chromatonema rubrum* indicate a still lower stage of development of cordyli (see Plate I, figs. 2 and 3). They differ from typical cordyli by the possession of a cluster of nematocysts in the distal end and by the general shape which is cylindrical or spindle-shaped. But the ground plane, the structure of the cell-layers, is exactly as in a cordylus. Through the cordyli of *Ptychogena antarctica*, mentioned above, as the transitional form they may, I think, without difficulty be homologized with real cordyli. They may not be called cirri, as they have a central lumen, and because they are short and rigid. In a nearly related species, *Chromatonema erythrogonon* (*Ptychogena erythrogonon* Bigelow), further mentioned below, Bigelow found a few cylindrical "cirri" with nematocysts and, besides, a number of spindle-shaped "cordyli" without nematocysts. Excepting the lacking of nematocysts, these cordyli have exactly the same shape as those of *Chromatonema rubrum*, and they occupy a corresponding position on the bell margin.

Thus they must undoubtedly be characterised as another transitional form, somewhat further advanced than the corresponding organs in *Chromatonema rubrum*. — In another nearly related species, *Chromatonema hertwigi* (*Ptychogena hertwigi* Vanhöffen, see below) the same organs are, according to the figure, partly cylindrical, partly spindle-shaped, partly somewhat club-shaped; Vanhöffen calls them "cirri".

Thus we find, within the *Laodiceidæ*, a series of transitional forms of cordyli from cylindrical or spindle-shaped with a distal cluster of nematocysts (*Chromatonema rubrum*) through spindle-shaped or slightly club-shaped with or without nematocysts, to the fully developed form: actually club-shaped without nematocysts.

As different points of connection exist between the *Laodiceidæ* and the *Tiaridæ*, as will presently be demonstrated, it is a natural question, whether anything corresponding to cordyli is found among the latter. We will find then, that a single form of *Tiaridæ* possesses certain organs, which bear a considerable likeness to the lowest form of cordyli, those of *Chromatonema rubrum*. The species in question is *Tiaranna rotunda* (Quoy & Gaimard).

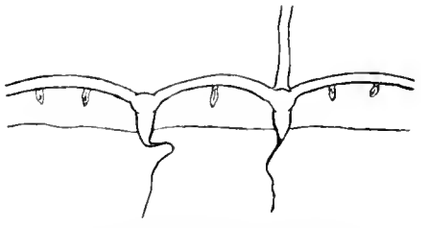


Fig. 1. Part of the bell-margin of *Tiaranna rotunda* Quoy & Gaimard).

I deeply regret that my paper on the Anthomedusæ and Leptomedusæ of the "Michael Sars" Expedition 1910 has not yet been printed, as two species of the interesting genus *Tiaranna* have been dealt with in that paper; a reference to the accounts of these species would have facilitated the following discussion on the relation between the *Tiaridæ* and the *Laodiceidæ*. As especially *Tiaranna rotunda* is of great interest in this respect, I have thought it better to make use, in this place, of my observations relating to the matter in spite of the fact, that they are destinated for printing in another place.

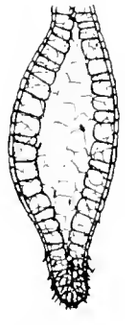


Fig. 2. Dwarf-tentacle of *Tiaranna rotunda* (Quoy & Gaimard), with numerous nematocysts at the distal end.

The marginal appendages of *Tiaranna rotunda* (textfig. 1) are very much like those of *Chromatonema rubrum*. Between every successive pair of tentacles in *Tiaranna rotunda* there are one or two minute appendages like the cordyli of *Chromatonema*, only they are never cylindrical, but always spindle-shaped, and provided with a tenon-like distal part greatly armoured with nematocysts (textfig. 2). The structure of the cell-layers is exactly as in the cordyli of *Chromatonema*. Dwarf-tentacles of a similar shape, though more lengthened, are found in *Bythotiara*.

Hartlaub (1897) considered cordyli to be juvenile stages of tentacles, and he meant to have observed the development of cordyli into tentacles in *Staurophora mertensii*. Browne has discussed this question in his paper, Revision of the ... *Laodiceidæ* (1907, p. 458). Browne has examined a large number of specimens of *Laodicea undulata* (early and intermediate stages). He is of opinion, that transformation of cordyli into tentacles does not take place normally, though such transformation may happen when the margin of the bell is overcrowded with marginal organs; in such case a cordylus may stand in the way of a developing tentacle and may, thereby, be lifted up by the growing bulb and become situated on the distal end of the young tentacle; afterwards it gradually loses its rounded form and is finally absorbed. Browne rightly remarks: "If cordyli are the forerunners of tentacles one would naturally expect to see them in the earliest stage or in the very early stages; but they do not make their appearance

until the Medusa has at least trebled the original number of its tentacles". Only in very few cases Browne found cordyli being converted into tentacles; on the other hand, I have observed several cases of the same phenomenon in *Staurophora mertensii*. Plate III fig. 7 illustrates different stages of cordyli being converted into tentacles in a specimen from Iceland. Fig. 7 a shows a normal cordylus without basal bulb; in fig. b is seen a normal cordylus mounted upon a young bulbus; figs. c—f illustrate some stages of the further development into a young tentacle, the distal part of which is still distinctly club-shaped; in stages, still further advanced, I have seen the bulbous terminal part in a state of absorption. On the other hand, I have also seen numerous young tentacles with an entirely pointed terminal part, tentacles which have, accordingly, never had any connection with cordyli. As a result of my investigations I may state, I believe, that Browne's view of this question is correct, though in species in which the marginal organs are very densely crowded, it will very frequently happen, that cordyli are picked up by developing tentacles.

According to Browne, the family *Laodiceidæ* comprises the following genera: *Laodicea*, *Staurophora*, *Ptychogena*, *Toxorchis*, *Staurodiscus*, and *Melicertissa*. To these we may add, I believe, the genus *Chromatonema*. Among the genera mentioned by Browne, I know only the three first by autopsy; the three others I have never seen. I will, therefore, not enter into a general account of the comparative morphology of the family. But from my studies on the species, represented in the material at my disposal, I shall call attention to certain parallels to structures within the family *Tiaridæ*, parallels which, after my opinion, render it probable, that the *Laodiceidæ* have taken their origin from that group.

One feature, common for the *Laodiceidæ* (the species examined by me) and the proper *Tiaridæ* (the *Neoturridæ* sensu Hartlaub) is the wide, open mouth tube, the free margin of which is more or less crenulated (except in the lower forms among the *Tiaridæ*), often complexly folded. The perradial corners of the mouth is, in most forms, more or less drawn out into four lips. Another common feature is the fact, that the manubrium is attached to the subumbrella along the arms of a perradial cross.

In the *Tiaridæ* the gonads are developed into folds or grooves in the walls of the stomach. Typically these grooves are arranged in the shape of four horse-shoes, the middle curves of which are placed interradially on the upper (proximal) part of the manubrium, while the arms go downwards along both sides of the perradial edges of the stomach. From this type the arrangement may be further developed in a more or less complicated manner. In some of the *Calycopsidæ* the horse-shoe-shape has been obliterated, because no sexual products are developed in the interradial parts, the gonads thus being arranged as eight adradial rows of sacks.

A characteristic structure in many *Tiaridæ* are the so-called "mesenteries", a double membrane connecting a greater or lesser part of the perradial edges of the stomach with the radial canals. These mesenteries are very differently developed in the different forms of *Tiaridæ*. In the lower forms they are quite absent; they are well-developed in such higher organized forms as *Leuckartiara*, *Catablema*, *Neoturris*, *Pandea* etc. If we imagine the mesenteries so far lengthened, that they reach as far downwards along the edges of the stomach as the gonads and, at the same time, just as far outwards along the radial canals, and if we fancy, thereafter, that they become narrowed in a dorso-ventral direction, the edges of the stomach will be drawn outwards towards the radial canals and, at last, coincide with the latter. That is, in fact, what we find in *Tiaranna rotunda* and *affinis* (figures of these

species are given in my paper on the Anthomedusæ and Leptomedusæ of the "Michael Sars"). Now it is not difficult to fancy a transition from the facts as established in these species to the type of gastrogenital organs found in most *Laodiceidæ*. If the gonads disappear in the interradial parts, we have, on each side of the radial canals so far as these are connected with the edges of the stomach, a series of gonadial folds, forming together a continuous, folded band along the part of the canal concerned. An outward displacing (towards the bell-margin) of these gonads will have the effect, that the proximal ends are somewhat withdrawn from the centre of the umbrella, while the distal ends, being removed outwards, will drag along with them the adjacent parts of the wall of the stomach, forming a funnel-shaped extension of the stomach along the lower side of each of the radial canals. Then we have the type, which is found in *Ptychogena* and *Laodicea* (see below). The modification of this type within the different forms, here dealt with, will be mentioned below under the descriptions of the species.

The emancipation of the gonads from the stomach is not so far advanced in the *Laodiceidæ* (the species here described) as in the other Leptomedusæ; this indicates a lower systematical position nearer to the Anthomedusæ. In *Laodicea*, *Ptychogena* and *Staurophora* the gonads are developed in folds of the lateral walls of the radial canals; in the case of the two first mentioned genera the proximal parts of the gonads are frequently developed in the walls of the stomach along both sides of the lines (the cross-shaped figure) by which the stomach is attached to the subumbrella. In *Staurophora* the structure of the gastrogenital organs is secondarily complicated (see below). In *Chromatonema* the gonads do not form continuous bands, but consist of a row of sack-shaped invaginations on each side of the radial canals; some of the proximal gonadial sacks are situated within the corners of the stomach in the dorsal walls of the latter along the arms of the cross-shaped figure. These gonadial sacks, with their narrow, split-shaped openings, recall the gonadial sacks, arranged in rows, in *Calycopsis*.

Genus **Chromatonema** Fewkes.

Chromatonema rubrum Fewkes.

Plate 1, figs. 1—8.

Chromatonema rubrum Fewkes 1882. Acalephae, East Coast of New England. — Bull. Mus. Comp. Zool. Vol. 9. No. 8, p. 305. Pl. I, fig. 41.

Thaumantias — Mayer 1910. Medusæ of the World. Vol. I, p. 199.

— — Kramp 1913. Medusæ, "Tjalfe"-Exp. — Vidensk. Meddel. Dansk naturh. Foren. Bd. 65, p. 267.

— — Kramp 1914. Medusæ og Siphonophorer. — Conspectus Faunæ Groenlandicæ, p. 419.

?*Ptychogena erythrogonon* Bigelow 1909. Medusae, Eastern Tropical Pacific. — Mem. Mus. Comp. Zool. Vol. 37, p. 150. Pl. 5, fig. 1. Pl. 38, figs. 8, 9. Pl. 39, figs. 1—7.

? — *Hertwigi* Vanhöffen 1911. Deutsche Tiefsee-Exped. Bd. 19, p. 220. Taf. 22, Fig. 9. Textfig. 13.

Description. — The bell is somewhat higher than a hemisphere, the gelatinous substance very thick, evenly rounded at the top, gradually tapering towards the bell margin. The base of the manubrium is broad, quadrangular, attached to the subumbrella along the arms of a perradial cross,

so that there are four triangular pouches between the dorsal wall of the stomach and the subumbrella (see the textfig. 3, which is a copy of a drawing made from a specimen from the "Michael Sars" and destinated for my paper on the material of that expedition). The mouth-tube is quadrangular, very wide. The edge of the mouth is somewhat crenulated, and the corners are a little dilatated, forming four short, simple lips. The length of the manubrium is variable; it never reaches the opening of the bell cavity, and in most specimens its length is less than $^2/_3$ of the depth of the bell-cavity; this variation may depend on the state of contraction. There are four radial canals. The proximal part ($^1/_2$—$^2/_3$) of each radial canal is wide and contains the gonads, the distal part is straight and narrow and communicates with the narrow circular vessel. The proximal part of the radial canal is funnel-shaped, communicating with the stomach by a perpendicular slit, somewhat broader at the top than at the bottom. A transverse section of the gonadial part of the radial canal is pear-shaped in the proximal part, nearly circular in the distal part. The line along which the gonadial part of the canal is attached to the subumbrella sends out a number of short lateral branches, so that the attachment of the dorsal wall of the canal has the shape of a pinnate figure (Plate I, fig. 1 and textfig. 3). Occasionally this figure is somewhat irregular, or it may be more or less zig-zag-shaped. Each of the radial canals contains two rows of sack-shaped gonads, attached to the dorsal wall of the canal in the spaces between the above-mentioned lateral branches of the line of attachment and hanging down into the cavity of the canal. The surface of a gonadial sack is covered with a thin entodermal epithelium (see Plate I, figs. 5, 6, 7, and 8), and each sack has a narrow ectodermal lumen communicating with the bell cavity through a fissure in the dorso-lateral wall of the canal (Plate I, figs. 4, 6, and 8). In view of the scarcity of room, the gonads of the two sides of the canal are more or less regularly alternating (Plate I, figs. 5 and 6). The number of gonads varies from 10 to 16 on either side of the canal. The side-walls of the canal are, as a rule, tightened closely over the gonads so that the wall becomes faintly lobed or undulated. In the upper part of the lateral walls of the canal (outside the gonads) the entoderm consists of one layer of cubical or cylindrical cells (Plate I, figs. 5 and 7). In the funnel-shaped part of the canal the lower parts of the lateral walls, which are not pressed by the gonads, are covered with a thicker entoderm, consisting of several layers of cells (Plate I, fig. 7); evidently the digestion of the food takes place in this part of the radial canal. In larger specimens some of the proximal gonads are frequently developed in the dorsal wall of the stomach on either side of the cross-arms.

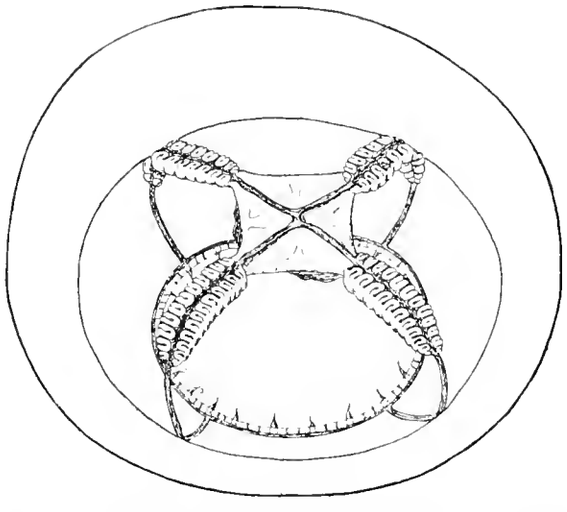


Fig. 3 *Chromatonema rubrum* Fewkes, seen obliquely from the top.

There are about 20—24 solid tentacles, all of the same shape and size; the tentacular bulb is hollow, conical, with a heart-shaped base. There is no trace of a basal spur. The tentacles may be spirally coiled (Plate I, fig. 2). In a contracted state the tentacles are deeply and closely transversally

wrinkled. The tentacles seem to be fairly long, but owing to the state of preservation the exact length cannot be stated. Between every successive pair of tentacles there are two (rarely one) appendages which are, I think, homologous with the cordyli of the other *Laodiceidæ*. These cordyli are cylindrical or somewhat spindle-shaped, provided with a cluster of nematocysts in the distal end (Plate 1, figs. 2 and 3); they are hollow and consist of a thin ectodermal epithelium and a thick entoderm of cubical cells in a single layer, enclosing a central lumen, which communicates with the circular vessel. The cordyli are translucent and colourless. — The velum is thin and narrow.

The colour of the manubrium, the radial canals, the circular vessel, and the tentacles is brightly orange or brick-red; moreover the tentacular bulbs contain a brownish entodermal pigment-mass. The gonadial sacks are white.

Dimensions. — The largest specimen, which I have seen ("Michael Sars" Stat. 84, 1910), is about 27 mm in diameter and about 22 mm high; it has about 24 tentacles and about 16 gonads on either side of each of the radial canals. In the Davis-Strait the species does not seem to grow to such large dimensions, the largest specimen from that area, a fully mature female individual ("Tjalfe" St. 336), being 17 mm wide, 14 mm high, with 18 tentacles, and with 13—14 gonads on either side of each radial canal. A male specimen from the Irminger Sea ("Thor" Stat. 180, 1904) shows the following dimensions: diameter 14 mm, height 12 mm, length of the gonadial part of the radial canals 6 mm, breadth of the same $2^1/_2$ mm, length of the distal narrow part of the radial canals $3^1/_2$ mm, 12 pairs of gonads on each radial canal, number of tentacles not stated.

Distribution. — Widely distributed in the deep parts of the northern Atlantic north of about 40° N. Towards the North the distribution is limited by the submarine ridge Scotland—Faeroe Islands—Iceland—Greenland—Baffin Land. The northernmost locality is: Lat. 65° N., Long. 54° W. (Moller), southernmost: Lat. 39° 52′ N., Long. 69° 45′ W., westernmost: Lat. 39° 57′ N., Long. 70° 15′ W., easternmost: Lat. 61° 15′ N., Long. 9° 35′ W.

Bathymetrical Distribution. — The species occurs almost exclusively in the deeper strata. Most specimens have been caught with instruments for pelagical fishing with 1000—3000 m wire out, i. e. about 600—2000 m below the surface. During the Atlantic expedition of the "Michael Sars" in 1910, however, a specimen was taken by a haul with 100 m wire (stat. 81, Lat. 48° 02′ N., Long. 39° 55′ W.), and in one case the species has even been taken with a hand-net at the surface, *viz.* off the west-coast of Greenland by H. P. C. Moller (see below).

The first published description and figure of this medusa were given by Fewkes (1882). But the species has been figured and described many years before, though that figure as well as the description seems to have disappeared.

In the Zoological Museum of the University of Copenhagen I have found a specimen, collected by H. P. C. Moller off the west-coast of Greenland. Though only slight traces of the gastrogenital organs are left, these slight traces in connection with the tentacles, which are fairly well preserved, partly expanded, and the entire shape of the medusa, with its very thick gelatinous substance, put it beyond doubt that the specimen must be referred to the species *Chromatonema rubrum*. The specimen was in a glass-tube with a label of the content shown on p. 10. The Zoological Museum possesses a large number of notes and drawings made by H. P. C. Moller, who was inspector in Greenland for some

years about 1840. On his journeys he made considerable zoological collections, particularly of molluscs, and put down his observations in his journals. While looking through these old papers I succeeded in finding the "*Oceania cardinalis*" mentioned in a journal from 1843; among some other notes from June 13th is the following: "June 13th, off Napparsok. Last night the weather was completely calm, and with the hand-net several things were fished to me at a distance from the land of about 40 miles, to wit: a remarkably pretty small Acaleph, which I have not seen before, and which I have drawn and described this afternoon (provisionally I will call it *Oceania cardinalis*) . . ."[1] Now was the question: where are that drawing and description? With the exception of the date and the locality, the marks on the label could give me no information. At first I could not even understand the significance of these marks, until I found, that they are partly due to erroneous copying: "Sp. F Journal" ought to be "Sp. S. Journal", i. e. "Spanske So Journal" (Moller calls the Atlantic with the name of Spanske Sø (Spanish Sea), and one of his journals bears that title); and "76" is a mistake for "Tb", i. e. "Tabula". And when I found "Spanske So Journal Tab. III, fig. A" I saw a drawing of some crustacean. It is evident, however, from the journal of 1843 that a description and drawing must have been made, but in spite of keen searching I have not found them. It is probable, however, that they have disappeared very soon, because the species is not included in Mörch's list of the Acalephs of Greenland, 1857. The species mentioned in that list have been derived "partly from descriptions in Fabricii Fauna Groenlandica, partly from various posthumous drawings of H. P. C. Moller" (loc. cit. p. 98).

Oceania cardinalis
13. Juni. Sukkertopp.
Sp. F. Journ. 76.
III fig. A.
Moller.

This find is of considerable interest, because it is the only time the species has been found at the surface and because the said locality is the northernmost place, where the species has hitherto been found. Napparsok is on the west-coast of Greenland a little south of Sukkertoppen. According to the quoted journal of Moller the position of the locality must be: Lat. 65° N., Long. 54° W.

The description of Fewkes is based upon 7 specimens, found during the investigations of the U. S. Fish Commission off the southern coast of New England in 1881, stat. 936 and 954. These stations are near the northern limit of the Gulf-Stream. The depth in which the specimens were taken, is not seen from the available data. Fewkes's description and figure are very deficient, probably owing to the bad state of preservation of the specimens. The gonads are said to occupy the proximal one-third of the radial canals, and Fewkes speaks about large white eggs (which evidently mean the white gonadial sacks), which, according to the figure, are placed irregularly within the "gonads". In every other respect the specimens, examined by me, agree so well with the description and figure given by Fewkes that I have not the slightest doubt, but that they belong to the same species. As to the systematical position of the medusa, Fewkes states that it is "apparently allied to *Staurophora*", but that the determination of its exact position is difficult; he will, therefore, provisionally call it with the name of *Chromatonema rubrum*, till its position can be fixed.

Mayer (1910) quotes the description of Fewkes and places the species within the genus *Thaumantias*.

[1] "Den 13. Juni, paa Höiden af Napparsok. Inat var det aldeles stille og der blev da med Ketzeren fanget adskilligt til mig i en Afstand fra Landet af en halv Snees Mile, nemlig en udmærket smuk lille Acaleph, som jeg ikke för har seet, og som jeg i Eftermiddag har tegnet og beskrevet (jeg vil forelöbig kalde den *Oceania cardinalis*) . .".

During the cruise of the "Tjalfe" to the west-coast of Greenland in 1909 seven medusæ were found in deep water in the Davis Strait; they were identified by me as belonging to the species here dealt with and shortly mentioned with the name proposed by Mayer, *Thaumantias rubrum* (Kramp 1913), and with the same name I included the species in my list of the medusæ of Greenland in "Conspectus Faunæ Groenlandicæ" (Kramp 1914). A more detailed description of this interesting medusa was postponed, till I had examined the specimens, taken on the "Michael Sars" North-Atlantic Deep-Sea Expedition 1910; these specimens had already arrived to me in the Zoological Museum. As my paper on the "Michael Sars" medusæ has not yet been printed (cf. p. 1), I have given the description in extenso in the present paper and, moreover, added several new observations, made on the material from the "Tjalfe" and on two specimens collected during the cruise of the "Thor" in 1904. During the cruise of the Norwegian motor-schooner "Armauer Hansen" in the Atlantic in 1913 5 specimens of the same species were found, which I had the opportunity of examining in Bergen in 1916.

Altogether 34 specimens of this medusa are known up to now. 27 of these specimens have been at my disposal for examination.

In the following complete list of the localities, where the species has been found hitherto, the localities are arranged in the following manner: 1. the Greenland occurrences from the North towards the South, 2. the Atlantic occurrences from the West towards the East.

Lat. 65° N., Long. 54° W., about 40 miles west of Napparsok on the west-coast of Greenland. June 13th 1843. Surface. H. P. C. Moller. — 1 specimen.

Lat. 64°06′ N., Long. 55°18′ W., Davis Strait. May 8th 1909. Depth 1046—1100 m. Ringtrawl, 1200 m wire. "Tjalfe" stat. 336. — 4 specimens, 11—17 mm wide with 15—18 tentacles (for further details, see Kramp 1913 p. 267).

Lat. 63°18′ N., Long. 54°55′ W., Davis Strait. May 7th 1909. Depht 1300 m. Ringtrawl, 1530 m wire. "Tjalfe" stat. 333. — 3 specimens, 9—15 mm wide.

Lat. 39°57′ N., Long. 70°15′ W., 91 miles S ½ E of Martha's Vineyard, New England. August 23rd 1881. Depth 1174 m (642 fms.). U. S. Fish Comm. stat. 954. (Fewkes 1882). — 2 specimens.

Lat. 39°52′ N., Long. 69°45′ W., 104½ miles S. by E. ½ E. of Martha's Vineyard, New England. August 4th 1881. Depth 1289 m (705 fms.). U. S. Fish Comm. stat. 936. (Fewkes 1882). — 5 specimens.

Lat. 42°59′ N., Long. 51°15′ W., southern edge of the Newfoundland Bank. June 30th 1910. Depth 1100 m. Ringtrawl, 700 m wire. "Michael Sars" stat. 70. — 1 specimen, diameter 23 mm.

Lat. 47°34′ N., Long. 43°11′ W., eastern slope of the Newfoundland Bank. July 11th 1910. Depth about 2000 m. "Michael Sars" stat. 80. — a. Young-fish trawl, 1000 m wire. 2 specimens. — b. Ringtrawl, 1500 m wire. 2 specimens.

Lat. 48°02′ N, Long. 39°55′ W. July 12th 1910. "Michael Sars" stat. 81. — a. Ringtrawl, 100 m wire. 1 specimen. — b. Young-fish trawl, 1000 m wire. 1 specimen, diameter about 17 mm, about 20 tentacles. — c. Young-fish trawl, 2000 m wire. 1 specimen, diameter 16 mm.

Lat. 48°24′ N., Long. 36°53′ W. Juli 13th 1910. "Michael Sars" stat. 82. — a. Young-fish trawl, 1000 m wire. 1 specimen, diam. 21 mm. — b. Young-fish trawl, 2000 m wire. 1 specimen.

Lat. 48°04′ N., Long. 32°25′ W. July 15th 1910. "Michael Sars" stat. 84. — a. Ringtrawl, 2500 m wire. 1 specimen, diam. 26 mm. — b. Young-fish trawl, 3000 m wire. 1 specimen, diam. about 27 mm, about 24 tentacles.

Lat. 54°51′ N., Long. 28°15′ W. July 17th—18th 1913. 1000 m wire. "Armauer Hansen" stat. 9. — 3 specimens: 1. Diam. about 17 mm, three-rayed. 2. Diam. 19 mm, height 15 mm, 20 tentacles. 3. A large, defect specimen.

Lat. 54°05′ N., Long. 26°08′ W. July 15th 1913. 1000 m wire. "Armauer Hansen" stat. 7. — 2 specimens, diam. 18—22 mm.

Lat. 61°34′ N., Long. 19°05′ W., Irminger Sea. July 10th 1904. Depth 2160 m. Young-fish trawl, probably 1800 m wire. "Thor" stat. 180 (04). — 1 specimen, diam. 14 mm.

Lat. 61°15′ N., Long. 9°35′ W., north-west of the Faroe Bank. May 22nd 1904. Depth 872—970 m. Young-fish trawl, 1000—1700 m wire. "Thor" stat. 99 (04). — 1 specimen, diam. 15 mm, about 16 tentacles.

The specimens from the "Michael Sars" and the "Armauer Hansen" are in Bergens Museum, the specimens from the "Thor" and the "Tjalfe" are in the Zoological Museum of Copenhagen.

Among the 5 specimens from the "Armauer Hansen" two are abnormally developed. One specimen from stat. 9 has only three radial canals; a specimen from stat. 7 shows the following features: It is a female individual, 22 mm in diameter. One of the four radial canals bifurcates at the point of issue from the stomach, forming two complete gonadial systems; at the distal ends of these the two branches of the canal unite once more, so that the distal part of the canal, free of gonads, is simple. Two others of the canals, otherwise normally shaped, converge very much in their distal parts and reach the circular vessel so near each other, that only one tentacle finds room between them.

The distribution of *Chromatonema rubrum* (see Chart I) is true oceanic and extends over the deep basins of the North-Atlantic on both sides of the submarine ridge which divides the Atlantic into a western and an eastern basin. The distribution of the species in the western basin extends northwards to the southern slope of the submarine ridge between Greenland and Baffin Land. In the eastern basin the north-limit of the distribution is the Wyville Thomson ridge. With two exceptions, viz. Moller 1843 (see below) and "Thor" Stat. 99 (depth 872—970 m), all of the localities are from outside the 1000 m line. The specimens mentioned by Fewkes were taken on the slope outside the coast of New England south of Cape Cod. The "Michael Sars" found the species on the southern slope of the Newfoundland Bank (depth 1100 m) and east of the same bank (depths more than 2000 m). The specimens brought home by the "Armauer Hansen" were found near the 3000 m line, and by the "Thor" the species was found outside the 2000 m line south of Iceland (stat. 180), and near the 1000 m line north-west of the Faroe Bank (stat. 99). The "Tjalfe" found it between 1046 and 1300 m in the Davis Strait.

The species has mostly been found far below the surface of the ocean, between 600 and 2000 m, i. e. in the true oceanic water. Thus in the Gulf-Stream area the species does not, as a rule, rise to the water-masses of that current, but keeps itself in the deeper and colder water layers. The "Michael Sars" stat. 70 on the southern edge of the Newfoundland Bank is north of the northern limit of the Gulf-Stream; here a specimen was caught about 400 m below the surface.

Though the species has, mainly, a bathypelagical occurrence, it may, however, occasionally rise to the upper water layers. On "Michael Sars" stat. 81 a specimen was fished by the ringtrawl with 100 m wire in water of a fairly high temperature (about 13° C).

More astonishing is the find, made by Moller, off the west coast of Greenland (see above, p. 9). It is a well-known fact that oceanic deep-sea organisms are occasionally carried towards the west coast of Norway and found there near the shore and in the upper water layers. Similar pheno-

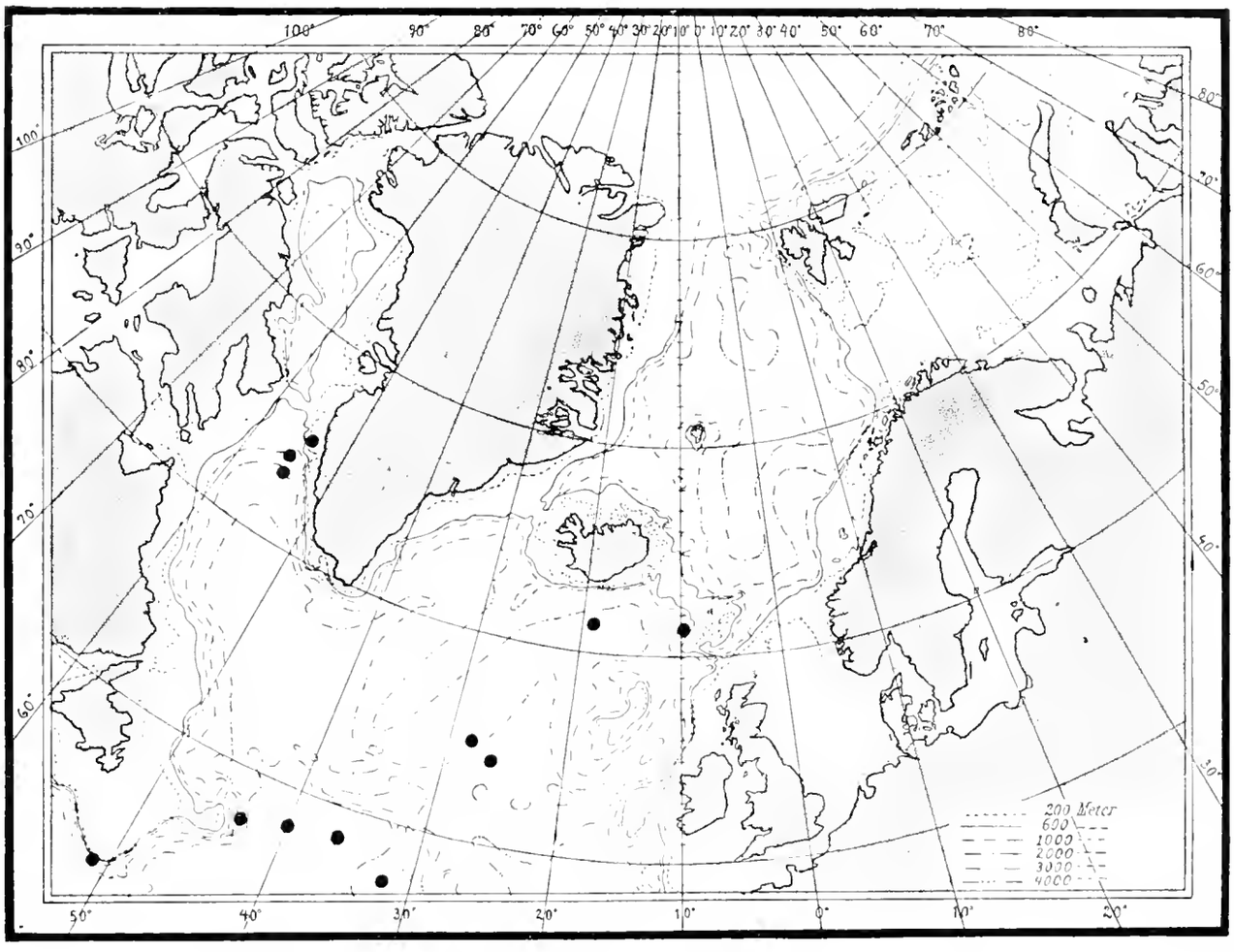


Chart I. Occurrence of *Chromatonema rubrum* Fewkes in the northern Atlantic.

mena have been observed on the west coast of Greenland, and this may account for the appearance of this oceanic deep-sea medusa comparatively near the coast and swimming at the surface of the water.

The hydroid stage is unknown, and no young stage of the medusa has been observed; it is impossible, therefore, to state, or even to guess, anything with regard to the development of the species.

Related Species. — Bigelow (1909) has described a similar medusa from the eastern tropical Pacific (the Humbolt-Current off the coast of Peru, in intermediate strata). He called it *Ptychogena erythrogonon*. Bigelow possessed a series of specimens in different stages of growth, the largest being 38 mm in diameter by 25 mm high. The general appearance of the species bears a striking resem-

blance to that of *Chromatonema rubrum*. The largest specimens have as much as about 64 tentacles; the tentacle bulbs have exactly the same shape as in *Chromatonema rubrum* (op. cit. Plate 39, fig. 5). According to the description Bigelow's species possesses both cirri and cordyli. Only a few cirri were present in his specimens; they are cylindrical and provided with a cluster of nematocysts in the distal end. The cordyli are spindle-shaped and carry no nematocysts. One or two cordyli are present between every two successive tentacles. As mentioned above the cordyli of *Chromatonema rubrum* may be cylindrical or more or less spindle-shaped, in both cases provided with nematocysts, and they are situated in a manner very similar to the arrangement of the cordyli described by Bigelow. The "cordyli" of "*Ptychogena erythrogonon*" are undoubtedly homologous with the cordyli of *Chromatonema rubrum*; as to the homologies of the "cirri" of the former I am not quite sure; the drawing of a single "cirrus" (Plate 38, fig. 9) recalls the cylindrical form of cordyli in *Chromatonema rubrum*, only a little more lengthened and somewhat more heavily armoured with nematocysts; in fig. 5 of Plate 39, however, the name of "cirrus" is attached to an organ which is undoubtedly a young tentacle.

As in *Chromatonema rubrum*, the base of the manubrium of "*Ptychogena erythrogonon*" is quadrate and attached to the subumbrella along the arms of a perradial cross. The mouth-tube is said to be barrel-shaped, while I have described it as being quadrangular in *Chromatonema rubrum*; but it is very likely, that the mouth-tube of the last-named species may attain a circular outline when fully expanded; such is the case in several other species, in which the stomach is quadrate when not expanded. The shape of the radial canals and the gonads of "*Ptychogena erythrogonon*" is exactly as in *Chromatonema rubrum*, the radial canals having "developed a series of short lateral diverticula along the narrow lines by which they are attached to the subumbrella (Plate 39, fig. 2). The main bodies of the canals, however, are so stout that they extend out as far as the ends of these short branches. The gonads develop in the spaces between the diverticula, and are confined to the aboral surfaces of the canals close to the subumbrella ..." (op. cit. p. 151). The distal narrow part of the radial canal is shorter in "*Ptychogena erythrogonon*" than in *Chromatonema rubrum*. — The colour seems to be the same in both species. — The two species are undoubtedly nearly related and must be referred to the same genus. In fact, I can see no other noticeable differences than the want of nematocysts in the cordyli of the Pacific species, and the size, *Chromatonema rubrum* reaching maturity when about 20—24 mm in diameter with about 20—24 tentacles, whereas *Chromatonema erythrogonon* grows to a larger size and may possess 64 tentacles when fully developed.

Another similar form is described by Vanhöffen (1911) as *Ptychogena Hertwigi*, found in the Indian Ocean by the German deep-sea expedition. Vanhöffen describes his species as very like *Ptychogena erythrogonon* Bigelow, but still larger, 50 mm in diameter, yet with a smaller number of tentacles, viz. 20. It has no cordyli but 5 cirri between each successive pair of tentacles. The "cirri", as shown in the figure in the text, seem to be partly cylindrical, partly somewhat club-shaped, partly spindle-shaped. According to the coloured figure (Taf. XXII, Fig. 9) the gonads reach only to the middle of the radial canals. Also this species is undoubtedly nearly related to *Chromatonema rubrum* Fewkes and belongs to the same genus.

Further investigations will show whether the three species mentioned are distinct or only local varieties of one and the same species, viz. *Chromatonema rubrum* Fewkes.

Table I. Synoptic Table of the Species of Chromatonema.

	C. rubrum Fewkes	C. erythrogonon Bigelow	C. hertwigi Vanhöffen
Diameter of full-grown medusa	24 - 27 mm	38 mm	50 mm
Number of tentacles in full-grown medusa	ca. 24	ca. 64	20
Number of cordyli between each successive pair of tentacles	2 (1)	1 (2)	5
Occurrence	Northern Atlantic Ocean	Eastern tropical Pacific	Indian Ocean

Systematical Position. — The structure of *Chromatonema* presents, in several regards, a considerable resemblance to the members of the family *Laodiceidæ* previously known, particularly to the genera *Laodicea* and *Ptychogena*. In all of the three genera the manubrium has the same shape: the square stomach, the broad base of which is attached to the subumbrella along the arms of a perradial cross; the short, wide mouth-tube, and the folded mouth-edge, in the four corners of which lips are just indicated. Common for the three genera is, moreover, the structure of the four radial canals; the proximal part of each of the canals contains the gonads; the ventral part of this gonadial part is funnel-shaped and is the proper digestive part of the canal. In *Chromatonema* as in *Ptychogena* the dorsal line of attachment of the radial canal to the subumbrella is pinnate, and in older individuals of all of the three genera the proximal part of the gonads may be developed within the corners of the stomach in the dorsal wall of the latter on both sides of the arms of the perradial cross. But with regard to the structure of the gonads *Chromatonema* presents a considerable difference, not only from *Ptychogena* and *Laodicea*, but from all other Leptomedusæ. As described above each of the radial canals in *Chromatonema* carries two rows of sack-shaped gonads, completely independent of one another. In all other Leptomedusæ each radial canal bears either two lateral gonads, forming two continuous masses in the ectoderm of a certain part of the lateral walls of the canal, or only one gonad completely surrounding a shorter or longer part of the canal. (A special case is the gonads of certain species of *Eutima*, being transversally divided into two separated pairs of gonads, one pair on the subumbrella, one pair on the stomachal peduncle). In some forms the gonadial bands are straight and linear, in others they are more or less undulated or folded. In *Laodicea* the lateral walls of the gonadial parts of the radial canals have a number of short lateral pouches; in *Ptychogena* these pouches are much more highly developed and have attained the shape of vertical lamellæ, the dorsal edges of which are attached to the subumbrella; but still there is only one gonad on each side of the canal; there is only one gonadial band, but it is highly folded. In *Staurophora* the gonads have a similar structure, but the folding is still more complicated.

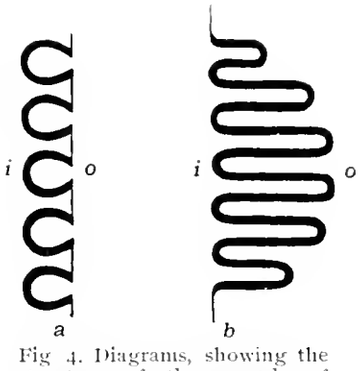


Fig. 4. Diagrams, showing the structure of the gonads of *Chromatonema* (*a*) and *Ptychogena* (*b*). — *i* inner side, *o* outer side.

The structure of the gonads of a *Chromatonema* and a *Ptychogena* may be illustrated by a diagrammatic figure as the textfig. 4. This diagram corresponds to that by which Hartlaub (1914, p. 347) illustrates the typical folding of the gonads in the two groups of *Tiaridæ*, viz. the *Calycopsidæ* and the *Neoturridæ*. It is not difficult to refer the two types to a common

ground-plane, and though the peculiar structure of the gonads of *Chromatonema* places that genus in opposition to the other members of the family *Laodiceidæ*, this structure does not contradict the supposition of a generic relationship.

The parallel between the structure of the gonads of *Chromatonema* and of the *Tiaridæ* mentioned above is hardly a casual one. There is, in fact, a striking resemblance between the gonads of *Chromatonema* and the eight adradial rows of gonadial sacks, communicating with the bell-cavity through transversal fissures in the outer surface of the manubrium in a *Calycopsis* (see the figure of Bigelow, copied by Hartlaub, 1913, p. 347, and the transversal section, Vanhöffen, 1911, Textfig. 10a, p. 216, copied by Hartlaub, 1913, p. 348. Compare also Hartlaub's Fig. 238, (1913, p. 287) of the gonads of a young *Leuckartiara octona*, seen from the inner side of the manubrium). The importance of the resemblances between the gonads of the *Tiaridæ* and the gonads of *Chromatonema* and the other *Laodiceidæ* is mentioned above in the introduction to the family *Laodiceidæ* (pp. 6—7). The marginal appendages of *Chromatonema* and their relations to the corresponding organs of the other *Laodiceidæ* and the *Tiaridæ* were also mentioned above.

Thus my considerations with regard to the systematical position of *Chromatonema* lead to the result, that it belongs to the family *Laodiceidæ*, among which it takes a low position, presenting several features pointing to the connection with the *Tiaridæ*. Its position among the *Laodiceidæ* is, however, not only a low, but also in certain regards a singular position, particularly owing to the peculiar structure of the gonads, and it seems probable that the genus has arisen from some other group of *Tiaridæ* than the predecessors of the other members of the *Laodiceidæ*.

Genus **Laodicea** Lesson.

Laodicea undulata (Forbes & Goodsir).

Plate II, figs. 1—8.

?*Medusa cruciata* Forskål 1775. Descriptiones Animalium, p. 110. — 1776. Icones rerum naturalium. Tab. 5, Fig. A.

Thaumantias undulata Forbes and Goodsir 1851. — Transact. Royal Soc. Edinb. Vol. XX, p. 313. Plate 10, fig. 7.

— *mediterranea* Gegenbauer 1856. — Zeitschr. wiss. Zool. Bd. VIII, p. 237. Taf. 8, Fig. 1—3.

Laodicea calcarata A. Agassiz, in L. Agassiz 1862. Contrib. Nat. Hist. U. S. Vol. 4, p. 350.

Laodice ulothrix Haeckel 1879. System d. Medusen, p. 133. Taf. 8, Fig. 5—7.

Laodicea marama A. Agassiz and Mayer 1899. Acalephs, Fiji Islands. — Bull. Mus. Comp. Zool. Vol. XXXII, p. 162. Plate 3, figs. 7—8.

Laodice indica Browne 1905 b. — Pearl Oyster Fisheries, Suppl. Rep. 27, p. 136. Plate I, fig. 5; Plate IV, figs. 7—11.

— — Browne 1907. Revision of the ... Laodiceidæ. — Ann. Mag. Nat. Hist. Ser. 7, Vol. XX, p. 460.

Laodicea cruciata Mayer 1910. Medusæ of the World, p. 201. Textfigs. 104—105. Plate 21, figs. 4 and 5; Plate 22, figs. 2—6; Plate 23, figs. 1—3.

— *Bigelowi* Neppi et Stiasny 1911. Zool. Anz. Bd. 38, p. 396.

? *Laodicea fijiana* A. Agassiz and Mayer 1899. — Bull. Mus. Comp. Zool. Vol. 32, p. 163. Plate 3, figs. 9—10.
? *Laodice* — var. *indica* Maas 1905. Craspedote Medusen d. Siboga-Exped. — Siboga-Exped., Monogr. X, p. 25. Taf. 2, Fig. 14—15; Taf. 5, Fig. 32—35.
? — *Maasii* Browne 1907. Revision of the ... Laodiceidæ. — Ann. Mag. Nat. Hist. Ser. 7. Vol. XX, p. 466.
? — *maasi* Vanhöffen 1911. — Deutsche Tiefsee-Exped. Bd. 19, p. 221.

Description: The bell somewhat flatter than a hemisphere. The gelatinous substance not very thick, about 2—3 mm at the apical point, evenly diminishing in thickness towards the bell-margin. The diameter of the bell is usually about 25 mm, but it may amount to 37 mm. The stomach is quadrate, spacious; its diameter is about one-fourth of the diameter of the bell. The stomach is fairly short, and the walls are rather thin. The mouth edge is folded in large folds; lips are just indicated, the four corners of the mouth being a little dilatated. The mouth-edge bends outwards, forming a narrow, outturned edge. The dorsal wall of the stomach is attached to the subumbrella along the arms of a perradial cross, four flat, triangular pouches being formed between the dorsal wall of the stomach and the subumbrella. The figure of attachment is, however, in several cases not exactly cross-shaped, but the four cross-arms meet somewhat obliquely (see Plate II, fig. 2). When seen from the mouth the cross has the appearance of four concurrent grooves. Near the centre of the stomach these grooves are open, but before they reach the corners of the stomach each of the grooves becomes transformed into a closed canal, on account of the sides of the groove being developed into two folds meeting each other from both sides, frequently after a wavy line (Plate II, figs. 2 and 3).

There are four radial canals, attached to the subumbrella by a very narrow line, straight or slightly sinuous. The distal part (2—4 mm) of each of the canals is free of gonads and communicates with the narrow circular vessel. The main part of the canal is occupied by the gonads, forming two lateral bands, provided with a number of short, rounded lateral extensions, usually 6—8 on each side of each of the canals. In fully developed individuals the breadth of the gonadial part of a radial canal is about 3 mm. The gonads commence, in well-developed specimens, at a considerable distance within the corners of the stomach, at the same point where the four dorsal grooves turn into closed canals (see Plate II, fig. 2). The gonads occupy only the dorsal part of the lateral walls of the canal; below the gonadial part there is a thin-walled part, which opens like a funnel into the corner of the stomach; this funnel-shaped part is separated from the space between the gonads by two lateral longitudinal folds, continuations of the folds along the dorsal grooves in the stomach, mentioned above (Plate II, figs. 2 and 3). At the distal end of the gonads the separation between the dorsal (gonadial) and the ventral (funnel-shaped) part is, as a rule, not complete. Microtome-sections demonstrate, that the entoderm is quite thin in the gonadial part of the wall, but much more highly developed in the walls of the funnel-shaped part; we must suppose, therefore, that the digestion of the food takes place in the latter.

The bell-margin carries a very large number of tentacles; in well-sized specimens the number amounts to about 600. In well-preserved specimens the tentacles are, usually, as long as the bell-radius; the distal end is spirally coiled. The tentacles are hollow. Tentacular bulbs are but slightly indicated, the proximal part of the tentacles being a little inflated. The ectoderm of the basal bulb is

thin except on the adaxial side, where it is somewhat thickened (Plate II, figs. 5 and 6). The young tentacle issues from the proper margin of the bell and possesses an abaxial entodermal spur-like process, imbedded in the gelatinous substance on the exumbrellular side of the bell-margin (Plate II, fig. 5). During the continuous growth the adaxial side of the basal part of the tentacle grows faster than the outer side, and thereby the point of issue of the tentacle is gradually removed from the bell-margin upwards on the outer side of the bell; older tentacles, therefore, issue from the exumbrella at some distance above the bell-margin (Plate II, figs. 6 and 8). On account of this removal the abaxial part of the tentacular base, which is pushed upwards on the outer side of the umbrella, invests the spur-like process, which at last entirely disappears (Plate II, fig. 6). Accordingly, a "spur" is only present on the young tentacles. The fully developed tentacle turns abruptly outwards and downwards, immediately after leaving the wall of the umbrella. The central canal in the tentacle has not the same width everywhere, but expands and narrows at different points (Plate II, fig. 8); the greatest width is a little outside the point of issue of the tentacle. The course of the canal is approximately central, except in the basal part, where it passes the sharp bend very close to the adaxial side (Plate II, fig. 6). Within the imbedded part of the tentacular base the canal is very narrow and opens in the circular vessel. In young individuals, in which the tentacles are not so densely crowded on the bell-margin, the basal bulbs are fairly broad, all the tentacles issue from the margin itself, and spurs are only just beginning to develop.

A small, dark, sharply defined ocellus is found on the adaxial side of the base of some of the tentacles. The number of ocelli is subject to much variation; as a rule ocelli are found on every 3rd—5th of the tentacles, but they may be found on every 2nd tentacle, rarely on two successive tentacles.

Typical cordyli are situated between the tentacles (Plate II, figs. 5, 6, and 8). The cordyli issue from the bell-margin close by the base of the velum; they are very small, hardly longer than the proximal breadth of a fully-developed tentacle; they have, as a rule, a fairly thick distal part and a very thin peduncle. In some of the cordyli the inner lumen is fairly large, in others it is very narrow or nearly obliterated, being just visible as a fine streak; this variation stands in no relation to the size of the cordylus. Some of the cordyli may be mounted upon fairly large bulbi; in such cases their basal part is turning inwards (adaxially). The number of cordyli is variable and may be a little larger or a little smaller than the number of tentacles. This seems to depend on the stage of development of the individual; in full-grown specimens the number of cordyli is, probably, always the same as the number of tentacles.

The bell-margin also bears fine cirri, which may be spirally coiled, and which are greatly armoured with nematocysts in their distal part. According to Mayer the cirri are "usually somewhat less numerous than the tentacles"; in preserved material, as a rule, only a small number of cirri are left; the material, examined by me, therefore, gives no available information of their number. In badly preserved specimens I have, in fact, been unable to find any cirri at all.

The velum is fairly well-developed; in full-grown specimens it is about 3 mm wide.

The colour is subject to much variation. The manubrium, the gonads, and the tentacular bulbs may be reddish or greenish or nearly colourless. Most of the specimens, examined by me, are reddish, provided that the colour is preserved. In an individual from the "Thor" stat. 72 (1905), the gonads are pale green.

The material contains a number of young individuals, viz. from the "Michael Sars", south of the Myrdalsjokel, Iceland, $^{17}/_{8}$ 1903; from the "Thor" stat. 45 (08), Iceland; from two localities near the Hebrides, "Thor" stat. 8 (08) and 11 (08); and from the Horns Rev light-vessel, west of Jutland, $^{23}/_{9}$ 1912. The smallest specimen is 5 mm wide. These young individuals show that the margins of the dorsal grooves in the wall of the stomach begin at an early stage to develop into folds which meet and transform a part of the groove into a closed canal; further that the gonads first appear near the corners of the stomach and, from these points, develop partly in a centripetal direction towards the centre of the stomach, which is, however, never reached, partly in an outward direction towards the circular vessel, which is, likewise, never reached. At an early stage the transversal folds of the gonads begin to form; in a specimen, 7 mm wide, each of the gonads has 2—3 pairs of transversal folds; in an individual, 9 mm wide, there are 6 pairs of folds on each of the gonads. When the diameter of the bell is about 20 mm, the gonads are somewhat far developed, particularly the female gonads, which already now contain very conspicuous eggs.

The structure, mentioned above: that the ventral, funnel-shaped part of the radial canal is separated from the dorsal gonadial part by two lateral longitudinal folds, does not seem to have been observed by previous authors. In this part of the gastro-genital system there is established a very interesting differentiation into two parts with different functions. The ventral, funnel-shaped part receives and dissolves the organisms, which serve as food for the medusa; they are however prevented from penetrating into the dorsal part between the gonads on account of the longitudinal folds; the dissolved nutritive matter, on the other hand, may pass between the folds into the dorsal part. Probably a part of the food is also digested in the stomach and may, by means of the ciliary motion in the dorsal grooves, be carried into the dorsal part of the radial canal; this part, accordingly, has two functions: to carry the gonads in its lateral walls, and to transport the nutritive substances into the peripheral parts of the canal system.

From what is said above with regard to the development of the gonads, it will be understood, that the length of the distal part of the radial canals free of gonads in proportion to the radius of the bell is considerably larger in young specimens than it is in full-grown individuals. In specimens, about 10 mm wide, the gonads reach to the middle of the radial canals. In full-grown individuals the length of the gonads is very variable. In a specimen, 28 mm wide, from Iceland ("Thor" stat. 241 (09)) the distance from the distal end of the gonads to the circular vessel is 2 mm; in another specimen, 30 mm wide ("Thor" stat. Da. 13 (04)), the length of the gonads is 9.5 mm; they commence 1.5 mm from the centre of the stomach and terminate about 4 mm from the circular vessel; in a specimen, 35 mm wide ("Thor" stat. 180 (04)), the length of the gonads is about 15 mm; they commence very near the centre of the stomach and terminate 2.5 mm from the circular vessel.

The number of tentacles is considerably larger than is usually stated in the literature. It is possible that the locality plays a part in this respect. All the specimens examined by me have been found in the waters around Scotland, the Faeroe Islands, Iceland, Norway, and Denmark. The smallest individual is from the Horns Rev light-vessel, $^{23}/_{9}$ 1912; it is 5 mm wide and has about 48 tentacles, placed at some distance from each other; in accordance herewith the basal bulbs are comparatively broad. Specimens from the waters near the Hebrides ("Thor" stat. 8 (08) and 11 (08)) have, when 7 mm

wide, 100—140 tentacles, and, when 8 mm wide, 160—180 tentacles; in specimens of this size the tentacles are very closely packed on the bell-margin. The number of tentacles increases tolerably proportionally with the diameter of the individual, the average number being as follows:

Diameter of bell	11—15 mm,	230	tentacles	
—	— 16—20 —	290	—	
—	— 21—25 —	390	—	
—	— 26—30 —	440	—	

The largest specimen examined ("Michael Sars" stat. 140 (03), east of the Orkney Islands) is 37 mm wide and has about 500 tentacles; but another specimen, 35 mm wide ("Thor" stat. 180 (04), south of Iceland) has about 620 tentacles; this is the largest number of tentacles, which I have seen in this species.

The number of ocelli is variable. There is an ocellus on, at least, every 5th of the tentacles. Even in one and the same individual the succession of the ocelli is irregular. In a specimen from Iceland ("Thor" stat. 241 (04)), about 25 mm wide, the ocelli are, on the whole, found on every second tentacle; here and there, however, two or even more successive tentacles are provided with ocelli, or ocelli are wanting on two successive tentacles. From the Hebrides ("Thor" stat. 8 (08)) we possess a number of young individuals, among others two specimens, 7 mm wide, with 100—140 tentacles; in one of these specimens the ocelli are fairly regularly distributed on every 2nd tentacle, while in the other specimen ocelli are only found on every 4th to 5th of the tentacles; among two specimens, 8 mm wide, one has an ocellus on every 2nd tentacle, in the other the ocelli are irregularly distributed on every 2nd to every 5th of the tentacles. Specimens from the same locality, 9 and 16 mm wide, have ocelli on about every 2nd tentacle. From the "Thor" stat. 11 (08), somewhat to the west of the Hebrides, we possess several specimens 8—22 mm wide; in most of these specimens there is an ocellus on every 3rd—5th of the tentacles, though in some specimens every 2nd tentacle bears an ocellus. In two specimens from the Orkney Islands ("Thor" stat. 2 (08)), 6—13 mm wide, the ocelli are fairly regularly distributed on every 5th tentacle. Most of the specimens from Iceland have ocelli on every 3rd—5th of the tentacles; in not a few cases, however, there is an ocellus on every 2nd tentacle; this is the case, for instance, in a 12 mm wide individual and in another, 25 mm wide. — It will be seen, from the facts here mentioned, that the number of ocelli stands in no ostensible relation to the size of the individual, nor to the locality, in any case as far as the area here dealt with is concerned.

The question, whether the cordyli may be transformed into tentacles, has been discussed above (p. 5). The number of cordyli has been used as a specific character, undoubtedly incorrectly. It is difficult, on preserved material, to state with certainty the number of cordyli, as they are very apt to drop off on the preservation. With regard to the material, examined by me, the fact is, that in all full-grown or nearly full-grown individuals, sufficiently well-preserved, the number of cordyli is equal to the number of tentacles. Most of the small specimens are badly preserved. In a specimen, 5 mm wide, from the Horns Rev, I have, in some cases, been able to find two cordyli between two successive tentacles.

With regard to the cirri, we may state as in the case of the cordyli: that they frequently dis-

appear on the preservation. In most of the specimens examined by me cirri are completely absent; but in all of the well-preserved specimens a greater or smaller number of cirri are present. In no case I have been able to state the number of cirri.

The Hydroid generation belongs to the genus *Cuspidella*. As to this point, see Browne 1907, pp. 463 ff.

This medusa, fairly large and conspicuous, widely distributed, and frequently occurring in great numbers, has been known from early times, and has been described several times, usually very deficiently, unfortunately, and under many different names. It is, therefore, very difficult to give a reliable list of synonyms. The confusion has been further increased thereby that several species, belonging to quite other genera or families, have been included in the lists, e. g. by Haeckel (1879), as demonstrated by Browne (1896). Among other species, *Thaumantias* (*Cosmetira*) *pilosella* Forbes has frequently been identified with "*Laodice cruciata*", and is even found under that name in Bedot: Histoire des Hydroïdes[1]. Browne has refound the *Cosmetira pilosella* of Forbes and demonstrated, that it belongs to quite another group of Leptomedusæ.

If we want to state the correct name of the species, we must do away with all descriptions, older than 1851; they are all so vague, that the species in question cannot be identified with any probability at all.

The generic name *Laodicea* has been established by Lesson (1843) for the "*Medusa cruciata*" Forskål, called by Lesson "*Laodicea crucigera*", and this generic name has been commonly used since that time for the genus here dealt with. The first description of a *Laodicea*, sufficiently clear for identification, is the description of "*Thaumantias undulata*" Forbes and Goodsir 1851[2] from the west-coast of Scotland. When we admit that none of the forms previously described, which have later on been referred to the genus *Laodicea*, may be identified with certainty, there can be no doubt that, according to the rule of priority, the correct name of the British *Laodicea* must be *Laodicea undulata* Forbes and Goodsir. The next question is, whether there is any reason, in this particular case, to abandon the strict application of the rule, and, as Mayer (1910) prefers, "to retain an old and familiar name rather than to reinstate an unfamiliar one such as *L. undulata*". In order to answer this question, we must see, how the name of *cruciata* has been used in the subsequent period.

The name *Laodicea cruciata* was assigned by A. Agassiz (in L. Agassiz 1860—62, p. 350) to Forskål's medusa, which was, in the same work, identified with *Thaumantias mediterranea* Gegenbaner and joined together with the new species *Laodicea calcarata*, *L. cellularia* (= *Thaumantias cellularia* Haeckel 1879, *Halistaura cellularia* Bigelow 1913), and *L. stauroglypha* (an apocryphal species) to form the genus *Laodicea*. The specific name *cruciata* has not been used at all during the subsequent period until 1879, when Haeckel united several medusæ from the European Atlantic coasts and the Mediterranean under the name of "*Laodice cruciata*". As demonstrated by Browne (1896 p. 482) there is only

[1] In "Histoire des Hydroïdes" 6e période (1891 à 1900), issued 1918, Bedot has separated "*Laodicea cruciata*" from *Cosmetira pilosella*, but some of the synonyms, placed under the former, do not actually belong to that species. The "*Irene viridula*" of Garstang 1894 seems to be a real *Eirene*, with distinct stomachal peduncle and with marginal vesicles (according to Garstang's description in the quoted paper, p. 215). — "*Laodice cruciata*" of Haddon (1886 c), Garstang (1894), Herdman (1894 c), Browne (1895, 1896 c, and 1898 a) should be referred to *Cosmetira pilosella*

[2] The paper was read before the Royal Society of Edinburgh on Jan. 20th and Febr 3rd 1851 and printed in the Transact Vol. XX, which was completed in 1853.

one single name among Haeckel's 25 synonyms, which really refers to a *Laodicea*, viz. *Thaumantias mediterranea* Gegenbauer. Before Haeckel, accordingly, the specific name *cruciata* was very far from being commonly used or "familiar", and Haeckel's list of synonyms made the confusion as complete as ever. Indeed, I am not able to find a better way out of the mess, than to release altogether the name of *cruciata* and follow the rule of priority, using the name by which the species has first been described in a manner which allows a recognition, viz. *undulata* Forbes and Goodsir. This was proposed by Browne in 1907, and the proposal was adopted by Vanhöffen in 1911 (p. 365).

Then we come to the question of the mutual relation between the different species of the Genus *Laodicea*.

Since new examinations of the medusæ belonging to this group have been carried out in later years (Browne 1907, Mayer 1910), it may be stated, that the Mediterranean "*Thaumantias mediterranea*", Gegenbaur, the North-American-Atlantic *Laodicea calcarata* A. Agassiz, and the Tropical-Atlantic *Laodice ulothrix* Haeckel are identical with the North-European *Laodicea undulata* (Forbes and Goodsir). Mayer is undoubtedly right, when he refers to the same species the *Laodicea marama* Agassiz and Mayer (from the Fiji Islands), a species which, according to the description (1899) is exactly like a young *undulata*. *L. indica* Browne (from Ceylon) is very like *L. undulata*, from which it is only distinguished (according to Browne 1905 b) "in having no spur at the base of the tentacles, in having larger ocelli, and perhaps in colour and size", characters to which, as will be understood from what is said above, we may hardly assign any specific importance. Cirri are present in *L. indica*, though only in small numbers.

In 1899 A. Agassiz and Mayer described a small medusa from the Fiji Islands, *Laodicea fijiana*; the most characteristic features of this species are the lacking of cirri, the very small number of cordyli, and the gonads which, in spite of the small size of the animal (6 mm), were provided with "complex diverticulæ". Tentacular spurs are not mentioned nor figured. — Maas (1905, Siboga-Exped.) describes a *Laodicea* from the Indian Archipelago and refers it to *Laodicea fijiana*, though it is much larger, being 20 mm wide; he is apt to suppose, however, that it belongs to a local variety, to which he will apply the name of var. *indica*. Browne (1907 p. 466) finds, that there is so much difference between the two forms, that it will be correct, in any case provisionally, to describe that medusa as an independent species, which he calls *L. Maasii*. As the most decisive difference Browne calls attention to the fact, that basal spurs are present on the tentacles of *L. Maasii*, whereas such are not described in *fijiana*. This, however, does not contradict the supposition, that *L. fijiana* may be a young stage of *L. maasii* (it was mentioned above that spurs are not developed in young individuals of *L. undulata* from the northern seas). The length of the gonads in *L. maasii* is highly variable; Maas writes as follows (p. 26): " ... ich habe jüngere Exemplare gesehen, bei denen die Geschlechtsproducte bis an die Peripherie reichten, und alte mit strotzenden Ovarien, die nur etwa die halbe Länge der Radiärcanäle einnahmen." The length of the gonads can, accordingly, have no great importance for specific distinction. The structure of the gonads involves more difficulty. In *L. maasii* the gonads are provided with simple lateral extensions, whereas in *L. fijiana* the proximal parts of the radial canals "exhibit complex diverticulæ", on which the gonads are situated. This is only a difference in degree, it is true, which has no decisive importance; but, on the other hand, the specimens of *L. fijiana*, in any case the female individuals,

seem to have contained mature sexual products, in so far as "the ova are prominent, and project outward in grape-like clusters over the surface of the genital organs". This, indeed, does not seem to suggest, that we have here to deal with young stages. It is not altogether excluded, however, that such is nevertheless the case; we know other examples, where the eggs of a still young medusa may develop into a considerable size and give the surface of the gonads a rugged appearance (see, for instance, the following pages on *Tiaropsis*). The description, given by Maas, is so clear and excellent, that it cannot be misunderstood. It may be worth while, therefore, to call attention to the fact, that Mayer (1910) identifies the two forms, an apprehension which he has not changed in his later work (1915, p. 200), after having had the opportunity of examining new material of *L. fijiana* from the Torres Straits.

During the German Deep-Sea Expedition a small *Laodicea* was found in the Gulf of Aden; it was 5 mm in diameter and had about 96 tentacles. Vanhöffen (1911) referred this medusa to *L. maasii* Browne. With regard to the size and the distribution of the large ocelli it agrees with *L. indica* Browne, but cirri could not be pointed out with certainty. On the other hand, the presence of spurs on the base of some of the tentacles evinces an agreement with *L. maasii*. It is an interesting fact, that Vanhöffen did only find spurs on the younger tentacles, whereas such were apparently absent in the case of the larger tentacles. Vanhöffen is of the opinion, "dass sämtliche Tentakel einen Sporn haben, dass er nur wegen der Krümmung des Schirmrandes häufig nicht sichtbar ist und besonders bei älteren Tentakeln undeutlich oder verdeckt wird .." (1911, p. 221). This agrees very well with what I have observed in *Laodicea undulata* (see above). Vanhöffen's medusa reminds one of the *L. bigelowi* Neppi & Stiasny (1911) from the Gulf of Triest, a small medusa (probably young), 7 mm in diameter with about 70 tentacles, some of which have basal spurs; cordyli, mounted upon small bulbs, are found in somewhat smaller number than the tentacles; cirri are wanting. There can be no doubt of the identity of this species with *Laodicea undulata*.

The three forms of *Laodicea* from the Indo-Pacific region, mentioned above, viz. *fijiana*, *maasii*, and *indica*, are undoubtedly nearly related. Their relation to the European *Laodicea undulata* may, most adequately, be elucidated through a comparison between the latter and Maas's excellent description of "*L. fijiana* var. *indica*" (= *maasii* Browne). The description and figure (Taf. V, Fig. 34) of the flattened, open, square stomach, the four corners of which are drawn out into four "Zipfel", agree exactly with the features found in *L. undulata*. The same holds good with regard to the gonads, which, in the case of the North-Atlantic forms, have not been sufficiently thoroughly described up to now. Maas mentions "Aussackungen, die nicht allein durch Faltung des die Geschlechtsprodukte tragenden Ectoderms bedingt sind, sondern auch durch entsprechende Aussackungen des entodermalen Raumes". Also in this respect we find a complete agreement with the facts, as I have observed them in *undulata*. The length of the gonads is, in *L. maasii*, very variable, being, as a rule, $^2/_3$ the length of the radial canal, but, in some cases, reaching nearly to the circular vessel. The number of tentacles seems to be somewhat smaller in *L. maasii* than in equally-sized individuals of *L. undulata*; in this regard *maasii* is more in accordance with *calcarata* and *ulothrix*. The shape of the tentacles is exactly as in *undulata*. Ocelli are said to be found on about three-fourth of the tentacles of *maasii*; in *undulata* the number of ocelli is, as mentioned above, very variable. *L. maasii* is said to possess a compara-

tively small number of cordyli; the highly irregular distribution of the cordyli, however, seems to indicate, that the number has been greater in the living animal, but that most of the cordyli have dropped off, as is often the case in preserved material. — Cirri have not been observed in *L. maasii*; it is possible, that cirri are really wanting in this form, but, on the other hand, there is an equal probability of the want being due to the preservation. As mentioned above, cirri were only ostensible in well-preserved specimens of *L. undulata*, and even then but a very small number were left; moreover, it is always very difficult to trace these delicate organs between the densely crowded tentacles. Also the above-mentioned *L. bigelowi* Neppi & Stiasny is said to be devoid of cirri, though its identity with the common European form is beyond doubt. The colour of the radial canals, the gonads etc. of *L. maasii* is light blue to bluish-green, thus particularly in accordance with the colour commonly found in *L. ulothrix*, a colour which may also be met with in others of the Atlantic forms of *Laodicea*. — Altogether, the description, as given by Maas, of the East-Indian medusa presents a correspondence, accomplished into minute details, with *Laodicea undulata* from the north-eastern Atlantic, the only feature of distinction being the want of cirri, a feature which, very probably, is due to preservation.

We still have to mention *Laodicea pulchra* Browne (1902, p. 280) from the Falkland Islands. This medusa grows to the size of 25 mm in diameter; in spite of this considerable size it has only about 50 tentacles; there are usually 3—4 cordyli between each successive pair of tentacles. This is evidently a well-defined form, specifically different from all the forms mentioned above.

Table II. Synoptic Table of the various forms of Laodicea.

Name	Occurrence	Size	Cirri	Basal Spurs	Colour
undulata	N.-Atlantic, Europe	large, up to 37 mm	present	present on the younger tentacles	usually reddish or orange, may be brownish, purple, blue or violet
mediterranea	Mediterranean	not stated	present	present	brownish-reddish
bigelowi	Mediterranean	7 mm	absent	present	not stated
calcarata	N.-Atlantic, America	large	present	present	usually dark-yellowish, but very variable, reddish, greenish, or blue
ulothrix	Tropical Atlantic	fairly large	present	present, but not on all tentacles	brownish-white, greenish-white
marama	Fiji Islands	5.5 mm	present	not mentioned	bluish or greenish
fijiana	Fiji Islands, Torres Straits	up to 10 mm	absent	not mentioned	bluish, greenish, or violet
maasii (acc. to Maas)	Malayan Archipelago	up to 20 mm	absent	present on several tentacles	light blue or bluish-green
indica (Browne)	Ceylon	up to 6 mm	present	absent	not stated
maasii (acc. to Vanh.)	Gulf of Aden	5 mm	not stated	present	not stated

The Table II includes all the different forms of *Laodicea* described up to now (except *L. pulchra*), arranged according to their geographical occurrence. It will be seen that all of the forms from the Atlantic-Mediterranean area possess both cirri and tentacular spurs, with the exception of *L. bigelowi* from the Adriatic Sea, in which cirri have not been observed. With regard to the forms from the Indo-Pacific region, the organs in question are said to occur in some forms, whereas they are

wanting in others. The predominant colours of the gastro-genital organs are bluish or greenish in the Indo-Pacific forms as also in the Tropical-Atlantic form, whereas the reddish, yellowish, or brownish colours are predominant in the North-Atlantic forms; blue, green, and violet may, however, also be met with in the latter.

I am inclined to suppose, that all the forms of *Laodicea* described up to now, with the exception of *Laodicea pulchra* Browne, belong to one and the same species: *Laodicea undulata* Forbes and Goodsir, a species which attains its most exuberant development in the North-Atlantic; in the tropical Atlantic, the tropical Pacific, and the Indian Ocean the species is represented by forms, which may be called more or less well-marked local varieties; in some cases the described differences from the typical *L. undulata* may even possibly be due to bad preservation.

If this view be correct, the Geographical Distribution of *Laodicea undulata* is the following:

1) *Atlantic Coasts of Northern Europe.* — (*L. undulata* Forbes and Goodsir). — The occurrence within this area will be discussed in a more detailed way further below.

2) *Mediterranean.* — Neapel, "occasionally during the winter of 1907—08" (*L. cruciata*, Mayer 1910). Messina, winter 1852—1853 (*Thaumantias mediterranea*, Gegenbauer 1856). Triest (*L. cruciata*, Graeffe 1884, *L. bigelowi*, Neppi & Stiasny 1911). Villafranca (*L. cruciata*, Metschnikoff 1886).

3) *Atlantic Coasts of North-America*, south of Cape Cod (*L. calcarata* A. Agassiz). — Naushon, Vineyard Sound, between Delaware Bay and Chesapeake Bay, Woods Hole (A. Agassiz 1865, Hargitt 1904, Mayer 1910. Bigelow 1914 b and 1915). — During the numerous investigations of the "Grampus" in the Massachusetts Bay *Laodicea* was never found. During the investigations in July and August 1913, ranging from Nova Scotia to Chesapeake Bay (Lat. about 44½° to 37° N.) the species was found at four of the southernmost stations, between Delaware Bay and Chesapeake Bay (i. e. Lat. 37° to 38°26′ N.) at the end of July (Bigelow 1915, p. 318 and the list p. 316—317).

4) *Tropical Atlantic* (*L. ulothrix* Haeckel). — Canary Islands (Haeckel 1879, Vanhöffen 1912). Bahamas (Mayer 1904). Tortugas, Florida, common during the summer-months (Mayer 1900).

5) *Fiji Islands*, common in December (*L. fijiana* and *marama*, Agassiz and Mayer 1899).

6) *Torres Straits*, September—October (*L. fijiana*, Mayer 1915).

7) *North-Coast of New Guinea and several places in the Malayan-Archipelago* (*L. fijiana* var. *indica*, Maas 1905, *L. maasii*, Browne 1907).

8) *West-Coast of Ceylon* (*L. indica*, Browne 1905).

9) *Gulf of Aden* (*L. maasii*, Vanhöffen 1911).

All records agree, that this species occurs exclusively in the neighbourhood of the coasts.

Distribution and Occurrence in the north-eastern Atlantic.

The material at my disposal has been collected at 28 different localities, which are here mentioned in the following order: the waters south of Iceland, round Rockall, west, north, and east of Scotland, North-Sea, Skagerrak. (See Chart II p. 26.)

1) — Lat. 64°06′ N., Long. 23°14′ W., Faxebugt, Iceland. July 2nd 1908. Depth 98 m. Young-fish trawl, 65 m wire. "Thor" stat. 45 (08). — 1 specimen, 12 mm wide.

2) — South of Myrdalsjökel, Iceland. August 17th 1903. "Michael Sars". — 1 specimen, 17 mm wide.

3) — Myri Bugt, Iceland. July 21st 1904. Depth 38 m. "Beskytteren". — 6 specimens, 21—26 mm wide.

4) — Lat. 64°04′ N., Long. 15°48′ W., Myri Bugt. July 24th 1904. "Beskytteren". — 2 specimens, 18—22 mm wide.

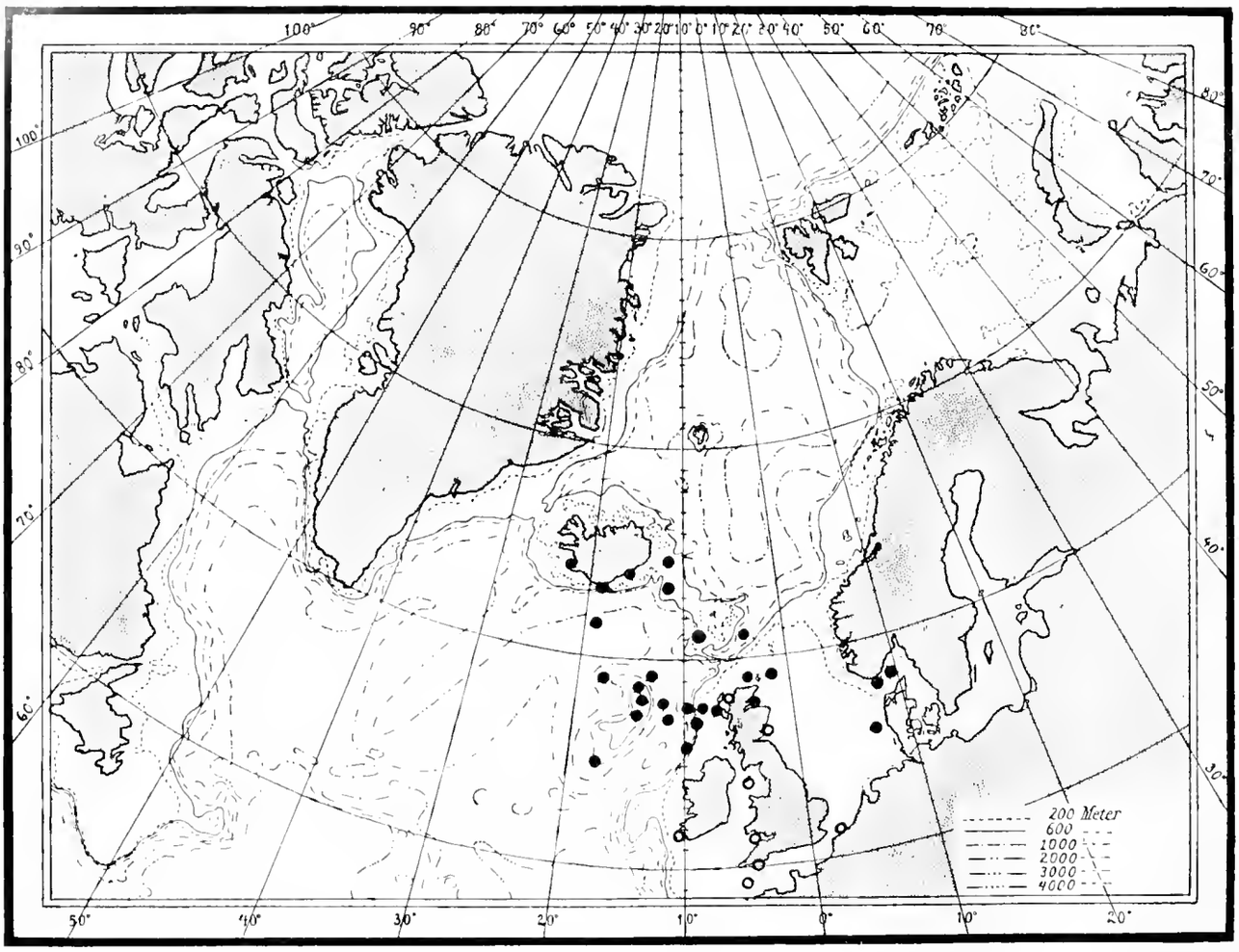


Chart II. Occurrence of *Laodicea undulata* in the northern Atlantic and adjacent waters.
o Occurrence according to the literature.

5) — Lat. 64°35′ N., Long. 11°45′ W., East-Iceland. August 8th 1904. Depth 348 m. Young-fish trawl, 20 or 70 m wire. "Thor" stat. 241 (04). — 2 specimens, 25—28 mm wide.

6) — Lat. 61°34′ N., Long. 19°05′ W., south of Iceland. July 10th 1904. Depth 2160 m. Young-fish trawl, 15 or 70 m wire. "Thor" stat. 180 (04). — 1 specimen, 35 mm wide.

7) — Lat. 63°12′ N., Long. 11°45′ W., between Iceland and the Faeroe Islands. August 7th 1904. Young-fish trawl, 20 m wire. "Thor" stat. Da 13. — 1 specimen, 30 mm wide.

8) — Lat. 59° N., Long. 18° W., between Iceland and Rockall. Olrik. — 3 specimens, 22—28 mm wide.

9) — Lat. 59°07′ N., Long. 13°32′ W., north of Rockall. Moberg. — 5 specimens, 14 — about 25 mm wide.

10) — Lat. 58—59° N., Long. 13—15° W., north of Rockall. Rink 1852. — 5 specimens, about 22 mm wide.

11) — Lat. 57°45′ N., Long. 13°40′ W., near Rockall. August 6th 1910. Young-fish trawl, 50 m wire. "Michael Sars" stat. 99 (10). — 5 or 7 specimens.

12) — Lat. 56°58′ N., Long. 14°39′ W., Rockall Bank. July 7th 1913. "Armauer Hansen" stat. 2. — 200 m wire: 4 large specimens, up to 33 mm wide. — 400 m wire: 1 large specimen.

13) — Lat. 54°42′ N., Long. 18°44′ W., south-west end of Rockall Plateau. July 10th 1913. "Armauer Hansen" stat. 4. — 400 m wire: 3 specimens, two very large, one smaller. — 600 m wire: 1 specimen. — 1000 m wire: 4 large specimens.

14) — East of Rockall. July 28th 1913. "Armauer Hansen" stat. 17. — Surface: 9 full-grown specimens. — 150 m wire: 3 specimens, two very large, one smaller. — 600 m wire: 4 specimens, three large, one smaller. — 1000 m wire: 3 large specimens. — 1300 m wire: 7 specimens, among which are 5 very large, being up to 35 mm wide.

15) Lat. 57°03′ N., Long. 11°20′ W., deep channel east of Rockall, May 28th 1908. Young-fish trawl, 300 m wire. "Thor" stat. 12 (08). — 1 specimen, 26 mm wide.

16) Lat. 55°44′ N., Long. 9°35′ W., north-west of Ireland. June 25th 1906. Depth 1600 m. Young-fish trawl, 350 m wire. "Thor" stat. 89 (06). — 1 specimen, 26 mm wide.

17) — Lat. 57°52′ N., Long. 9°53′ W., deep channel east of Rockall. June 8th 1905. Young-fish trawl, 600 m wire. "Thor" stat. 72 (05). — 1 specimen, about 23 mm wide.

18) — Lat. 56°56′ N., 9°01′ W., west of Scotland. May 28th 1908. Depth 140 m. Young-fish trawl, 65 m wire. "Thor" stat. 11 (08). — 9 specimens, 8—22 mm wide (8, 11, 13, 14, 14, 16, 21, 21, 22 mm).

19) — Near St. Kilda. July 5th 1913. "Armauer Hansen" stat. 1. — Surface: 1 specimen. — 50 m wire: 1 specimen.

20) — Lat. 57°36′ N., Long. 7°05′ W., Little Minch. May 27th 1908. Depth 90 m. Young-fish trawl, 65 m wire. "Thor" stat. 8 (08). — 7 specimens, 7—16 mm wide (7, 7, 8, 8, 9, 11, 16 mm).

21) — Lat. 59°00′ N., Long. 3°34′ W., west of Orkney Islands. May 21st 1908. Depth 66 m. Young-fish trawl, surface. "Thor" stat. 2 (08). — 2 specimens, 6—13 mm wide.

22) — Lat. 60°55′ N., Long. 8°56′ W., Faeroe Bank. August 12th 1902. Depth 130 m. "Michael Sars" stat. 78 (02). — 1 specimen, about 15 mm wide.

23) — Lat. 61°04′ N., Long. 4°33′ W., Faeroe-Shetland channel. July 23rd 1905. Depth 1075 m. Young-fish trawl, 1000 m wire. "Thor" stat. 124 (05). — 1 specimen, about 26 mm wide.

24) — East of Orkney Islands. June 26th 1903. "Michael Sars" stat. 140 (03). — 8 specimens, 25—37 mm wide (25, 30, 30, 33, 33, 33, 35, 37 mm).

25) — Murray Firth. September 4th—5th 1904. "Thor". — 1 specimen, 23 mm wide.

26) — Horns Rev lightvessel, west coast of Jutland. September 23rd 1912. Depth 30 m. Vertical haul, 30—0 m. — 1 specimen, 5 mm wide with about 48 tentacles.

27) — 18 miles south of Oxö lighthouse, Skagerrak. May 28th 1907. Depth 510 m. "Thor" stat. 1074. — 2 specimens. (Plankton Laboratory, Copenhagen).

28) — 12 miles NW. 3/4 W. of Hirshals lighthouse, Skagerrak. October 9th 1904. Depth 640 m. Young-fish trawl, in intermediate strata. "Thor" stat. 273. — 7 specimens. (Plankton Laboratory, Copenhagen).

The specimens from the "Michael Sars" 1910 and the "Armauer Hansen" are in Bergens Museum, the specimens from the "Thor" stat. 273 and 1074 are in the collection of the Plankton Laboratory in Copenhagen; the other specimens are all in the Zoological Museum of Copenhagen.

The information, given in the literature, on the occurrence of *Laodicea undulata* in the North Atlantic area are rather few and scattered and, moreover, not always reliable, in so far as the species has frequently been confounded with *Cosmetira pilosella* Forbes.

The type-specimens of Forbes and Goodsir were found in the Minch between Scotland and the Hebrides "on a very warm day, when the sea was very calm ...".

"*Laodice cruciata* (*Thaumantias pilosella* Forbes)" has been recorded from St. Andrews Bay by McIntosh (1888) and by Crawford (1891) who states, that it "swarmed throughout August and continued in diminishing numbers till November". After recording the species under the name quoted above, the latter author adds: "with marginal cirri and clubs". This seems to show, that the recorded species is really *Laodicea undulata* and not *Cosmetira pilosella*.

During the investigations of Browne in the Firth of Clyde 1901—02 *Laodicea undulata* was not found.

According to Browne (1900, p. 720) the species has been found several times in the neighbourhood of Valencia Harbour, Ireland. In 1895 it was found in April and July, in 1896 from July to the beginning of September; in 1897 it appeared in May and was fairly common in August and September and again in November, whereafter it disappeared. In 1898 it was found from June to November and was very abundant during July and August. Browne adds: "This species has not often been recorded in British seas". In the paper here quoted Browne calls the species with the name of *L. calcarata*. — It was also at Valencia Harbour that Miss Delap succeeded in rearing *Laodicea* from the Hydroid *Cuspidella costata* Hincks, in June 1906 (Browne 1907, p. 464).

The medusa recorded by Browne 1895 (Report on the Medusæ of the L. M. B. C. District) as "*Laodice cruciata*" belongs to *Cosmetira pilosella* Forbes. But in the same paper (p. 276) is mentioned a specimen of "*Laodice calcarata* L. Agassiz", found at Port Erin on May 5th 1894, a young specimen, 5 mm in diameter "... with about 30 tentacles, and cirri of both shapes" (i. e. filiform cirri and cordyli). "It corresponds to the description given by Agassiz". This medusa has, undoubtedly, been a *Laodicea undulata*, which species may, accordingly, be found at Port Erin.

From Plymouth "*Laodice cruciata*" has been mentioned by Garstang (1894, p. 215), but also in this case the medusa in question has actually been *Cosmetira pilosella* Forbes. Browne (1897 b) gives a list of medusæ, found at Plymouth during September 1893, 1895, and 1897. *Laodicea* is not mentioned in that list. Neither is it recorded in the "Plymouth Marine Invertebrate Fauna" 1904, whereas "*Euchilota pilosella* (Forbes)" is said to be common every summer in the neighbourhood of Plymouth.

Nevertheless, *Laodicea undulata* actually occurs in the British Channel. In the British Museum of Natural History in London I have seen two specimens from Plymouth, and it is recorded from the

Channel (under the name of *Laodice calcarata*) in the International Plankton Catalogues (Catalogue, 1906, 1909, and 1916). We have to be very cautious, it is true, in employing these catalogues, as the identifications of the species have, as a rule, not been made by specialists; in the present case, however, I believe the identification to be correct. In one particular instant I have been able to verify the identification directly, some specimens being present in the type collection of the plankton laboratory in Copenhagen. — During the years from 1903 to 1908 the species has been taken in the Channel almost every year in the month of August, and sometimes also in May; only once it was found in November (1905). It was found in the Bristol Channel in August 1905, 1906, and 1907, and in May 1908. It has also on one occasion been found in the North Sea off the coast of Belgium, viz. in August 1905.

As far as I am aware, *Laodicea undulata* has never been recorded from the east coast of Great Britain south of St. Andrews.

Neither has it been mentioned from Heligoland.

I have worked through a very considerable material of plankton from the Horns Rev light-vessel off the southern part of the west coast of Jutland, but I have only found one single, small specimen of this species.

It seems also to be scarce in the Skagerrak, in so far as it has only been observed twice in that sea; it does not penetrate into the Kattegat.

I have never seen this species recorded from the west coast of Norway, and it seems, on the whole, to be altogether lacking in the Norwegian Sea[1].

Nor is it known to occur off the Atlantic coasts of Europe south of the British Channel.

If we compare the records of the literature with the data derived from the material examined by me, we will gain the following general picture of the horizontal distribution of *Laodicea undulata* in the North-East Atlantic area: The species occurs off the southern coasts of Iceland, is numerous around the Rockall plateau and Scotland; it is also found, though apparently in smaller quantities, off the western coasts of Ireland and England, in the Channel, and in the south-western part of the North Sea. Finally it may be found, occasionally, off the western and northern coasts of Jutland.

All records agree, that this species does not occur in any great distance from the coasts, that the distance from the shore, accordingly, sets a limit to the horizontal distribution. On the other hand, the actual depth is without importance with regard to the occurrence. Some of the specimens here dealt with have been taken in shallow water near the coasts or above the Rockall Bank, others have been found above very deep water, as for instance on the "Thor" stat. 180 (04), where the depth was 2160 m, and several specimens have been found in the Rockall Channel, the Faeroe-Shetland Channel, and the Norwegian Channel.

With regard to the vertical distribution we will find, that the species may occur in very different depths below the surface, it having been found in all strata between the surface and about 800 m below the surface. The results of the cruise of the "Armauer Hansen" in 1913 are particularly instructive with regard to the occurrence of this species. *Laodicea undulata* was lacking on all of the

[1]) Hartlaub (1900, p. 172) mentions numerous specimens "der schönen, scheinbar magenlosen *Laodice cruciata*", found during the expedition of the "Olga" at Tromsö (northern Norway) on June 28th 1898. If the identification be correct, we have here an isolated find of high interest.

western stations of this expedition, these stations being situated too far from land; on the other hand, it was found on all of the eastern stations, stat. 1, 2, 4, and 17. But in these localities, all in comparatively short distance from land, the species was found down to the very greatest depths, in which hauls were made, and by no means in small numbers. Particularly interesting is the station 17 in the deep channel between Rockall and Scotland; at this station 9 specimens were taken at the surface, 7 specimens in about 800 m depth, and a number of specimens about 100, 400, and 650 m below the surface. On this locality, accordingly, the species was fairly common in all strata, at least as far down as about 800 m below the surface.

Young specimens are, however, found in the upper water layers exclusively, whereas large and middle-sized individuals may be met with in all depths. In the material at my disposal young individuals are present from the following localities:

Loc. Nr. 1. "Thor" stat. 45 (08). July 2nd 1908. Surface. — 1 specimen, 12 mm.
— - 18. — — 11 (08). May 28th 1908. About 40 m depth. — 9 specimens, 8—22 mm.
— - 20. — — 8 (08). May 27th 1908. About 40 m depth. — 7 specimens, 7—16 mm.
— - 21. — — 2 (08). May 21st 1908. Surface. — 2 specimens, 6—13 mm.
— - 26. Horns Rev. September 23rd 1912. 30—0 m. — 1 specimen, 5 mm.

These localities are all situated very near land. It will be observed, moreover, that most of the young specimens have been found at the end of May; one specimen was taken at the beginning of July in Faxebugt on the west coast of Iceland, and one specimen, the smallest which I have seen, was found in September off the west coast of Jutland. — Larger individuals may also be met with early in the year. Thus on May 28th 1908 (Loc. Nr. 15) a specimen, 26 mm wide, was found in about 200 m depth, and the very largest among the specimens observed, 37 mm wide, was found together with 7 other specimens on June 26th 1903 east of the Orkney Islands ("Michael Sars" stat. 140 (03), depth not stated). Most of the large specimens were, however, taken in July and August. This agrees very well with the statements in the literature. According to these the species appears off the British coasts in May, more seldom in April (Valencia Harbour, Browne 1900), is common during the summer months, and disappears in October or November. The material, examined by me, gives no information as to how late in the autumn the species may be met with in the area investigated, because none of the expeditions, the material of which has been at my disposal, has worked in these regions later than in October, most of them only during the summer months.

According to the above statements *Laodicea undulata* is, in the North-East Atlantic area, a summer form, deliberated from the littoral hydroid *Cuspidella* in the spring or the first summer months, reaching its full size in the warm months, and disappearing in the late autumn, after having accomplished its breeding season; probably the planula larvæ attach themselves in the autumn and develop into the hydroid *Cuspidella*, which passes the winter and sends out its medusa generation in the next spring.

Also off the east coast of North America *Laodicea undulata* is a summer form, occurring from June to the beginning of the winter, being most frequent in July and August. — In the Mediterranean, on the other hand, it is found during the winter.

Genus Ptychogena A. Agassiz.

Ptychogena lactea A. Agassiz.

Plate III, figs. 1—6. Textfig 5.

Ptychogena lactea A. Agassiz 1865. North American Acalephæ, p. 137, figs. 220—224.
— — Haeckel 1879. System der Medusen, p. 147.
— *pinnulata* Haeckel 1879. ibid. p. 148.
— — — 1881. Tiefsee-Medusen der Challenger-Reise, p. 6. Taf. II.
— *lactea* A. Agassiz 1888. Bull. Mus. Comp. Zool. Harvard Coll. Vol. XV, p. 128.
— *pinnulata* Levinsen 1892. Meduser etc. fra Gronlands Vestkyst. — Vidensk. Meddel. Naturhist. Foren., 1892, p. 145.
— — — Aurivillius 1896. Plankton der Baffins Bay und Davis' Strait. — Festskr. Wilh. Lilljeborg tillegnad, p. 198.
— *lactea* Vanhöffen 1897. Fauna und Flora Grönlands. — Drygalski's Grönland-Exped. Bd. II, p. 273.
— *pinnulata* Grönberg 1898. Hydroid-Medusen des arktischen Gebiets. — Zool. Jahrb. Bd. XI, p. 465.
— — — var. Linko 1904 b. Zool. Studien im Barents-Meere. — Zool. Anz. Bd. XXVIII, p. 217.
— *lactea* Browne 1907. Revision of the Laodiceidæ. — Ann. Mag. Nat. Hist. Ser. 7. Vol. XX, p. 473.
— — Mayer 1910. Medusæ of the World, p. 215.
— — — Bigelow 1913. Medusae ... N. W. Pacific. — Proceed. U. S. Nat. Mus. Vol. 44, p. 28.
— — — Kramp 1913. Medusæ ... "Tjalfe" Exped. — Vidensk. Meddel. Dansk Naturhist. Foren. Bd. 65, p. 268.
— — — 1914. Conspectus Faunæ Groenlandicæ, p. 422.

Description of a full-grown specimen from the south coast of Disco, Greenland, "Tjalfe" Exped. stat. 125.

Diameter (the specimen is preserved in alcohol) about 90 mm, height of the bell about 30 mm. The gelatinous substance is very thick, 10 mm at the apical point; the thickness is almost equal throughout the greater part of the bell; only in the peripheral part, within a short distance from the bell-margin, it is evenly diminishing towards the latter. The stomach is quadrate, attached to the subumbrella along the arms of a perradial cross, so that there are four interradial, triangular pouches between the dorsal wall of the stomach and the subumbrella. The length of the sides of the stomach is 20 mm. The prismatic mouth-tube is short, hardly 10 mm long. The mouth-opening is quadrate; the four perradial corners are dilatated into four quite short lips. The mouth-edge is faintly folded. The perradial cross, mentioned above, along the arms of which the stomach is attached to the subumbrella, is seen on the inner side of the dorsal wall of the stomach as four ciliated grooves; in this specimen the grooves do not meet exactly in the centre (see Plate III, fig. 1); the grooves are centripetal continuations of the dorsal wall of the radial canals. The proximal two-thirds of the 4 radial canals are

funnel-shaped, with a wide opening into the corners of the stomach; the distal one-third of the radial canal is a narrow tube, communicating with the narrow circular vessel. The umbrellular part of the funnel-shaped canal is narrow, and from this part issue a large number of lateral folds or branches, perpendicular to the main canal. The umbrellular walls of these lateral folds are attached to the subumbrella, whence the folds hang as perpendicular lamellæ, the ventral edges being free. Below the narrow, lamelliferous part of the radial canal is the wide, funnel-shaped part, mentioned above, reaching outwards nearly to the outermost (distal) lateral folds, gradually narrowing outwards and terminating in a point. The narrow dorsal part is separated from the wide ventral part by a longitudinal fold on each side (Plate III, figs. 2 and 3). These two folds continue in a centripetal direction in the dorsal wall of the stomach nearly to the centre along both sides of each of the ciliated grooves (Plate III, fig. 1). Towards the distal end of the funnel-shaped part the folds are gradually tapering; in the distal part of the folding system there is, accordingly, no complete separation between the ventral and the dorsal part of the canal. Thus a differentiation of the gastro-vascular system, similar to that in *Laodicea undulata*, is established in this species. Probably the food is received and dissolved in the wider, ventral part (I have found half-digested copepods therein); the dorsal part only communicates with the ventral part for a short distance near the distal end of the funnel-shaped part. Proximally the dorsal part opens into the dorsal wall of the stomach through a narrow opening, distally it passes into the narrow, tube-shaped part of the radial canal, free of gonads, through which the dissolved nutritive substances, which have been carried from the funnel-shaped part into the dorsal part, are transported further into the circular vessel.

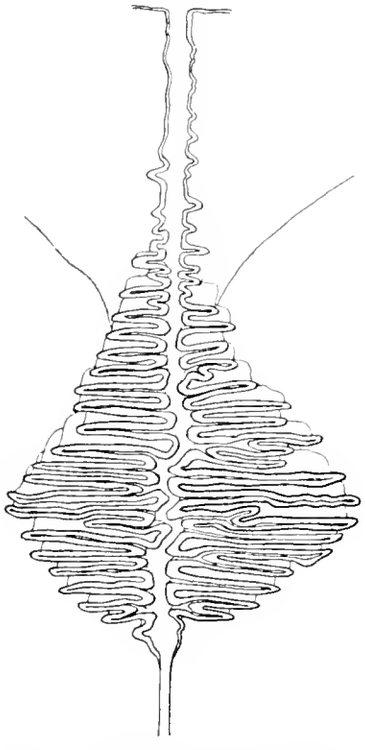


Fig. 5. *Ptychogena lactea* A. Agassiz. A radial canal with its branches and gonads, seen from the apical side. From a specimen from Ritenbenk, Greenland.

Seen from the aboral side the systems of transversal folds form together four elliptical figures, commencing at a short distance from the corners of the stomach. In the present specimen the length of the elliptical figures is about 24 mm, the largest breadth about 19 mm, the longest (middle) of the lateral branches being about 9 mm long, perpendicularly to the main canal. Within this part of the radial canals there are altogether 20—25 folds on each side of the main canal. Besides these closely set folds there are some short, isolated folds in the lateral walls of the grooves in the dorsal wall of the stomach (see textfig. 5, which has been drawn from another specimen). Each of the lateral branches of the radial canals has the shape of a flat, perpendicularly placed pouch, the dorsal edge of which is attached to the subumbrella along a narrow line, and which opens into the main canal by a perpendicular fissure in the narrow, dorsal part of the canal (Plate III, fig. 4). In the walls of these pouches the gonads are developed. The gonads (Plate III, fig. 5) surround the pouch completely except in the line, by which the latter is attached to the subumbrella. Thus the gonads on the two sides of the pouch communicate around the free (ventral and distal) edges of the pouch. Moreover the gonads of two successive pouches communicate proximally in the perpendicular edge between the openings of the two pouches

into the main canal. Accordingly, each of the four radial canals of the medusa has actually only two gonadial bands, separated in the median line of the canal, but each of these bands is folded in a complicated manner. The free edge of each of the pouches gives rise to a row of papillæ of different length (Plate III, fig. 2). The papillæ are hollow; they are extensions from the lateral branches of the radial canal, and their lumen communicates with the lumen of the latter (Plate III, fig. 5). The papillæ are more closely set in the distal part of each of the lamellæ; in the middle part they are more dispersed, and in the proximal part the edge of the lamella is smooth (Plate III, fig. 2). On the shorter (younger) lamellæ the smooth part is comparatively long, only a few papillæ being present, and these are distally situated; on the longest (oldest) lamellæ the smooth part is quite short; on the quite young lamellæ no papillæ are found, the edge is quite smooth. — The oldest lamellæ are in the middle part of the system; the proximal and the distal lamellæ are the younger. New lamellæ are formed, however, not merely proximally and distally, but also intermediary between the older lamellæ in any spare room in the system. — The side-walls of the lamellæ are, as a rule, not quite plane, but are more or less uneven. We may even, occasionally, find a secondary branch, forming an acute angle with the mother-branch. — In the present specimen the ventral, funnel-shaped part of the radial canals reaches nearly to the distal end of the folded system.

The bell margin carries a large number of tentacles and cordyli. In the present specimen there are 400—500 tentacles. Each of the tentacles has a somewhat compressed bulb, about 2.5 mm long; this bulb is somewhat broader distally than proximally. Its outer (abaxial) edge is convex, the inner (adaxial) edge is straight or faintly concave (Plate III, fig. 6). The distal end of the bulbus bends sharply inwards (adaxially) at the point of transition into the thread-like part of the tentacle; very soon the latter bends sharply outwards. The tentacular bulb is hollow; its lumen opens like a funnel into the circular vessel. On the abaxial side of the basal part of the bulb there is a short, conical protuberance (a rudimentary tentacular spur) extending into the gelatinous substance of the exumbrella (Plate III, fig. 6). — The cordyli are small; in the present specimen they are about $^1/_6$ the length of the tentacular bulbs. They alternate fairly regularly with the tentacles, forming a row a little inside the row of tentacles. Each of the cordyli has the shape of a lengthened club, mounted upon a small tubercle closely outside the base of the velum. The cordyli are hollow, but their lumen is very narrow, and in fully developed cordyli it is apparently always separated from the circular vessel, the lumen of the peduncle being quite obliterated. — This specimen seems to represent the fully developed stage of growth, in so far as the tentacular bulbs are all of equal size, and the cordyli alternate with the tentacles and are all situated on small tubercles.

The velum is well developed but weak.

As far as I am aware, this individual is the largest specimen of *Ptychogena lactea* hitherto described. In younger individuals there are a smaller number of lateral folds on the radial canals, and the free edges of the lamellæ carry a smaller number of papillæ; in specimens, less than about 35 mm in diameter, the edges are quite smooth. In younger specimens the funnel-shaped extensions of the corners of the stomach do not reach the distal ends of the gonadial part of the radial canals. The lateral folds, which separate the dorsal part of the radial canal from the ventral part, are not developed in

young individuals. The secondary branching of the lateral branches of the radial canals seems to be a feature of individual variation with no relation to the developmental stage of the specimen.

The smallest specimen, which I have examined, was found near Jakobshavn in Greenland. It is 14 mm in diameter. The state of preservation is not good, especially the stomach is much destroyed. The bell seems to have been comparatively higher than in grown-up individuals; in the present condition of the specimen the height is 8 mm. The length of the folded parts of the radial canals is about 3.5 mm, the largest breadth about 2—2.5 mm. In each of the folding systems 5—6 pairs of lateral folds are present; they confirm the above statement, that new lateral branches are developed not only proximally and distally, but also intermediary; there are no secondary branches. The free margins of

Table III. Synopsis of the specimens of *Ptychogena lactea* examined.

Locality No.	Diameter of specimen	Height of specimen	Sides of the stomach	Distance from the centre to the beginning of the closely-folded part	Length of the closely-folded part	Largest breadth of the closely-folded part	Number of primary folds in the closely-folded part	Length of the distal part of the radial canals, free of gonads	Number of tentacles	Number of cordyli	Remarks
	mm	mm	mm	mm	mm	mm		mm			
3	90	30	20	11	25	19	40—50	10	400—450	same number as tentacles	Lamellæ with papillæ, a few with secondary branching.
—	70	..	14	11	13—15	13	37—43	13—14	...	..	Largest lamellæ with about 15 papillæ, no secondary branching.
2	68	..	..	..	14—16	12—13	41—49	...	...	...	Lamellæ with as many as 5—6 papillæ; secondary branching.
1	50	..	11	10	10—12	8—9	25—28	...	...	...	Papillæ present; secondary branching. One of the radial canals abnormal, its dimensions not included in the table.
7	40	..	..	..	...	...		...	...	..	Secondary branching. Fairly long papillæ.
9	35	20	..	..	8	7.5	about 25	7	...	about equal to number of tentacles	Edges of lamellæ smooth; secondary branching of a few lamellæ. Only one gonadial system measured.
4	14	8	..	..	3.5	2—2.5	10—12	2—3	60—80	more numerous than tentacles	No papillæ; no secondary branching.

the lamellæ are smooth. The length of the distal part of the radial canals, free of gonads, is 2—3 mm. The number of tentacles cannot be stated exactly, but there are about 15—20 tentacles in each quadrant. The cordyli are somewhat more numerous than the tentacles (compare Bigelow 1913, who states that there is a comparatively larger number of cordyli in young specimens than in older ones). Some of the cordyli are situated on quite small tubercles as in the large individual, but some others are mounted upon large, thick bulbs, very like tentacular bulbs of half size; still others are placed in a manner intermediary between these two extremes.

In order to illustrate the variation and development of the species I have worked up the above synoptic table (Table III) of the specimens examined by me. — Most of the specimens are badly preserved, so that especially the number of tentacles cannot be stated. As will be seen from the synopsis, the shape of the folded part of the radial canals is subject to much variation; it may be

nearly circular in outline, as in the specimen from the Kara Sea (locality No. 9) and the 70 mm wide specimen from the "Tjalfe" stat. 125, or it may be more lengthened, elliptical.

From the "Tjalfe" stat. 171 we have a specimen, 50 mm wide, in which the canal system is abnormally developed. One of the radial canals is bifurcate proximally near its point of issue from the stomach. Each of the two branches has its own system of lateral branches and gonads, and the two systems do not touch each other. The one system is somewhat smaller than the other and diverge somewhat more from the perradial direction. This "secondary" canal has, probably, not reached to the circular vessel; this cannot, however, be stated with certainty. The gonads in the "secondary" system are on the same stage of development as the others, though the lamellæ are somewhat shorter. Another radial canal in the same specimen is bifurcated distally. The folded gonadial part has nearly the normal shape, but the distal end of this part gives rise to two narrow, divergent canals, running to the circular vessel. One of the lateral branches of this gonadial system is twice dichotomically branched.

It has been acknowledged long ago, that the difference between *Ptychogena lactea* Agassiz and *Ptychogena pinnulata* Haeckel depends on development and variation. Haeckel's description is based on two specimens from the Atlantic north of Rockall and a fragment of a specimen, found by the "Challenger" expedition in the neighbourhood of Halifax. The two first mentioned specimens are in the Zoological Museum of Copenhagen; thus I have been able to examine these specimens. Haeckel states that the abaxial side of the tentacular bulbs is concave, whereas the adaxial side is convex, and he gives a drawing in accordance herewith (Haeckel 1881, Plate II, fig. 4). Actually the fact is the contrary (see Plate III, fig. 6). Moreover the cordyli have been drawn too large, especially too thick; they are fairly thin in this specimen. — There is another specimen from the same locality, very badly preserved. As the specimen has hitherto been labelled "*Thaumantias*", and as Haeckel only mentions two specimens from this locality, this specimen has, I think, not been in the hands of Haeckel.

Bigelow's record of *Ptychogena lactea* from the north-western Pacific (1913) is of considerable interest, partly owing to the statement of the occurrence of this species in the Pacific, partly on account of the observation, that the young specimens have a comparatively larger number of cordyli than the full-grown individuals; a specimen with about 50 tentacles had about 160 cordyli.

Among other species, which have been referred to the genus *Ptychogena*, I have already mentioned (p. 13—14) "*Ptychogena erythrogonon*" Bigelow and "*Ptychogena Hertwigi*" Vanhöffen, which both belong to the genus *Chromatonema*.

The medusa, described by Maas (1893) as *Ptychogena longigona* from the north-eastern Atlantic, has not been found since it was described by Maas, though numerous collections have been made in the same region. Setting aside that ocelli are not mentioned in the description, this reminds one to a considerable degree of *Laodicea undulata*, and I am, in fact, very much inclined to think that this is actually the species described by Maas.

Torrey (1909, p. 13) describes a species from San Diego, California: *Ptychogena californica*. Two young specimens were found, 10 mm in diameter by more than half as high, with about 48 tentacles, 1—5 cordyli between every successive pair of tentacles, gonads with 12—14 folds. This is undoubtedly a *Ptychogena*, but I dare not decide, whether it is a distinct species or only young individuals of *Ptychogena lactea*.

Ptychogena antarctica Browne (1907, more thoroughly described in 1910, p. 29) is distinguished from *Ptychogena lactea* by the fact that the gonadial lateral folds are shorter and not attached to the subumbrella, and by the colour, the base of the tentacles being, according to Browne, provided with red entodermal pigment; according to Vanhöffen (1912), who has refound the species in the material from the German South-Polar expedition, the organs are dark coffee-brown. There is one cordylus between every successive pair of tentacles, and in some of these cordyli Browne found nematocysts (see p. 4).

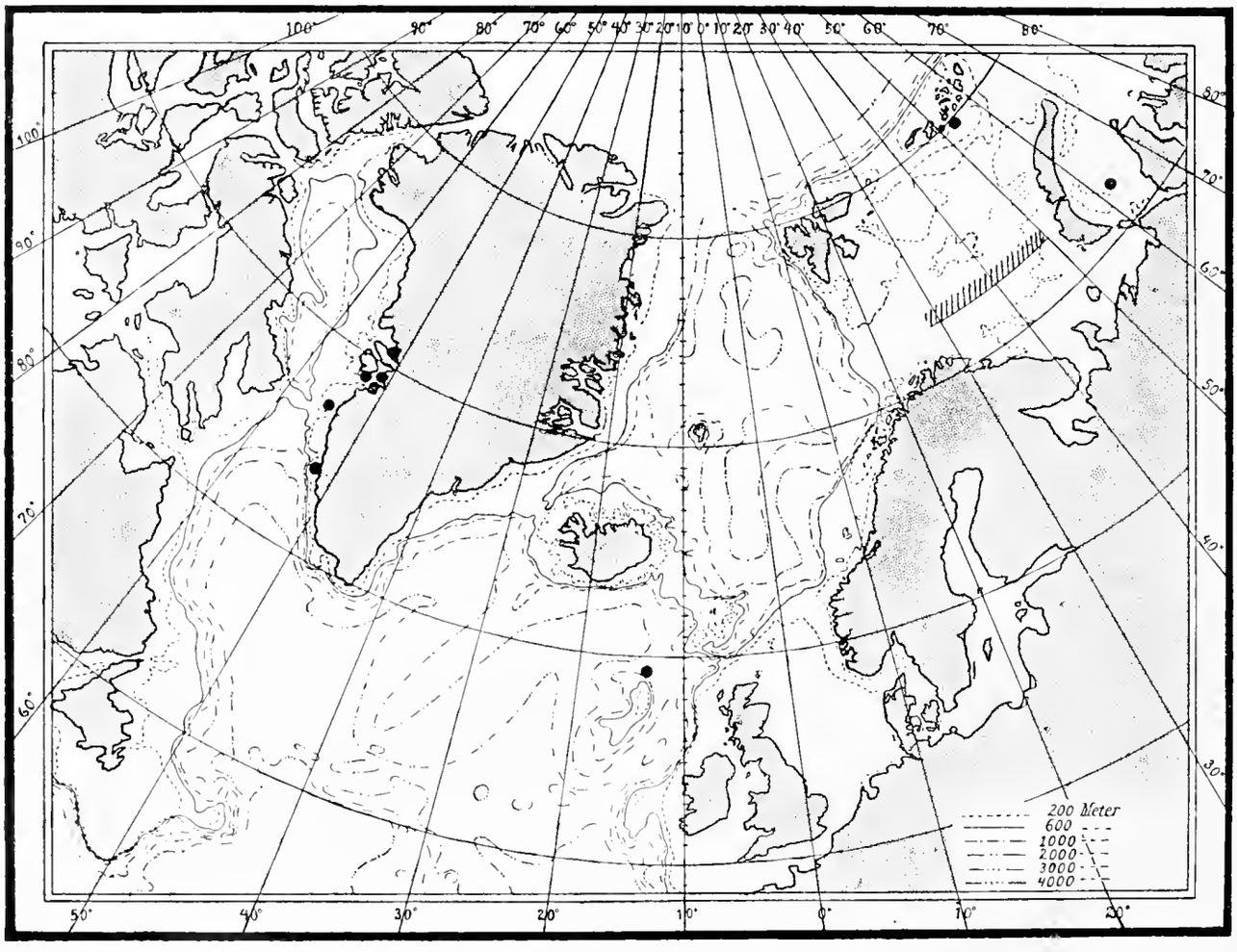


Chart III. Occurrence of *Ptychogena lactea* A. Agassiz in the northern Atlantic and adjacent arctic waters. — The hatching denotes the southern limit of the occurrence in the Barents Sea, according to Linko.

Vanhöffen (1912, p. 366) describes another species, *Ptychogena aurea*, from four small specimens with about 32 tentacles and gold-yellow gonads with mature sexual products. Cordyli are not present. I am not convinced that this medusa belongs to the genus *Ptychogena*, but I will not deny the possibility.

I have had at my disposal for examination 12 specimens of *Ptychogena lactea* from 9 different localities. In the following list I have also included some non-preserved specimens from Godthaab Fjord, Greenland, found by the "Tjalfe" expedition; in the journal of the expedition they are shortly but clearly described, so much so that they may be identified with complete security.

Material (see Chart III).

Greenland:

1) — Lat. 70°41′ N., Long. 52°07′ W., Umanak Fjord. August 6th 1908. Depth 727 m. Ringtrawl, 800 m wire. "Tjalfe" stat. 171. — 1 specimen, about 50 mm wide.

2) — Ritenbenk, Disco Bay. Bergendal. — 1 specimen, about 68 mm wide.

3) — Lat. 69°17′ N., Long. 52°14′ W., south coast of Disco. July 16th 1908. Depth 430—440 m. Ringtrawl, 550 m wire. "Tjalfe" stat. 125. — 2 specimens, 70—90 mm wide.

4) — Jakobshavn, Disco Bay. Bergendal. — 1 specimen, 14 mm wide.

5) — Lat. 66°55′ N., Long. 54°37′ W., 20 miles west of Holstensborg, August 23rd 1908. Depth 66 m. Ringtrawl, 80 m wire. "Tjalfe" stat. 211. — 1 specimen, about 40 mm wide.

6) — Godthaab Fjord, Lat. 64°11′ N. August 30th 1908. Ringtrawl, 120—80 m wire. "Tjalfe" stat. 234. Ringtrawl, 30 m wire. "Tjalfe" stat. 235. — Some few specimens, not preserved.

7) — Greenland, without further details. "Fylla". — 1 specimen, about 40 mm wide.

Atlantic:

8) — Lat. 59°07′ N., Long. 13°32′ W. Moberg. — 3 specimens, two of which are the type specimens of *Ptychogena pinnulata* Haeckel.

Kara Sea:

9) — Kara Sea, without further details. "Dijmphna". — 1 specimen, about 35 mm wide.

Polar Sea:

10) — Cape Stephens, Franz Joseph Archipelago. H. Fisher. — 1 specimen.

The last-mentioned specimen have I seen in the British Museum of Natural History in London, the others are all in the Zoological Museum of Copenhagen.

Moreover the species has been recorded from the following localities: Near Jakobshavn, Greenland (Vanhöffen 1897, p. 273). — Eastern and western part of the Barents Sea north of Lat. 72°30′ N. (Linko 1905, p. 217). — Near Halifax, Lat. 42°08′ N., Long. 69°39′ W. ("Challenger", Haeckel 1881, p. 6). — Nahant, Massachusetts Bay (A. Agassiz 1865, p. 137). — Bering Sea, Sea of Okhotsk, and off the east coast of Hokkaido, Japan (Bigelow 1913, p. 28). — Moreover Levinsen (1892, p. 3) mentions this species from Iceland from the authority of Faber. In his "Naturgeschichte der Fische Islands" (1829) Faber describes 10 species of medusæ, but I am not able to see, how any of his descriptions could refer to *Ptychogena lactea*.

The places of occurrence off the west coast of Greenland are all near the coast in the cold water. No specimen has been found in that part of the Davis Strait, which is occupied by the comparatively warm Atlantic water.

The data now in hand give us the following general picture of the horizontal distribution of this species:

Ptychogena lactea has its home in the arctic regions, and has probably a circumpolar distribution. It is found off the west coast of Greenland between Lat. 64°11′ and 70°41′ N., further in the Barents Sea, the Kara Sea, and near Franz Joseph Archipelago. Only occassionally it has been found in the Atlantic outside the arctic region, viz. north-west of Scotland[1] and in the Massachusetts Bay. In the Pacific it follows the Kamtschatka Current southwards as far as the northern part of Japan.

[1] If the statement of that localty is correct.

A. Agassiz was of opinion that *Ptychogena lactea* was a deep-water species, and he describes, how it is very rapidly killed by the influence of the light and the higher temperature of the surface water. In the Massachusetts Bay, however, the conditions are so unfavourable for this species, that its occurrence in this area gives no reliable information with regard to its habits under normal conditions. Bigelow (1914 a, p. 98) states as follows: "The occasional occurrence of Arctic pelagic organisms in Massachusetts Bay and the Bay of Fundy, such as the medusa *Ptychogena* and the ctenophore *Mertensia*, neither of which has been able to establish itself in the Gulf, shows that there are occasional indraughts of the St. Lawrence water into the latter. But ... its influence is either sporadic, or seasonal, not constant." A. Agassiz (1888, p. 128) repeats the statement, that *Ptychogena lactea* probably is a deep-sea medusa. On the other hand, Vanhöffen (1897, p. 273) mentions a specimen, found frozen up in the ice in the neighbourhood of Jacobshavn in Greenland, and he remarks (p. 274): "Dieses Vorkommen scheint mir nicht dafür zu sprechen, dass diese Art eine Tiefsee-Meduse ist, wie angenommen wurde". Browne (1907, p. 473) likewise remarks: "There is no trustworthy evidence that it is a deep-sea form".

As far as the material, examined by me, is concerned, the depth in which the specimens have been found is only stated in the case of the material, brought home by the "Tjalfe" expedition. The statements of this expedition show that the species may be found in very different depths off the west coast of Greenland. In Umanak Fjord, which is more than 700 m deep, and the deeper water layers of which have a temperature of about 1° C, *Ptychogena lactea* was found in about 500 m depth. In Disco Bay, the lower strata of which consist, likewise, of cold water, the species was found about 350 m below the surface, at a temperature of 0°.9 C. On stat. 211, on the Store Hellefiskebanke, it was found about 50 m below the surface; we have no hydrographical data from the station itself, but judging from observations from neighbouring places, made on the same day, the temperature in the depth in question must have been about 1.5—2° C. Godthaab Fjord is one of the fjords, into which the comparatively warm water-masses of the Davis Strait are not admitted on account of a threshold in the mouth of the fjord. On August 30th 1908, when the temperature of the water in the fjord had been under the influence of the conveyance of a whole summers warmth, the temperature was found to be gradually decreasing from 2°.8 at the surface to 1°.3 near the bottom (77 m). *Ptychogena lactea* was, in this fjord, found both near the surface (30 m wire) at a temperature of about 2°.5, and in 50—70 m depth at about 1°.4 C. As the collections of the "Tjalfe" expedition were made with open nets, we may, of course, not be absolutely certain, but that a few animals may have been captured during the hauling up of the net through higher water layers. With regard to the stations 171 (Umanak Fjord) and 125 (Disco Bay) it should be remarked, however, that hauls where also made in higher water layers, and no specimens of *Ptychogena* were taken in these hauls; it is most probable, therefore, that the specimens from these stations have actually been captured in the fairly great depths here stated.

The most important factor determinating the distribution of *Ptychogena lactea* off the west coast of Greenland seems to be the temperature of the water, the species being only found, where the water is cold.

As far as the other biological habits of the species are concerned, nothing positively can be

stated. The specimens from the "Tjalfe" expedition were all found in July and August. With regard to the other material no information of the time of collection are present.

Genus **Staurophora** Brandt.

Staurophora mertensii Brandt.

Plate I, fig. 9; Plate II, figs. 9—10; Plate III, fig. 7.

Staurophora mertensii Brandt 1838. Schirmquallen. — Mém. Acad. Imp. Sci. St. Pétersb. Sér. 6. Tom. 4. — p. 400. Taf. 24—25.

— *laciniata* L. Agassiz 1849. Contrib. Nat. Hist. of the Acalephæ of North America. — p. 300. Pl. 7.

Oceania multicirrata M. Sars 1851. Beretning ... Reise i Lofoten og Finmarken. — Nyt Magazin f. Naturv. Bd. 6. — p. 158.

Staurophora vitrea M. Sars 1863. Geol. og zool. Iagttag. ... Reise i Trondhjems Stift. — Ibid. 1863. — p. 339.

— *Keithii* Peach 1867.

Staurostoma arctica Haeckel 1879. System der Medusen. — p. 131.

Thaumantias melanops Mc Intosh 1890. Notes from the St. Andrews Mar. Lab. — Ann. Mag. Nat. Hist. Ser. 6. Vol. V. — p. 40. Pl. 8.

Staurophora falklandica Browne 1907. Revision of the ... Laodiceidæ. — Ann. Mag. Nat. Hist. Ser. 7. Vol. XX. — p. 472.

— — Browne 1908. Medusæ, Scottish Nat. Antarct. Exped. — Trans. R. Soc. Edinb. Vol. XLVI. Part II. — p. 235. Pl. I, figs. 1—7.

— *discoidea* Kishinouye 1910. Some Medusæ of Japanese Waters. — Journ. Coll. Sci. Imp. Univ. Tokyo. Vol. 27. — p. 29.

The genus *Staurophora* was established and the species *mertensii* was described by Brandt from drawings and notes of Mertens, who had collected this interesting medusa in the northern Pacific during his circumnavigation. L. Agassiz (1849) gave a new description of the genus, based on several specimens from Boston Harbour, North America. Agassiz rightly referred his specimens to the genus *Staurophora* Brandt, but established a new species, *Staurophora laciniata*. The description given by Agassiz is very thorough and clear. He has not, however, observed the cordyli, and none of his specimens were full-grown; later investigations, therefore, have occasioned certain alterations of the description of the species. The species is now so well known that it is unnecessary to give a general description in this place. Maas (1893) and Hartlaub (1897) have demonstrated that it is unreasonable to separate *Staurophora arctica* from the genus *Staurophora* and place it in a proper genus *Staurostoma*; Haeckel (1879) even placed the two genera within two different families at the same time as he observed that they were nearly related.

With regard to the systematical position there can be no doubt but that the nearest relatives of *Staurophora* are the genera *Laodicea* and *Ptychogena*. Mayer (1910), however, separates the genus widely from these genera and places it within the family *Eucopidæ* on account of the presence of

marginal vesicles. These have been described by Linko (1900, p. 4. Taf. II, Fig. 22—25). The marginal vesicles are described as being very small and numerous, one inside each of the tentacles, situated in the ectoderm on the subumbrellular side of the bell inside the circular vessel, just above the supporting lamella of the velum. The structure of the single vesicle could not be examined thoroughly "wegen der schlechten Conservierung" (p. 5). Browne (1908) has tried to find these marginal vesicles, but he found no trace of such organs; it seems reasonable, therefore, to suppose that the vesicles, which Linko found is his, as he states himself, badly preserved material, have simply been due to destruction of the tissues. We must, in any case, wait for new investigations of well-preserved material, before the presence of marginal vesicles in this species can be stated. I myself have sectioned a part of the bell margin of *Staurophora* without finding any vesicles, but, I admit, the material at my disposal is not well suited for such examination.

In the paper quoted above Linko mentions the structure of the ocelli, and he states that within the same specimen we may find every transitional stage from a simple pigment-spot to a cup-shaped eye with a lens.

The most interesting feature in this species is the structure of the mouth. Braudt was of the opinion that the animal had no mouth at all, but that the food was received through the lancet-shaped "arms" in a manner corresponding to the facts in a *Rhizostoma*. Agassiz, on the other hand, calls attention to the eminent extention of the mouth, the corners of the mouth being prolonged along the four arms of the "cross". M. Sars (1863, p. 339) had a similar apprehension. When Haeckel states as a feature characteristic for "*Staurostoma arctica*", that the outer half of the gonadial part is closed, this must undoubtedly be due to a mutual gluening of the folded edges of this part of the mouth; such gluening has been observed by several authors and is also seen in some of the specimens examined by me.

As the corners of the mouth extend as far outwards as the gonads, the latter may in some way be said to have their position on the walls of the "stomach". Hartlaub (1897) takes this as an argument of a near relationship to the *Tiaridæ*. I am more inclined to think that the large extent of the mouth in *Staurophora* is a secondary character, and *Staurophora* is hardly the genus among the *Laodiceidæ* which is nearest related to the *Tiaridæ*. A clear picture of the manner in which the mouth in *Staurophora* has to be understood, has been delivered by Browne (1907, p. 470): "If one were to slit open along the middle the enlarged portions of each radial canal of *Laodicea pulchra*, and imagine the cut margins to be the margins of a mouth, then the position of the mouth, stomach, and gonads would be similar to those of *Staurophora*. I think the mouth of *Staurophora* has arisen by the outgrowth of a central mouth along the enlarged portions of the radial canals of a *Laodice*-like medusa, and consequently those portions of the radial canals have been converted into a four-rayed stomach. The gonads have not changed their position, but in *Staurophora* they have lengthened slightly and meet in the centre of the cross". I quite agree with this apprehension.

The hydroid generation is unknown; but quite young stages of the medusa have been observed by A. Agassiz (1862, p. 2, and 1865, p. 136) and Hartlaub (1897, p. 487), who have been able to follow the development so far that the species might be identified with certainty. — The first developmental stages of the egg have been observed by Wagner (1885, p. 80—81). — Hargitt (1904, p. 43)

has demonstrated that the development of the eggs takes place in the genital folds, and that the larvæ leave these folds in the shape of actinulæ.

It is beyond all doubt that the species *Staurophora vitrea* Sars, *Staurophora Keithii* Peach, and *Staurostoma arctica* Haeckel are identical with *Staurophora laciniata* Agassiz. Since Bigelow (1913, p. 27) has seen a number of specimens from the same regions, where Mertens found the medusæ described by Brandt as *Staurophora mertensii*, and has had the opportunity of comparing these specimens from the Pacific with specimens from the Atlantic, it may be stated definitely that the species of Brandt and Agassiz are identical. The *Staurophora discoidea* described by Kishinouye (1910) is only separated from *mertensii* "by the more numerous lateral folds of the genital gland", the number of which was 17 in *mertensii*. The description shows that this Japanese medusa in no respect differs from the Atlantic form of *Staurophora*. Thus all *Staurophora* from the northern seas belong to one and the same species, *Staurophora mertensii* Brandt. — In a paper, published in Danish (1914, p. 420), I have stated that *Staurophora falklandica* Browne also belongs to the same species. This fact will be further demonstrated below.

Vanhöffen mentions this species from the Atlantic outside the Bay of Biscay and from the Indian Ocean (1911, p. 219), further from the southern Atlantic between Trinidad and St. Helena and north-east of St. Paul (1912, p. 366). In the last-named paper he also describes a new species, *Staurophora antarctica* from the antarctic Sea. I feel convinced that none of these medusæ belong to the genus *Staurophora*. The specimens were all quite small, and Vanhöffen found that they agreed with Hartlaub's description of the young *Staurophora* from Heligoland. Common for the latter and Vanhöffen's small medusæ is a general likeness to a young Tiarid. The medusæ from the Indian Ocean (and the Bay of Biscay) are 1—18 mm wide with 4—64 tentacles. The 3 weeks old specimens described by Hartlaub were 10 mm high and a little broader, though far from 18 mm, and they had already more than 100 tentacles and, besides, a number of cordyli; the latter are not found in Vanhöffen's medusæ. In Hartlaub's specimens no traces of gonads were yet visible; Vanhöffen, on the other hand, mentions visible traces of gonads as grooves in the walls of the stomach in some of the specimens from the Indian Ocean (he does not state how many specimens or what sizes) as well as in the specimen from the southern Atlantic, which was only 5 mm high. Vanhöffen rightly calls attention to the fact, that the gonads being developed as grooves in the walls of the stomach is a feature pointing towards the *Tiaridæ*. But in *Staurophora* the gonads are not placed in grooves, but in lateral extensions developed along the line by which the cross is attached to the subumbrella. Finally, Vanhöffen states that the specimens from the Indian Ocean (and the Bay of Biscay) are provided with ocelli on the outer (abaxial) side of the tentacular bulbs. This statement might possibly be due to a slip of the pen or a misprint; but in the figure of the medusa from the southern Atlantic (1912, Taf. XXV, fig. 3) the ocelli are clearly drawn as being abaxial. Altogether, I feel sure that the medusæ, referred by Vanhöffen (in 1911 as well as in 1912) to *Staurophora laciniata*, are really some kind of young *Tiaridæ*. The same is undoubtedly the fact with regard to "*Staurophora antarctica*". This medusa is 10 mm in diameter and has 8 tentacles; the stomach is deep brown with groove-shaped gonads.

In the following I am going to present some scattered morphological observations, made on the material of *Staurophora mertensii* from the North-Atlantic area, examined by me.

The lower, free margin of the folded mouth-edge is sharply turned outwards as in *Laodicea* and *Ptychogena*.

In full-grown specimens the gonadial folds are more highly developed in the middle part of the cross-arms than in the proximal and distal parts, each cross-arm thus being narrowly lancet-shaped. The primary lateral folds have usually 4—6 secondary folds, more seldom 7 or more. In middle-sized specimens the primary folds have, as a rule, the same number of secondary folds as in full-grown specimens, but as the sexual products are not fully developed, and the walls accordingly are thinner, the secondary folds do not come into contact, but are separated by open spaces. During growth of the animal, new primary folds are formed intermediary between the existing ones. The lateral folds are flattened

Table IV. Dimensions of some specimens of *Staurophora mertensii* from Greenland and Iceland.

Locality number	Diameter of specimens, cm	Largest breadth of cross-arms, mm	Length of narrow part of radial canals, mm	Number of tentacles
3	4 1/2	1 1/4	3 1/2	. .
2	about 5	1 1/4	4	. . .
3	5 1/2	2	4	. . .
—	7	. . .	5	about 1000
5	8	3	5	more than 1200
—	9	4 1/2	6	about 1100
—	9	2 1/2	5	— 1400
—	10	5	6	— 1400
—	11	7	6	— 1400
—	about 12	8	9—10	— 4400[1]

[1] calculated.

on their upper (umbrellular) side, but they are only fastened to the subumbrella by narrow branched lines (see Plate II, fig. 9, presenting some lateral folds seen from the aboral side after being carefully loosened from the subumbrella).

The largest breadth of the cross-arms and the length of the distal parts of the radial canals, free of gonads (the "proper" radial canals) have been measured on some specimens from Greenland and Iceland. The results are presented in Table IV, in which I have also given the number of tentacles. The numbers of localities will be found in the list of material below. The specimens are arranged according to the size.

In larger specimens the peripheral part of the exumbrella is provided with numerous deep, sharp, radiating furrows of very different length, though rarely more than 10 mm long; the number of furrows is variable, one being found off every second or fourth of the tentacles (see Plate I, fig. 9).

The tentacles (Plate I, fig. 9; Plate II, fig. 10) are hollow. The basal bulbs are conical; the ectoderm of the bulb is somewhat thickened, particularly on the adaxial side (Plate II, fig. 10). Every

tentacle bears, on its abaxial side, a narrow, pointed, entodermal spur, penetrating into the gelatinous substance close to the exumbrellular side (Plate II, fig. 10). The distal part of the tentacle is, as a rule, spirally coiled. The tentacles are very numerous and, frequently, so densely crowded that, owing to the lack of room, they seem to be situated in somewhat different height on the bell-margin.

In the young medusa the tentacles are developed in a certain regular succession, as demonstrated by A. Agassiz (1863). In older specimens we find tentacles of every size in quite irregular succession. We may find, however, fully developed tentacles and quite young tentacles almost regularly alternating, particularly in very large specimens. When the tentacles are very densely crowded, these young tentacles may be quite thin and delicate, almost like cirri, and apparently situated a little inside the fully developed tentacles. By closer examination, however, we will always find that the small tentacles are not quite alike, but that some of them are a little larger than the others and approach the fully developed tentacles in shape. When there is a little better room, the young tentacles are placed in the same row as the others and have a fairly broad base, clearly indicating that they are real tentacles, not cirri; besides, a spur is very soon developed. Ocelli, on the other hand, are usually not developed until the tentacle has reached a fairly considerable size. The nearly regular alternation of small tentacles without ocelli and large tentacles with ocelli was the feature, on which Browne (1908, p. 235) based the species *Stauroplora falklandica*. As exactly the same feature is frequently found in northern specimens of *Stauroplora*, and as *Stauroplora falklandica* in all other respects has a complete likeness to the northern *Stauroplora mertensii*, there can be no doubt as to the identity of the two forms. Browne himself remarks (p. 236): "It is rather a risky point, I admit, on which to base the character of a new species, as there is the probability of the small tentacles developing into full-sized tentacles with ocelli".

As a rule, there is one adaxial ocellus on the base of each of the tentacles with the exception of the quite young ones. Some irregularity may, however, be found. In 4 specimens from North-Iceland ("Thor" stat. 220 (04), Loc. No. 5) the ocelli are arranged in the following manner: 1) Diameter of the specimen 8 cm, ocellus on about every 4th of the tentacles; 2) diameter 9 cm, ocellus on about every 3rd—4th of the tentacles, not seldom two ocelli on one tentacle; 3) diameter 10 cm, ocellus on every 3rd—4th of the tentacles; 4) diameter 11 cm, ocellus on almost every 2nd of the tentacles. Sometimes the pigment of the ocelli may disappear on account of the preservation, and we cannot exclude the possibility that this has happened in the specimens mentioned above, as far as the tentacles now destitute of ocelli are concerned.

In this species the number of cordyli (Plate I, fig. 9; Plate III, fig. 7) is always equal to the number of tentacles, the cordyli regularly alternating with the latter, situated in a row a little inside the row of tentacles. The peduncle is thin and lengthened, the distal part is fairly much swollen. With regard to the question of their transformation into tentacles, see above, p. 5.

The velum is very narrow, 1—2 mm broad.

According to the literature this species may attain a size of 20 cm in diameter. Among the material in hand no specimen is more than about 12 cm wide; this is probably due to the collectors having not, for lack of room, preserved the largest of the specimens found. I remember having seen numerous very large individuals, far more than 12 cm wide, in the waters round Iceland in 1908.

Material (see Chart IV).

Greenland:

1) — Egedesminde. Bergendal. — 1 specimen, destructed with osmic acid.

2) — Egedesminde. Traustedt. — 1 specimen, about 5 cm wide.

3) — Lat. 66°06′ N., Long. 54°27′ W., Davis Strait, off Southern Stromfjord. August 28th 1908. Ringtrawl, 150 m wire. "Tjalfe" stat. 223. — 2 specimens, 4.5 and 5.5 cm wide.

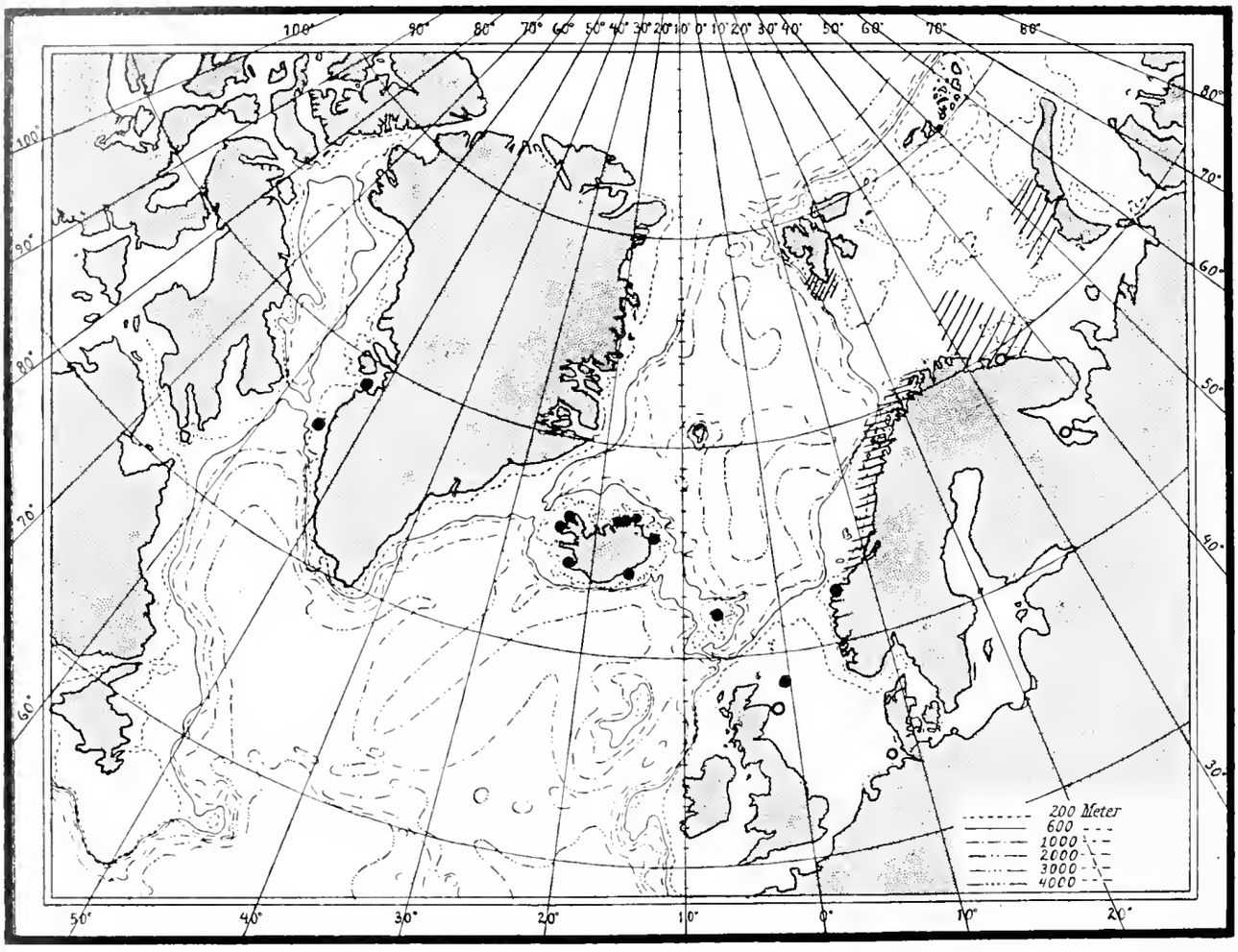


Chart IV. Finds of *Staurophora mertensii* Brandt in the northern Atlantic. ○ and hatching: Occurrence according to the literature.

4) — Lat. 66°01′ N., Long. 54°23′ W., Davis Strait, off Southern Stromfjord. August 28th 1908. Ringtrawl, 150 m wire. "Tjalfe" stat. 225. — A few specimens, not preserved.

Iceland:

5) — Lat. 65°31.5′ N., Long. 13°32′ W., East-Iceland. July 29th 1904. Depth 55 m. 60 m wire. "Thor" stat. 220(04). — 5 specimens, diam. 8, 9, 9, 10, 11 cm.

6) — Near Grjotnæs, Melrakka. July 26th 1896. "Ingolf" Exp. — 1 specimen, about 7 cm wide.

7) — Axarfjord. August 12th 1903. "Beskytteren", Gemzoe. — 1 specimen, torn, probably about 6 cm wide.

8) — Lat. 66°14′ N., Long. 17°28′ W., Skjalfandifjord. July 21st 1904. "Thor" stat. 208 (04). — Pieces of several specimens.

9) — Lat. 66°15′ N., Long. 23°30′ W., off Isafjord. June 15th 1903. "Thor" stat. 134 (03). — One specimen, in the collection of the Plankton Laboratory, Copenhagen.

10) — Dyrefjord. July 14th 1892. Lundbeck. — 1 specimen 7 cm wide.

11) — Lat. 64°06′ N., Long. 23°14′ W., Faxebugt. July 2nd 1908. Depth 98 m. 65 m wire. "Thor" stat. 45 (08). — A piece of the bell-margin with the outer part of a radial canal of a large specimen.

12) — Lat. 63°51′ N., Long. 16°29′ W., Myri Bugt. August 9th 1904. Depth 40 m. "Beskytteren", Gemzoe. — Pieces of a large specimen, which must have been about 12 cm wide. On a 5 cm long piece of the bell margin there are 115 well-developed and as many young and very thin tentacles; the specimen must, accordingly, have had several thousands of tentacles.

Faeroe Islands:

13) — Thorshavn. August 18th 1895. "Ingolf" Exp. — Small pieces of several individuals of different size and stage of development, treated with Flemmings solution.

Norway:

14) — Borgundfjord near Aalesund. June 25th 1902. "Michael Sars", Ad. S. Jensen. — Several torn specimens, not very large.

North Sea:

15) — Lat. 59°46′ N., Long. 0°07′ W., east of the north-point of Scotland. May 7th 1905. 130 m wire. "Thor" stat. 21 (05). — In the collection of the Plankton Laboratory, Copenhagen.

With the exception of the specimens from the localities 4, 9, and 15 the whole of the material here mentioned is in the Zoological Museum of Copenhagen.

Further Distribution:

North Atlantic Area, eastern part:

Spitzbergen (Haeckel 1879, p. 131).

Barents Sea (Linko 1904 a, p. 16 and 1904 b, p. 218). In the eastern (coldest) part of the Barents Sea *Stauroplora* is common in the open sea as well as in the neighbourhood of the coast; in the western part it is somewhat scarce in the open sea, and in the summer it is almost never found near the coast. In the unusually *cold* summer of 1899 it was, however, numerous in Kolafjord and in Ekaterin Harbour. Towards the end of the year, on the other hand, it occurs regularly in the neighbourhood of the coast, and it seems then to breed in this region, young medusæ being found here during the first half-part of the year; towards the spring these young medusæ emigrate towards the North.

White Sea (Wagner 1885, p. 80; Birula 1896, p. 16). Wagner found several specimens, 6—12 cm wide, in the Solowetsky Bay in July 1880.

Norway. According to M. Sars (1851, p. 158 and 1863, p. 339) the species is not rare at the coast of Finmarken, where Sars found two specimens, 16 cm wide, in Øxfjord and Havosund in the

summer of 1849. Sars also found a single specimen near Christiansund. Broch (1905, p. 7) records it, though with some doubt, from Puddefjord at Bergen.

East coast of Scotland. Peterhead, May-June (Peach 1868, p. 97); St. Andrews (Mc Intosh 1890, p. 40).

Heligoland. Young specimens about April 1st, full-grown specimens at the end of May 1895 (Hartlaub 1897, p. 484 ff).

North Atlantic area, western part:

West coast of Greenland. All specimens hitherto known from Greenland (Levinsen 1892, p. 145; Kramp 1913, p. 269 and 1914, p. 420) have been mentioned above.

East coast of North America. New Foundland: Fogo Island, at the surface in July (Bigelow 1909 b, p. 307). — New England: Grand Manan (Stimpson 1854, p. 11; Fewkes 1888 a, p. 233); Eastport (Verrill 1872, p. 6); Massachusetts Bay (L. Agassiz 1849, p. 300 ff.; A. Agassiz 1865, p. 136); Woods Hole (Hargitt 1902, p. 553 and 1904, p. 43—44); Fishers Island Sound (Verrill 1875, p. 43); Frye's Island, New Brunswick (Fewkes 1888 a, p. 233). Bigelow, in a series of papers (1914 a, p. 123—124; 1914 b, p. 12; 1914 c, p. 407; 1915, pp. 267, 273, 274, 319, 320), has dealt with the occurrence of this species off the coasts of New England. It appears from his statements that *Staurophora mertensii* is common north of Cape Cod, whereas sout of this point it occurs only occasionally, and then only in the spring. In the Gulf of Maine it is "a constant inhabitant", though it occurs particularly in the neighbourhood of the shore; Bigelow states that this is not surprising "because it is undoubtedly neritic" (1914 a, p. 124). Young specimens are found at the end of April or at the beginning of May; thus many very young stages were found in Gloucester Harbour on May 3rd 1913 (op. cit. 1914 c); these young stages probably "have passed through the fixed stage in the near neighborhood". On May 17th of the same year several specimens were found, about 2 inches (5 cm) wide. Grown-up individuals are found in June, July, and August. During the investigations in July and August 1913 (op. cit. 1915) *Staurophora* occurred in the whole of the Gulf of Maine, but not south of Cape Cod. Hargitt (1902 and 1904) has found the species in considerable numbers at Woods Hole, but he remarks: "Its occurrence seems to be somewhat erratic, however, as I have taken specimens but twice within recent years" (1904, p. 44).

The American investigations show that *Staurophora mertensii* is indigenous to the Gulf of Maine and breeds here; further that in the said area its occurrence is not limited to the cold water; south of Cape Cod, on the other hand, it is only an occasional visitor, and in the hot season of the year it is quite absent from that area.

Northern Pacific:

Norfolksound; in the Ocean as far as Unalaschka and between Sitka and the Aleutean Islands (Brandt 1835); Dutch Harbor and Prince William Sound, Alaska (Bigelow 1913); Sachalin and northern part of Japan (Kishinouye 1910). In short, it occurs along the southern coast of Alaska, but not off the west coast of North America south of Sitka; further along the coast of Asia as far south as the northern part of Japan.

Falkland Islands:

January 7th 1903 (Browne 1907, p. 473 and 1908, p. 235).

If we compare the statements of the literature with the experiences derived from the material dealt with in the present paper, we will get the following general picture of the distribution and occurrence of *Staurophora mertensii*: In the Atlantic as well as in the Pacific the main distribution of the species is within the arctic region; in both of these oceans, however, the species may penetrate fairly far southwards into boreal regions, though decreasing in frequency. It is exceedingly numerous off the northern and eastern coasts of Iceland, but somewhat scarce off the southern coast, which is washed by the water of the Gulf Stream. In the Barents Sea it mainly keeps itself in the northern and eastern cold parts, whereas it only penetrates to the south-western part, near the Murman coast, in the autumn or in very cold summers. It does not seem to be scarce in the fjords of Finmarken, but only at a few occasions has it been met with at more southerly parts of the Norwegian coast. The occurrence of quite young specimens at Heligoland demonstrates that the species may live and breed in the North Sea, but it is apparently very rare in that area. — Off the Atlantic coast of North America it is indigenous in the Gulf of Maine, but south of Cape Cod it is only met with occasionally and only in the spring months. — In the eastern part of the Pacific its occurrence is limited to the coast of Alaska, in the western part it penetrates as far southwards as extends the influence of the cold Kamtschatka Current.

Everywhere the species is a well-marked coastal-water form. Particularly it is worth mentioning that all finds of young individuals, hitherto known, have been made very near the shore. Young specimens are always found in the spring, April—May, whereas the grown-up specimens are mainly found in August or later (cfr. the statements of the occurrence in the Barents Sea). There can be no doubt, but that *Staurophora* has a neritic, fixed hydroid-generation, which hibernates, and from which the young medusæ are deliberated in the spring.

Of great interest is the bipolar distribution. The medusa described by Browne from the Falkland Islands was found at the beginning of January; thus also in the Antarctic the species is a summer-form.

Family Thaumantiadæ.

Genus Melicertum L. Agassiz.

This genus has an interesting but not very joyous history, in so far as it has given rise to much confusion owing to a peculiar want of criticism by some otherwise prominent authors. Haeckel (1879), as the first, has called attention to this confusion and unravelled the history of the genus. But at the same time Haeckel introduced the generic name *Melicertidium* for a species, which was later found to belong to the same genus, which L. Agassiz called *Melicertum*, and thus the question rose, which of these two names ought to be used as the correct one. Browne (1905) and Mayer (1910) have discussed this question and thereby given new accounts of the history of the genus. As the said authors arrive to opposite results with regard to the question of the correct name, I have thought it worth while to deal with the matter once more from a historical point of view, in order to make out my position to that question.

The *Medusa campanula*, as described by Fabricius (Fauna groenlandica, 1780, p. 366), had

4 radial canals and a small number of tentacles, as it appears from the rather short and vague description. — Péron and Lesueur (1809, p. 352) quoted the description of Fabricius and referred the species to the genus *Melicerta*, established by these authors, and written by Oken (1815) *Melicertum*[1]. Lamarck (1816, p. 508) called the species with the name of *Dianæa campanula*. — Eschscholtz (1829, p. 105—107 has 4 species of Gen. *Melicertum* Oken, all of which have 4 radial canals: *M. campanula* Fabricius, *M. campanulatum* Chamisso, *M. penicillatum*, and *M. pusillum* Swartz. — *Melicertum campanula* is mentioned again by Oken (1835, p. 226) with reference to the description of Fabricius. — Lesson (1843, p. 313) called it *Campanella Fabricii*, and in Morch's list of the Acalephs of Greenland (Morch 1857, p. 95) Fabricii medusa is included as *Campanella campanula*.

In 1835 (p. 24) M. Sars described a medusa, *Oceania octocostata*, with 8 radial canals and numerous (40—60) tentacles, found at the coast of Norway. The next year the same species was figured by Ehrenberg (1836, Taf. VIII, figs. 5—7), who does not seem to have known Sars's description. Ehrenberg gives no description of the animal, but his figures are very good and leave no doubt as to the identity of the species. It is peculiar, therefore, that Ehrenberg, in the explanation of the plates, p. 77, refers this 8-rayed medusa to *Melicertum campanulatum* Eschscholtz, which, as mentioned above, has 4 radial canals. — Some specimens from the north coast of Ireland were identified by Wm. Thompson (1843, p. 281) as *Melicertum campanulatum* Ehrenberg. — Sars's medusa was included in the work of Lesson (1843, p. 312) as *Aequorea octocostata*, and in Forbes's Monograph (1848, p. 30, Plate IV, fig. 1) as *Stomobrachium octocostatum*.

A medusa related to *Oceania octocostata* Sars was found in Massachusetts Bay, North America, by L. Agassiz. It is quite unintelligible, that Agassiz should refer this medusa to the genus *Melicertum* Oken and identify it with *Medusa campanula* Fabricius. With Agassiz the genus *Melicertum* gets an entirely new meaning and is even used (as appears from the note on p. 352) as the type of a family *Melicertidæ*, which is characterised by the possession of 8 radial canals. Agassiz referred four species to his genus *Melicertum*: 1) *M. campanula* Fabricius; 2) *M. pusillum* Eschscholtz (which is incorrectly identified with *Oceania octocostata* Sars, *Melicertum campanulatum* Ehrenberg, *Stomobrachium octostatum* Forbes etc.); 3) *M. campanulatum* Eschscholtz (non Ehrenberg); 4) *M. georgicum* A. Agassiz, shortly described in a footnote on p. 349. — A. Agassiz (1865, p. 130—134) gives a thorough and clear description of *Melicertum campanula* sensu L. Agassiz, but A. Agassiz, like his father, regards the species as identical with *Medusa campanula* Fabricius. Browne (1905, p. 765) rightly remarks: "*Melicertum* has really become a new genus, and with a new type species, *M. campanula* A. Agassiz (non Fabricius)".

Since the forthcoming of the work of Agassiz the American species has always been called by the name of *Melicertum campanula*, and when that name is used for medusæ from the Atlantic coast of North America, any doubt of the identity is excluded. But the mistake of Agassiz has been the cause, why the species for a long time to follow was recorded as occurring at the coast of Green-

[1] In the front-list of contents in Oken's Lehrbuch der Zoologie, erste Abth., *Melicertum* is mentioned as the fourth genus of "Walnmanete", and reference is given to p. 125. Also in the alphabetic register in the rear of the book *Melicertum* is found with reference to p. 125. But if we look at p. 125, we will find that "Walnmanete" only includes three genera. Group D of Gen. *Charybdea* is characterised as follows: "Stiel verlängerte Magen, löst sich in viele Hare auf — *Melicerta*". The name *Melicertum* is not found, nor the specific name *campanula*.

land; Lütken (1875, p. 188) who was not aware of the mistake, included *Melicertum campanula* in his list of the medusæ of Greenland, and from the authority of Lütken it was likewise included in the lists published by Winther (1880, p. 274) and Fewkes (1888 b).

Haeckel (1879, p. 136) was the first to see the mistake, and he sharply criticises Agassiz, because he referred the American 8-rayed medusa to *Melicertum campanula* (Fabricius), Eschscholtz, Oken, as also because he referred *Oceania octocostata* Sars to *Melicertum pusillum* Eschscholtz. Haeckel is of opinion, however, that the generic name *Melicertum* Agassiz, *non* Oken and Eschscholtz, ought to be retained for the species *campanula* and *georgicum*, because "Agassiz wirklich die erste gute Beschreibung und Abbildung ... gegeben und die acht Radial-Canäle als Familie-Character hervorgehoben hat".

The European form, on the other hand, is elevated by Haeckel to be the type of a new genus, *Melicertidium*, on account of the presumed presence of "marginale Kolben (oder Cirren)" (op. cit. p. 137). As a matter of fact, Haeckel himself has not seen this medusa, but his meditations are based on the previous descriptions and, obviously, mainly on the figures of Ehrenberg. These figures exhibit a series of short tentacles alternating with the long ones, but on account of the way in which these short tentacles were drawn by Ehrenberg, Haeckel got the apprehension that they were clubs. — After Haeckel (1879) the European form has, mostly, been recorded as *Melicertidium octocostatum*; also Hartlaub (1894, p. 192) uses that name at the same time as he states that the medusa has no marginal bulbs but small tentacles as numerous as the common tentacles, and that this is not a sufficient reason for a generic distinction between the American and the European species.

A review of the generic names, which in the course of time have been applied to these species, will give us the following list: *Oceania*, *Æquorea*, *Stomobrachium*, *Melicertum* and *Melicertidium*. When we want to state, which of those names ought to be used as the correct one, we may at once release the three first, as they are now used for medusæ belonging to quite different groups. Thus remains the choice between the two last-mentioned names.

Browne (1905, pp. 764—767) has discussed this question. After a record of the history of the genus and a demonstration of the identity of *Melicertum* and *Melicertidium* the author states as follows: "After due deliberation, I think it would be the best to retain and amend the genus *Melicertidium*, and to do away with the genus *Melicertum*. To retain the latter genus would only lead to more confusion, as it is clear that *Melicerta* or *Melicertum* of Oken is not the same genus as *Melicertum* of Agassiz. It is really a new genus, with a new type species" (p. 766).

Mayer (1910), on the contrary, prefers the generic name *Melicertum* for the following reason: "... it appears that Ehrenberg, 1837, placed Sars's species in the genus *Melicertum*, and I think it should remain there and be considered a cotype of that genus" (op. cit. p. 207).

Mayer's vindication seems to me to be objectionable, because Ehrenberg's use of the name of *Melicertum* for that medusa was simply due to an erroneous identification. Ehrenberg did not refer his specimens to the species described by Sars (he has, probably, not seen Sars's description), but he identified them erroneously with *Melicertum campanulatum* Eschscholtz.

Something may account for the view of Browne to release the equivocal generic name *Melicertum*, but the use of the name *Melicertidium* seems to me to be precarious, because this genus was

founded by Haeckel owing to a false supposition (the presence of clubs), and because the description, therefore, is erroneous. On the other hand, the characterisation of the genus *Melicertum*, given by Agassiz on the basis of the species *campanula*, is clear and correct. Moreover the genus *Melicertum* Agassiz is older than *Melicertidium* Haeckel. Before we decide to release the name *Melicertum* we must, therefore, examine how far the use of that name may give rise to a continued confusion.

First we must examine the fate of the different species of "*Melicerta*" and "*Melicertum*". In order to illustrate the question I have worked out the adjacent synopsis (Table V) including (first column) all species of the genera *Melicerta* Péron & Lesueur and *Melicertum sensu* Oken and Eschscholtz. In the second column I have recorded by whom and when these generic names have been

Table V. Synopsis of the Species of *Melicerta* Péron & Lesueur and *Melicertum* Oken and Eschscholtz.

Generic name *Melicerta* or *Melicertum* used		Name now used
First time	Last time	
Péron & Lesueur 1809:		
Melicerta digitale (O. F. Müll.)	Melicerta digitale Pér. & Les. 1809	Aglantha digitalis
— campanula (Fabr.)	Melicertum campanula Fewkes 1888	? Catablema campanula
— perla (Slabber)	Melicerta perla Blainville 1834	Pelagia perla
— pleurostoma nov.	— pleurotoma Lesson 1843	Turritopsis pleurostoma
— fasciculata nov.	— fasciculata Lesson 1843	Rathkea fasciculata
Eschscholtz 1829:		
Melicertum campanulatum (Chamisso)[1]	Melicertum campanulatum Dujardin 1840	Polyorchis campanulatus
— penicillatum nov.	— penicillatum Lesson 1843	— penicillata
— pusillum (Swartz)[2]	— pusillum Lesson 1843	? swimming actinia-larva
Lesson 1843:		
Melicerta morchella nov.	not mentioned later	(undetermined

[1] Used by Ehrenberg 1836 and Thompson 1843 for *M. octocostatum* Sars.
[2] Used by L. Agassiz 1862 and Kölliker 1864 for *M. octocostatum* Sars.

used for the last time for the species in question. Finally, the last column gives the names, which are now commonly used for these species. *Melicertum pusillum* Eschscholtz and *Melicerta morchella* Lesson have not later been identified.

The application of the name of *Melicertum campanulatum* in Ehrenberg (1836) and of *Melicertum pusillum* in L. Agassiz (1862) is simply due to erroneous identifications, which are, indeed, regrettable enough, but they have done no continuous harm and are of no importance whatever with regard to the question here discussed.

When *campanula* is temporarily excepted, we will see, from the synopsis, that the use of the names *Melicerta* and *Melicertum* in the old meaning (*sensu* Péron & Lesueur, Oken, and Eschscholtz) ceases entirely after the year 1843 (Lesson), in the case of some species even earlier, thus, in any case, long before L. Agassiz used *Melicertum* in a new meaning.

When *Melicertum campanula sensu* Agassiz still as late as in 1888 (Fewkes 1888 b) is recorded

as occurring at the coast of Greenland[1], it is due to Lütken who, not being aware of the mistake of Agassiz, included the species in his list of the medusæ of Greenland, whence it proceeded to the lists of Winther and Fewkes. This is rather annoying, it is true, and may, possibly, still involve misunderstandings; but I am not able to comprehend, how this danger might in any way be removed by the introduction of the name *Melicertidium* in the place of *Melicertum*.

Altogether, it seems to me that the use of the generic name *Melicertum* involves no danger any more for a continuation of the confusion. Since 1843 the names *Melicerta* and *Melicertum sensu* Péron & Lesueur, Oken, Eschscholtz have been applied to no other species than *campanula*. "*Medusa campanula*" Fabricius has to be excluded from the system, as it has not been identified with certainty, and all records of "*Melicertum campanula*" from Greenland have to be omitted. When this is remembered, nobody can have any doubt as to the meaning of the names *Melicertum campanula* Agassiz, *Melicertum georgicum* Agassiz, and *Melicertum octocostatum* (Sars).

When, thus, *Melicertum* Agassiz cannot involve misunderstanding this generic name seems to me to be preferable to *Melicertidium*, because *Melicertum* is older and is correctly defined, whereas the definition of *Melicertidium* is incorrect.

The species of the genus *Melicertum*.

Melicertum proboscifer Maas (1897, p. 19) is undoubtedly a Trachymedusa. — Mayer (1910, p. 209) includes *Melicertella panocto* Haeckel among the species of *Melicertum*, though he indicates the possibility that it may belong to the genus *Melicertissa*. In any case, the presence of ocelli on the base of the tentacles excludes the species from the genus *Melicertum*.

Melicertum georgicum A. Agassiz (L. Agassiz 1862, p. 349; A. Agassiz 1865, p. 135) seems to differ but very slightly from *Melicertum campanula* Agassiz; but since the species was described, no medusa belonging to the genus *Melicertum* has been found in the Pacific; it is impossible, therefore, to state, whether it is identical with the Atlantic-American species. *Melicertum georgicum* is found in the Gulf of Georgia on the west coast of U. S. A.

The two Atlantic species, the European *Melicertum octocostatum* Sars and the American *M. campanula* Agassiz, are undoubtedly nearly related. In the first-mentioned species the height of the bell is about 12 mm, the diameter about as much or a little smaller, and there are fairly constantly 64 longer and 64 shorter tentacles. In *Melicertum campanula* the height and the diameter amount to about 25 mm, and in the full-grown individual the tentacles are all alike; Agassiz and (after him) Mayer state their number to be about 70. There does not seem to be any important difference with regard to the shape of the bell, the manubrium, or the gonads. In *campanula*, it is true, the gonads are said to reach entirely to the circular vessel, whereas in *octocostatum* a small distal part of each of the radial canals is free of gonads; but this feature may, as in other medusæ, be subject to much variation. The tentacles of *octocostatum* are going to be further mentioned below; here I shall only remark that there is no decisive difference between the two series of tentacles. *Melicertum campanula* might very well be considered as a variety which attains a more exuberant development, i. e. when the individual is mature it has a comparatively large size, and all of the tentacles are developed to

[1] My record of *Melicertum campanula* as occurring at Frederikshaab in Greenland (1913, p. 268 and 1914, p. 424) is due to a mistake which I very much regret.

the same size, whereas in *octocostatum* the maturity is accomplished, and the growth comes to a standstill, when the individual is only about 12 mm high, and while half the number of the tentacles have not yet reached full size.

The question, whether *campanula* and *octocostatum* are varieties or independent species can only be solved by direct comparison of specimens of both forms. Particularly it must be examined, whether *campanula* possesses the same peculiar subumbrellular lines of nematocysts, which in *octocostatum* issue from the circular vessel running towards the base of the manubrium. Mayer expressly states that such lines are not yet found in *campanula*. Until these lines have been found, the American species must be regarded as specifically different from the European species.

Melicertum octocostatum (M. Sars).

Plate I, fig. 10; Plate III, fig. 8.

Oceania octocostata M. Sars 1835. Beskrivelser og Iagttagelser ... — p. 24. Pl. 4, Fig. 9.

Melicertum campanulatum Ehrenberg 1836. Akalephen des rothen Meeres ... — p. 77. Taf. VIII, Fig. 5—7.

Aequorea octocostata Lesson 1843. Histoire naturelle des Zoophytes. — p. 312.

Stomobrachium octocostatum Forbes 1848. British Naked-eyed Medusæ. — p. 30. Pl. IV, fig. 1.

Melicertum pusillum Agassiz 1862. Contrib. Nat. Hist. U. S. A. Vol. IV. — p. 349.

— — Kölliker 1864. Würtzburger naturwiss. Zeitschr. Bd. 5. — p. 233.

Melicertidium octocostatum Haeckel 1879. System der Medusen. — p. 138.

Melicertum — McIntosh 1890. Ann. Mag. Nat. Hist. Ser. 6. Vol. V. — p. 304.

— *campanula* Linko 1904 b. Zool. Studien im Barents-Meere. — Zool. Anzeiger. Bd. XXVIII. — p. 218.

Melicertidium octocostatum Browne 1905 a. Medusæ ... Firth of Clyde. — Proc. R. Soc. Edinb. Vol. XXV, Part IX. — p. 762.

Melicertum octocostatum is one of the most pretty and elegant among the medusæ of the northern seas. It seems to be fairly common; the number of specimens in the possession of the Zoological Museum is not large, it is true, and the records in the literature are likewise, as a rule, dealing with a comparatively small number of specimens. Only McIntosh states that he has found the species in considerable quantities at St. Andrews. But the journals of the "Thor" frequently mention a "yellow-rayed medusa", which undoubtedly means this species, as being found in considerable numbers, among others at the coasts of Iceland. In the following record of the distribution of the species I have not, however, thought it advisable to pay regard to these records of the journals, but I restrict myself exclusively to mentioning the preserved material in my possession and the statements of the literature.

Description: The umbrella is bell-shaped. The gelatinous substance is fairly much thickened in the apical part of the bell, while the side-walls are thin-walled. The largest diameter is a little above the margin of the bell.

The stomach is, when contracted, longitudinally folded in 8 folds, and there are apparently 8 short, recurved mouth-lips. Sars (1835), however, states that "When these 8 folds are extended, which

sometimes happens, the opening of the stomach or the mouth becomes fairly large and circular. Besides the margin is entire ..."[1]. The base of the stomach is broad, octangular, and the whole dorsal side is entirely attached to the subumbrella; there are, accordingly, no "grooves" or "centripetal continuations of the radial canals". The 8 radial canals open in the upper part of the sides of the stomach through perpendicular slit-shaped openings (Plate I, fig. 10). On each side of these openings there is a perpendicular fold. Probably the opening may be closed by means of these two folds, the lumen of the radial canal thus being separated from that of the stomach.

The radial canals are attached to the subumbrella along straight lines, but the lateral walls of the canal are, for the greater part of their length, folded and sinuous and contain the gonads. The folded gonads commence at some distance (about one-fourth of the length of the radial canal) from the stomach; they are most highly developed towards the distal end; distally about 1 mm of the radial canal is free of gonads. It is interesting that even fully developed gonads do not cover the whole of the lateral wall of the radial canal in the dorso-ventral direction; they commence at a fairly considerable distance from the subumbrella, so that on each side of the radial canal nearest to the subumbrella there is a stripe free of gonads; ventrally, on the other hand, there is only a very narrow streak which separates the gonads of the two sides. This structure is demonstrated in Plate III, fig. 8, which represents a transversal section through a radial canal with female gonads.

The subumbrellular lines of nematocysts are clearly visible in several of the specimens examined. There are usually 5–7 of these lines in each octant. They issue from the circular vessel and run in a centripetal direction towards the base of the manubrium; a few of the lines may reach almost to the base of the stomach. It is, probably, those stripes, which were described by Wright (1867, p. 42. Pl. 1, fig. 1) as "a supplementary canal system"; Wright states, however, that they issue from the sides of the stomach, running to the circular vessel, forming anastomoses with one another.

The tentacles are hollow; their basal part is laterally compressed. With regard to their number and development I shall make the following remarks: In full-grown specimens there are about 64 large tentacles and about as many small ones; the latter are directed somewhat inwards (adaxially). The large and small tentacles do not, however, alternate in an absolutely regular manner; now and again between two successive fully developed tentacles we may find one quite small tentacle and one of intermediate size, or two fully developed tentacles are placed immediately beside each other, no small tentacle or tentacular bud being found between them. In younger specimens we find tentacles in all stages of development, but as a rule they may be divided into three groups according to size. Specimens 6—7 mm wide have, as a rule, got all of their 128 tentacles, viz. 32 fully developed, a similar number of somewhat smaller, and about 64 quite small tentacles. In an individual, about 7 mm wide, from the north-east coast of Iceland ("Thor" stat. 203 (04)) the mode of development of the tentacles is clearly visible from their size. Beside the 8 perradial tentacles there are, in each octant, 3 long tentacles, which however seem to be a little smaller than the perradial ones; further 4 tentacles, somewhat smaller and still somewhat inwardly directed; and finally 8 quite small tentacles. It is seldom, however, that the grouping in three groups of size is so distinct and regular; as a matter of

[1] "Naar disse 8 Folder udbredes, som undertiden skeer, bliver Mavens Aabning eller Munden temmelig stor og cirkelrund. Iovrigt er den heelrandet ...".

fact, in such younger specimens we usually find every possible transitional stage of development between the smallest and the fully developed tentacles.

Material (see Chart V):

North-East Iceland:

1) — Lat. 66°10′ N., Long. 14°29′ W., near Langenæs. August 13th 1904. Surface. "Thor" stat. 253 (04). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

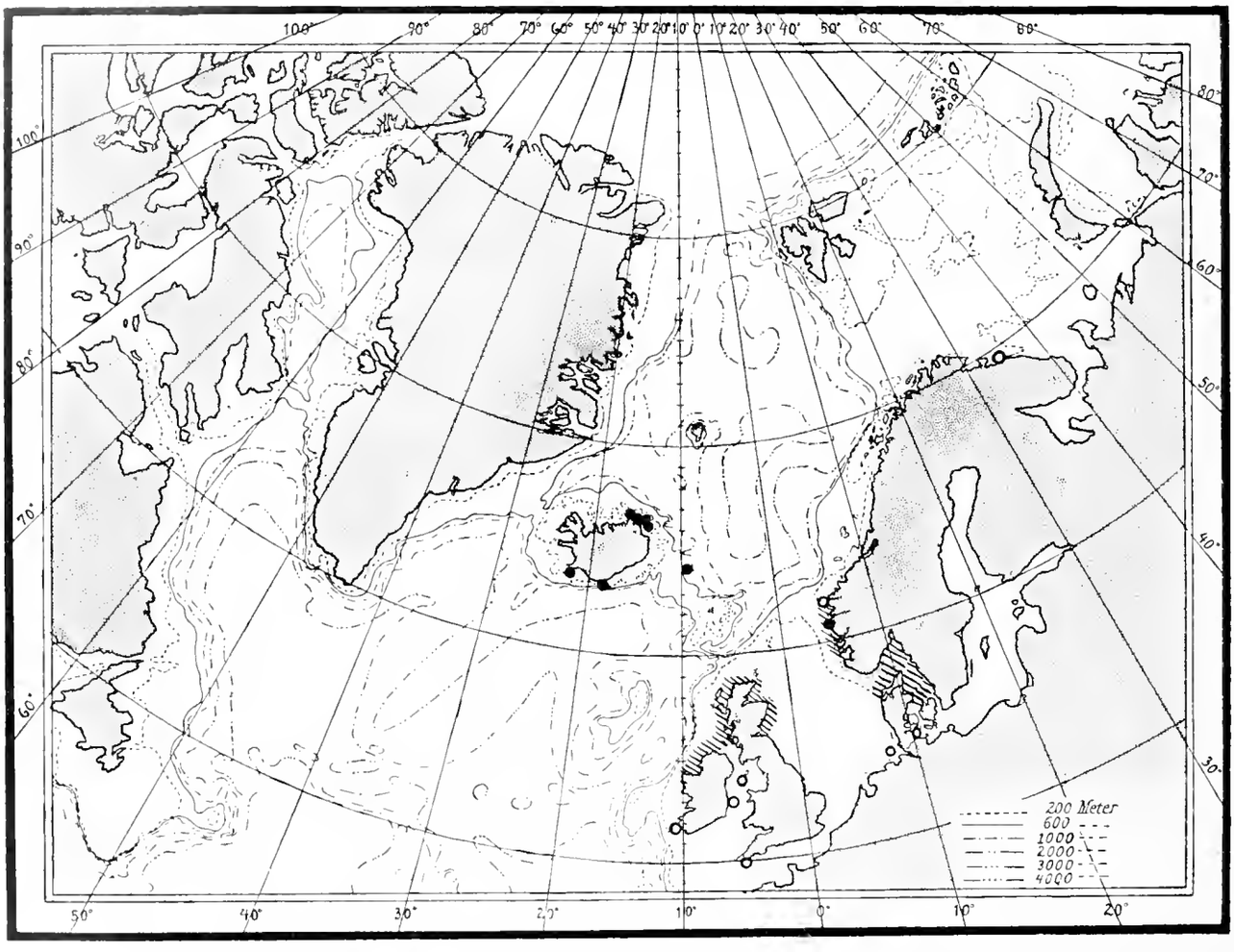


Chart V. Occurrence of *Melicertum octocostatum* M. Sars. o Occurrence according to the literature. In the hatched regions the species is commonly occurring.

2) — Lat. 66°17′ N., Long. 14°27′ W., near Langenæs. July 20th 1904. Depth 77 m. Young-fish trawl, 80 m wire. "Thor" stat. 203 (04). — 1 specimen, height 6 mm, diameter 7 mm.

3) — Lat. 66°25′ N., Long. 14°51′ W., near Langenæs. August 14th 1904. 70 m wire. "Thor" stat. 257 (04). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

4) — Lat. 66°46.5′ N., Long. 14°57′ W. August 20th 1904. Depth 102 m. "Beskytteren", Gemzoe. — 1 specimen, height 11 mm, the apical jelly 3 mm.

5) — North of Tistil Fjord. August 30th 1904. Depth 28 m. "Beskytteren", Gemzoe. — 1 specimen, fairly large.

6) — Lat. 66°38′ N., Long. 16°18′ W., off Melrakka. August 15th 1904. Depth 102 m. "Thor" stat. 258 (04). — 5 specimens, diam. 6—11 mm.

South Iceland:

7) — 9 miles off Krisuvikrberg. July 11th 1903. "Thor" stat. 162 (03). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

8) — Portland Head. July 18th 1903. "Thor" stat. 176 (03). — Specimens in the collection of the Plankton Laboratory, Copenhagen.

Between East Iceland and the Faeroe Islands:

9) — Lat. 64°05′ N., Long. 9°38′ W. August 6th 1904. 80 m wire. — Specimens in the collection of the Plankton Laboratory, Copenhagen.

Norway:

10) — Borfjorden, near Bergen. August 8th 1903. "Michael Sars". — 1 specimen, 5 mm wide.

11) — Bergen. July 6th 1911. Th. Mortensen. — 2 specimens, height 5—8 mm, diameter 6—7 mm.

The specimens from the localities 2, 4, 5, 6, 10, and 11 are in the Zoological Museum of Copenhagen.

Further Distribution:

According to Browne (1900, p. 696) *Melicertum octocostatum* is common at the coasts of Scotland but rare in the southern part of the British area. As to the east coast of Scotland it has been found in Cromarty Firth (Romanes 1876 a, p. 526), at St. Andrews (McIntosh 1890, p. 304; Crawford 1891, p. 296), and in Firth of Forth (Wright 1867, p. 42). At the west coast of Scotland it seems to be common in Firth of Clyde and in the fjords and sounds of the surrounding area (Forbes 1848, Kölliker 1864, Browne 1900 and 1905 a).

It is still common in the gulfs on the north coast of Ireland (Thompson 1843 and 1856, Forbes 1848), but only occasionally it drifts further southwards. A few specimens are found at Dublin (Greene 1857), Port Erin (Browne 1895) and Valencia Harbour (Browne 1900 and 1905 a, Delap 1905).

In the British Channel it has only been taken once, *viz.* at Falmouth (Cocks 1849), "abundant in the summer".

The northernmost locality, where the species has been found, is the Murman coast; here it has been taken at three occasions (Linko 1904 b). — At the Norwegian coast it was taken in great numbers at the Floro by M. Sars (1835). It is also recorded from the surroundings of Bergen (Broch 1905) and from Drobak in Kristiania Fjord (Ehrenberg 1836).

In the Danish waters it has been found at several localities in the Skagerrak and the Kattegat, and Möbius (1873) records it from the harbour of Kiel.

The literature as well as the data derived from the present material demonstrate that *Melicertum octocostatum* is a distinctly neritic species (the American *Melicertum campanula* is likewise "strictly confined to the coast water" (Bigelow 1914 a, p. 125)). The only locality in some considerable distance from the coast is that which is mentioned in the above list as No. 9.

The depth in which the individuals have been captured is only stated in very few cases. Some of the specimens from Iceland are fished with 70—80 m wire out; on "Thor" stat. 259 (04) three hauls were made with the young-fish trawl; the journal records as follows: 20 m wire: "yellow-rayed medusa"; 35 m wire: about 20 do.; 70 m wire: about 20 do. The depth of the bottom was 102 m, and *Melicertum* has been evenly numerous at least in the upper fifty meters. Undoubtedly it does not penetrate down into any great depth; it may be met with, on the other hand, close to the surface.

The horizontal distribution, it will be seen, is rather narrowly limited. The species has never been found in high-arctic regions, and it does not, on the other hand, penetrate very far southwards. It is indigenous at the northern coasts of the British Isles, but only occasionally it is carried towards the Channel. It is very noticeable that most of the Icelandic localities are crowded around Cape Langenæs, the north-eastern point of Iceland. This seems to be more than a casuality and it may possibly be explained by the fact, that the Polar Current strikes the coast of Iceland at this point and puts a stop to the effects of the Irminger Current (that branch of the Gulf Stream which runs northwards along the west coast and eastwards along the north coast of Iceland). It is hardly possible that the numerous individuals of *Melicertum*, found around Langenæs in July and August 1904, may have been carried to the Icelandic coast by the Polar Current; most probably they have been hatched at the west or north coast of Iceland and carried eastwards by the Irminger Current as far as Langenæs, where they have come to a stop, because the cold water of the Polar Current barred the passage. At the Norwegian coast the species is numerous off the part between Stavanger and Stat. It has frequently been found in the Danish waters, but never in any large number, so that this area is possibly beyond the proper area of distribution of the species. The fact is, probably, that the polyp generation does not live at the Danish coasts and the southern parts of the British coasts, but that the medusa is usually carried to these regions in the summer. In order to elucidate this question more thoroughly we shall have to look at the seasons, in which the species has been found on the various localities.

All the Icelandic collections have been made during the summer months; we have no information from the other seasons of the year. The finds from the north-east point are from the time between July 20th and August 30th.

The specimens from West-Norway, mentioned by Broch, as well as the specimens from Bergen, recorded in the present paper, have all been taken in July and August. More interesting is the statement of Sars, that the species occurs at the Floro from the early spring to September.

We possess several and detailed records of the occurrence at the British Isles, but it is not very easy to get a reliable apprehension of the occurrence in that area. Most statements agree that the species appears in the Scottish fjords in the month of May and is numerous during the summer months. Browne (1905) states that it occurred in the Firth of Clyde from May 20th to October 11th 1902, grown-up specimens in May, grown-up as well as young specimens in July; besides many grown-up individuals were found at Arran in August 1897. According to McIntosh (1890), on the other hand, it appeared at St. Andrews in August; it was numerous in October but not yet mature; large specimens were found in December; he also found it at St. Andrews in January, and Crawford (1891) likewise found a mature specimen in January at the same locality. All records being kept together, it seems

to me the most probable that the breeding of the medusa takes place at the end of the autumn or in the winter, that the unknown polyp-generation lives during the later winter months and deliberates the medusæ in the first spring-months; the medusæ then appear in the fjords in May or later and grow to maturity in the course of the summer and autumn.

The finds at Port Erin and Valencia Harbour were made on May 26th and 27th and on June 2nd and July 19th (altogether 4 finds, according to Browne 1900 and Delap 1905). There are two possible explanations of these finds: The few specimens, mentioned by the said authors, may have been carried southwards after their deliberation from the polyps; but as the dates of the finds are mostly antecedent of the season, at which the species is most numerous in the northernmore regions, there is also the possibility that they have been deliberated in the neighbourhood of the finding-places from hydroids originating from medusæ, which were carried down there in the preceding winter or autumn, that the hydroid, accordingly, is able to live here in the winter, as also the medusæ may pass the spring but die away towards the hot summer time. Both explanations give the result, that the whole cyclus of development cannot be traversed on the spot, but new specimens must be imported every year. From the data now in hand it is impossible to state with certainty, which of the two possibilities is the correct one. It seems to me, however, that the first explanation is the more probable, as it appears that the species is able to live in the Danish waters in the warmest months of the year.

As far as the Danish waters are concerned, the facts lie more clearly. All finds from the Kattegat have been made between medio June and medio August. According to Möbius it occurs at Kiel in October—November. In the eastern part of the Skagerrak it has been found in November (International Plankton Catalogues). Nothing indicates that the polyp generation should live in the Danish waters. The medusæ found here have undoubtedly been imported by the current. They are able to keep themselves alive in our seas during the hot summer months, but it is very improbable that they ever breed here. More detailed records of the occurrence of *Melicertum octocostatum* in the Danish waters will appear in a future paper.

Melicertum campanula L. Agassiz.

As mentioned above this species is possibly identical with *Melicertum octocostatum* Sars. It occurs at the eastern coasts of North America, being common from Eastport to Cape Cod. It has been mentioned from that area by the following authors: L. Agassiz (1862, p. 349), A. Agassiz (1865, p. 130—134), Verrill (1871, p. 6), Fewkes (1888 a, p. 233), Mayer (1910, p. 207), Bigelow (1914 a, p. 125; 1914 b, p. 11; 1915, p. 316, 319, 320). South of Cape Cod it has only been taken once, *viz.* at Woods Hole (Nutting 1901, p. 382).

According to these authors the species appears at the coasts of New England in May and disappears in July or August. Young individuals are found in the spring.

Bigelow characterises it as boreal-neritic; it has never been found more than 10 miles from the shore.

Genus Dipleurosoma Boeck.

Dipleurosoma typicum Boeck.

Mayer 1910, Medusæ of the World, p. 224.

Bell usually flatter than a hemisphere and about 15 mm in diameter. Stomach flat, with an irregular outline; there are four lips. The number of radial canals arising from the periphery of the stomach ranges from 5 to 18; they branch in an

irregular manner, all branches communicating with the circular vessel. The gonads are developed upon a number of the radial canals adjacent to the stomach. More than 100 marginal tentacles, each carrying an ocellus on the inner side of the bulbous base. Velum is well developed.

North-Atlantic coasts of Europe and off Newfoundland.

Family Mitrocomidæ Torrey.

Leptomedusæ with open marginal vesicles.

The first author who has paid attention to the systematical importance of the open marginal vesicles is E. Metschnikoff (1886 a, p. 5; 1886 b, pp. 81 ff.). He separated *Halopsis ocellata* Agassiz from the *Æquoridæ* (among which it had been placed by A. Agassiz and Haeckel) and the genera *Tiaropsis* and *Mitrocoma* from the *Eucopidæ*, and united the said forms into a family *Lafoëidæ*. Metschnikoff had demonstrated that the planulæ of "*Laodice cruciata*" as well as of *Mitrocoma annæ* developed into hydroids, exactly resembling *Cuspidella* Hincks. At the first sight this seems rather peculiar; but Metschnikoff calls attention to the fact that *Laodice* is an Ocellate, *Mitrocoma* a Vesiculate, while *Tiaropsis* forms the connecting link between the two. If we regard *Tiaropsis* as a more primitive form of the *Lafoëidæ*, the *Thaumantidæ* (to which belongs *Laodice*) and the medusæ with open marginal vesicles have to be regarded as two diverging branches of the same group.

Maas (1893, p. 60) amends the family *Lafoëidæ* sensu Metschnikoff, including *Tiaropsis*, *Mitrocoma*, *Phialis* (i. e. *Halopsis cruciata* Agassiz), *Halopsis ocellata*, and perhaps *Euchilota* and *Mitrocomella*.

Torrey (1909, p. 16) proposes the name of *Mitrocomidæ* for this family, because the medusæ in question bear no relation to the hydroid-family *Lafoëidæ*. The name *Mitrocomidæ* is also used by Browne (1910, p. 32), who gives a revision of the genera of the group and announces a critical revision of the species. Browne hesitates to refer *Halopsis* to this family, until its marginal vesicles have been thoroughly examined. Later Bigelow (1914 a, p. 102) has demonstrated that *Halopsis ocellata* has open sensory pits of the type of the *Mitrocomidæ*. Bigelow (1913) also unites the leptomedusæ with open marginal vesicles into a family *Mitrocomidæ*, whereas Mayer (1910) does not apply more systematical importance to the open marginal vesicles than that of a generic character. In the quoted paper (1913) Bigelow demonstrates that "*Laodice cellularia*" A. Agassiz has open marginal vesicles and accordingly belongs to the *Mitrocomidæ*. As this species has many marginal vesicles but is destitute of cirri, it makes a proper genus, *Halistaura* nov. — As generic characters Browne uses the presence or absence of cirri or ocelli together with the number of marginal vesicles. Thus the genus *Mitrocomella* is only separated from *Mitrocoma* by the number of vesicles being constantly 16, whereas in the full-grown *Mitrocoma* the number exceeds 16. This does not seem to me to be sufficient reason for a distinction of genera. The species *polydiademata* (the only species of *Mitrocomella* hitherto known) does not differ from the species of the genus *Mitrocoma* in any important characters, and I prefer, therefore, to refer it to that genus, following Mayer (1910, p. 290).

A synopsis of the genera of the family *Mitrocomidæ* will now look as represented in Table VI:

Table VI. Synopsis of the Genera of *Mitrocomidæ* Torrey.

Genera	Number of radial canals	Cirri	Ocelli	Number of marginal vesicles
Cosmetirella Browne	4	÷	÷	8
Cosmetira (Forbes) Hartlaub	4	÷	+	8
Tiaropsis Romanes	4	÷	+	8
Mitrocoma Haeckel	4	+	÷	16 or more
Halistaura Bigelow	4	÷	÷	about 12—24
Halopsis Agassiz	12—16 or more	÷	÷	numerous

+ present; ÷ absent.

Strictly spoken, the "cirri" of *Cosmetira* should not be called with that name, as they are comparatively short and rigid and may not be coiled up spirally; they ought, as stated by Hartlaub (1905), be designated as dwarf-tentacles.

Genus Mitrocoma Haeckel.

Mitrocoma polydiademata (Romanes).

Tiaropsis polydiademata Romanes 1876 a, Prelim. Observations on the Locomotor System of Medusæ. — Philos. Trans. Roy. Soc. London. Vol. 166. — p. 274.

Tiarops — Romanes 1876 b, Some New Species, Varieties and Monstrous Forms of Medusæ. — Journ. Linn. Soc. London. Vol. XII. — p. 525.

Tiaropsis — Romanes 1877, do. (plates). — ibid. Vol. XIII. — p. 194; Pl. XV, fig. 3.

Mitrocomella polydiadema Haeckel 1879, System der Medusen. — p. 185.

— — Browne 1895, Medusæ, L. M. B. C. District. — Proc. Trans. Liverpool Biol. Soc. Vol. IX. — p. 279.

— *fulva* Browne 1903, Medusæ from Norway and Spitzbergen. — Bergens Museums Aarbog 1903. — p. 17. Pl. I, fig. 3; Pl. III, figs. 1, 3.

— *polydiademata* Browne 1905 a, Medusæ, Firth of Clyde. — Proc. R. Soc. Edinb. — p. 767.

— *polydiadema* Browne 1910, National Antarctic Exped., Nat. Hist. Vol. V. — p. 33.

Mitrocoma polydiademata Mayer 1910, Medusæ of the World. — p. 290.

Mitrocomella — Bedot 1912, Histoire des Hydroïdes, 4me période. — p. 414.

Umbrella nearly hemispherical, 12—22 mm wide. Stomach small with a cross-shaped base and 4 short, folded lips. Gonads linear or somewhat sinuous, extending along the outer three-fourth of the 4 radial canals. About 48 long tentacles with conical basal bulbs; numerous long marginal cirri; 16 open marginal vesicles; no ocelli. Manubrium, gonads, and tentacular bulbs red or yellowish-brown. — Hydroid unknown.

Haeckel introduced the spelling *polydiadema*, but Romanes called it *polydiademata* in all of the four papers in which he mentioned the species.

Romanes mentions this species for the first time in his preparatory work on the locomotor system of the medusæ (1876 a) and describes it in the other paper of the same year (1876 b). Romanes

describes the 16 "diadems", each containing 30 "pearly nodules"; he further mentions the high illuminating power of the animal. The description is, however, rather short and not very exhaustive.

In 1903 Browne described a species, *Mitrocomella fulva* from Bergen and Plymouth, but in 1905 he states that it is identical with *polydiademata*, of which species he gives, at the same time, a new and more thorough description based on specimens from the Firth of Clyde (1905, p. 767).

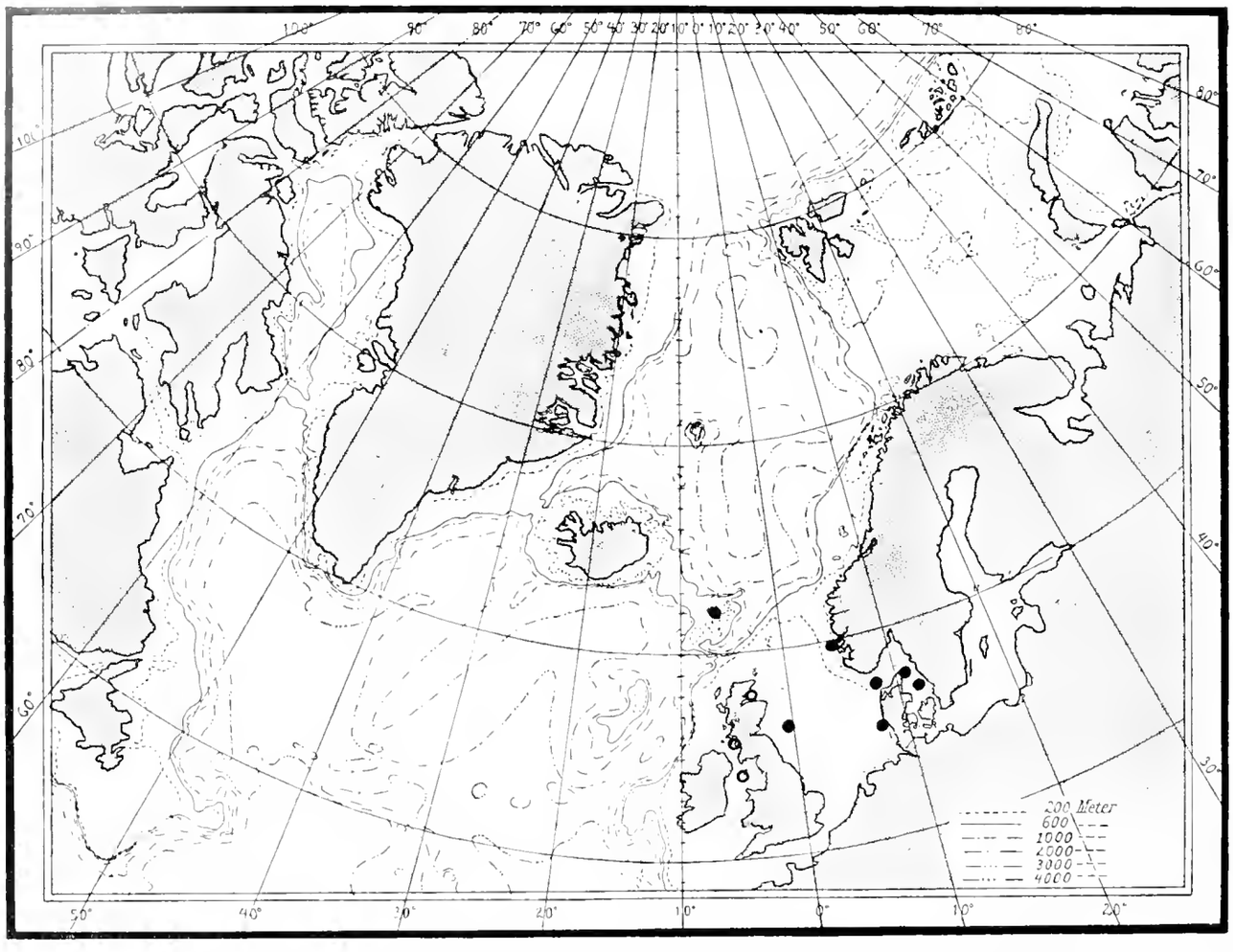


Chart VI. Finds of *Mitrocoma polydiademata* (Romanes). o Occurrence according to the literature.

Material (see Chart VI):

1) — Off Trangisvaag, Faeroe Islands. May 14th 1904. Young-fish trawl at the surface. "Thor" stat. 80 (04). — 1 specimen, about 13 mm wide. In the collection of the Plankton Laboratory, Copenhagen.

2) — Lat. 59°54′ N., Long. 4°34′ E., near the coast of Norway south of Bergen. May 8th 1905. Young-fish trawl, 65 m wire. "Thor" stat. 24 (05). — 1 specimen, about 22 mm wide.

3) — Lat. 56°08′ N., Long. 0°15′ W., about 90 miles off the mouth of Firth of Forth. May 4th 1905. Young-fish trawl, 80 m wire. "Thor" stat. 16 (05). — 4 specimens, 10—14 mm wide. In the collection of the Plankton Laboratory, Copenhagen.

The specimen from the Faeroe Islands (Loc. 1) is a female, the gonads of which are very much sinuous but not mature. From Loc. 3 there are one female and three males. The specimen from Loc. 2 is a male, the gonads of which are three-fourth the length of the radial canals; the number of tentacles in this specimen cannot be stated exactly, but it exceeds 40. In the males the gonadial part of the radial canal is laterally compressed like a broad band and somewhat sinuous. Beside the specimens here mentioned the Zoological Museum possesses a number of fairly small specimens from Danish waters.

The species is previously known only from rather few localities, viz. Bergen (Browne 1903), Cromarty Firth (Romanes), Firth of Clyde (Browne 1905 a), Port Erin (Browne 1895 and 1905 a), and perhaps Plymouth (Browne, 1905, is not quite sure that the specimen of "*Mitrocomella fulva*" from Plymouth belongs to the present species). The known area of distribution is now extended to comprise the Faeroe Islands and the Danish waters from the Slugen (near Esbjerg) to Anholt Knob in the Kattegat.

At Port Erin and in the Firth of Clyde it was found in June and July; moreover Browne found many large specimens at Port Erin in May and quite young stages at the end of April 1894. The comparatively large specimens examined by me from the Faeroe Islands, the coast at Bergen, and the North Sea have all been found in May. The specimens from the Danish waters, which are all fairly small, have been taken on the following dates: Slugen September 29th, Horns Rev September 11th and November 9th, Skagerrak June 1st and Juli 29th, Anholt Knob November 2nd.

The data now at hand do not constitute a sufficient base on which to give a reliable picture of the life history of the medusa. As large specimens have been found in the spring, the medusa must be able to pass the winter and thus to breed in the spring; but it seems also that the breeding may take place in the summer time, as the specimen described by Browne from Firth of Clyde, taken on June 27th, contained large eggs, many of which were "ready for liberation"; the specimen in question was only 10 mm in diameter, so that the size, at which the medusa becomes mature, is subject to much variation.

Genus **Cosmetira** (Forbes) Hartlaub.

Forbes (1848, p. 42) divided the genus *Thaumantias* into two subgenera, *Cosmetira* with two kinds of tentacles, *Thaumantias* with only one kind of tentacles. The genus *Cosmetira* was again defined by Hartlaub (1909, pp. 82—89). It is characterised as *Mitrocomidæ* with 4 radial canals, 8 marginal vesicles, and with dwarf-tentacles between the proper tentacles. The genus comprises the following species: *Cosmetira pilosella* Forbes, *C. megalota* (Maas), and the antarctic *C frigida* Browne; the latter was described by Browne (1910, p. 35) from some badly preserved specimens, and only provisionally referred to this genus.

Cosmetira pilosella Forbes.

Thaumantias (Cosmetira) pilosella Forbes 1848, British Naked-eyed Medusæ. — p. 42. Pl. VIII, fig. 1.
i. p. *Laodice cruciata* Haeckel 1879, System der Medusen. — p. 132.
Euchilota pilosella Browne 1896, British Hydroids and Medusæ. — Proc. Zool. Soc. London, 1896. — p. 484. Pl. XVI, figs. 7, 7 a.

Cosmetira pilosella Hartlaub 1909. Ueber *Thaumantias pilosella* Forbes und die neue Lafoëiden-Gattung *Cosmetira*. — Zool. Anz. Bd. 34. — p. 82.

Umbrella much rounded, about 20 mm wide. Stomach small, with a cross-shaped base and 4 folded lips. Gonads narrow, linear, somewhat sinuous, placed along the 4 radial canals, leaving both ends free. About 64 short tentacles with globular basal bulbs; between each successive pair of tentacles there are about 6 short, solid dwarf-tentacles; a number of similar organs are distributed over the outer part of the exumbrella. There are 8 large, open, adradial marginal vesicles. Velum is broad. Stomach and gonads are reddish-purple, tentacle-bulbs dark purple.

Forbes's description and particularly his coloured drawings of this species are excellent. Among others the following remark is appropriate: "... towards the margin ... it is as if woolly ...". Forbes, it is true, did not observe the marginal vesicles; these have first been described by Gosse (1853), who also mentions the high illuminating power of the animal. Haeckel included Forbes's medusa among his numerous synonyms of "*Laodice cruciata*", and this has caused a good deal of confusion. Thus the "*Laodice cruciata*" of Garstang (1893—1895, pp. 215 and 233 ff.) and Browne (1895, p. 276) is actually *Cosmetira pilosella*, as later demonstrated by Browne. On the other hand, the medusa which in Crawford (1891) and McIntosh (1890) is called "*Laodice cruciata* (*Thaumantias pilosella* Forbes)" is a real *Laodicea* (see above, p. 28). In 1896 Browne (1896, p. 484. Pl. XVI, figs. 7 and 7 a) identified some medusæ, examined by him, as Forbes' species, which he referred provisionally to the genus *Euchilota*, and thereafter we find it in the literature under the name of *Euchilota pilosella* until 1909, when Hartlaub (1909, pp. 82—89) gave a new definition of the genus *Cosmetira* and a new and thorough description of the type-species *pilosella*, based on some specimens from Bergen previously identified by Broch (1905, p. 7) as *Irene viridula*. The name *Cosmetira pilosella* has been adopted by Mayer (1910, p. 261) and Browne (1910, p. 32). In Bedot's Histoire des Hydroïdes, on the other hand, it is unfortunately mentioned as a synonym of "*Laodice cruciata*"[1].

I have no objections or additions to Hartlaub's thorough description. Hartlaub calls attention to the fact that the "cirri" are fairly short and rigid threads and are never spirally coiled; they are, accordingly, no typical cirri and ought to be called dwarf-tentacles.

Material (see Chart VII):

Lat. 59°48′ N., Long. 1°23′ W., close south of the Shetland Islands. July 22nd 1905. Depth 85 m. "Thor" stat. 122 (05). — 3 specimens.

In the journal of the "Thor" from this station only one species of Leptomedusæ is recorded, and a roughly made sketch makes it probable that it means the present species. It was taken in the young-fish trawl with 25 m wire in great quantities, with 65 m wire commonly, and with 125 m wire in smaller numbers. It is possible that the specimens from the deepest haul have been captured during the hauling up through the upper water-layers, where the species, according to the journal, was present in great numbers.

The area of distribution of this species is fairly narrowly limited. It has been found near Bergen (Broch 1905, Hartlaub 1909), at the Shetland Islands (Forbes 1848), at the Isle of Man (Browne 1895), Valencia Harbour (Browne 1895 and 1900, Delap 1905), Falmouth (Alder in For-

[1] Compare the note on p. 21.

bes 1848), Plymouth (Garstang 1893—95, Lebour 1917); it is mentioned in the International Plankton Bulletins from the Bristol Channel and the British Channel every year in May and August.

The present author has seen this species in great quantities during his stay at Plymouth in 1914. It was found for the first time on the night between May 19th and 20th, 7 miles south of Eddystone lighthouse; the individuals were of different sizes, none were fully grown; it was found again on nearly the same spot on the night between May 25th and 26th and further until June 11th con-

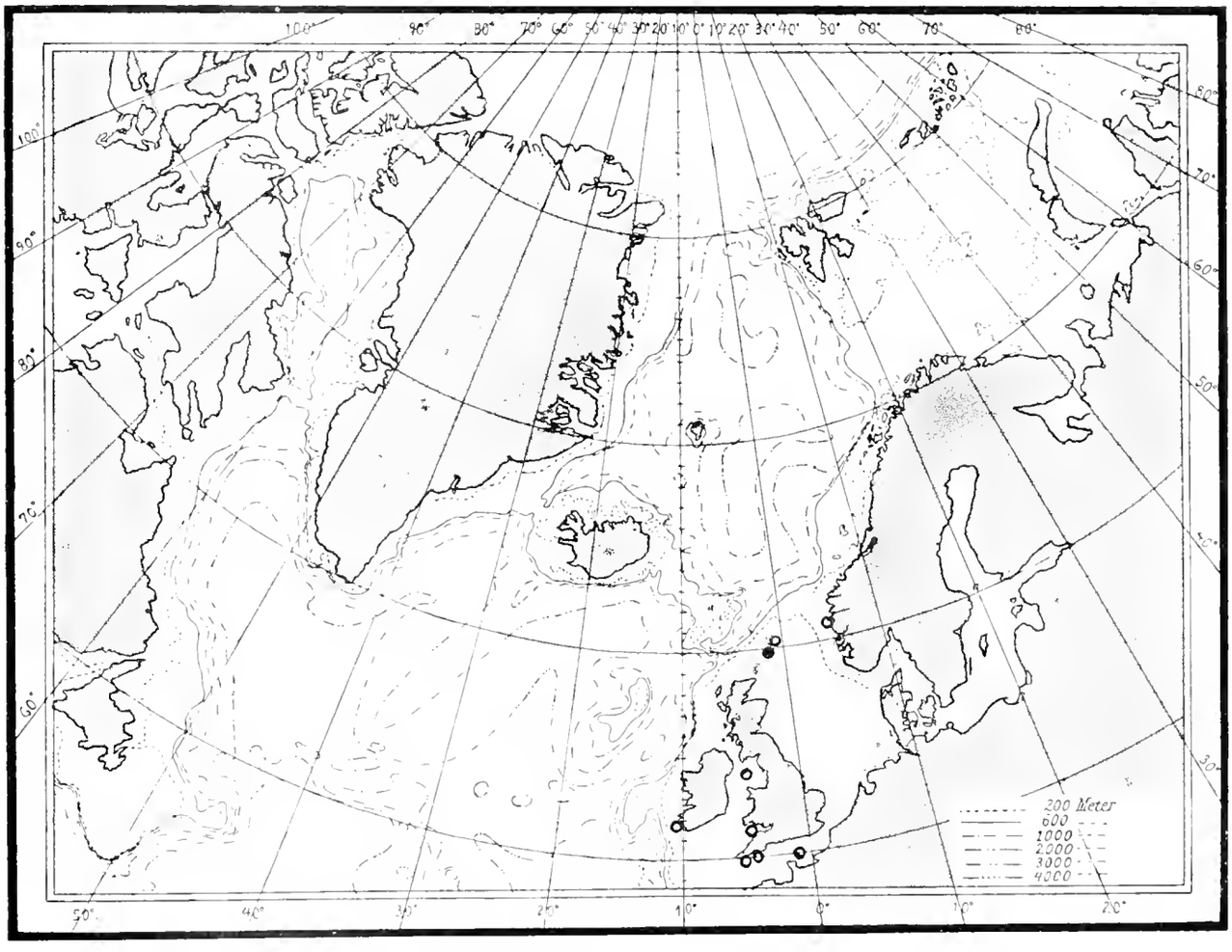


Chart VII. Occurrence of *Cosmetira pilosella* Forbes. ○ Occurrence according to the literature.

stantly in large numbers, but still no full-grown specimens. Plankton samples taken nearer the shore in the neighbourhood of Plymouth during the same space of time contained no specimens of this medusa.

According to Garstang (1893—95, pp. 233 ff.) and Lebour (1917, p. 161) it appears at Plymouth in May or June, is one of the most predominant medusæ in July and August, and disappears in September. At Valencia Harbour it has been found from the end of April until October (Browne 1896, p. 484 and 1900, p. 719; Delap 1905, p. 11). Browne has found quite young specimens at Valencia Harbour both in May and in August. Moreover a tiny medusa (with 2 tentacles), found at Plymouth in September 1895, is considered to belong to this species. As mentioned above, I found no full-grown

individuals at Plymouth as late as June 11th; the Misses Delap, on the other hand, found large specimens at Valencia Harbour on May 28th 1900; some of these specimens spawned in the aquaria, and the eggs developed into planulæ and further to small hydroids.

The statement of the last-mentioned authors shows that in certain localities the species may breed as early as about June 1st, but all other records as well as my own observations indicate that

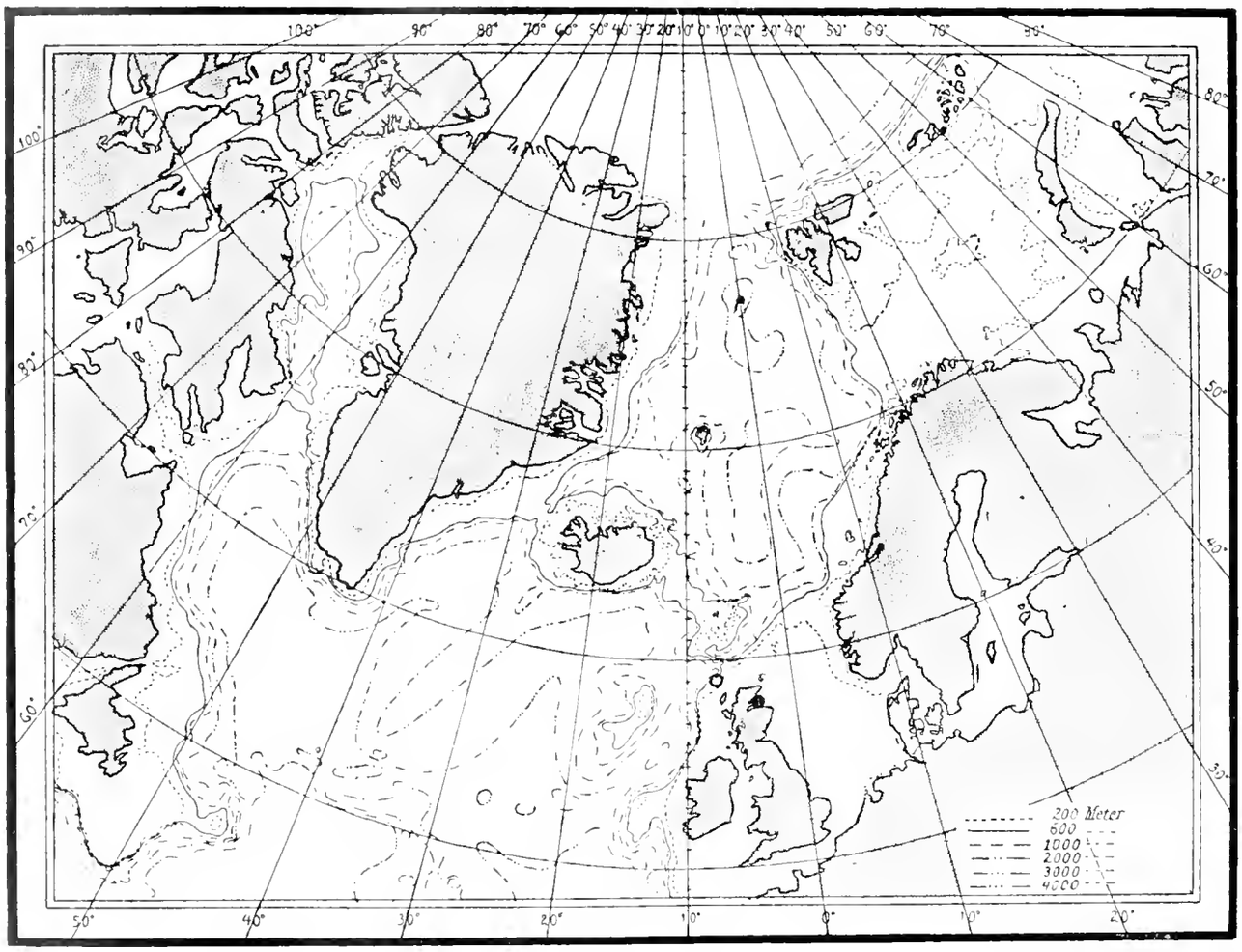


Chart VIII. Occurrence of *Cosmetira megalotis* (Maas). ○ Occurrence according to the literature.

the medusæ reach maturity in the late summer months, and that the hydroid generation, which has never been found in nature, passes the winter and deliberates the young medusæ in the early spring.

Cosmetira megalotis (Maas).

Halopsis megalotis Maas 1893, Ergebn. d. Plankton-Exped. Bd. II. K. c. — p. 57. Taf. VI, Fig. 3, 4, 5, 6.
Mitrocoma megalota Mayer 1910, Medusæ of the World. — p. 289.
Cosmetira megalotis Browne 1910, National Antarctic Exped., Nat. Hist. Vol. V. — p. 33.

This medusa was taken by the Plankton-Expedition north-west of Scotland on July 19th 1889; it has not been found again since it was described by Maas.

The species is very like *Cosmetira pilosella*; it is, however considerably larger (about 30—40 mm wide) and has a greater number of tentacles (about 100 against 64) and about 800 dwarf-tentacles; the tentacle-bulbs are less broad. The stomach is larger, and the gonads are shorter, extending along the outer one-third or half part of the 4 radial canals. The marginal vesicles seem to be somewhat more flattened.

The Zoological Museum of Copenhagen possesses 2 specimens from the following locality (see Chart VIII):

Murray Firth. September 4th—5th 1904. "Thor". — 2 specimens.

The specimens are 25—30 mm wide. They have about 100 tentacles and about 8 times as many dwarf-tentacles, most of which are placed on the bell-margin itself, some being, however, displaced a little upwards upon the exumbrella. There are 8 large, flat marginal vesicles. The gonads occupy the distal half-part of the radial canals but do not quite reach the circular vessel. The larger specimen is a male, the smaller one is a female.

The specimens agree very well with Maas's description. Maas, however, does not mention the fact that the dwarf-tentacles may partly be situated on the exumbrella at a little distance above the bell-margin. Moreover it is not appropriate to state, that the shape of the umbrella is flat; this medusa has the same bent-down margin as *Cosmetira pilosella*. The specimens are preserved in alcohol; the dark pigmentation has disappeared, and the tentacle-bulbs as well as the manubrium and the gonads have now a dirty-yellow colour.

The possession of 8 large, open marginal vesicles and the short and rigid (not spirally coiled) dwarf-tentacles put it beyond doubt that this medusa belongs to the genus *Cosmetira*.

Genus Halopsis A. Agassiz.

Halopsis ocellata A. Agassiz.

Plate IV, figs. 1, 2, 3, 4, 5. Textfigs. 6, 7, 8, 9 a—r.

Halopsis ocellata A. Agassiz 1863. Mode of Development of the marginal tentacles of ... Medusæ. — Proc. Boston Soc. Nat. Hist. Vol. IX. — p. 219.

— — A. Agassiz 1865, North American Acalephæ. — p. 99. Figs. 143—150.

— — Haeckel 1879, System der Medusen. — p. 217.

— — Fewkes 1888 a. On certain Medusæ from New England. — Bull. Mus. Comp. Zool. Harvard Coll. Vol. XIII, No. 7. — p. 233. Pl. III, fig. 3.

— — Hargitt 1904. Medusæ from the Woods Hole Region. — Bull. U. S. Bureau of Fisheries. Vol. 24. — p. 51.

— — Mayer 1910. Medusæ of the World. — p. 323.

— — Bigelow 1914 a. Explorations in the Gulf of Maine July and August, 1912. — Bull. Mus. Comp. Zool. Harvard Coll. Vol. 58, No. 2. — p. 102.

Description: Umbrella is watchglass-shaped, the gelatinous substance comparatively thick, particularly so in the central part of the disk, evenly diminishing in thickness towards the margin.

The diameter of the largest specimen at my disposal is about 56 mm. The manubrium consists of a flattened stomach (Plate IV, fig. 1), circular or star-shaped in outline, and a short mouth-tube. The diameter of the stomach is abont one-fifth the diameter of the disk. The length of the mouth-tube of a well-grown specimen is about 4 mm, its diameter at the narrowest part about one-half the diameter of the stomach. The lower (distal) part of the month-tube is somewhat expanded, divided into 4 folded lips separated by 4 slight incurvations, not by deep incisions. The stomach is fastened to the subumbrella along the edges of the proximal parts of the radial canals, thus a number of triangular pouches existing between the subumbrella and the dorsal wall of the stomach. The number of radial canals varies (in the present material) from 12 to 17; the canals are arranged in four clusters (Plate IV, fig. 1). From the central point four canals issue, each of which is very soon divided into 3—5 branches; as a rule the branching is completed within the outline of the stomach, so that apparently the radial canals arise separately from the periphery of the latter. The fully developed canals reach the circular vessel,

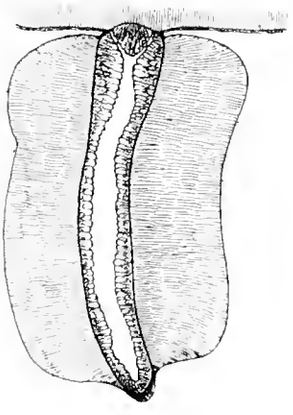


Fig. 6.

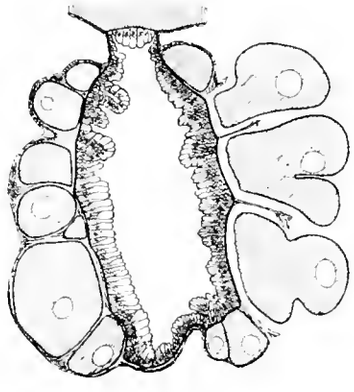


Fig. 7.

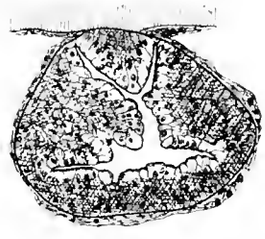


Fig. 8.

Fig. 6. *Halopsis ocellata* A. Agassiz. Transversal section through a radial canal with male gonads. × 85. — Fig. 7. *Halopsis ocellata* A. Agassiz. Transversal section through a radial canal with female gonads. Three of the eggs are ready for liberation. × 120. — Fig. 8. *Halopsis ocellata* A. Agassiz. Transverse section through the distal part of a radial canal, free of gonads. *Obs.* the high development of the entoderm and the narrow lumen. × 240.

but sometimes we may find young canals terminating blindly somewhere on the subumbrella (textfigs. 9 *c*, *f*, *h*, *k*). The points of connection between the radial canals and the circular vessel are, as a rule, not equidistant. The stomach sends out a short conical prolongation along each of the radial canals (Plate IV, figs. 1 and 5). The lines of attachment of the radial canals to the subumbrella are very narrow (Plate IV, figs. 1 and 5; textfigs. 6, 7, 8). The gonads (Plate IV, figs. 1, 3, 4; textfigs. 6 and 7) are situated along the radial canals, forming a narrow, somewhat folded band on each side of the canal, leaving both ends free. The gonads commence at a distance of 2—7 mm from the periphery of the stomach and terminate 1—2 mm from the circular vessel. The dorso-ventral extension of the gonadial bands comprises nearly the whole of the lateral walls of the canals, commencing very close to the subumbrella and ventrally leaving but a very narrow line to separate the gonads of the two sides (textfigs. 6 and 7). In the short distal part of the radial canals, free of gonads, the entoderm is highly developed, so that in this part the lumen of the canal is quite narrow (textfig. 8).

There is a large number of hollow tentacles (Plate IV, fig. 2), fairly long and very contractile;

the tentacular bulbs are broadly conical; the number of tentacles amounts to at least about 450. Between every successive pair of tentacles there is one long, fine, solid cirrus (more seldom two cirri), which may coil itself spirally. The marginal vesicles are large open folds of the velum, containing a large number of lithocysts. The number of marginal vesicles between two successive radial canals is very variable according to the distance between the points of termination of the canals; the average number is 5—6. The velum is 2.5—3 mm broad. — The specimens, preserved in formaline or alcohol, are colourless.

The genus *Halopsis* was established by A. Agassiz (1863 and 1865) as a genus belonging to the family *Æquoridæ* and containing the species *H. ocellata* with about 16 radial canals, and *H. cruciata* with 4 radial canals. In Haeckel's System der Medusen (1879) *Halopsis ocellata* remained among the *Æquoridæ*, whereas *Halopsis cruciata* became the representative of a new genus *Phialis* of the *Eucopidæ*. — As mentioned above (p. 58), Metschnikoff (1886 a, 1886 b) established a new family for Leptomedusæ with open marginal vesicles, the family which we now call *Mitrocomidæ*, and he referred *Halopsis cruciata* as well as *ocellata* to this family. He was followed in this respect by Maas and Torrey, whereas Browne (1910) thought it more correct to await a closer investigation of the marginal vesicles of *Halopsis ocellata*, before it should be definitively included in the family *Mitrocomidæ*. Such an investigation was carried out by Bigelow (1914 a), and the systematical position of the species is thus stated. In Mayer, Medusæ of the World (1910) *Halopsis ocellata* is still placed among the *Æquoridæ*.

A. Agassiz (1865) has given a thorough description of this species. True, the marginal vesicles are called "large compound eyes", but the drawings (figs. 146 and 147) leave no doubt but that they are identical with the large open marginal vesicles. The North-European specimens, examined by me, agree in every regard with Agassiz's description of the American *Halopsis ocellata*. Agassiz states, it is true, that the mature individuals are 2—2½ inches in diameter (= 50—65 mm), whereas the European specimens reach maturity when about 35 mm wide and, according to the material hitherto known, do not exceed 56 mm in diameter. It must be remembered, however, that I have only measured preserved specimens, and the size becomes usually somewhat reduced by the preservation. But even though the European specimens do not, as a rule, reach quite the size of the American specimens, the agreement with regard to the shape is so complete that there can be absolutely no doubt, but that they belong to the same species. — Agassiz has examined young specimens and found that they have only 4 radial canals.

The species, described by Agassiz, was seen again, for the first time, by Fewkes (1888 a, p. 233), who found individuals up to 6 inches in diameter. His specimens differ from the type by the fact that "the radial canals arise regularly, not in four groups, from the stomach cavity". This may depend, I think, on the fact mentioned above, that the branching of the radial canals takes place and is completed inside the periphery of the stomach, so that the canals are completely separated when leaving the latter. The same "independent origin of the radial canals" has been observed by Bigelow (1914 a, p. 102), who found four fragmentary specimens of the species.

The mode of origin of the radial canals was the chief character by which Agassiz would

separate the genera *Halopsis* and *Stomobrachium*. It is very probable that the two genera cannot be kept apart. But nothing definitely can be stated about the matter, as the two species of *Stomobrachium* (*lenticulare* Brandt and *tentaculatum* A. Agassiz) are very deficiently described and have never been found again since the original descriptions were published (Brandt 1835, p. 358. Taf. III, Fig. 6, 7. — A. Agassiz 1865, p. 98, figs. 140—142). Neither cirri nor marginal vesicles have been observed in any of the species of *Stomobrachium*.

Halopsis ocellata has never been recorded from the European waters, though it is actually not uncommon in the Atlantic between the British Isles and Iceland[1].

A few of the specimens at my disposal are in the collection of the Plankton Laboratory in Copenhagen. The medusæ of that collection are mostly identified by Professor Damas, who has labelled the specimens of *Halopsis ocellata* as *Stomobrachium norvegicum*. I have never seen this name mentioned in the literature, and Dr. Browne, on inquiry, has informed me that neither he knows that name. Damas has possibly been of opinion that the specimens represented a new species; but a description was never published. Owing to the war I have not been able to communicate with Professor Damas concerning the matter; a letter, sent to him, has never been answered and has, probably, not reached him. As mentioned above, I consider it to be beyond any doubt that this North-European medusa is identical with the North-American *Halopsis ocellata* A. Agassiz.

Material (see Chart IX):

Iceland:

1) — Lat. 63°43.5′ N., Long. 22°22′ W., south of Reykjanæs. July 8th 1904. Depth 109 m. "Thor" stat. 174 (04). — 2 specimens.

2) — Lat. 63°18′ N., Long. 21°30′ W., south of Eyrarbakki. July 8th 1904. — Depth 178 m. Young-fish trawl, 70 m wire. "Thor" stat. 176 (04). — 1 specimen.

3) — Lat. 62°43′ N., Long. 20°42′ W., south of the Vestman Islands. July 9th 1904. Young-fish trawl, 50 m wire. "Thor" stat. 179 (04). — 2 specimens.

4) — The Gulf at Heimaey, Vestman Islands. August 7th 1905. "Beskytteren", Fr. Johansen. — 1 specimen.

5) — South of the Myrdalsjokel. August 17th 1903. "Michael Sars". — 3 specimens.

6) — Under Iceland. August 16th 1903. "Michael Sars". — 5 specimens.

7) — Lat. 64°04′ N., Long. 13°48.2′ W., Myri Bay. July 24th 1904. Depth 68 m. "Beskytteren", Gemzoe. — 3 specimens.

8) — Lat. 64°35′ N., Long. 11°45′ W., off the south-eastern coast of Iceland. August 8th 1904. Depth 348 m. Young-fish trawl, 20 or 70 m wire. "Thor" stat. 241 (04). — 3 specimens.

9) — Lat. 63°12′ N., Long. 11°45′ W., between Iceland and the Faeroe Islands. August 7th 1904. Young-fish trawl, 20 m wire. "Thor". — 4 specimens.

10) — Lat. 61°34′ N., Long. 18°43′ W., south of Iceland. July 10th 1904. Young-fish trawl, 15 m wire. "Thor" stat. 181 (04). — 2 specimens, in the collection of the Plankton Laboratory, Copenhagen.

[1] Günther (Report on the Coelenterata ... of the North Atlantic. — Ann. Mag. Nat. Hist., ser. 7, vol. XI, 1903, p. 426) mentions two small medusæ which "bear a considerable resemblance to the young of *Halopsis ocellata* as described by Agassiz", but from his description it does not seem probable that the specimens have belonged to that species.

West of Scotland:

11) — East of Rockall. July 28th 1913. 150 m wire. "Armauer Hansen" stat. 17 (1913). — 1 specimen, in Bergens Museum.

12) — Lat. 57°03′ N., Long. 11°20′ W. May 28th 1908. Young-fish trawl, 65 m wire. "Thor" stat. 12 (08). — 1 specimen.

13) — Lat. 56°56′ N., Long. 9°01′ W. May 28th 1908. Depth 140 m. Young-fish trawl, 65 m wire. "Thor" stat. 11 (08). — 1 specimen.

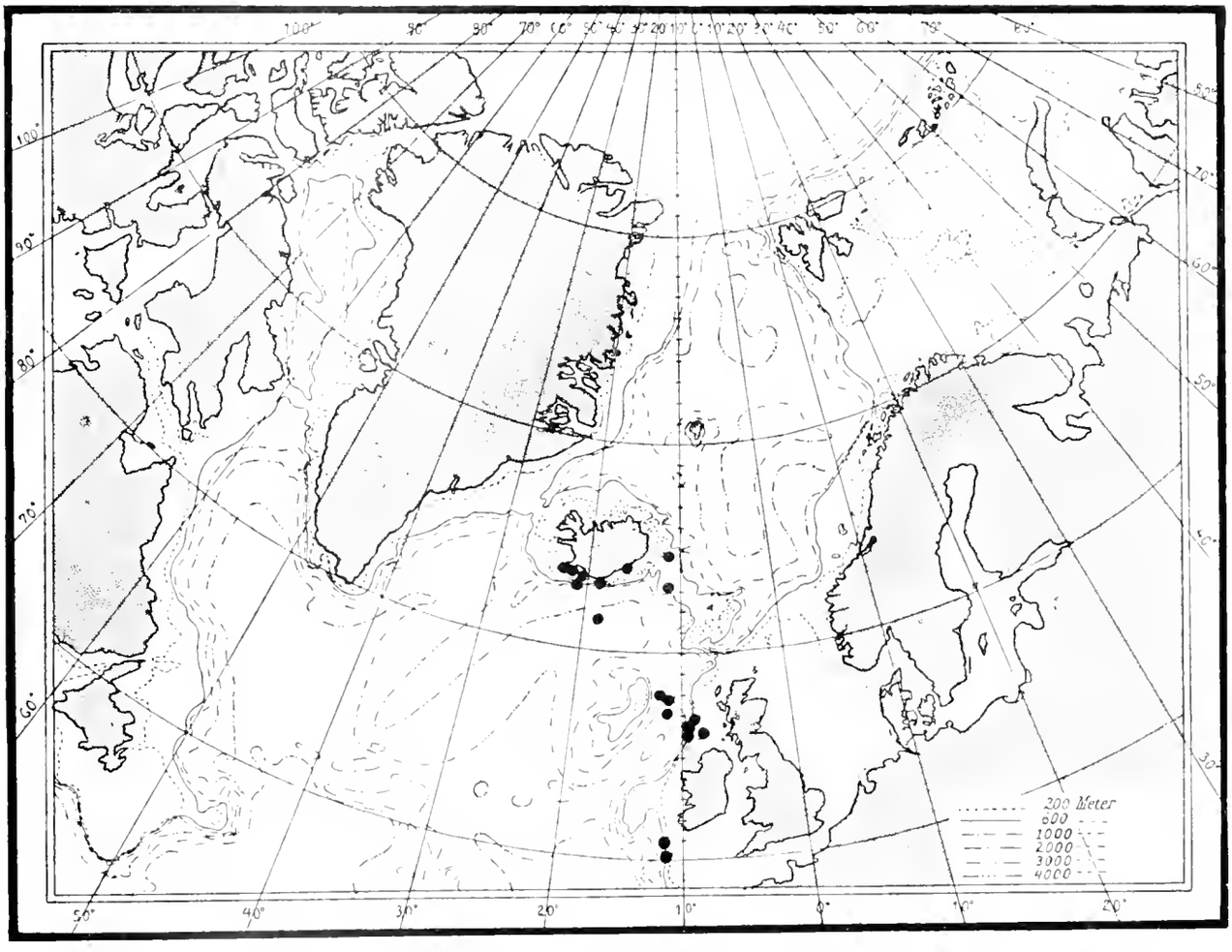


Chart IX. Occurrence of *Halopsis ocellata* A. Ag. in the north-eastern Atlantic.

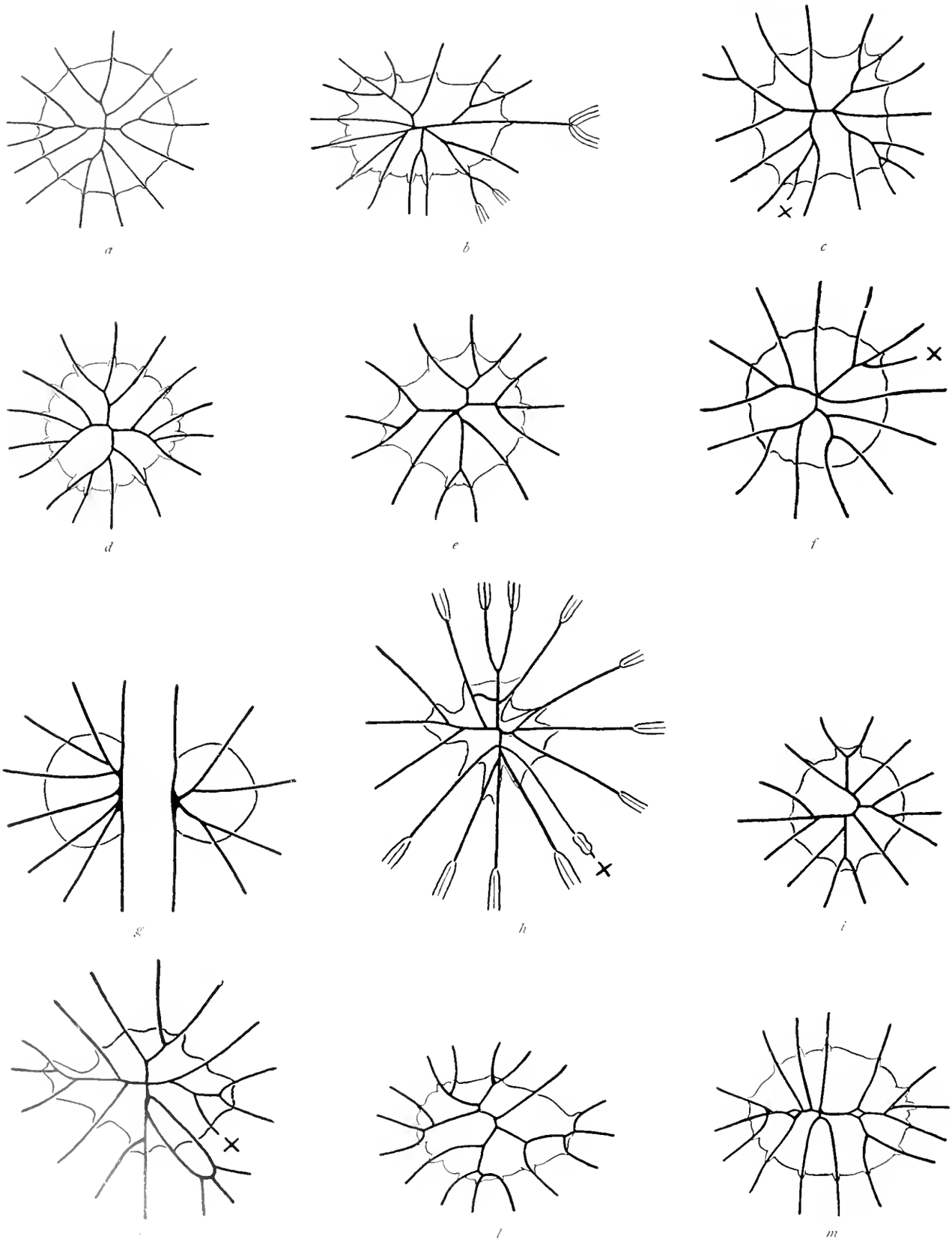
14) — Lat. 56°00′ N., Long. 9°32′ W. June 10th 1905. Depth 1040 m. Young-fish trawl, 300 m wire. "Thor" stat. 74 (05). — 1 specimen.

South-west of Ireland:

15) — Lat. 51°00′ N., Long. 11°43′ W. June 15th 1905. Depth 840—1400 m. Young-fish trawl, 200 m wire. "Thor" stat. 82 (05). — 1 specimen, in the collection of the Plankton Laboratory, Copenhagen.

Moreover from the "Michael Sars" 1910:

a) — Lat. 57°41′ N., Long. 11°48′ W., between the Hebrides and Rockall. August 6th—7th 1910.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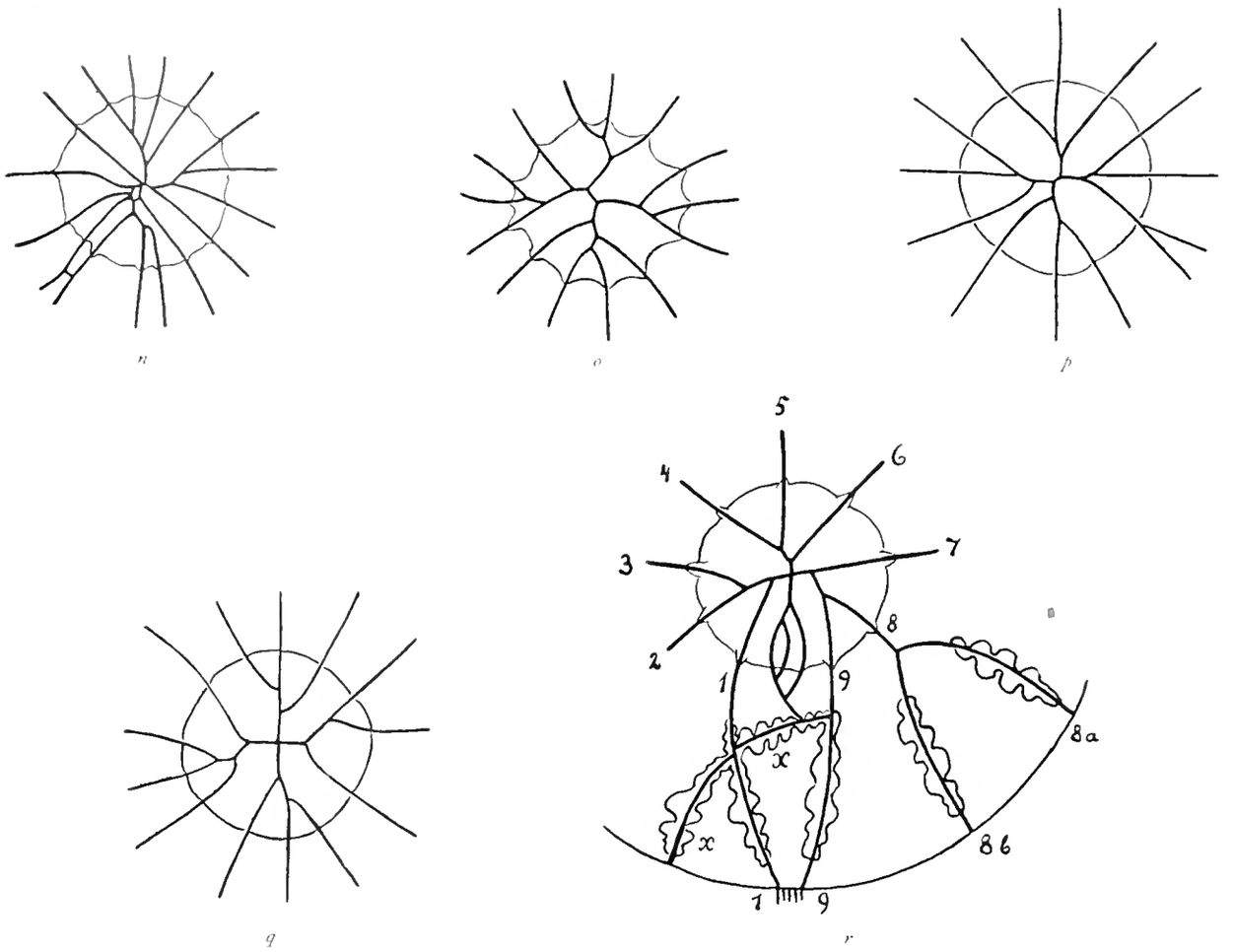

Fig. 9 *a*—*r*. *Halopsis ocellata* A. Agassiz. Diagrams of the stomachs and the proximal parts of the radial canals of different specimens, seen from the apical side. For further explanation, see the text, pp. 71—73.

Depth 1853 m. Stat. 101. — Young-fish trawl, 1000 m wire: 1 specimen. — Ringtrawl, 200 m wire: 1 specimen.

b) — Lat. 56°33′ N., Long. 9°30′ W., south-west of the Hebrides. August 5th 1910. Depth 1000—1360 m. Ringtrawl, 200 m wire. Stat. 98. — 1 specimen.

c) — Lat. 56°15′ N., Long. 8°28′ W., between the Hebrides and the north coast of Ireland. August 4th 1910. Depth 139 m. Ringtrawl, 50 m wire. Stat. 97. — 2 specimens.

d) — Lat. 50°13′ N., Long. 11°23′ W., south-west of Ireland. July 26th 1910. Depth 1565 m. Ringtrawl, 1500 m wire. Stat. 94. — 1 specimen.

Remarks on the individuals.[1]

Loc. 1. — Specimen No. I (textfig. 9 *a*): Diameter about 30 mm, ♂, 14 radial canals, regularly arranged in 4 groups of 3-3-4-4 canals. — Specimen No. II (textfig. 9 *b*): Diam. 35 mm, ♀, 17 radial

[1] The individuals from Loc. a, b, c, and d are mentioned in my paper on the Anthomedusæ and Leptomedusæ from the "Michael Sars" North-Atlantic Expedition in 1910.

canals, two of which are not separated until so far outside the periphery of the stomach that their gonads are confluent (Plate IV, fig. 5); the canals are very irregularly arranged.

Loc. 2. — (textfig. 9 *c*): Diam. 24 mm, ♀, 17 radial canals, one of which (x) is quite young and terminates blindly; arrangement irregular.

Loc. 3. — Specimen No. I (textfig. 9 *d*; Plate IV, figs. 1 and 3): Diam. 35 mm, ♂, mature, 15 radial canals, regularly arranged in 4 groups of 3-4-4-4 canals. — Specimen No. II (textfig. 9 *e*): Diam. 45 mm, ♀, gonads containing eggs of different sizes; 13 radial canals in groups of 3-3-3-4; 442 tentacles (with regard to the distribution of the tentacles in relation to the radial canals, see below).

Loc. 4 (Plate IV, fig. 2): Diam. 35 mm, ♀, 15 radial canals, fairly regularly arranged in groups of 3-3-4-5.

Loc. 5. — Specimen No. I (textfig. 9 *f*): Diam. 25 mm, ♂, 14 radial canals, irregularly arranged, one of the canals (x) is quite young and terminates blindly. — Specimen No. II: Diam. 26 mm, ♂, 17 radial canals, 5-4-4-4, in the third group one small blind canal. — Specimen No. III (textfig. 9 *g*): Diam. 33 mm, ♂; the specimen has 2 stomachs; 6 canals issue from the one of the stomachs, 8 from the other. The distance between the stomachs is 2 mm. The dimensions of the stomachs are, respectively, 3.8 by 3.0 mm and 4.0 by 2.7 mm.

Loc. 6. — Specimen No. I: Diam. 28 mm, ♀, 15 radial canals, 3-5-3-4. — Specimen No. II: Diam. 32 mm. — Specimen No. III: Diam. 36 mm, ♂, 15 radial canals. — Specimen No. IV: Diam. 37 mm. — Specimen No. V: Diam. 40 mm.

Loc. 7. — Specimen No. I (textfig. 9 *h*): Diam. 23 mm, ♂, 15 radial canals, one of which ends blindly (x), but has already a short gonad. — Specimen No. II (textfig. 9 *i*): Diam. 28 mm, ♂, 14 radial canals, 4-4-3-3. — Specimen No. III (textfig. 9 *k*): Diam. 40 mm, ♀, 17 radial canals, 3-4-5-5. Two of the canals, issuing from the periphery of the stomach, make an anastomosis, from which 3 canals issue. In the 2nd group there is a young canal (x) beginning to develop.

Loc. 8. — Specimen No. I (textfig. 9 *l*): Diam. 30 mm, ♀, 16 radial canals, irregularly arranged. — Specimen No. II: Diam. 35 mm, ♂, 15 radial canals, 3-4-3-5. — Specimen No. III: Diam. 35 mm, ♂, 17 radial canals.

Loc. 9. — Specimen No. I: Diam. 30 mm, ♀, 15 radial canals. — Specimen No. II (textfig. 9 *m*): Diam. 30 mm, ♂, 15 radial canals, irregularly arranged. — Specimen No. III (textfig. 9 *n*): Diam. 44 mm, ♂, sexual products spawned, 16 radial canals, irregularly arranged. 428 tentacles and 80 marginal vesicles (see below). — Specimen No. IV (textfig. 9 *o*): Diam. 56 mm, ♀; the individual has spawned, but the gonads still contain some eggs. 14 radial canals, 3-3-4-4. 83 marginal vesicles (see below); the tentacles cannot be counted.

Loc. 10. — Specimen No. I: Diam. 33 mm, ♂, 15 radial canals, 3-3-4-5. Specimen No. II: Diam. 34 mm, ♂, 15 radial canals.

Loc. 11. — Diam. 45 mm, ♀, fully mature, 15 radial canals.

Loc. 12. — Diam. 40 mm, ♂, 12 radial canals, 3-3-3-3.

Loc. 13 (textfig. 9 *p*): Diam. 35 mm, ♀, 13 radial canals, 3-3-3-4.

Loc. 14 (textfig. 9 *q*): Diam. 30 mm, ♂, 13 radial canals, 3-3-3-4.

Loc. 15 (textfig. 9 *r*): Diam. 20 mm, ♀. The radial canals are abnormally arranged. 12 canals

leave the periphery of the stomach, 3-3-3-3, and 11 canals reach the circular vessel. One of the quadrants is stunted, pressed between the neighbours; in connection herewith it must be remarked that the specimen is unusually highly arched. The arrangement of the canals is as follows:

Group I. 3 canals (marked 1, 2, and 3 in the figure) leave the stomach and reach the circular vessel (as to No. 1, see below).

Group II. 3 canals (4, 5, 6) leave the stomach and reach the circular vessel in normal way.

Group III. 3 canals (7, 8, 9) leave the stomach. No. 7 reaches the circular vessel normally; No. 8 divides into 8 *a* and 8 *b*, both of which reach the circular vessel. No. 9 runs to the margin and reaches the circular vessel so near No. 1, that there is only room for 3 tentacles between the two canals. On the way towards the margin No. 9 sends out a branch (*x*), which, crossing No. 1, runs towards the margin and reaches the circular vessel between No. 1 and 2, nearest to No. 1.

Group IV. 3 canals leave the stomach, all very close together, and unite just outside the stomach into one canal, which opens into the link canal *x* between 9 and 1, nearest to No. 9.

The arrangement of the gonads on the abnormal radial canals is sketched in the figure.

Only in a few cases it has been possible to count the tentacles and marginal vesicles.

Loc. No. 3, specimen No. II (diam. 45 mm) has 442 tentacles, the distribution of which in relation to the 13 radial canals will be seen from the following scheme:

Off the 13 radial canals		13 tentacles
Group I	19 + 49 + 30 =	98 —
— II	25 + 34 + 27 =	86 —
— III	46 + 29 + 34 + 32 =	141 —
— IV	29 + 37 + 38 =	104 —
	Total...	442 —

Thus the number of tentacles between two successive radial canals varies, in this specimen, from 19 to 49.

Loc. No. 9. specimen No. III (diam. 44 mm) has 16 radial canals (arrangement irregular), 428 tentacles, and 80 marginal vesicles, distributed between the radial canals in the following manner:

Tentacles.....	10	29	28	16	31	23	25	28	31	20	11	36	28	36	29	31
Marginal vesicles	1	7	6	2	5	4	5	4	8	3	3	6	9	6	5	6

Thus in the present case the number of tentacles between two successive radial canals varies from 10 to 36, the number of marginal vesicles from 1 to 9. The average number of marginal vesicles between two canals is 5.35, the average number of tentacles between two successive marginal vesicles is 5.70. The arrangement of the marginal vesicles is, however, fairly irregular, in so far as two vesicles may be found immediately beside each other.

Specimen No. IV from the same locality (diam. 56 mm) has 14 radial canals (3-3-4-4); the tentacles cannot be counted; there are 83 marginal vesicles, distributed between the radial canals in the following manner:

4 3 5 4 7 8 5 10 3 7 9 5 6 7

The average number of marginal vesicles between two successive radial canals is 5.9, varying from 3 to 10.

The map (Chart IX) demonstrates that the North-European localities, in which this species has been found, fall into two separated groups: 1) south of Iceland, 2) west of the British Isles. Though these areas are very near each other, there seems, however, to exist an obvious difference between the individuals from the two areas, in any case in one regard, in so far as the specimens from Iceland have a greater number of radial canals than the British specimens of corresponding sizes. In Table VII, which serves to elucidate this fact, the specimens collected by the "Michael Sars" in 1910 are included among the specimens from the British area.

Also with regard to the relation between the diameters of the stomach and the umbrella there seems to be a difference between the British and the Icelandic specimens, the stomach being comparatively larger in the former than in the latter.

Table VII. Numbers of radial canals of specimens of different sizes of *Halopsis ocellata*.

Numbers of radial canals	Diameters of specimens from South of Iceland					Diameters of specimens from West of British Isles				
	21—30 mm	31—40	41—50	51—60	Total	21—30 mm	31—40	41—50	51—60	Total
11	.	1	.	.	.	1	.	.	.	1
12	.	.	.	.	.	.	4	.	.	4
13	.	.	1	.	1	2	2	.	.	4
14	3	.	.	1	4	.	.	.	.	.
15	4	6	.	.	10	.	.	1	.	1
16	1	.	1	.	2	.	.	.	.	.
17	2	3	.	.	5	.	.	.	.	.
	Average diameter 33.5 mm Average number of radial canals 15.3 22 specimens examined					Average diameter 34.7 mm Average number of radial canals 12.6 10 specimens examined				

I have measured the stomachs in 21 Icelandic and 10 British specimens, and I give the figures obtained in Table VIII, at the same time as I expressly remark that too much importance must not at present be applied to the results, the material investigated being rather small. The figures look, however, interesting as far as they indicate the existence of two different local races in areas very near each other; if future investigations should confirm this result, it would be of great interest to the studies of the variation of medusæ.

It will be observed from the table that, as far as the smaller and middle-sized individuals are concerned, the figures representing the proportion between the size of the stomach and that of the umbrella exhibit a somewhat considerable difference between the specimens from the two areas. The figures from Iceland show, moreover, that the stomach grows in size nearly proportionately to the umbrella until the latter has reached a diameter of towards 40 mm; at this size the sexual products

are mature, partly even spawned (see below); thereafter the umbrella continues its growth, whereas the stomach does not further increase in size.

To the measurements presented in the tables VII and VIII one may object that it is difficult to measure the umbrella exactly, because it is very contractive and may, at the preservation, be contracted to a very different degree. This objection is entirely correct, and we must, therefore, take a certain reservation to the figures of the tables. But, on the other hand, the difference between the Icelandic and the British specimens, as shown by the figures of the tables, both with regard to the diameter of the stomach and the number of the radial canals, is so obvious that it can hardly be due to erroneous measurements owing to different contraction of the umbrella. Moreover, when regarding the absolute figures of the dimensions of the stomach, which can be measured fairly exactly, we will find that in most of the British specimens the stomach is actually larger than in the Icelandic specimens. And a comparison of the two tables (VII and VIII) will give the result that the individuals

Table VIII. Correlation between Diameter of Stomach and Umbrella of *Halopsis ocellata*.

Diameter of umbrella	South of Iceland (21 specim.) Diameter of stomach mm 4 5 6 7 8	Average diameter of umbrella	Average diameter of stomach	Proportion between stomach and umbrella	West of British Isles (10 specim.) Diameter of stomach mm 6 7 8 9	Average diameter of umbrella	Average diameter of stomach	Proportion between stomach and umbrella
20—25 mm.	1 2 . . .	24	4.7	0.20	1 1 . .	21	6.5	0.31
26—30 —	1 3 2 . .	29	5.2	0.18	. . 1 1	29	8.5	0.29
31—35 —	3 1 3	35	7.0	0.20	. . 1 2	34	8.7	0.26
36—40 —	. . 2 .	38	7.0	0.18	. 2 1	40	8.3	0.21
41—45 —	. 2	44.5	7.0	0.16	. . .	—	—	—
56 —	. . . 2 .	56	7.0	0.13	. . .	—	—	—

from the area west of the British Isles have, generally spoken, larger stomachs and a smaller number of radial canals, whereas the specimens from the waters south of Iceland have smaller stomachs and a larger number of radial canals, even quite setting aside the total size of the specimens.

The young gonads are straight, but according as the sexual products are developed, the gonads gradually become sinuous; this development commences, when the diameter of the specimen is 20—25 mm. When the individual is 30—35 mm wide the gonads are much thickened and greatly sinuous. The male gonads may have up to 9 bends on either side; the female gonads never become so much thickened or sinuous as the male ones. The maturity is reached, when the animal is about 35 mm wide. Then, in the case of the female, we can see the eggs having penetrated the ectodermal epithelium and being situated freely on the lateral walls of the radial canals, ready to be detached (Plate IV, fig. 4; textfig. 7). When the male gonads become mature, they become much swollen and, besides being sinuous, they get a finely wrinkled surface (Plate IV, fig. 3). — After the ripening and detachment of the sexual products the animal continues its growth. According as the main part of the sexual products are evacuated, the radial canals stretch and become straight again; at the same time the

walls are destructed and detached from the subumbrella, only the narrow entodermal stripe, along which the canal was attached to the subumbrella, remaining. The sexual products are first evacuated in the proximal part of the gonads, so that at a certain moment the radial canals are seen attached to the subumbrella by the parts free of gonads and by the distal part of the gonadial part, from which the sexual products are not yet evacuated, while the part, in which the evacuation has been completed, hangs freely downwards like a bow (see the diagram, textfig. 10). Female individuals, which have evacuated the eggs, are found to measure 40—56 mm in diameter; a male specimen, 44 mm wide, has spawned.

Occurrence:

The occurrence of *Halopsis ocellata* at the coast of North America is limited to the Gulf of Maine from Grand Manan to Cape Cod (A. Agassiz, Fewkes, Bigelow).

The distribution on the European side of the North Atlantic is as follows: The species is common all along the south coast of Iceland, mainly in the neighbourhood of the coast. Hitherto it has not been found at the Faeroe Islands. It is common in the waters between Scotland and Rockall, and has been found, moreover, south-west of Ireland. As mentioned above, it has not previously been recorded from the European waters, thus all our knowledge of its occurrence in that area is based on the material here dealt with. It will be observed from chart IX, that it does not at any point surpass the Wyville Thomson ridge. As it has, besides, not been found at the western or northern coasts of Iceland, its distribution may be designated as being entirely Atlantic. The occurrence seems, moreover, to be mainly neritic. Thus during the cruise of the "Armauer Hansen" in 1913 the species was only found on stat. 17, the easternmost station of the expedition, above the deep channel east of Rockall, whereas it was completely absent on all of the westernmore stations.

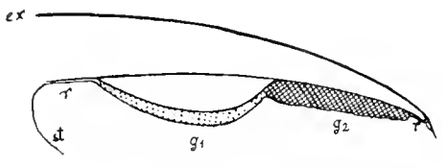

Fig. 10. *Halopsis ocellata* A. Agassiz. Diagram, showing a radial section through the umbrella. — *ex* exumbrella, g_1 part of the gonads, from which the sexual products have been evacuated, g_2 part of the gonads, still containing sexual products. *r*, *r* proximal and distal parts of radial canal free of gonads, *st* stomach.

With regard to the bathymetrical distribution, the data at hand show that the species may be found at very different depths. — The specimens from the south coast of Iceland have all been taken at a fairly short distance below the surface, in no case deeper than about 40 m (with 70 m wire); some of the specimens have undoubtedly been found very close to the surface. The specimens from Loc. No. 10, which is situated comparatively far south of Iceland, were taken with 15 m wire, i. e. close by the surface. — West of Scotland, on the other hand, it has been found, on certain occasions, in considerable depths, thus, for instance, by the "Michael Sars", loc. a, with 1000 m wire. The various depths, in which the species has been found within that area, will be seen from the following figures, representing the length of wire used by the hauls made: 50, 65, 65, 150, 200, 200, 300, and 1500 m, that means between about 30 and about 1000 m below the surface. Of special interest is the station 17 of the "Armauer Hansen", where a specimen was taken in a haul with 150 m wire out, whereas none were found in the deeper hauls (with 600, 1000, and 1300 m wire). — South-west of Ireland 1 specimen was found in a haul with 200 m wire (loc. 15), and 1 specimen in a haul with 1500 m wire ("Michael Sars", loc. d).

The very most of the finds have been made in the months of July and August. West of Scot-

land it has also, however, been found on May 28th and June 10th, and south-west of Ireland a specimen was taken on June 15th. — Mature specimens have been found both at the end of May and in the summer months. Quite young individuals have not been observed; from the present material we can, therefore, state nothing more with regard to the breeding season, than that the spawning of the eggs may take place during the summer. With regard to the further fate of the eggs and the hydroid generation nothing can be stated.

Genus Tiaropsis L. Agassiz.

This genus was established by L. Agassiz (1849, pp. 289 ff.) for the North American *Tiaropsis diademata* L. Agassiz. — Browne (1910, p. 33) characterises the genus in the following manner: "*Mitrocomidæ* with four radial canals; with eight sensory pits; with an ocellus adjacent to each sense organ; without marginal cirri". — The genus and its species have recently been dealt with by Browne (1910, p. 33) and Bigelow (1913, p. 32).

The genus comprises, probably, 6 species: *multicirrata* Sars in the eastern and western part of the northern Atlantic and in the northern Pacific (*diademata* Agassiz and *multicirrata* Sars are identical, which shall be further demonstrated below); *macleayi* v. Lendenfeld (1884) from Australia; *davisii* Browne (1902) from the Falkland Islands. Common for these three species is the possession of numerous tentacles, all of the same size, whereas the three other species, all of which live in warmer seas, have 4—8 well-developed tentacles and a number of rudimentary ones. The three species are the following: *Tiaropsis rosea* Agassiz & Mayer (1899) from the Fiji Islands (Agassiz & Mayer 1899), Malyan Archipelago (Maas 1905), and Tortugas, Florida (*Tiaropsis diademata* Fewkes 1882, *Tiaropsis punctata* Mayer 1900); *Tiaropsis mediterranea* Metschnikoff (1886) from the Mediterranean; *Tiaropsis kelseyi* Torrey (1909) from the San Diego region, Pacific coast of North America.

The genus *Tiaropsis* has, thus, a very extensive geographical distribution.

Tiaropsis multicirrata (M. Sars.)

Plate IV, figs. 6, 7, 8, 9, 10; textfigs. 11, 12, 13, 14.

Thaumantias multicirrata M. Sars 1835. Beskrivelser og Iagttagelser ... — p. 26. Pl. 5, fig. 12 a—c.

— *melanops* Forbes 1848. British Naked-eyed Medusæ. — p. 45. Pl. X, fig. 3.

Tiaropsis diademata L. Agassiz 1849. Contrib. Nat. Hist. of the Acalephæ of North America. — p. 289. Pl. 6, figs. 1—18; Pl. 8, fig. 11.

Thaumantias eschscholtzii Haeckel 1879. System der Medusen. — p. 129. Taf. VIII, fig. 4.

Bell flatter than a hemisphere, about 20 mm wide, gelatinous substance not very thick. Stomach fairly small, provided with 4 folded lips; there is a broad, flat stomachal peduncle. 4 straight radial canals, carrying the gonads, which extend from the base of the stomachal peduncle nearly to the circular vessel. About 300 short tentacles with well developed basal bulbs. 8 adradial, open marginal vesicles, each containing about 12 concretions; at the base of each marginal vesicle there is a large, black ocellus. Velum well developed. Stomach and gonads yellowish; the tentacular bulbs contain an entodermal pigment mass and are also provided with fine ectodermal pigment granules.

The particular aim of my studies on this species has been to elucidate the relation between the European form *Tiaropsis multicirrata* M. Sars and the American *Tiaropsis diademata* L. Agassiz, the identity of which appears to be beyond doubt.

Before I enter on a discussion of that question I shall, however, communicate the interesting fact, that "*Thaumantias eschscholtzii*" Haeckel appears to be identical with *Tiaropsis multicirrata*. *Thaumantias eschscholtzii* was described and figured by Haeckel in his System der Medusen and has frequently, in text books and manuals, been mentioned as a typical *Thaumantias*. Haeckel's description was based on some specimens from Greenland in the Zoological Museum of Copenhagen. I have seen these specimens and found that the large, black oeelli are so conspicuous, that it seems incomprehensible, how they have escaped the attention of Haeckel, when he examined the individuals in order to describe them. The specimens are certainly the same, which were examined by Haeckel, and not some others, erroneously identified by another person. This is clearly demonstrated by the label being provided with a number referring to a list of the collection of medusæ, then in the museum

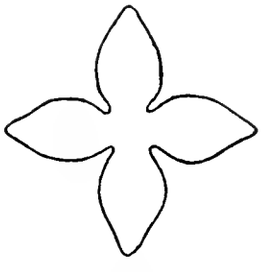

Fig. 11.

Fig. 12.

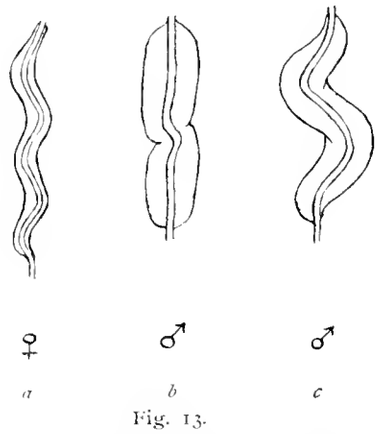

Fig. 13.

Fig. 11. *Tiaropsis multicirrata* Sars. Mouth-lips of a young specimen, 1.5 mm wide. — Fig. 12. *Tiaropsis multicirrata* Sars. Diagram of a young specimen, 1.8 mm wide. — Fig. 13. *Tiaropsis multicirrata* Sars. Radial canals with gonads. *a* female, *b* and *c* male.

of Copenhagen, written by Haeckel with his own hand. Another specimen, from Egedesminde, West Greenland, has been referred by Levinsen (1892) to the species of Haeckel, and I myself, seing that the specimens collected by the "Tjalfe" expedition quite agreed with the description and figures of Haeckel, I referred them, unfortunately, to "*Thaumantias eschscholtzii*" without closer examination (Kramp 1913, p. 267 and 1914, p. 419).

Morphological remarks:

The base of the stomach is cross-shaped. In quite young individuals (diameter 1.5—2 mm) the mouth-lips are egg-lancet-shaped, entire, without folds (textfig. 11, from a specimen, 1.5 mm wide, from Trangisvaag at the Faeroe Islands). Later they become much folded and are besides, in large specimens, rather much lobated. There is a stomachal peduncle, very short and broad, but distinctly marked from the subumbrella. Young specimens (when about 2 mm wide) have no stomachal peduncle, the future presence of which is however indicated by a flattened area in the upper part of the subumbrella, whereas the exumbrella is evenly rounded on the top (see the diagrammatic figure, textfig. 12, drawn from a specimen, 1.8 mm wide, from Trangisvaag, Faeroe Islands).

The gonads always commence at or very near the base of the stomachal peduncle (Plate IV, figs. 9 and 10) without relation to the developmental stage of the individual. The distance from the distal end of the gonads to the circular vessel, on the other hand, depends on the developmental stage.

The female gonads are sinuous, with 2—3 bendings towards either side (textfig. 13 *a*). The male gonads are thick, cylindrical, only provided with a single constriction or bend near the middle (textfig. 13 *b*), more seldom with a couple of bends (textfig. 13 *c*). — In the gonadial part of the radial canals the gonads occupy the lateral walls from the subumbrella nearly to the ventral edge, leaving only a very narrow edge to separate the gonads of the two sides (see Plate IV, fig. 6, representing a transverse section of a radial canal with male gonads). Plate IV, figs. 7, 8, 9, and 10 represent the female gonads. It will be observed that the eggs are placed in the ectoderm in a single layer; fig. 7 is a transverse section of a canal with unripe eggs; in fig. 8 the eggs are mature, and some of them have penetrated the ectodermal epithelium; several eggs have already been detached; figs. 9 and 10 represent mature female gonads, the ripe eggs situated closely side by side on the outer surface of the lateral walls of the canal, ready for deliberation. In the gonadial part the radial canal is much compressed laterally, having a high and narrow lumen.

The size of the individuals, when the sexual products become mature, is somewhat variable. In a few cases I have found fully mature specimens being 10—12 mm wide, but as a rule the maturity does not seem to be reached until the diameter of the animal is 14—15 mm. I have seen female individuals, which have deliberated their eggs, with the following diameters: 15, 16, and 18 mm (all from Iceland).

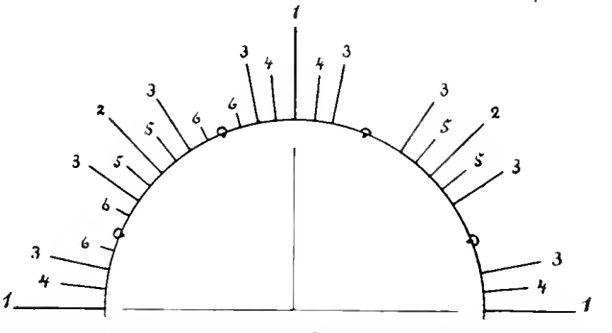

Fig. 14. *Tiaropsis multicirrata* Sars. Diagram, showing the succession in the development of the tentacles. From a specimen, 1.5 mm wide, with 47 tentacles.

The marginal vesicles and the ocelli have been examined by Böhm (1878) and Linko (1900). The concretions are, as a rule, placed in a single bow-shaped row; not seldom, however, one or more of the concretions are pushed out from the row, so that there may even be two rows. The concretions are large, globular, or somewhat angular owing to mutual pressure. They are placed closely side by side. As a rule most of them are of equal size, only the outermost on both sides being smaller (younger); not seldom there is a very tiny concretion at one of the outer ends of the row. Accordingly the concretions seem to be formed and developed from the middle of the row outwards.

A specimen from Trangisvaag, Faeroe Islands (locality No. 20 b in the list below), 1.5 mm in diameter, has 47 tentacles, the sizes and arrangement of which clearly indicate the succession in which the tentacles are developed. The facts are represented in the diagrammatic figure, textfig. 14. The diagram agrees very well with that given by A. Agassiz (1863) for *Tiaropsis diademata*, though I am not sure, whether No. 4 and 5 may not be of the same age. The position of the marginal vesicles corresponds to that of a third series of tentacles, and possibly the marginal vesicles actually have to be regarded as being homologous with as many tentacles. Thus the formula for the first 40 tentacles in the present specimen is as follows: $4t_1 - 4t_2$ (+ 8 marginal vesicles) + $16t_3 + 8t_4 + 8t_5$, or, if t_4 and t_5 are of the same age: $4t_1 + 4t_2$ (+ 8 marginal vesicles) + $16t_3 + 16t_4$. — The tentacles are densely

crowded on the bell margin, and not seldom two successive tentacular bulbs are more or less coalesced. In the countings of tentacles, mentioned below, two such tentacles with coalesced bulbs are always counted as two tentacles. The number of tentacles in different specimens of equal size is very variable (see below). The greatest number, which I have observed, is 328, found in a specimen, 15 mm wide, from Dyrefjord, Iceland (Loc. No. 18 c).

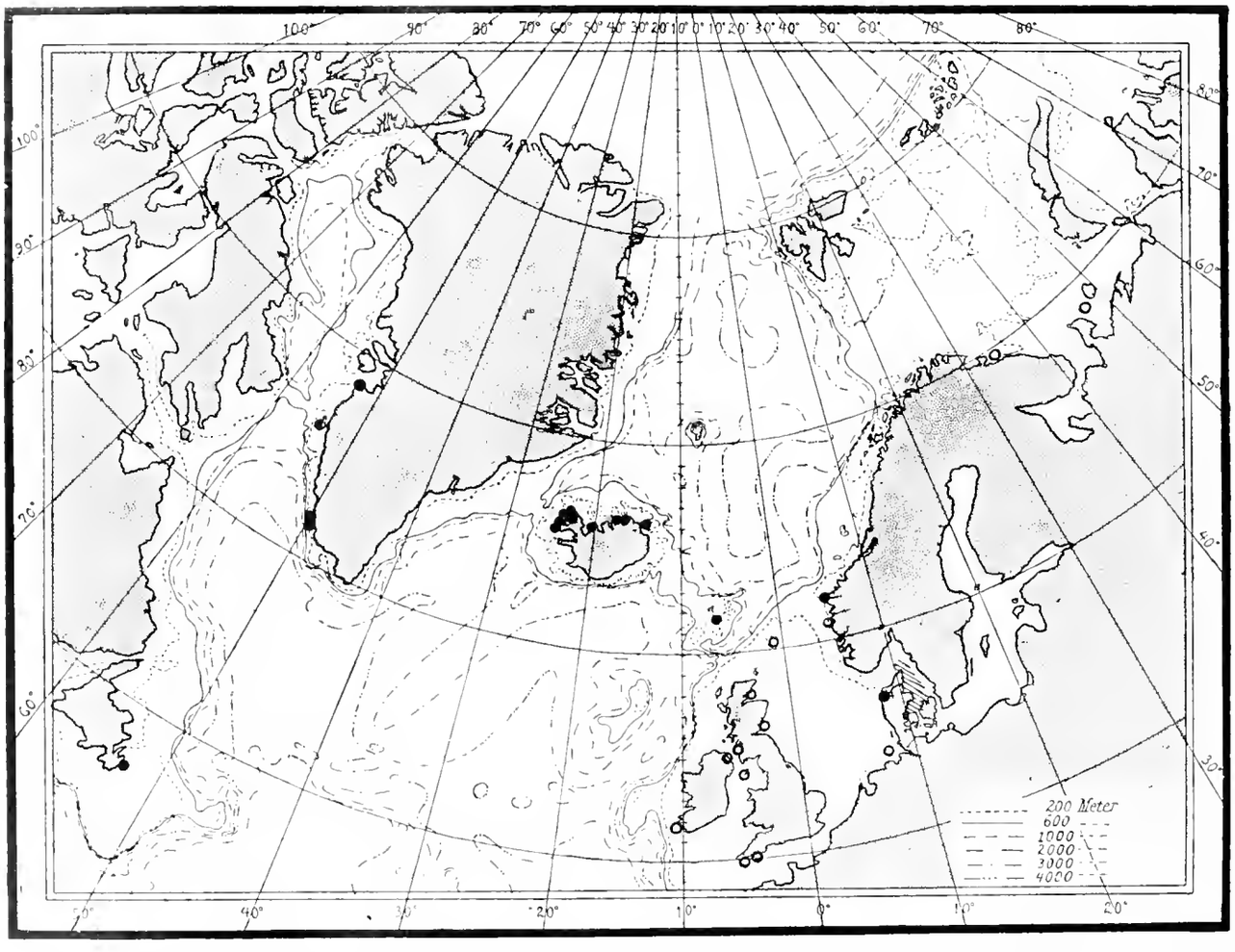

Chart X. Occurrence of *Tiaropsis multicirrata* M. Sars in the northern Atlantic and adjacent waters.
○ Occurrence according to the literature.

Material (see Chart X):

West Greenland:

1) — Greenland, Holboll (1841). — 1 specimen. Type specimen of *Thaumantias eschscholtzii* Haeckel.

2) — Greenland (1865). — 2 specimens, labelled *Thaumantias eschscholtzii*.

3) — Egedesminde, Bergendal (1890). — 1 specimen.

4) — Lat. 66°11′ N., Long. 54°27′ W., off Sondre Stromfjord. August 28th 1908. Ringtrawl, 80 m wire. "Tjalfe" stat. 221. — 1 specimen, 15 mm wide.

5) — South of Northern Storo near Frederikshaab. July 2nd 1909. Depth 265 m. Ringtrawl, 100 m wire. "Tjalfe" stat. 502. — 18 specimens 6—10 mm wide.

6) — Frederikshaab harbour. July 8th 1909. Surface. "Tjalfe" stat. 519. — Several hundreds of specimens, the smallest being about 6 mm wide; most of the specimens are 10—14 mm wide.

New Foundland:

7) — St. Johns. July 5th 1910. Surface. "Michael Sars" 1910. — 37 specimens, from 6 mm in diameter; most specimens are 10—12 mm wide. In Bergens Museum.

Iceland:

8) — Lat. 66°17′ N., Long. 14°27′ W., near Cape Langenæs. July 20th 1904. Depth 77 m. Young-fish trawl, 80 m wire. "Thor" stat. 203 (04). — 1 specimen, 13 mm wide.

9) — Axarfjord. August 12th 1903 Depth 38 m. Young-fish trawl about 1 m below the surface. "Beskytteren", Otterstrom. — 1 specimen, 12 mm wide.

10) — Lat. 66°14′ N., Long. 17°28′ W., off Skjalfandifjord. July 21st 1904. Depth 200 m. "Thor" stat. 208 (04). — 14 specimens, 11—18 mm wide.

11) — Ingolfsfjord. July 13th 1902. "Diana", A. Ditlevsen. — 5 specimens, 7—13 mm wide.

12) — Hesteyrifjord. June 25th 1902. Surface. "Diana", A. Ditlevsen. — 115 specimens, 5—13 mm wide, most specimens 10—12 mm.

13) — Veidileysafjord. June 26th 1902. Surface. "Diana", A. Ditlevsen. — 6 specimens.

14) — Mouth of Hrafnsfjord. June 27th 1902. "Diana", A. Ditlevsen. — 18 specimens, 7—12 mm wide.

15) — Skutilsfjord. June 5th 1892. Lundbeck. — 9 specimens, 2—5 mm wide.

16) — Isafjord. June 6th 1895. "Ingolf". — 42 specimens, 3—9 mm wide; most specimens 3—5 mm. 24 of these specimens are treated with osmic acid.

17) — Onundarfjord. July 20th 1892. Lundbeck. — 4 specimens, 11—16 mm wide.

18) — Dyrefjord:

a. July 14th 1892. Lundbeck. — 16 specimens, 7—12 mm wide.

b. June 1st 1895. "Ingolf". — 33 specimens, 2—5 mm wide.

c. August 4th 1895. "Ingolf". — 3 specimens, 11—15 mm wide.

19) — Patreksfjord. June 22nd—23rd 1904. Surface, fished from the ship. "Thor" stat. 159 (04). — 4 specimens, 10—11 mm wide.

Faeroe Islands:

20) — Trangisvaag:

a. May 3rd 1895. "Ingolf". — 2 specimens, 1.8—3.5 mm wide.

b. May 9th 1895. "Ingolf". — 2 specimens, 1.5—3.5 mm wide.

Norway:

21) — Kalvaag. June 14th 1903. "Michael Sars". — 4 specimens, 11—14 mm wide.

All specimens here mentioned, except those from loc. No. 7, are in the Zoological Museum of Copenhagen.

The investigations, mentioned below, are based on this material and, besides, on material from the Danish waters, *viz.* from: Næs Sound in the Limfjord; north of the Hirtsholme; Frederikshavn; Læso Channel; Snoghoj in Lillebelt.

As will be seen from the list above, I have had at my disposal for investigation abundance of material from the following regions: New Foundland, West Greenland, Iceland, the Faeroe Islands, Norway, and Denmark. It was reasonable, therefore, to make use of this material in order to examine, whether the European and the American form are to be regarded as distinct species or merely varieties of one and the same species, or whether there might, possibly, prove to be no traceable difference whatever between the two forms.

With regard to the shape and size of the manubrium, the length and position of the gonads, and the shape of the tentacular bulbs, I have been unable to find any differences.

According to the literature, the pigmentation of the tentacular bulbs has been estimated as establishing the main difference between *Tiaropsis diademata* and *multicirrata*. Mayer (1910, pp. 258 and 259) expresses the difference in the following way: *Tiaropsis diademata*: "Entoderm of tentacle-bulbs and of stomach ocher-yellow. Gonads are cream-colored". *Tiaropsis multicirrata*: "... distinguished from the American *T. diademata* by the black entodermal pigment of its tentacle-bulbs". "Entoderm of gonads, stomach, and bell-margin dull-yellow. Ocelli and pigment of tentacle-bulbs black." — Bigelow (1913, p. 32) states as follows with regard to *Tiaropsis diademata*: "The fact that *diademata* lacks tentacular ocelli has been established on great numbers of specimens, but the tentacular bulbs are not altogether without pigment, for in all the numerous specimens which I have studied they contain a small amount of entodermic pigment of a pale greenish or yellowish-brown color", and with regard to *multicirrata* that, according to the figures at hand, they have "the same entodermic pigment, only in much denser masses, and black instead of pale greenish". With regard to the specimens from the northern Pacific, examined by him, Bigelow states as follows (p. 33): "the entoderm of each bulb contains pale greenish, or in some cases greenish-brown, pigment, in a roughly triangular mass"; this pigment is denser than that, which the author has observed in Atlantic specimens of *diademata*, but never black as in *multicirrata*. In a footnote (p. 33) he states that in some specimens from Massachusetts Bay "the tentacular bulbs were densely pigmented with black granules, thus exactly reproducing the European type". These "black granules" probably means the ectodermal pigment granules, which I have likewise found in specimens from both sides of the Atlantic, and which must be well distinguished from the entodermal pigment.

There can be no doubt, but that the pigment may disappear to a greater or lesser extent owing to the preservation. I have seen specimens from Greenland, Iceland, the Faeroe Islands, Norway, and Denmark, preferably when preserved in alcohol, which have retained no other pigment than that of the 8 large ocelli at the marginal vesicles. In better preserved specimens, particularly when preserved in formalin, from New Foundland, Greenland, Iceland, and Denmark, fine black granules are nearly always found on the surface of the marginal vesicles and the nematocyst-bearing pads of the tentacular bulbs, i. e. on the adaxial and lateral sides of the bulbs. After clearing in xylol and under high power this pigment appears to consist of accumulations of fine, black granules. Once I conceived

the suspicion that these granules might possibly not be pigment, but foreign matters (dirt, particles of china-ink from the labels). Their mode of distribution, however, contradicts such an apprehension, as they are only found in the said places, *viz.* on the nematocyst-pads and on the surface of the marginal vesicles; they are wanting on the bulbs of younger tentacles. Similar dark pigment granules may also be found on the surface of the gonads. In the angle between the gonads and the subumbrella unquestionable particles of dirt of quite another appearance are frequently observed.

It is not always easy to detect the entodermal pigment mass in the tentacular bulbs, and in several cases, when a number of specimens were at hand from one and the same locality, I have been able to find the pigment masses in some specimens but not in others. It is only to be observed when placed above a white support and when lighted from above; it then appears as a triangular mass; as a rule it stands out most distinctly when seen from the adaxial side. Frequently the colour is indeterminable, but in other cases the colour has been very clear and distinct. As mentioned above Bigelow has found the entodermal pigment in the bulbs of American specimens being pale greenish or yellowish-brown. In the specimens, examined by me, from St. Johns, Newfoundland (Loc. 7) the entodermal pigment is yellowish-brown, mostly very clearly visible. In specimens from Greenland, Iceland, and Denmark I have found the same yellowish-brown colour and, frequently, also a distinct green colour in the entoderm of the tentacular bulbs; black entodermal pigment I have never seen.

It appears, accordingly, that the *Tiaropsis* from the whole of the North-Atlantic area from the Danish coasts through the waters round Iceland and Greenland to North-America and from the northern Pacific agree completely with regard to the ectodermal as well as the entodermal pigmentation, and thus the character, which has been considered to be the only important feature separating the two "species", does not hold good.

There can be no doubt, accordingly, but that the European and the American *Tiaropsis* belong to the same species. Still the question may arise, whether there might exist a difference between the specimens from the different regions with regard to the size of the bell, the number and arrangement of the tentacles, and other measurable characters. Regarding this question I have measured the diameter and counted the tentacles in a large number of specimens, in so far as they are sufficiently well-preserved for such purpose. I have found that within each of the areas in question there appears a considerable variation concerning these characters, but that the average figures for the various areas are so near each other, that we can hardly speak about local varieties. As the investigation may possibly have some importance from a variation-statistical point of view, I am going to give a short account of the results.

One of the characters I wanted to examine, was the relation between the number of tentacles and the diameter of the bell. It is evident that measurements of preserved medusæ have to be used with caution, because the individuals always contract at the preservation and not always to the same degree. The figures in the tables (IX and X), representing the diameter, must therefore be used with reservation, but they seem to indicate that the specimens from the different areas agree in the main with regard to the said feature.

In table IX is represented the correlation between the number of tentacles and the diameter of the bell of specimens from the different regions; the general results of the table have been gathered

Table IX. Variation of *Tiaropsis multicirrata*.

Correlation between the number of tentacles and 1) the diameter of the specimens, 2) the quantity $\frac{p}{i}$.

Denmark.

Number of tentacles, about	Diameter of specimens, mm															Total	Average diameter, mm	$\frac{p}{i}$								Total	Average of $\frac{p}{i}$
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5		
150	.	.	2	1	1	.	.	1	3	.	1	.	.	.	.	9	7.8	1	1	.	3	1	1	1	1	9	1.02
200	.	.	.	3	1	2	1	2	3	7	12	6	1	2	1	41	11.0	.	8	11	16	4	2	.	.	41	1.05
250	.	.	.	.	.	.	1	.	3	.	.	3	2	2	.	11	12.3	.	.	4	.	3	4	.	.	11	1.16
Total number of specimens	.	.	2	4	2	2	2	3	9	7	13	9	3	4	1	61		1	9	15	19	8	7	1	1	61	1.09 ± 0.14

Faeroe Islands and Norway.

50	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2.0	.	1	.	1	.	.	.	.	2	1.00
100	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	..	.	.	.	.	.	.	.	.	.	..
150	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	4.0	.	.	.	.	.	.	1	.	1	1.40
200	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	11.0	.	.	.	.	.	.	.	.	.	...
250	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	3	14.0	.	.	.	1	.	.	.	.	1	1.10
Total number of specimens	2	.	1	.	.	.	.	.	.	1	.	.	3	.	.	7		.	1	.	2	.	.	1	.	4	1.125 ± 0.18

Iceland.

50	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2.0	.	.	.	1	.	.	.	.	1	1.10
100	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2.3	.	.	.	1	1	1	.	.	3	1.20
150	.	.	2	.	1	2	.	.	.	.	.	.	.	.	.	5	5.6	1	.	1	1	.	1	1	.	5	1.12
200	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	2	8.5	.	1	1	.	.	.	.	.	2	0.95
250	.	.	.	.	.	1	.	1	1	2	1	1	.	1	1	9	11.6	.	1	.	2	2	1	1	1	8	1.21
300	.	.	.	.	.	.	.	.	.	.	1	2	.	.	.	3	12.7	.	.	.	1	1	1	.	.	3	1.20
350	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	15.0	.	.	.	1	.	.	.	.	1	1.10
Total number of specimens	3	1	2	.	1	4	.	1	2	2	2	3	.	2	1	24		1	2	2	7	4	4	2	1	23	1.16 ± 0.17

Greenland.

100	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	3	6.0	.	.	.	.	.	.	.	.	.	...
150	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2	7.0	1	.	1	.	.	.	.	.	2	0.90
200	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	3	11.7	.	1	2	.	.	.	.	.	3	0.97
250	.	.	.	.	.	.	.	.	.	.	1	.	2	1	.	4	13.8	.	2	1	.	1	.	.	.	4	1.00
Total number of specimens	.	.	.	1	1	3	.	.	1	1	1	.	3	1	.	12		1	3	4	.	1	.	.	.	9	0.97 ± 0.11

New Foundland.

200	.	.	.	2	1	1	2	.	.	.	.	.	.	.	.	6	7.5	.	2	3	1	.	.	.	.	6	0.98
250	.	.	.	.	.	.	1	3	3	4	.	.	.	.	.	11	10.9	2	2	3	3	1	.	.	.	11	0.99
300	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	3	12.0	1	.	.	2	.	.	.	.	3	1.00
Total number of specimens	.	.	.	2	1	1	3	3	3	7	.	.	.	.	.	20		3	4	6	6	1	.	.	.	20	0.99 ± 0.11

Table X. Synopsis of the Results, obtained from Table IX.

Number of tentacles, about	Average diameter, mm				
	Denmark	Faeroe Islands and Norway	Iceland	Greenland	New Foundland
50	.	2.0	2.0	.	..
100	.	...	2.3	6.0	.
150	7.8	4.0	5.6	7.0	
200	11.0	11.0	8.5	11.7	7.5
250	12.3	14.0	11.6	13.8	10.9
300	..	.	12.7	..	12.0
350	..	.	15.0	..	. .
Number of specimens examined..	61	7	24	12	20
	Values of $\frac{p}{i}$				
Lowest value of $\frac{p}{i}$	0.82	0.85	0.81	0.75	0.78
Highest —	1.50	1.40	1.54	1.22	1.22
Average	**1.09**	**1.12**	**1.16**	**0.97**	**0.99**
Standard deviation	± 0.14	± 0.18	± 0.17	± 0.11	± 0.11
Number of specimens examined	61	4	23	9	20

in table X. The columns of this table give the average diameter of specimens with so and so many tentacles. The differences between the figures for the various regions are not larger, but that they may be due to casual variation and different degree of contraction. This is most obviously seen, when the figures are represented by curves, one curve representing the results for each of the areas (textfig. 14). The 5 curves cut each other in a quite irregular manner in different points, at the same time as their courses are mainly alike.

A feature, which may be characterised by means of mere countings, being independent on contraction or other phenomena produced by preservation, is the situation of the marginal vesicles in relation to the tentacles. A numeral expression of this situation may be attained in the following manner. In each individual we count the number of tentacles situated between the two marginal vesicles of one and the same quadrant (i. e. around the interradials of the animal), and the number of tentacles between the two marginal vesicles situated on either side of one and the same radial canal (i. e. around the perradials of the animal). When one of the figures found is divided by the other, we obtain a numeral expression of the place of the marginal vesicles in the specimen in question. For the sake of brevity I use the letter i to represent the number of tentacles in the interradial spaces between the marginal vesicles, whereas the letter p represents the number of tentacles in the perradial spaces. Then I operate with the quantity $\frac{p}{i}$. This quantity appears to be highly variable. One should expect it to keep tolerably near 1, but as will be seen from the table, the value may vary between about 0.8 and 1.5 within one and the same locality. It will be seen from table IX that there is no correlation between $\frac{p}{i}$ and the absolute total number of tentacles. Table X gives the average value of $\frac{p}{i}$ within each of the geographical regions, the standard deviation, and the lowest and highest

values found. According to the table a difference between the East- and West-Atlantic specimens seems actually to exist with regard to the quantity $\frac{b}{l}$, in so far as the average value as well as the extremes of the series of variation are distinctly lower as far as the specimens from the two western areas are concerned than in the case of the specimens from the three eastern areas. That means that the marginal vesicles are placed somewhat nearer to the radial canals in the specimens from the western Atlantic than in the specimens from the eastern Atlantic area. The standard deviations are, however, so large that we cannot state at present, whether this result rests on a real fact or whether it is merely casual.

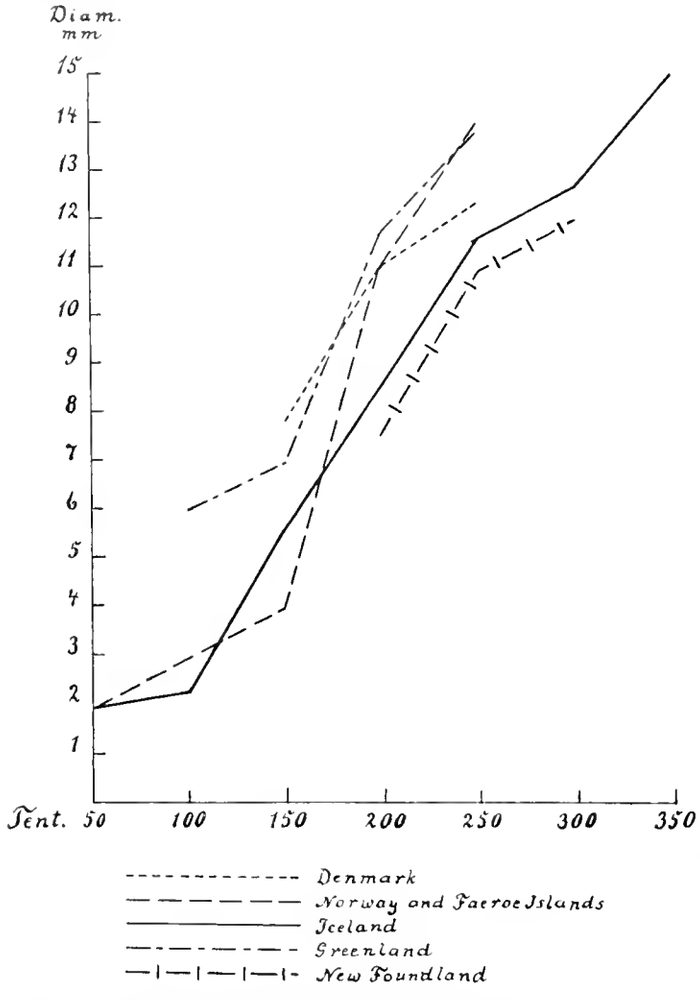

Fig. 15. *Tiaropsis multicirrata* Sars. Curves showing correlation between the diameter of the specimens and the number of tentacles within different geographical areas.

Distribution and Occurrence.

Tiaropsis multicirrata has a fairly wide distribution in the North-Atlantic area. Its occurrence is distinctly neritic.

It is very common at the Atlantic coast of North-America from Eastport to Cape Cod (L. Agassiz 1849, A. Agassiz 1865, Bigelow 1912, 1914 a, 1915). Within that region it occurs during the spring from March to May or the beginning of June. It is met with only occasionally south of Cape Cod, penetrating as far as Woods Hole (Nutting 1901, Hargitt 1902 and 1904).

At the west coast of Greenland *Tiaropsis multicirrata* has been found on several localities near the shore (see chart X), as far northwards as Egedesminde (loc. 3). With regard to the occurrence on loc. 4, 5, and 6 (the stations of the "Tjalfe" expedition) I shall make the following remarks: On stat. 221 (loc. 4), August 28th 1908, a specimen was taken about 50 m below the surface; in an adjacent place the temperature of the water was found to be evenly decreasing from 4°.78 at the surface to 0°.63 near the bottom (128 m); about 50 m below the surface the temperature was about 2°, the salinity about 33 ‰. In 1909 the species was found on July 2nd and 8th very near the shore in the neighbourhood of Frederikshaab (stat. 509 and 519), at both occasions in large numbers and in water of low, though positive temperature. On stat. 509 (depth 265 m) 18 specimens were found about 60—65 m below the surface; the temperature was: in 50 m 0°.42, in 75 m 0°.14, the salinity was 32.5—33 ‰. On stat. 519 (depth 406 m) several hundreds of specimens were taken at the surface at a temperature of 0°.83; in 10 m depth the temperature was + 0°.10,

whence it was slowly increasing towards the bottom. — The occurrence of *Tiaropsis multicirrata* in the Greenland waters must, probably, be regarded from the point of view, that the species is strictly neritic and, therefore, does not occur in the Atlantic water-masses in the deep parts of the Davis Strait, being restricted to the coastal regions where the water is very cold during the main part of the year, except in the deeper strata in certain fjords. Not until rather late in the summer, when the effects of the Polar Current are comparatively slight, and the surface of the sea is lighted by the sun during the greater part of the twenty-four hours, the upper water layers attain a tolerably high temperature. In agreement herewith *Tiaropsis*, which disappears from the coasts of New England as early as in May, occurs at the Greenland coasts in the middle of the summer. Most of the individuals found are large, mature or near maturity; probably the young specimens live in the deeper, warmer strata in the fjords earlier in the summer. The fact that the species occurs in this area in the warmest part of of the summer, while in other regions it is found in the spring, and the fact that it has not hitherto been found in water of negative temperature, agree very well with our knowledge of the occurrence of the species in other regions, *viz.* that it is a boreal species and avoids warm as well as ice-cold water.

Tiaropsis multicirrata has a fairly wide distribution at the coasts of the British Isles, but nowhere it seems to occur in any great abundance. It has been found at the Shetland Islands ("*Thaumantias melanops*", Forbes), in Cromarty Firth ("*Tiaropsis oligoplocama*", Romanes), west-coast of Scotland, Port Erin, Belfast on Ireland ("*Thaumantias pattersonii*" Greene), Valencia Harbour, Falmouth, and Plymouth; in the southern of those places it has only been found occasionally. — The data regarding the seasons of the finds demonstrate that the species appears at the British coasts in the early spring, at the end of March, and disappears in May, seldom as late as in June. Browne (1895, 1900, 1905 a) has found quite young specimens at the end of March and in April in Firth of Clyde, at Port Erin, and at Valencia Harbour.

Tiaropsis multicirrata has been found at Heligoland by Böhm (1878, p. 184, in great abundance in April, never in the summer) and by Hartlaub (1894, p. 192, from March 3rd to April 12th, being most common at the end of March).

It seems to be a regular visitor to the Danish waters in the spring; it has frequently been found in the northern part of the Kattegat, and in May 1915 I found some few specimens in Lillebelt. The Danish finds are altogether from the end of April and the first half-part of May; large specimens have been taken in the middle of May.

We know very little about the distribution of *Tiaropsis multicirrata* along the coast of Norway. M. Sars (1835) found it in the neighbourhood of Bergen; moreover it has been found at Kalvaag south of Stat in June 1903 (loc. 3, also mentioned by Broch 1905, p. 7).

It occurs in the Barents Sea (Linko 1900 and 1904 b), most commonly in the eastern part between Kanin and Kolguev Island; in the western part of the Barents Sea it is met with only occasionally.

Near Trangisvaag on the Faeroe Islands some few specimens were found by the "Ingolf" expedition at the beginning of May 1895 (loc. 20).

The occurrence at the coasts of Iceland is peculiar. As will appear from the above list of localities, *Tiaropsis multicirrata* has been found on several Icelandic localities, all of which are on the

north coast or in the fjords of the north-western part of the country. As the species lives at the British, Norwegian, and Danish coasts, one should also expect it to occur at the southern and western coasts of Iceland and not to be restricted to the north coast, where the water is distinctly colder. By a more thorough examination of the facts we may, however, find a natural, though hypothetical, explanation of the fact here mentioned. First we must pay attention to the currents around the Icelandic coasts. The northern branch of the Gulf Stream runs towards the south coast of Iceland and turns in a westerly direction (the Irminger Current), running towards the west along the south coast, towards the north along the west coast, and towards the east along the north coast, its power and effects gradually decreasing. The Polar Current, coming from the Polar Sea, strikes the north-east point of Iceland (Cape Langenæs) and divides into two branches; the left branch runs towards the south along the east coast of Iceland, meeting the above mentioned northern branch of the Gulf Stream over the Wyville Thomson ridge; thereby the warm current is forced towards the west, the cold current towards the east; there may be an extraordinaryly sharp limit between the warm and the cold water near the island Papey on the south-east coast of Iceland. The right branch of the Polar Current bends towards the west, but meets the comparatively warm coastal current and is forced, therefore, to run in some distance from the coast in a direction towards the east coast of Greenland, where it unites with the East-Greenland Polar Current. The distance of the cold water from the north coast of Iceland varies very much according to the season and other circumstances, but during the summer the warm current has usually so much power that the coastal water is comparatively warm all along the north coast as far as Langenæs. There is nothing particular, therefore, in the boreal species *Tiaropsis multicirrata* being able to live in the fjords of the northern coasts of Iceland, and it is quite natural that the species is entirely wanting on the cold east coast; but why has it never been found at the west and south coasts? Now we must remember that in the British and adjacent waters the species has its occurrence in the spring, the young medusæ appearing in March—April, reaching maturity in May. Undoubtedly young *Tiaropsis* might also be found at the south and west coast of Iceland in the spring months, but no collections have been made in Icelandic waters during that season. My hypothesis is, that the medusæ which are deliberated on the south and west coast are carried along by the coastal current to the north coast, where they come at rest in the numerous fjords together with individuals, hatched and developed on the spot; thus the want of material of the species from the south and west coast is due partly to want of collections from the spring time, partly to the comparatively strong current running along these coasts. The finds from the northern coasts of Iceland have been made between June 1st and August 12th. There are a number of young specimens, 2—9 mm wide, from the first days of June, whereas larger individuals have been found during the later half-part of June, and mature specimens at the end of June, during July, and at the beginning of August.

The specimens, mentioned by Bigelow, from the northern Pacific (Dutch Harbour and Agattu Island) were found on May 25th and June 7th; they were altogether well-sized individuals.

We may then state as a general result that *Tiaropsis multicirrata* is a neritic-boreal species, living in the boreal coastal regions in the North Atlantic area and in the northern Pacific. In the greater part of the area of distribution its occurrence is limited to the spring months, the young specimens appearing in March, growing to maturity in May, and disappearing in May or June. In the

waters of Iceland and Greenland the season of its appearance falls somewhat later, in accordance with the later commencement of the spring. Young specimens may be found at the northern coasts of Iceland as late as in June, and at Iceland as well as at the west coast of Greenland full-grown specimens may still be met with in August.

Family Eucopidæ Gegenbaur.

Genus Obelia Péron et Lesueur.

Three species of the hydroid genus *Laomedea* producing free-swimming medusæ (*Obelia*) occur in the North Atlantic area, viz. *Laomedea geniculata*, *dichotoma*, and *longissima*, all of which are very widely distributed. Several authors have tried to find characters serviceable for separation of the medusæ of these species, but up to now the results have been very poor. The question has especially been dealt with by Browne. In 1900 he described a new species, *Obelia nigra*, easily recognizable on account of some of the tentacular bulbs (about 6 in each quadrant in full-grown medusæ) being double the size of the others and provided with dark pigment. Browne is now of the opinion that *Obelia nigra* is the medusa of *Laomedea longissima*. Browne has succeeded in rearing the medusæ of the two other species and keeping them alive in aquaria for a considerable time, but he has told me that there is no traceable difference between the medusæ of the two species. I myself has likewise tried to rear the medusæ of the three species of *Obelia* during a stay in Plymouth in 1914. I think that I have found certain characteristical differences between the species in the early stages, but I was not able to make the specimens grow very much in the aquaria, evidently because I did not give them the right kind of food. Later on, in 1916, I have tried to keep *Obelia geniculata* in plunger-aquaria in the laboratory for zoo-physiology in Copenhagen, but here the question of food-supply was still more difficult. Some of the specimens lived in the aquaria for several weeks, but they did not increase in size. I have, however, not yet relinquished all hope but that I shall succeed sometimes in solving the problem of the difference between the three species, but for the present we must leave the matter in abeyance.

In the following I shall give a list of the North-Atlantic material of *Obelia* at my disposal, first recording the specimens which may be referred with certainty to *Obelia nigra*, and then the others which may not at present be specifically identified.

Obelia nigra Browne.

Obelia nigra Browne 1900. Fauna and Flora of Valencia Harbour. — Proceed. Roy. Irish Acad. Ser. 3. Vol. V. — p. 721.

Material:

Iceland:

1) — Lat. 66°17′ N., Long. 14°27′ W., near Cape Langenæs. July 20th 1904. Depth 77 m. Youngfish trawl, 80 m wire. "Thor" stat. 203 (04). — 2 specimens.

2) — Ingolfsfjord. July 12th 1902. "Diana", A. Ditlevsen. — 8 specimens, partly very large.

3) — Hesteyrifjord. June 25th 1902. Surface. "Diana", Ditlevsen. — 9 specimens.

4) — Veidileysafjord. June 26th 1902. Surface. "Diana", Ditlevsen. — 32 specimens.

5) — Mouth of Hrafnsfjord. June 27th 1902. Vertical haul. "Diana", Ditlevsen. — 10 specimens.

6) — Dyrefjord. June 3rd and 6th 1895. "Ingolf". — 5 specimens.

Faeroe Islands:

7) — Kvannesund. May 26th 1902. Surface. "Diana", Ditlevsen. — 37 specimens.

8) — Sorvaag. May 13th 1902. Surface. "Diana", Ditlevsen. — 1 specimen.

9) — Trangisvaag. May 3rd 1895. "Ingolf". — 3 specimens.

British Isles:

10) — Lat. 59°00′ N., Long. 3°34′ W., at the Orkney Islands. May 21st 1908. Depth 66 m. Surface. "Thor" stat. 2 (08). — 2 specimens.

11) — Lat. 57°36′ N., Long. 7°05′ W., Little Minch, west of Scotland. May 27th 1908. Depth 90 m. Young-fish trawl, 65 m wire. "Thor" stat. 8 (08). — 12 specimens.

The medusa *Obelia nigra* is previously known from the British Isles (Plymouth, Valencia Harbour, Port Erin, Firth of Clyde, according to Browne 1900, p. 721 and 1905 a, p. 770; M. & C. Delap 1905, p. 12), and from different localities at the Norwegian coast (Browne 1903, p. 16; Broch 1905, p. 7). Moreover it is very common in the Danish waters.

Obelia spp.

Material:

Greenland. Bergendal. — 2 specimens.

Iceland:

Hesteyrifjord. June 25th 1902. Surface. "Diana", Ditlevsen. — 2 specimens.

Skutilsfjord. June 5th 1892. Lundbeck. — 4 specimens.

Dyrefjord. May 30th—June 3rd 1895. "Ingolf". — Altogether 24 specimens, partly treated with osmic acid; some of these specimens probably belong to *Obelia nigra*.

Danmark Strait, near Snefjeldsjokel on Iceland. June 11th 1895. "Ingolf". — 1 specimen.

Agastra mira Hartlaub.

Mayer 1910, Medusæ of the World, p. 234.

Bell somewhat higher than wide, 1 mm high; gelatinous substance quite thick, with a deep, funnel-shaped depression at the apex. No stomach. 4 narrow radial canals. Gonads irregularly lobated, sack-shaped evaginations on the middle part of the radial canals. The eggs become mature in the entoderm. No tentacles, but 4 minute, pigmented bulbs. Colour of bulbs, gonads, and canals dark-brown. Abortive medusa of the hydroid *Campanularia integra* Mc Gillivray (syn. *C caliculata* Hincks).

The medusa has been found in Valencia Harbour, Ireland, and at Heligoland.

Eucope globosa (Forbes).

Mayer 1910, Medusæ of the World, p. 235.

Bell thick-walled, slightly higher than a hemisphere, about 13 mm wide. Manubrium short, whit 4 simple, recurved lips. 4 short, linear gonads, extending from the middle point of the 4 slender radial canals outwards towards the circular

vessel. About 32 fairly long tentacles. 8 marginal vesicles, each containing 3—4 or more concretions. Velum well developed. Manubrium, gonads, and tentacular bulbs yellowish or reddish-brown.

This diagnosis is based on specimens, examined by me at Plymouth, and it differs in certain regards from that given by Mayer.

The corresponding hydroid is *Campanulina repens* Hincks.

The medusa is common off the coasts of Great Britain and Holland

Genus Phialidium Leuckart.

Phialidium hemisphæricum (Gronovius).

Plate IV, fig. 14; Plate V, fig. 3. Textfigs. 16 and 17.

Medusa hemisphærica Gronovius 1760. Observationes de animalculis ... Acta Helvetica. Vol. IV. — p. 35.

Thaumantias hemisphærica Forbes 1848. British Naked-eyed Medusæ. — p. 49.

i. p. *Phialidium variabile* Haeckel 1879. System der Medusen. — p. 186.

Phialidium temporarium Browne 1896. On British Hydroids and Medusæ. — Proceed. Zool. Soc. London. — p. 489. Plate XVII, figs. 4, 5, 6.

— *hemisphæricum* Mayer 1910. Medusæ of the World. — p. 266.

For further synonymy, see Browne 1896 and Mayer 1910.

Bell nearly hemispherical, 20—25 mm wide; gelatinous substance thin. Manubrium small, with 4 simple lips. 4 slender radial canals. Gonads oval or linear, their length very much varying; they are placed along the radial canals, somewhat nearer to the circular vessel than to the manubrium. 30—58 long tentacles with somewhat swollen basal bulbs. Usually 2 marginal vesicles between every successive pair of tentacles, each vesicle containing one concretion. Velum fairly narrow. Stomach, gonads, and tentacular bulbs yellowish-brown or reddish-brown.

Among the numerous species of *Phialidium* described, two species are recorded as occurring in the North-Atlantic area, *viz. Phialidium hemisphæricum* (Gronovius), about 20 mm in diameter, with up to 39 tentacles (according to Browne; as to the Icelandic specimens, see below), usually with 2 marginal vesicles between every successive pair of tentacles, and with linear, elongate gonads on the outer halves of the radial canals; and *Phialidium buskianum* (Gosse) Browne, up to 6 mm in diameter, with 20—32 tentacles, with one, sometimes 2, marginal vesicles between every successive pair of tentacles, and with short, oval gonads between the middle of the radial canals and the circular vessel.

I am very much inclined to think that these two species cannot be kept apart. But the North-Atlantic material at my disposal cannot serve as foundation for a discussion of the matter. The Zoological Museum of Copenhagen possesses, however, a very large material of *Phialidium* from the Danish waters and, moreover, a great many specimens, which I brought home from Plymouth in 1914. I consider it most convenient, therefore, to postpone a thorough discussion of the variation of *Phialidium* and the question of the limitation of the species, until that material has been further examined. In the present paper I shall restrict myself to give some information concerning the present material.

Material (see Chart XI):

Iceland:

1) — South of the Myrdalsjøkel. August 17th 1903. "Michael Sars". — 9 specimens, 8—16 mm wide.

2) — Myri Bugt. July 27th 1904. "Beskytteren", Gemzoe. — 6 large specimens.

3) — Lat. 64°04′ N., Long. 15°48′ W., Myri Bugt. July 24th 1904. Depth 49 m. Young-fish trawl about 28 m below the surface. "Beskytteren", Gemzoe. — 20 specimens, one of which is 7 mm wide, while the others are 13—25 mm.

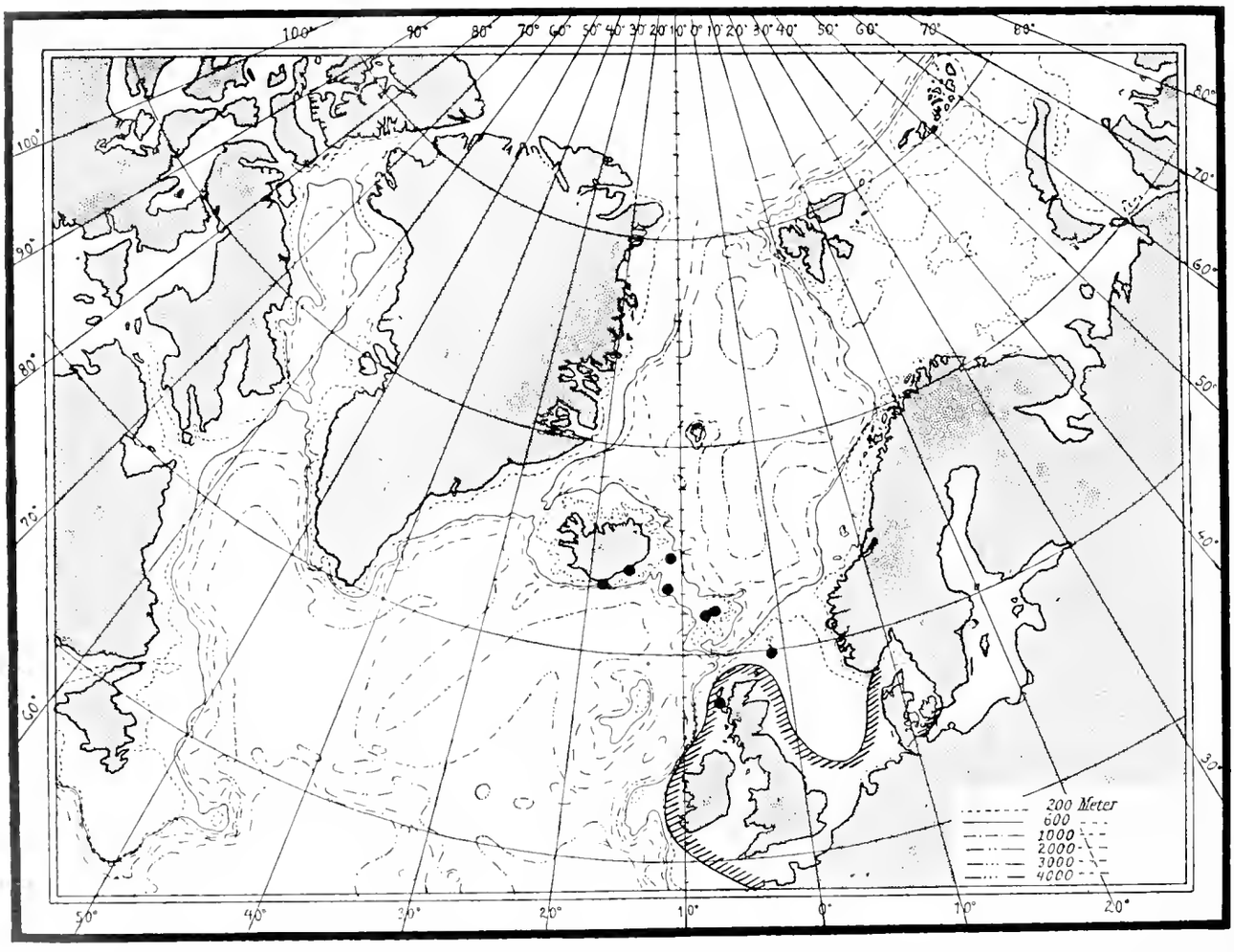

Chart XI. Occurrence of *Phialidium hemisphæricum* (Gronov.) in the northern Atlantic and adjacent waters. — From the regions within the hatched line the literature notes a common occurrence.

4) — Lat. 63°12′ N., Long. 11°45′ W., south-east of Iceland. August 7th 1904. Young-fish trawl, 20 m wire. "Thor". — 7 specimens, 15—20 mm wide.

5) — Lat. 64°35′ N., Long. 11°45′ W., east of Iceland. August 8th 1904. Depth 348 m. Young-fish trawl, 20 or 70 m wire. "Thor" stat. 241 (04). — 2 specimens, 19 mm wide.

The Faeroe Islands:

6) — Thorshavn. August 18th 1895. "Ingolf". — 6 specimens, 1—10 mm wide (see below).

7) — Lat. 61°47′ N., Long. 7°29′ W., west of the Faeroe Islands. August 15th 1895. "Ingolf". — 2 specimens, one of which is 10 mm wide with 32 tentacles; the gonads (female) are short and thick.

British Isles:

8) — Lat. 59°48′ N., Long. 1°23′ W., south end of the Shetland Islands. July 22nd 1905. Depth 85 m. "Thor" stat. 122 (05). — 2 specimens, one large and one middle-sized.

9) — Lat. 57°36′ N., Long. 7°05′ W., Little Minch, west of Scotland. May 27th 1908. Depth 90 m. Young-fish trawl, 65 m wire. "Thor" stat. 8 (08). — 2 specimens, the largest of which is 10 mm wide with mature female gonads, 3 mm long.

The largest specimens, found by Browne at the British coasts, were 21 mm in diameter and had 39 tentacles. Among the specimens from Iceland here mentioned several appear to be of more considerable size (up to 25 mm) and, particularly, to possess a larger number of tentacles (up to 58). In all other regards the specimens agree completely with the British *Phialidium hemisphæricum*, so that I do not hesitate to refer them to the same species. It seems quite natural that this species might be found off the southern coasts of Iceland, where the hydroid *Campanularia johnstoni*[1] is fairly common (according to Sæmundsson 1911 and Broch 1918).

The fully expanded tentacles are 2—3 times as long as the diameter of the bell (according to my observations from Plymouth). The tentacular bulbs are fairly broad, spherical, owing to the high development of the ectoderm on the lateral sides of the bulb. The ectoderm is likewise fairly highly developed on the adaxial side (Plate V, fig. 3). The lumen of the bulb is actually somewhat laterally compressed. — Plate IV, fig. 14 shows a section through a marginal vesicle of this species. The marginal vesicle is spherical, half-way inserted on the margin of the bell. There is, as a rule, 2 marginal vesicles between every successive pair of tentacles, though in younger specimens there is usually but one; in large specimens there are not seldom 3 marginal vesicles between two successive tentacles.

In specimens from Iceland the number of tentacles may amount to 58 (this number has been found in 3 specimens). Table XI presents a tabular view of the number of tentacles in 29 Icelandic specimens of different sizes. The calculation of the average numbers of tentacles is based on the exact

Table XI. Number of tentacles in specimens of different sizes of *Phialidium hemisphæricum* from Iceland.

Diameter of individuals, mm	Number of tentacles									
	25	26—30	31—35	36—40	41—45	46—50	51—55	56—58	Total	Average
6—10	1	.	3	.	.	.	.	.	4	30
11—15	.	.	1	2	1	1	.	.	5	40
16—20	.	.	.	4	1	2	3	3	13	48
21—25	.	.	.	.	.	4	2	1	7	51
Total	1		4	6	2	7	5	4	29 specimens	

[1] During my stay at Plymouth in 1914 I confirmed the observation of Browne, that *Campanularia johnstoni* is the hydroid corresponding to *Phialidium hemisphæricum*.

figures found by the measurements. — It will be observed that the number of tentacles varies fairly considerably within one and the same group of size; thus in specimens, 16—20 mm wide, there may be 38—58 tentacles.

Each of the radial canals carries only one gonad, completely encircling the canal without leaving a ventral edge free. This will be seen from the textfigures 16 and 17, representing transversal sections of male and female gonads. The section of the female gonad shows that the eggs are first developed in the middle part on both sides, whereas small, immature eggs are still present in the dorsal and ventral parts.

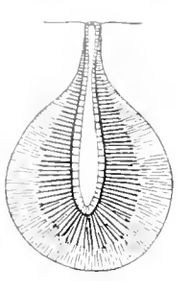

Fig. 16.

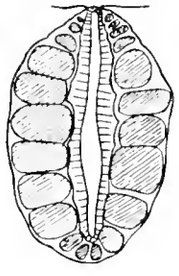

Fig. 17.

Fig. 16. *Phialidium hemisphæricum* (Gronovius). Transversal section through radial canal with mature male gonads. — Fig. 17. *Phialidium hemisphæricum* (Gronovius). Transversal section through radial canal with female gonads.

From the Faeroe Islands we possess a number of young specimens. In the smallest specimens (diameter 1—5 mm) the gonads are spherical and placed near the middle of the radial canals; in a specimen 7 mm wide the gonads (female) are oval, about $1^1/_4$ mm long; in the largest specimen (diam. 10 mm) they are elongate, 2 mm long.

In all specimens from Iceland the gonads are linear. Their length in relation to the length of the radial canals varies from $^1/_3$ to nearly $^3/_4$, but stands in correlation to the developmental stage of the individual, as will be seen from table XII. This table represents the correlation between the diameter of the individuals and the relative length of the gonads (i. e. the relation between the length of the gonads and that of the radial canals, expressed by means of the figure $\frac{g}{r}$). For each individual I have calculated $\frac{g}{r}$ with 2 decimals, and these figures have been used for the calculation of the average numbers presented in the table. In the specimens examined the figure $\frac{g}{r}$ varies from 0.33 to 0.73. It will be seen from the table that up to a size of 6—10 mm in diameter the gonads have nearly the same relative length in both sexes ($\frac{g}{r}$ = about 0.4), but during the

Table XII. Relative length of gonads in specimens of different sizes of *Phialidium hemisphæricum* from Iceland.

Diameter of individuals, mm	$\frac{g}{r}$ relation between length of gonads and length of radial canals						
	0.3	0.4	0.5	0.6	0.7	Total	Average
♂							
6—10	1	1	.	.	.	2	0.39
11—15	.	1	3	1	.	5	0.50
16—20	.	.	1	5	.	6	0.59
21—25	.	.	.	2	2	4	0.67
Total	1	2	4	8	2	17 specimens	
♀							
6—10	.	3	.	.	.	3	0.42
11—15	.	1	1	.	.	2	0.45
16—20	.	2	4	1	.	7	0.49
21—25	.	.	1	2	.	3	0.53
Total	.	6	6	3	.	15 specimens	

further development there is a well marked difference between the sexes, the gonads being distinctly longer in the males than in females of corresponding sizes. The difference is so obvious that it can hardly be due to casuality. We may state, in short, that in full-grown specimens the male gonads are about $^2/_3$ *r*, the female gonads about $^1/_2$ *r*. — In large specimens the gonads, particularly the male gonads, are more or less sinuous.

Occurrence: The medusa *Phialidium hemisphæricum* is very abundant round the British coasts, in the North Sea, and in the Danish waters to the western part of the Baltic. Within this region it is found throughout the year. Young specimens are found in the spring and summer; during the summer we also find half-grown specimens; during the autumn and far into the winter we find large, full-grown specimens. The medusa has also been found at the coast of Norway in the neighbourhood of Bergen. Among the material, here dealt with, there are a number of small specimens from the Faeroe Islands, found in August, and numerous large individuals from the south coast of Iceland from July and August. — If Mayer (1910) is right that the "*Clytia flavidula*" of Metschnikoff is identical with *Phialidium hemisphæricum*, we will have to add the Mediterranean to the known area of distribution of the species.

Phialidium islandicum nov. spec.

Plate IV, figs. 11, 12, 13; Plate V, figs. 1 and 2

Diagnosis: *Phialidium* of large size, with elongated gonads, with numerous tentacles and an equal number of marginal vesicles.

Description: Umbrella is watchglass-shaped, about 35—40 mm in diameter, gelatinous substance comparatively thin, exumbrella evenly rounded from the apex towards the margin. The stomach is cross-shaped, very small, its perradial diameter being only about one-tenth the diameter of the bell. There is a short mouth-tube provided with four pointed, crenulated lips (Plate IV, fig. 12). Four radial canals, straight and narrow, and a narrow, simple circular vessel. The gonads are developed on the radial canals, completely encircling the canal from both sides of its line of attachment to the subumbrella without leaving a ventral line free of gonads. The gonads are very much elongated, linear, usually not sinuous (Plate IV, fig. 11), commencing about 2 mm from the base of the manubrium, terminating about 1 mm from the circular vessel. The number of tentacles amounts to about 200; their basal bulbs are swollen (Plate V, fig. 1), particularly owing to the ectoderm of the lateral sides being highly developed; there is a slight trace of an abaxial process at the base of the tentacles. There are no cirri. Small, closed marginal vesicles (Plate IV, fig. 13) are present in the same number as the tentacles. Velum is fairly broad but thin and weak. — Hydroid generation unknown.

The number of species of *Phialidium* hitherto described is very large, and several of the species are very much like each other. It might be considered as rather a risky undertaking, therefore, to add a new species to the number already described, but as far as I am aware, there has never been found a *Phialidium* of such considerable size and with a similarly great number of tentacles as that found in the present species. It was pointed out in the preceding pages that *Phialidium hemisphæricum* may attain a larger size and a larger number of tentacles in the waters near Iceland than in the more

southerly parts of its area of distribution. It is possible, accordingly, that the species just described will prove in time to be only a northern giant variety of a species already known to science; but as long as it cannot be referred with certainty to any known species, I prefer to describe it as an independent species, for which I propose the name of *Phialidium islandicum*, because all the specimens in hand have been found in the neighbourhood of Iceland.

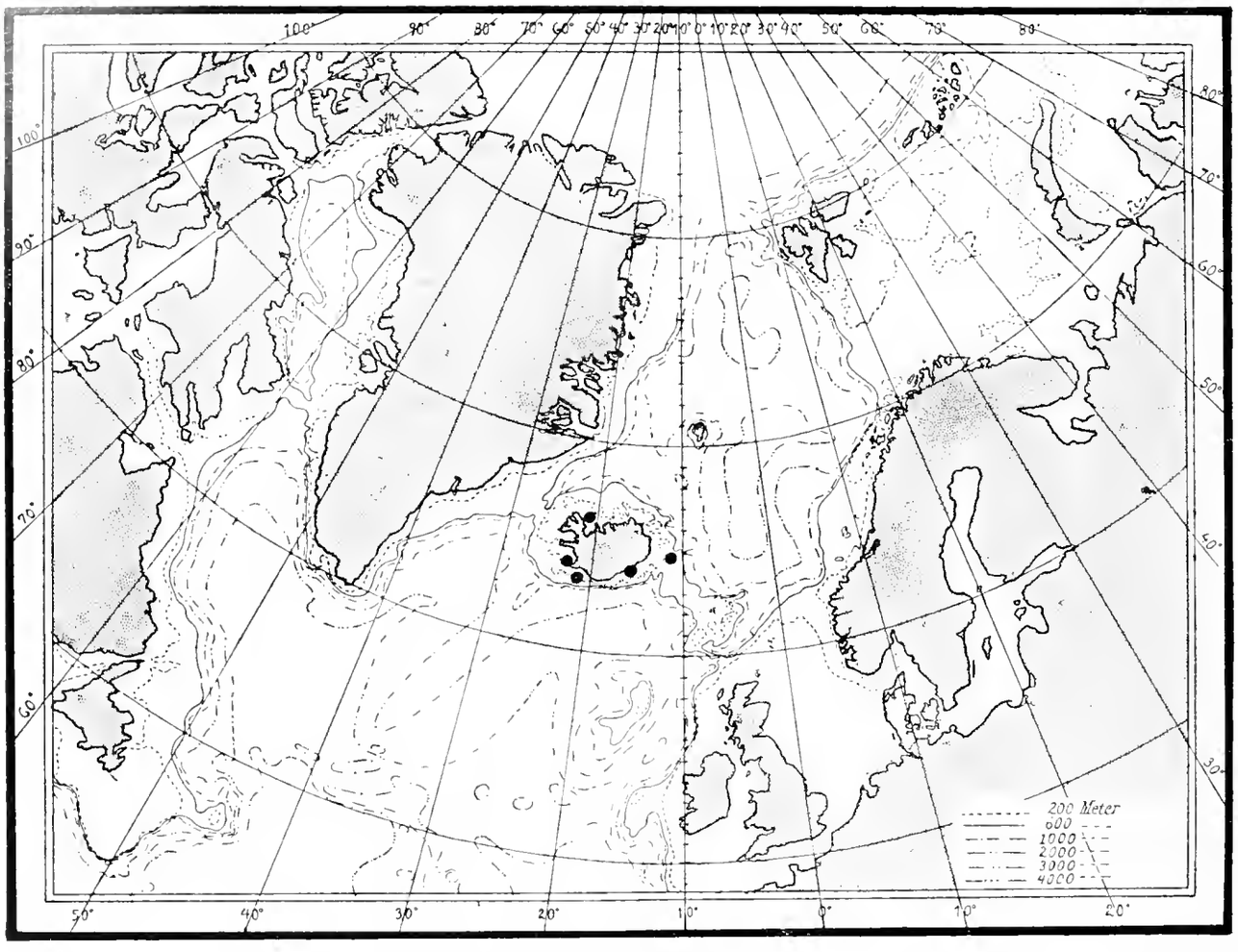

Chart XII. Finds of *Phialidium islandicum* nov. sp.

The species is quite distinct from *Phialidium hemisphæricum*, not only by its size and the large number of tentacles, but also by the number of marginal vesicles never exceeding the number of tentacles. Furthermore the mouth-lips are larger and more crenulated than in the case of *Phialidium hemisphæricum*, and the gonads are longer. The sagittal sections through the tentacular bulbs show (Plate V, figs. 2 and 3) that the ectoderm on the adaxial side of the bulb is more highly developed in *Phialidium hemisphæricum* than in *Ph. islandicum*. The trace of an abaxial process on the base of the tentacular bulbs in *Phialidium islandicum* is not always distinct; in *Ph. hemisphæricum* it is entirely lacking. The shape of the marginal vesicles (see the sections, Plate IV, figs. 13 and 14) presents no

particular difference; unfortunately the state of preservation does not allow a determination of the number of concretions in the marginal vesicles.

Material (see Chart XII):

1) — Myri Bugt, south coast of Iceland. July 27th 1904. "Beskytteren", Gemzoe. — 2 specimens, 37—38 mm wide.

2) — Lat. 63°18′ N., Long. 21°30′ W., South-Iceland. July 8th 1904. Depth 178 m. "Thor" stat. 176 (04). — 3 specimens, 22—28—35 mm wide.

3) — Lat. 64°06′ N., Long. 23°14′ W., Faxebugt. July 2nd 1908. Depth 98 m. Young-fish trawl, 65 m wire. "Thor" stat. 45 (08). — 1 specimen, 21 mm wide.

4) — Lat. 66°23′ N., Long. 21°21′ W., North-Iceland. August 24th 1904. Depth 108 m. Young-fish trawl, 70 m wire. "Thor" stat. 266 (04). — 1 specimen, 32 mm wide.

5) — Lat. 64°35′ N., Long. 11°45′ W., east of Iceland. August 8th 1904. Depth 348 m. "Thor" stat. 241 (04). — 2 large specimens, about 40 mm wide.

Table XIII. Diameter, number of tentacles, and length of gonads in *Phialidium islandicum* from Iceland.

Number of locality	Diameter of individuals mm	Number of tentacles	Length of gonads mm	Sex
3	21	152		♂
2	28	abt. 175	10	♀
4	32	abt. 200	11	♂
2	35	abt. 185	11—12	♀
1	37	abt. 200	15	♂
1	38	200	15	♀

The specimens from loc. No. 5 are very large, about 40 mm wide; both specimens have lost the gastro-genital organs, but these are regenerating; in one specimen three new stomachs are developing; a nematode is enclosed in the gelatinous substance near the three stomachs.

As will appear from the above list of the material, this species has been found both south, west, north, and east of Iceland; it is probable, therefore, that it is derived from a hydroid widely distributed at the coasts of Iceland (possibly *Campanularia volubilis*?). The specimens have all been found in July or August.

Genus Eucheilota Mc Crady.

Eucheilota maculata Hartlaub.

Mayer 1910, Medusæ of the World, p. 285.

Bell somewhat flatter than a hemisphere, about 13 mm vide. Gelatinous substance thick above, but thin at the sides of the bell. Stomach short, with 4 well-developed lips. 4 linear gonads along the outer two-thirds of the 4 radial canals, not touching the circular vessel. 16—30 long tentacles with well-developed tapering basal bulbs, flanked by cirri. Cirri also arise from the bell-margin between the tentacles. Marginal vesicles, each containing 5—10 concretions, alternating with the tentacles. Gonads and tentacular bulbs light reddish-brown; on each interradial wall of the stomach there is a large black spot.

The species occurs in the North-Sea, whence it is occasionally carried into the Kattegat.

Genus Eutonina Hartlaub.

Eutonina indicans Hartlaub.

Tiarops indicans Romanes 1876 b. New Species, Varieties, and Monstrous Forms of Medusæ. — Journ. Linn. Soc. London. Zool. Vol. XII. — p. 525.

Tiaropsis — Romanes 1877, ibid. — Plate XV, fig. 1.

Thaumantias sp. McIntosh 1888. Seventh Annual Report of the Fishery Board of Scotland. — p. 282, Pl. 5, figs. 6—9.

— - McIntosh 1890. Ann. Mag. Nat. Hist., Ser. 6. Vol. V. — p. 300.

Eutimalphes indicans Haeckel 1879. System der Medusen. — p. 195.

— — Hartlaub 1894. Die Coelenteraten Helgolands. — Wissensch. Meeresuntersuch. N. F., Bd. I. — p. 194.

Eutonina — Hartlaub 1897. Die Hydromedusen Helgolands. — ibid. Bd. II. — p. 507.

— *socialis* Hartlaub. Ibid. — p. 506. Taf. XXII, Fig. 1, 3, 4, 6, 7; Taf. XX, Fig. 19, 20.

Eutimium — Mayer 1910. Medusæ of the World. — p. 306.

Eutonina indicans Bigelow 1913. Medusae and Siphonophorae collected by the "Albatross" in the northwestern Pacific 1906. — Proceed. U. S. Nat. Mus. Vol. 44. — p. 34.

Umbrella somewhat flatter than a hemisphere, 25—30 mm wide; gelatinous substance rather thick. Stomach small, cross-shaped, mounted upon a spindle-shaped peduncle reaching to the level of the bell opening; there are four crenulated lips. 4 radial canals. Gonads linear, wavy, developed upon the lateral sides of the radial canals, leaving a narrow median line on the ventral side free of gonads; the gonads commence at a short distance from the base of the stomachal peduncle and do not quite reach the circular vessel. There are about 200 short tentacles with conical basal bulbs; no cirri; 8 adradial marginal vesicles, each containing about 12 concretions. The velum is narrow.

Like Bigelow (1913) I prefer the generic name *Eutonina* Hartlaub for this medusa. Bigelow writes as follows: "Mayer uses the name *Eutimium* Haeckel for this group (he, however, does not include the number of tentacles as a generic character), but the type species of that genus, *E. elephas* Haeckel, was beyond question a *Eutima*. I formerly used the name *Eutimalphes*; but *Eutonina* seems to have the better claim, because its type species is well known, while that of *Eutimalphes*, *E. pretiosa* Haeckel, was founded for a fragmentary specimen which may have been a *Tima*. It has never been seen since first recorded".

With regard to the question of the specific name, it seems to me that Romanes' description of "*Tiarops indicans*" agrees so well with Hartlaub's description of "*Eutonina socialis*", that there is every probability that they are identical. The high shape of the bell in Romanes' medusa really presents the only noticeable difference and may, as is rightly remarked by Bigelow, very likely be due to contraction. Haeckel's characterisation of "*Eutimalphes indicans*" is a quotation of Romanes. The figure of "*Thaumantias sp.*" given by McIntosh is not to be mistaken.

L. P. van Beneden (1867, p. 87, Pl. III, figs. 1—6) describes and figures a medusa, "*Geryonopsis Forbesii*", which is probably identical with *Eutonina indicans*; true, the gonads are most like those of

a *Tima*, but there are too many tentacles for a *Tima*, and the size and shape remind one very much of *Eutonina*. Bedot in his Histoire des Hydroïdes includes "*Geryonopsis Forbesii*" among the synonyms of *Irene viridula* Pér. & Les. Peach (1868, p. 97) mentions a medusa, "*Tima Forbesii*", which is said to be distinguished from *Tima bairdii* by the possesion of numerous tentacles; probably also this medusa belongs to *Eutonina indicans*. The same may be the case with a medusa mentioned by Crawford (1891, p. 296): "A form evidently allied to *Tima*, but with shorter peduncle, with more numerous tentacles, and with the reproductive organs only on a portion of the canals ...".

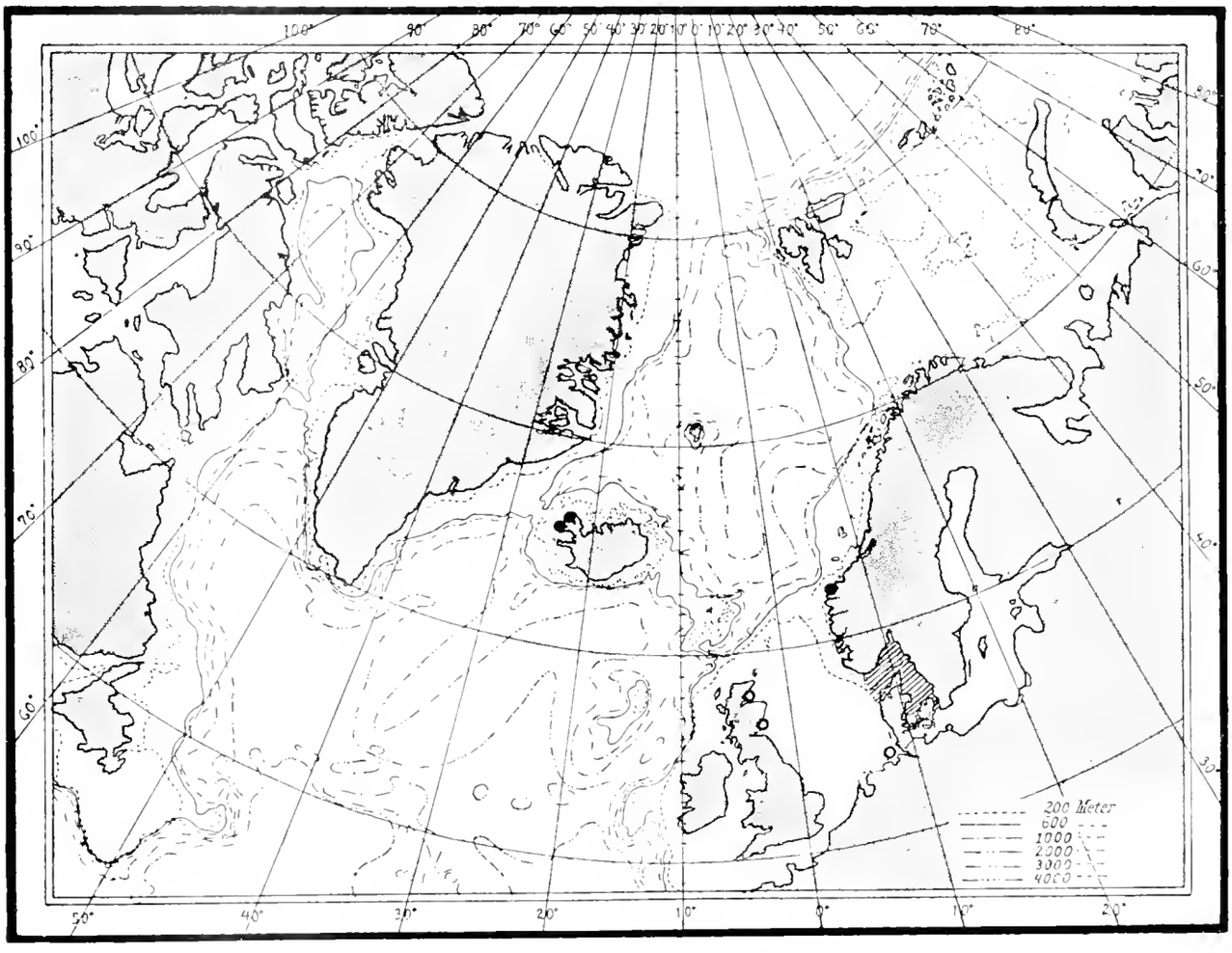

Chart XIII. Occurrence of *Eutonina indicans* in the Atlantic. ○ Occurrence according to the literature. In the hatched region the species has a common occurrence.

Material (see Chart XIII):

1) — Isafjord, north-western part of Iceland. Mariboe 1865. — 1 specimen, 22 mm wide. Identified by Haeckel as "*Eirene (viridula Esch.?)*".

2) — Patreksfjord, north-western part of Iceland. June 22nd—23rd 1904. Fished from the ship. "Thor" stat. 159 (04). — 2 specimens, 12, 14, and 17 mm wide.

3) — Borgundfjord, near Aalesund, Norway. June 25th 1902. "Michael Sars", Ad. S. Jensen. — 19 specimens, about 16—27 mm wide.

Moreover the Zoological Museum of Copenhagen possesses a large number of specimens from Danish waters, where this species is exceedingly abundant right into the Belt-Sea.

It is very interesting that Bigelow has found this North-European species in the northern Pacific. Bigelow states that "the only noticeable separation between examples from the two localities is that in those from the Bering Sea the gonads begin close to the base of the peduncle, instead of at a slight distance from it, as in the Helgoland specimens, but the difference is so slight that it is probably a developmental feature". I have paid attention to this statement, and I have found that the authors last-mentioned supposition does not hold good; as a matter of fact, in young as well as full-grown individuals there is always some distance from the stomachal peduncle to the proximal end of the gonads (see Table XIV).

Table XIV. Dimensions of specimens of *Eutonia indicans* from the above-mentioned localities.

Number of locality	Diameter of individuals mm	Number of tentacles	Length of gonads mm	Distance from		Sex	Remarks
				gonads to stomachal peduncle mm	gonads to circular vessel mm		
2	12	171	$4^1/_2$	$1^1/_4$	1	♂	somewhat contracted
—	14	abt. 185	.	$1^1/_4$	1	♀	
—	17	169	..	$1^1/_2$	1	♀	
1	19	175	4	$2^1/_4$	$1^1/_4$	♀	immature
3	22	..	7—8	$1^1/_2$	1	♀	somewhat contracted
1	25	206	$6^1/_2$	$2^1/_4$	$1^1/_4$	♀	mature
—	26	abt. 196	7	$3^1/_4$—$3^1/_2$	1	♂	—
—	26	188	6	3	$1^1/_2$	♀	hardly mature
—	27	204	8	$2^1/_4$	1	♂	mature
—	27	213	$6^1/_2$	3	1	♂	—

Measurements on Danish specimens have given corresponding results with regard to the distance from the base of the stomachal peduncle to the proximal end of the gonads; thus there actually seems to exist a characteristic difference in this respect between the specimens from Europe and those from the Bering Sea; but as they agree exactly in all other respects, this slight difference hardly justifies a separation of the two forms as distinct species, unless the corresponding hydroids should prove to be specifically different.

Hartlaub gives the number of tentacles as about 150, but, as will appear from the figures in table XIV, the number may amount to about 200.

Eutonina indicans has up to now been found on the following localities in the Atlantic area: east coast of Scotland: Cromarty Firth (Romanes) and St. Andrews Bay (McIntosh); Heligoland (Hartlaub); and, if "*Geryonopsis Forbesii*" van. Beneden is identical with the present species, also off the coast of Belgium. It is mentioned in the International Plankton-lists as occurring in the Skagerrak. In Johansen and Levinsen: De danske Farvandes Plankton (1903), it has been confounded with *Tiaropsis multicirrata*.

The present material augments the known area of distribution to comprise the west coast of Norway at Aalesund and the fjords on the north-western part of Iceland.

The Norwegian specimens as well as those from Patreksfjord in Iceland are found in the later half-part of June. The species is said to occur off the east coast of Scotland from May to August. It occurs at Heligoland from the end of March to the beginning of July and may be carried into the beach in enormous quantities. It is found in the Danish waters from the beginning of April to the end of June. In May 1916 I saw enormous quantities at the surface of the water in Lillebelt.

Genus Saphenia Eschscholtz.

Saphenia gracilis (Forbes and Goodsir).

Mayer 1910, Medusæ of the World, p. 294.

Syn. *Saphenia mirabilis* Wright) Haeckel.

Bell hemispherical, about 15–20 mm wide. There is a long and thin, cylindrical gelatinous peduncle which may be extended to a length of 5–10 times the diameter of the bell. The peduncle is entirely surrounded by the four linear gonads, which extends from the base of the peduncle to the stomach; the latter is small, flask-shaped, with 4 small, recurved lips. Two long, opposite tentacles and a large number of marginal warts and cirri. 8 adradial marginal vesicles, each containing about 3 concretions. Stomach and gonads delicately pink.

British coasts and North Sea

Genus Eutima Mc Crady.

Eutima insignis (Keferstein).

Mayer 1910, Medusæ of the World, p. 299

Umbrella hemispherical, about 8 mm wide. The stomachal peduncle is once or twice as long as the diameter of the bell, narrow, of equal width. Stomach about half as long as the bell-radius, flask-shaped, with 4 large lips. The gonads extend from near the stomach upwards along the 4 radial canals on the peduncle; there are no gonads on the subumbrella. There are 4 long perradial tentacles, each flanked by a pair of cirri; moreover there are about 30 rudimentary bulbs, likewise flanked by cirri. 8 adradial marginal vesicles, each containing 2–5 concretions. The animal is colourless.

British coasts and north-west coast of France.

Eutima elephas (Haeckel).

Mayer 1910, Medusæ of the World, p. 300.

Umbrella about 16–20 mm wide; gelatinous substance thick. The upper part of the stomachal peduncle is broadly conical; the entire length of the peduncle is about 3 to 4 times the diameter of the bell. Stomach short, urn-shaped, with 4 recurved, slightly folded lips. 4 radial canals; the gonads are developed along the radial canals on the narrow part of the peduncle. There are 4 long perradial tentacles and numerous minute warts on the bell-margin; no cirri; 8 adradial marginal vesicles, each containing about 8–10 concretions. Stomach, canal system, and tentacles green.

North Sea.

Genus Octorchis Haeckel.

Octorchis gegenbauri (Haeckel).

Syn. *Eutima campanulata* (Claus). Mayer 1910, Medusæ of the World, p. 302.

Umbrella hemispherical, about 25–30 mm wide. Stomachal peduncle about as long as the bell-diameter, the upper part broadly conical. Stomach small, urn-shaped, with 4 folded lips. 4 radial canals; the gonads are developed partly along the subumbrella part of the radial canals, partly on the peduncle about half-way between the base of the peduncle and the stomach. There are 16–32 long tentacles and about 120–150 tubercles, flanked by cirri. 8 adradial marginal vesicles, each containing 16–20 concretions. Stomach, canal-system, gonads, and tentacles greenish.

North Sea, Atlantic coasts of Great Britain and France, Mediterranean, Canary Islands.

Genus Eirene Eschscholtz.

Eirene viridula (Péron et Lesueur).

Mayer 10 Medusæ of the World, p. 311.

Umbrella very flat, about 6—15 mm wide; gelatinous substance thin. Stomachal peduncle half as long as bell-radius, pyramidal, slender. Stomach small, with 4 long, crenulated lips. 4 radial canals, very narrow. Gonads linear, somewhat sinuous, developed along the subumbrella parts of the radial canals. 50—60 short tentacles and about 100 even smaller tentacles; each of the latter is flanked by a pair of cirri; each of the tentacular bulbs bears an abaxial excretion papilla. There are about 100 small marginal vesicles, each containing 2—4 concretions. Velum very narrow. Stomach, gonads, and tentacles milky-white, green or reddish

Atlantic coasts of Europe, Mediterranean.

Genus Tima Eschscholz.

Tima bairdii (Johnston) Forbes.

Plate V, figs. 4, 5, 6, 7, 8, 9, 10.

Dianea Bairdii Johnston 1833. Illustrations in British Zoology. Art. IV. — Mag. Nat. Hist. Vol. 6. — p. 320, fig. 41.

— — Thompson 1844. Report on the Fauna of Ireland, Invertebrata. — Rep. 13th Meeting, Brit. Assoc. — p. 282.

Tima? — Forbes 1846. On the Pulmograde Medusæ of the British Seas. — Ann. Mag. Nat. Hist. Vol. 18. — p. 286.

Medusa (*Tima* Eschsch.) Dalyell 1847—48. Rare and remarkable Animals of Scotland. Vol. 2. — p. 250; Pl. 52, fig. 5.

Tima Bairdii Forbes 1848. British Naked-eyed Medusæ. — p. 37; Pl. 5, fig. 1.

— — Allman 1871. Monograph of the Gymnoblastic or Tubularian Hydroids. — pp. 36, 140, figs. 11, 12.

— — Böhm 1878. Helgolander Leptomedusen. — Jenaische Zeitschr. Bd. XII (N. F. Vol. I). — pp. 143, 145.

— — Haeckel 1879. System der Medusen. — p. 205.

Description:

Umbrella hemispherical or somewhat higher than a hemisphere, about 60 mm wide when fully developed. Gelatinous substance very thick. The stomachal peduncle is nearly conical; it is highly contractile; its length as well as the width of its base are, accordingly, very much variable, and measurements of preserved material are, therefore, of no great value; but the approximate dimensions may be stated as follows: The diameter of the base of the peduncle varies between about $^1/_2$ and $^2/_5$ of the diameter of the bell; the length is, when expanded, about equal to the bell-diameter, the peduncle extending more or less beyond the level of the bell-margin.

The stomach (Plate V, fig. 5) is small, square, fixed to the flattened terminal end of the peduncle by a cross-shaped figure; thus there are four flat, triangular pouches between the dorsal wall of the stomach and the terminal end of the peduncle. In some cases, i. e. in certain conditions of contraction, the entire stomach is cross-shaped in transverse section. The four perradial lines of attachment

(the cross-arms) are seen, from the stomachal cavity, as deep, narrow grooves (Plate V, fig. 4). From the distal ends of these four grooves issue the four radial canals which, from these points, run upwards along the peduncle (Plate V, fig. 5). The openings of the radial canals may be completely closed by contraction of the borders of the grooves, thus the lumen of the canals being separated from the cavity of the stomach; in the stomach figured in Plate V, fig. 4, the openings on the left side have been closed in that manner.

The basal part of each radial canal is a little widened and has a number of fine, transverse folds.

The mouth-opening is wide and is provided with four large, pointed lips, complexly folded and with a crenulated margin (Plate V, fig. 5).

There are four straight radial canals and a very narrow circular vessel. The mode of attachment of the radial canals to the subumbrella (and the stomachal peduncle) is remarkable (see Plate V, fig. 10). The usual median streak of high entodermal cells is very narrow, but the uppermost parts of the lateral entodermal layer of the canal on both sides are attached to the subumbrella, the ectoderm and the mesosare leaving the subumbrella at some distance from the median streak; thus the line of attachment has secondarily become rather broad.

The gonads are developed upon both sides of the radial canals from the attachment to the subumbrella, leaving a narrow median line free on the ventral edge. Though the line of attachment to the subumbrella is straight, the lateral walls of the canals are, in the parts carrying the gonads, very much folded in a fairly regular, wavy manner. The gonads extend partly over the subumbrella from the base of the peduncle towards the bell-margin, reaching nearly to the circular vessel, partly downwards along the peduncle, ceasing at a distance of some few millimeters above the stomach. The gonads attain their highest development and are most highly folded upon the subumbrella, gradually tapering during their course downwards upon the peduncle. Sections laid through different parts of the gonads of one and the same specimen show, however, that the sexual products are in the same state of maturity in every part. In the highly folded parts the ventral median line, free of gonads, is sometimes fairly broad, sometimes very narrow, shaped like a deep furrow, and is, in such cases, hardly visible, except in sections.

The usual number of tentacles is 16. When fully expanded, the length of the tentacles is about 3 times the diameter of the bell. The tentacular bulbs (Plate V, figs. 6, 7, 8) are oblong, pear-shaped, gradually passing into the thread-like part of the tentacles. The ectoderm of the bulb is somewhat thickened, equally developed all round the bulb (Plate V, fig. 8). Proximally the abaxial side of the bulb is sharply set off from the exumbrella. There is a well-developed, hollow, entodermal basal spur projecting into the gelatinous substance of the exumbrella, curving outwards and upwards, its abaxial side resting close to the exumbreilular epithelium, which is slightly thickened in this part (Plate V, fig. 8). Above each of the tentacles there is a slight, rounded prominence of the exumbrella (Plate V, figs. 6 and 7); this may be due to contraction owing to the preservation. The points of insertion of the tentacles are usually not quite equidistant.

Between the tentacles there is a large number of marginal warts (see Plate V, fig. 6). The base of the warts is rectangular, the warts being placed closely together. In some cases they are separated from each other by a sharp furrow, but sometimes they pass gradually into one another; it is difficult,

fore, to state their exact number; in well-grown specimens there may be about 200–250 warts. The ectoderm of the warts is somewhat thickened (Plate V, fig. 9). On the abaxial side of some of the warts may be found a small tenon, a rudimentary tentacle.

The marginal vesicles are very numerous, about half as numerous as the warts; they are situated, with a broad base, in the middle of the adaxial side of the warts, close to the velum (Plate V, fig. 9)[1]. Marginal vesicles are never found on warts provided with tentacular rudiment. As all of the material at my disposal has been preserved in formalin and left there for several years, the concretions of the marginal vesicles have been dissolved; according to Allman (1871) the number of concretions in each marginal vesicle varies from 4 to 20 in one and the same specimen.

The velum is well-developed and as broad as the length of the tentacular bulbs.

In living specimens the tentacles are said to be light pink.

Though this medusa is very common in the North Sea and adjacent waters, no description has been given since 1848 (Forbes). It was first discovered by G. Johnston (1833) who made a short description and a somewhat rough figure of the species. A very fine drawing was given by Dalyell (1847—48). The description delivered by Forbes (1848) was rather incomplete. A few morphological remarks are found in the works of Allman (1871) and Böhm (1878). The description in Haeckel's monograph (1879) is based on the descriptions and drawings of Dalyell and Forbes. — The records on the occurrence of the species are likewise rather few. It is no wonder, therefore, that Mayer (1910, p. 319) has an entirely incorrect interpretation of the relationship and distribution of the species. Mayer suggests that *Tima bairdii* may prove to be the young of *Tima formosa* which is found off the Atlantic coasts of New England, and that it is an arctic form occasionally appearing at the coasts of Scotland.

Tima formosa L. Agassiz reaches twice the size of *Tima bairdii* and has about 32 tentacles of three different sizes; according to Bigelow (1913, p. 36) the number of tentacles may amount to 39; it has about 100 marginal warts, whereas *Tima bairdii*, though it is a smaller species, may have more than 200. Mayer (1910, p. 317) and Bigelow (1913, p. 36) confirm the statement of A. Agassiz, that the marginal vesicles in *Tima formosa* alternate with the warts, being placed in the spaces between the latter; in *Tima bairdii* they are placed on the warts themselves (see above). The two species may be nearly related to one another, but they are clearly distinct species.

More peculiar is the suggestion of Mayer (1910, p. 319), that *Tima flavilabris* Eschscholtz might be the young of *Tima formosa*. It is not very likely that a large species with about 80 short tentacles might be a young stage of a smaller medusa with only 32 tentacles. *Tima flavilabris* Eschscholtz from the Azores is, without any doubt, identical with *Tima lucullana* Delle Chiaje from the Mediterranean, *flavilabris* being the correct name of the species[2].

Besides the species already mentioned, we know another Atlantic species of *Tima*, viz. *Tima leuscheri* Haeckel from the coast of Brazil, possessing 8 long and 40 short tentacles.

[1] A. Agassiz in his description of *Tima formosa* states that the marginal vesicles are situated in the spaces between the warts.

[2] The question of the correct name of this species will be discussed in a later work.

In the Pacific the genus is represented by *Tima saghalinensis* Bigelow (1913, p. 35), a large species, distinguished by its very short peduncle and by the lips being extraordinarily complexly folded.

Material:

I have had at my disposal for investigation numerous specimens from Danish waters, but only 4 specimens from one locality outside the Danish area:

Lat. 55° 10′ N., Long. 1°55′ E. May 3rd 1905. Depth 33 m. Young-fish trawl. "Thor" stat. 14 (05). — 4 specimens, diameter: 35, 42, 43, and 58 mm.

The Danish specimens have been found at 23 different localities in the North Sea, the Skagerrak, the Kattegat, and the northern part of the Sound. The species has also been found in the northern part of the Lillebelt.

I am not going to give a thorough account of the Danish finds in this place, but shall restrict myself to make some few remarks on the appearance of a number of young specimens.

Most of the specimens, examined by me, are large and medium-sized, the largest being 58 mm in diameter. But there are also some young specimens, the smallest being 6 mm. The height of a specimen, 6 mm wide, is 4 mm, the gelatinous substance being 2 mm thick apically, and the depth of the bell-cavity being likewise 2 mm. — The peduncle is short in these small specimens. In a specimen, 13 mm wide, the peduncle is 4 mm long, 3 mm wide at the base.

When the diameter is below 13 mm only slight traces of gonads are present, and they are confined to the subumbrella part of the radial canals, ranging from the base of the peduncle very nearly to the circular vessel.

Three of the specimens, which are 6, 7, and 10 mm wide, have 8 tentacles, all alike; 8 adradial swellings just visible indicate the places of the remaining tentacles. In two specimens, 11 and 13 mm wide, one of the adradial tentacles has developed, but is much smaller than the 8 perradial and interradial ones. One specimen, 13 mm wide, possesses 16 tentacles, the perradial and interradial all alike, while the others are much smaller and in different stages of development. I have not seen specimens with less than 8 tentacles, and these have always been of equal size in the same individual. The number of marginal vesicles in these small specimens (6—13 mm) is 29—34. A specimen, 23 mm wide, has about 84 marginal vesicles.

One of the specimens from the above-mentioned locality in the western part of the North Sea is abnormal, in so far as one of the four quadrants is narrower than the others, and there are no tentacles between the two adjacent radial canals. I have observed the same abnormality in no less than 3 of the Danish specimens.

Distribution (see Chart XIV):

This large medusa seems to be strictly confined to the North Sea, the Skagerrak, and the Kattegat. It has been recorded from Berwick Bay (Johnston 1833), May Island (Dalyell 1847—48), Burtisland (Forbes 1848), and St. Andrews Bay (Forbes 1848, McIntosh 1890, Crawford 1891); all these localities are at the southern part of the east coast of Scotland. According to McIntosh the species abounds all along the eastern shores of Great Britain to the estuary of the Thames (Mc

Mcintosh 1890, p. 304, but no precise records are given. Hartlaub (1894, p. 196) has found it at Heligoland. Broch (1905, p. 7) records it from the Sondeledfjord on the Norwegian coast of the Skagerrak. In the International Plankton Catalogues (1906 and 1908) it is recorded from various localities in the eastern part of the Skagerrak. Also Anrivillius (1897—98) records it from the Skagerrak. A. C. Johansen and Chr. Levinsen (1903) have mentioned it from the Kattegat. No other records as to the

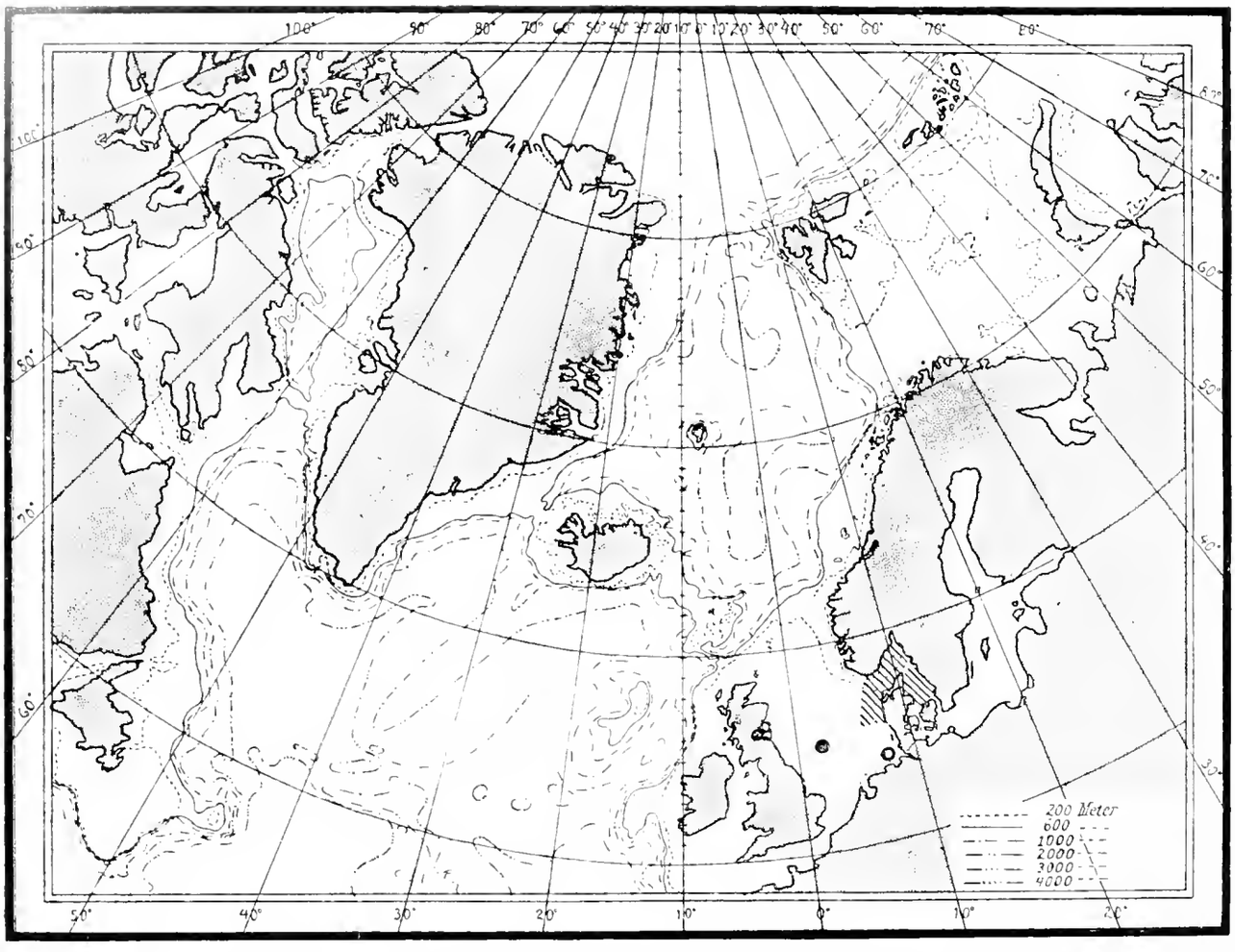

Chart XIV. Occurrence of *Tima bairdii* Fewkes. ○ Occurrence according to the literature. Within the hatched region the species has a common occurrence.

occurrence of *Tima bairdii* are found in the literature. Thus it seems certain that it does not occur north and west of the North Sea. It is very remarkable and interesting that the distribution of one of the largest species among the Leptomedusæ of the North-European waters is entirely restricted to a comparatively small area.

Tima bairdii may be found at different depths. Most frequently it has been found in the upper water layers, but in the Skagerrak it has been found near the bottom at considerable depths, *viz.* 105, 140, 254, and 547 m.

Seasonal occurrence: Off the British coasts large specimens are found during the autumn and winter, apparently not later than the end of January; according to McIntosh young specimens have been found in February, May, and August. — In the Danish waters quite young specimens have been found in June and July; large specimens occur during the winter and early spring from November to April, rarely in May.

Family Æquoridæ.

Genus Æquorea Péron et Lesueur.

Æquorea forskålea Péron et Lesueur.

Mayer 1910, Medusæ of the World, p. 325.

Umbrella usually flatter than a hemisphere, up to about 400 mm wide; gelatinous substance thick in the middle part, thin at the margin. Stomach wide, mouth usually widely gaping, with several pointed lips. Numerous simple radial canals (up to about 200), carrying the gonads. Numerous tentacles of varying length. No cirri. Marginal vesicles even more numerous than the tentacles, each containing 2—4 concretions. Colour highly variable.

The species is widely distributed, but the distribution cannot be stated exactly, because we are not yet able to establish the limitations between the different species or variaties of *Æquorea* described. It has been found off the Atlantic coasts of Great Britain and the northern part of Norway.

Genus Zygodactyla Brandt.

Zygodactyla groenlandica (Péron et Lesueur).

Mayer 1910, Medusæ of the World, p. 335.

Umbrella usually flatter than a hemisphere, large; gelatinous substance very thick in the middle part, thin at the margin. Stomach broad, flattened, with a prolonged, cylindrical mouth-tube; the mouth is provided with long, pointed lips, equal in number to the radial canals. About 100 simple radial canals, carrying the gonads; between each successive pair of radial canals the subumbrella carries a row of gelatinous, wart-like protuberances. Tentacles slightly more numerous than the radial canals, long, with tapering bulbs. Between each successive pair of tentacles there are about 8—12 marginal vesicles, each containing 2 concretions. There are no cirri. Velum rudimentary. Colour of gastro-genital system and tentacles very delicately pink.

East coast of North America and west coast of Greenland.

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Errata.

Page 19, line 29 stands: stat. 241 (09), read: stat. 241 (04).
" 46, line 17 stands: sout, read: south.
" 59, text, line 3 stands: (1905), read: (1909).
" 85, text, line 4–5 stands: textfig. 14, read: textfig. 15.

Explanation of the Plates.

List of abbreviations.

ap. j. apical jelly.
c. cordylus.
c. v. circular vessel.
ex. exumbrella.
g. gonads.
m. e. mouth-edge.
m. v. marginal vesicle.
m. w. marginal wart.
n. nematocysts.
r. c. radial canal.
r. s line of connection between radial canal and subumbrella.
sp tentacular spur.
st. d. dorsal wall of stomach.
st. l. lateral wall of stomach.
st. p. stomachal peduncle.
sub. subumbrella.
t. tentacle.
v. velum.

Plate I.

Plate I.

Figures 1—8 *Chromatonema rubrum* (Fewkes).

Figure 1. A specimen from the Davis strait, "Tjalfe" stat. 336. Diameter 17 mm, height 14 mm. — × 5.

— 2. Part of the bell-margin with two tentacles and three cordyli. — "Tjalfe" stat. 336. — × 20.

— 3. Cordylus with nematocysts. — "Tjalfe" stat. 336. — × 65.

4. Lateral view of a part of a radial canal with four female gonads. The gonads are faintly discerned through the lateral wall of the radial canal. The subumbrella has been lifted up in front in order to make it possible to peep into the pouches between the subumbrella and the dorsal wall of the radial canal. The eggs are visible, and the fissures leading to the inner, narrow lumen of the gonadial sacks are seen. — × 12.

— 5. Horizontal longitudinal section through the lower part of the gonadial sacks. In most of the gonads the inner lumen with its ectodermal epithelium is seen. Two of the gonads on the left side have been hit so far below, that the lumen has not been touched by the section. — × 24.

— 6. Horizontal longitudinal section through the same radial canal. This section has passed through the upper part of the gonadial sacks, showing the openings of the gonads into the bell cavity. — × 24.

— 7. Transverse section of a radial canal with two female gonads. The gonad to the left has been hit nearly in the middle, exhibiting the entodermal (outer) epithelial cover of the sack, the eggs, and a small part of the ectodermal epithelium of the lumen. On the right side the section has just passed through the entodermal epithelium of the gonad. Above the left gonad is seen the pouch between the dorsal wall of the canal and the subumbrella. On the right side the section has passed through one of the branches of the line of attachment of the canal. — × 25.

— 8. Transverse section through a radial canal with two male gonads. To the left the section has passed nearly through the middle of the gonad, showing the ectodermal lumen, the spermatocytareous and the spermatogonial parts of the testis, and the entodermal epithelium of the sack. On the right side the section has passed mainly through the spermatogonial part of the testis. The ventral part of the canal is wanting. — "Thor" stat. 93 (04). — × 25.

— 9. *Staurophora mertensii* Brandt. — A part of the bell-margin of a specimen from Borgundfjord near Aalesund, Norway. Showing tentacles with entodermal spurs, cordyli, and centripetal furrows in the exumbrella. — × 30.

— 10. *Melicertum octocostatum* (M. Sars). — Radial canal seen from the subumbrella side. A part of the lateral wall of the stomach is seen from the inner side, showing the vertical fissure connecting the radial canal with the stomach cavity. — "Thor" stat. 203 (04). — × 10.

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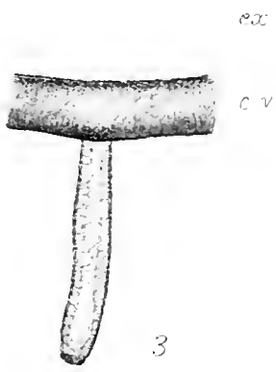

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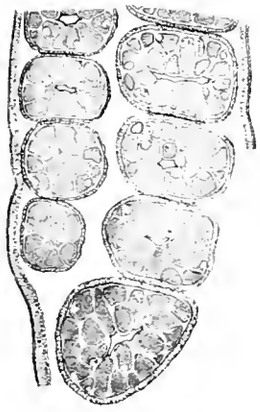

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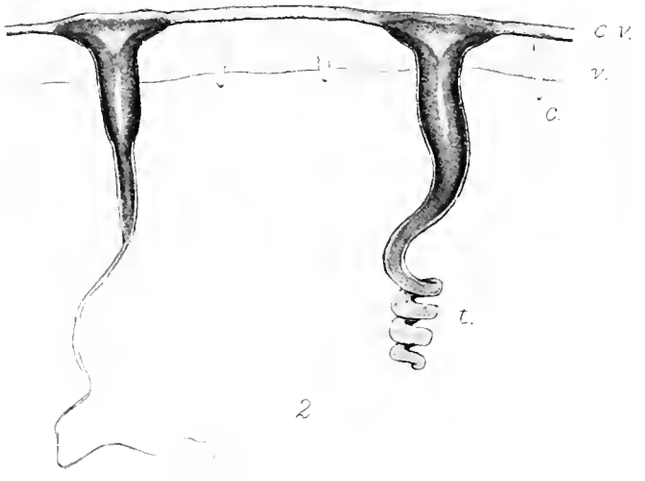

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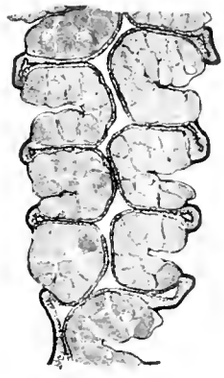

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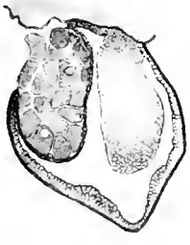

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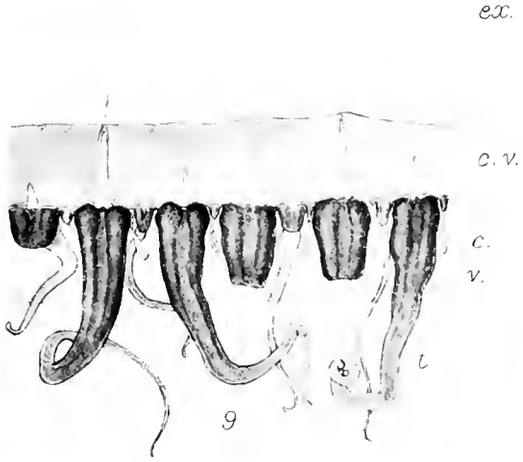

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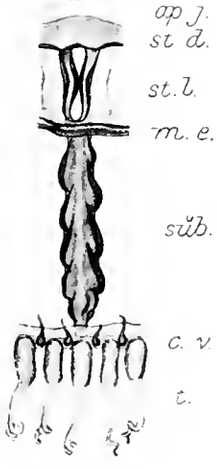

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Plate II.

Plate II.

Figures 1—8 *Laodicea undulata* (Forbes and Goodsir).

Figure 1. A specimen seen from the top. — × 3.

— 2. Radial canal with gonads and a part of the stomach; showing the grooves along which the dorsal wall of the stomach is attached to the subumbrella. The corner of the mouth and the ventral side of the funnel-shaped part of the radial canal have been cut open. The gonads commence at the point, where the open groove becomes closed by means of the two lateral folds, mentioned in the text (p. 17). The dark, wavy line is the narrow, nearly closed fissure between these folds, connecting the space between the gonads with the stomach and the funnel-shaped dilatation. The proximal parts of the gonads are faintly visible through the dorsal wall of the stomach. — From a specimen, about 25 mm in diameter, from Myri Bugt, Iceland, July 21st 1904. — × 6.

— 3 and 4. Transverse sections (made by hand) through the radial canal of a male specimen from "Michael Sars" stat. 140, June 26th 1903. Showing the lateral folds of the walls of the canal containing the sexual products, and, below, the funnel-shaped part of the canal.

— 5 and 6. Radial sections (made by hand) through the bell-margin with tentacles in different stages of development. The tentacle represented in fig. 5 is comparatively young and has a well-developed basal spur. The tentacle in fig. 6 is fully developed the basal part of the abaxial side of the tentacle has grown upwards along the exumbrella and caused the spur to disappear. Observe the ectodermal thichening on the adaxial side, and the course of the central canal.

— 7. Transverse section (microtome-section) through the dorsal wall of the stomach near the corner of the latter, showing male gonads and the two lateral folds. Owing to the preparation these have separated a little from one another, thus not completely separating the space between the gonads from the stomachal cavity. — "Michael Sars" stat. 140 (03). — × 30.

— 8. Part of the bell-margin seen from the abaxial side, with tentacles, cordyli, and a single cirrus (to the left). In two of the tentacles the spur has disappeared. — Myri Bugt, Iceland, July 24th 1904. — × 15.

Figures 9—10 *Staurophora mertensii* Brandt.

Figure 9. Complexly folded gonads seen from above. The gonads have been carefully detached from the subumbrella, showing the branched lines, by which they have been attached. — Myri Bugt, Iceland, August 9th 1904. — × 10.

— 10. Longitudinal section through a tentacular bulb and the circular vessel. The gelatinous substance of the bell-margin is much shrivelled. — "Thor" stat. 45 (08). — × 50.

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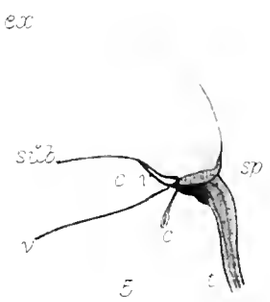

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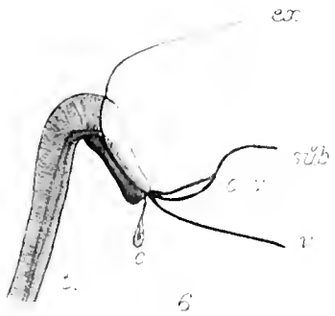

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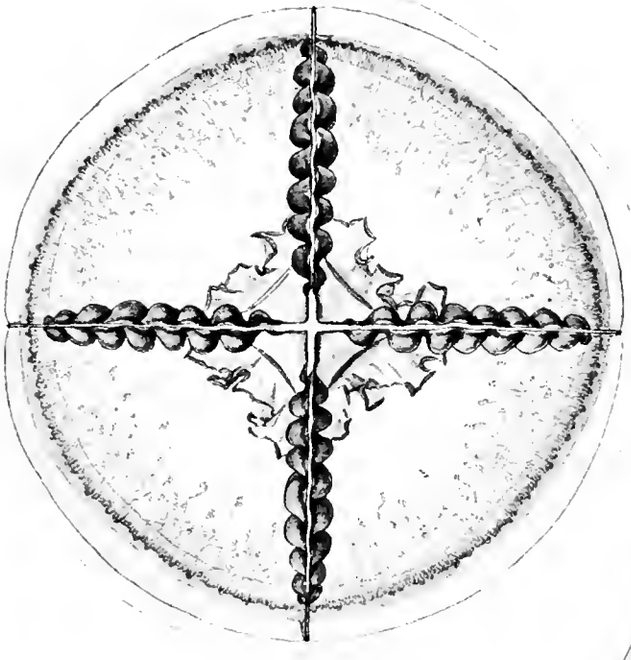

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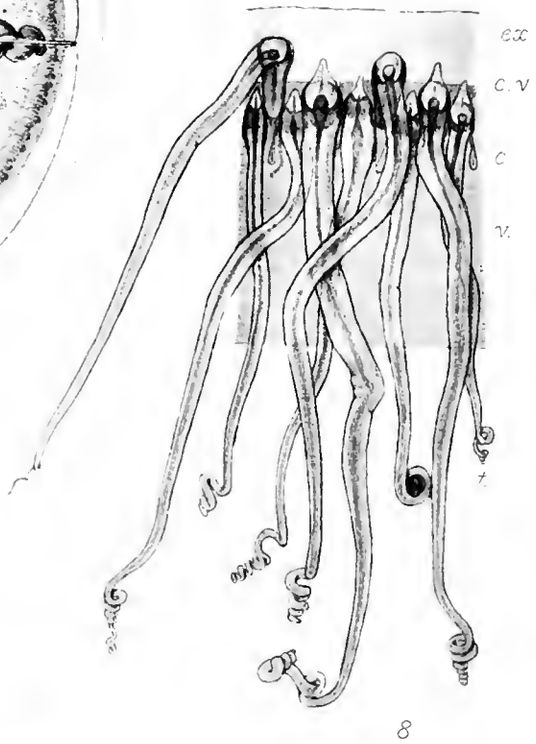

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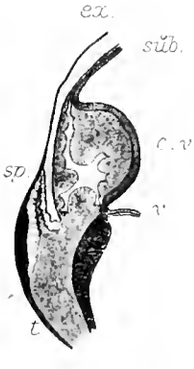

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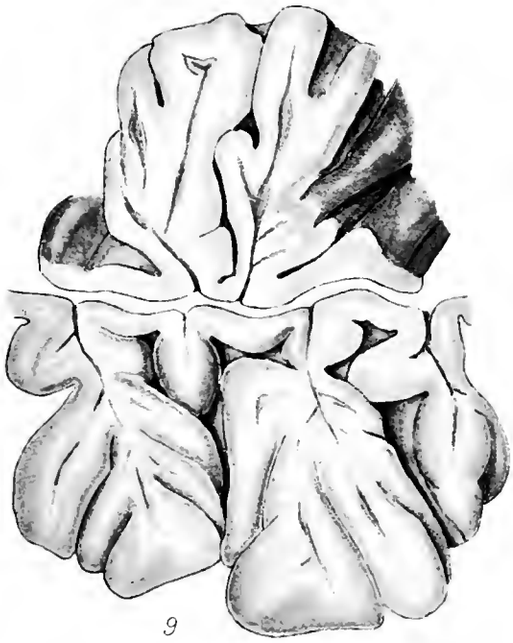

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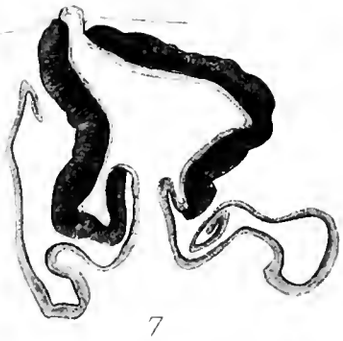

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Plate III.

Plate III.

Figures 1—6 *Ptychogena lactea* A. Agassiz.

Figure 1. Dorsal wall of the stomach seen from the inner side, showing the four grooves, which in this specimen do not meet exactly in the centre. The margins of the grooves are developed into lateral, longitudinal folds, which transform the grooves into closed canals, which open into the stomach near the centre; these openings are seen in the figure. — From a specimen, 90 mm wide, from "Tjalfe" stat. 125. — × 3.

— 2. Transverse section of a radial canal with two lamellæ with their papillæ. The lower part of the figure represents the funnel-shaped, ventral part of the radial canal, separated from the narrow, dorsal part by the two longitudinal folds, which are clearly visible in the figure. — From the same specimen. — × 6.

— 3. Part of the conical part of a radial canal. The ventral wall is partly cut away, so that the longitudinal folds, which separate this part from the narrow, dorsal part, are visible. — From the same specimen. — × 6.

— 4. Longitudinal section through a part of a radial canal, showing the entrances to the lateral pouches, the longitudinal-fold, and the lateral wall of the funnel-shaped part of the canal. — From the same specimen. — × 6.

— 5. Transverse section through four of the lamellæ (parallel with the radial canal) with male gonads. In the second lamella from the right the section has passed through the middle of one of the papillæ, demonstrating that the lumen of the latter communicates with the lumen of the lamella. In the first lamella from the right the section has touched one of the papillæ. In the papillæ the entoderm consists of a single layer of cubical cells; in the lamellæ there are several layers of smaller entodermal cells. — Microtome-section. — From the same specimen. — × 20.

— 6. Radial section through the bell-margin, showing a tentacle and a cordylus. On the abaxial side of the base of the tentacle is seen the short conical extension, the rudimentary spur. The cordylus is mounted upon a small tubercle. — From a specimen from Lat. 59°07′ N., Long. 13°32′ W. One of the type-specimens of *Ptychogena pinnulata* Haeckel. — × 17.

— 7 a—f. *Staurophora mertensii* Brandt. — Examples of cordyli developing into tentacles (see p. 6 in the text). — From a specimen from Iceland, "Thor" stat. 208 (04). — × 20.

— 8. *Melicertum octocostatum* (M. Sars). — Transverse section through a radial canal with female gonads. Showing the broad line of attachment to the subumbrella and the considerable distance from the subumbrella to the upper edge of the gonads. — From a specimen from Iceland, "Thor" stat. 258 (04). — × 50.

Plate III.

Plate III.

Figures 1—6 *Ptychogena lactea* A. Agassiz.

Fig. 1. Dorsal wall of the stomach seen from the inner side, showing the four grooves, which in this specimen do not meet exactly in the centre. The margins of the grooves are developed into lateral, longitudinal folds, which transform the grooves into closed canals, which open into the stomach near the centre; these openings are seen in the figure. — From a specimen, 90 mm wide, from "Tjalfe" stat. 125. — × 3.

— 2. Transverse section of a radial canal with two lamellæ with their papillæ. The lower part of the figure represents the funnel-shaped, ventral part of the radial canal, separated from the narrow, dorsal part by the two longitudinal folds, which are clearly visible in the figure. — From the same specimen. — × 6.

— 3. Part of the conical part of a radial canal. The ventral wall is partly cut away, so that the longitudinal folds, which separate this part from the narrow, dorsal part, are visible. — From the same specimen. — × 6.

— 4. Longitudinal section through a part of a radial canal, showing the entrances to the lateral pouches, the longitudinal fold, and the lateral wall of the funnel-shaped part of the canal. — From the same specimen. — × 6.

— 5. Transverse section through four of the lamellæ (parallel with the radial canal) with male gonads. In the second lamella from the right the section has passed through the middle of one of the papillæ, demonstrating that the lumen of the latter communicates with the lumen of the lamella. In the first lamella from the right the section has touched one of the papillæ. In the papillæ the entoderm consists of a single layer of cubical cells; in the lamellæ there are several layers of smaller entodermal cells. — Microtome-section. — From the same specimen. — × 20.

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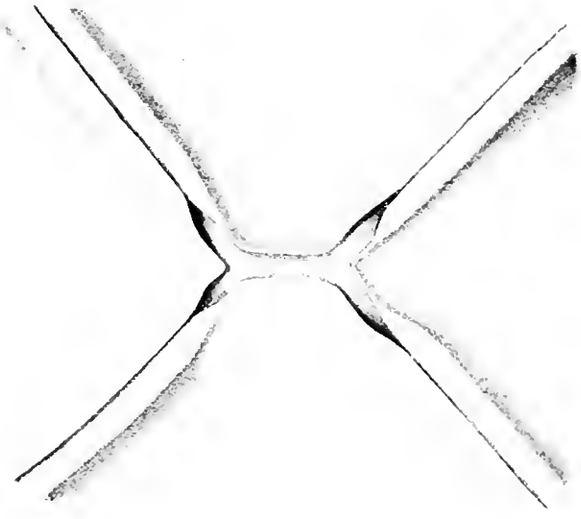

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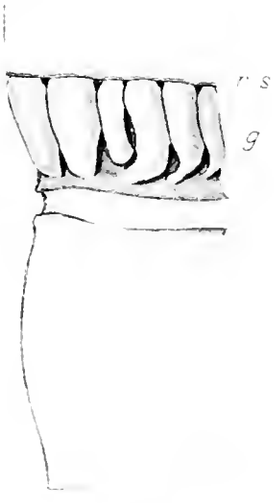

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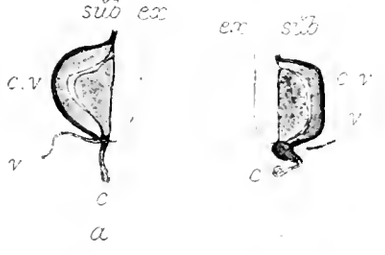

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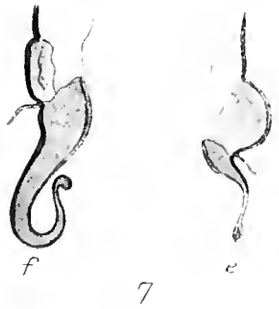

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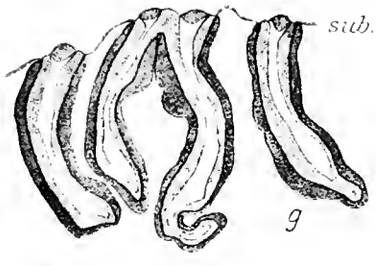

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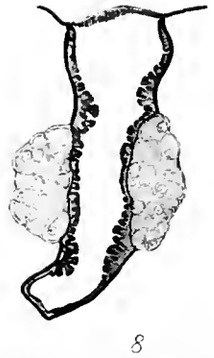

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Plate IV.

Plate IV.

Figures 1—5 *Halopsis ocellata* A. Agassiz.

Figure 1. A male specimen, 35 mm wide, seen from the aboral side. — Iceland. "Thor" stat. 179 (04). — × 2.

— 2. Part of the bell-margin seen from the abaxial side; showing 5 tentacles, 4 cirri, 1 marginal vesicle, and the velum. — From a specimen, 35 mm wide, from the Vestman Islands. — × 28.

— 3. Mature male gonad. — From the same specimen as fig. 1. — × 5.

— 4. Mature female gonad. — From a specimen, 30 mm wide, from between Iceland and the Faeroe Islands. — × 5.

— 5. Bifurcated female gonad. — Iceland, "Thor" stat. 174 (04). — × 5.

Figures 6—10 *Tiaropsis multicirrata* (M. Sars).

— 6. Transverse section through radial canal with mature male gonads. — Hrafnsfjord, Iceland. — × 28.

— 7. Transverse section through radial canal with immature female gonads. — Veidileysafjord, Iceland. — × 28.

— 8. Transverse section through radial canal with mature female gonads. Most of the eggs have been detached, some eggs have not yet penetrated the ectodermal epithelium. — Dyrefjord, Iceland, August 4th 1896. — × 30.

— 9. Lateral view of the proximal part of a radial canal with female gonads, showing a number of mature eggs situated on the outer side of the lateral wall of the canal. — From the same specimen. — × 15.

— 10. The same radial canal seen from the ventral edge. — × 15.

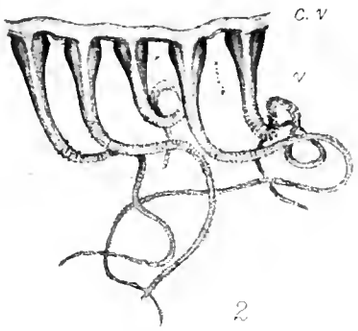
Figures 11—13 *Phialidium islandicum* nov. spec.

— 11. A specimen seen from the aboral side. — Iceland, "Thor" stat. 176 (04). — × 2.

— 12. Manubrium seen obliquely from the aboral side. — From another specimen from the same locality. — × 8.

— 13. Section through the circular vessel and a marginal vesicle. — Iceland, "Thor" stat. 266 (04). — × 220.

— 14. *Phialidium hemisphæricum* (Gronovius). — Section through the circular vessel and a marginal vesicle. — Myri Bugt, Iceland, July 24th 1904. — × 220.



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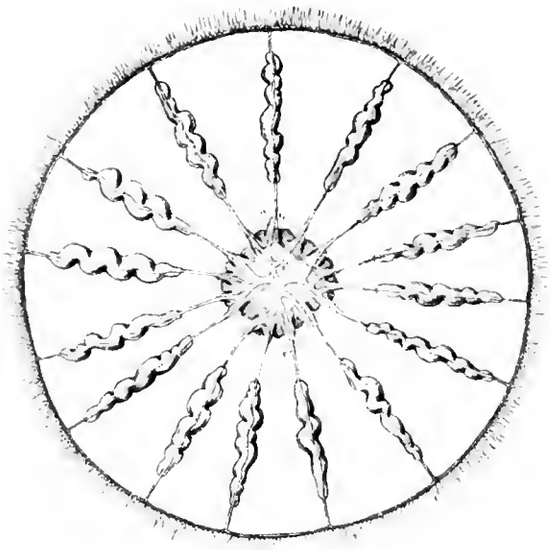

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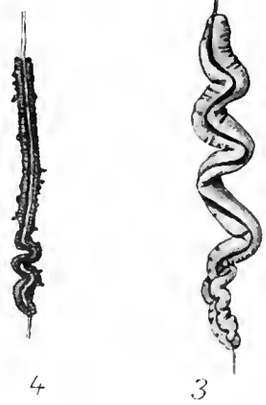

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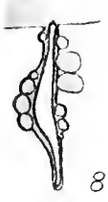

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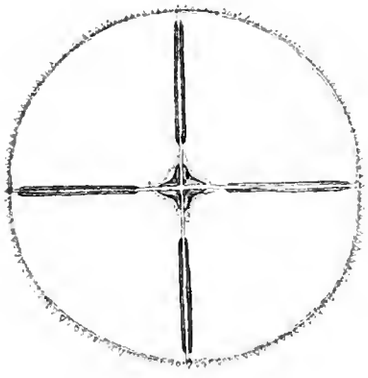

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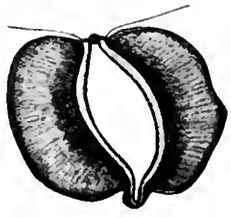

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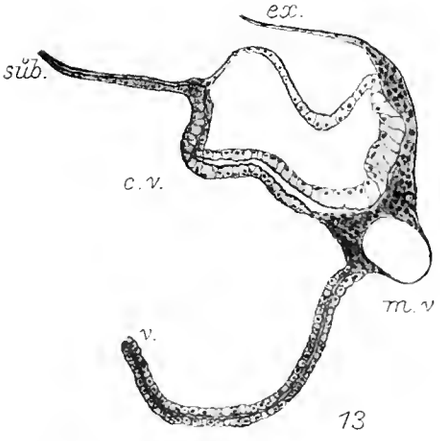

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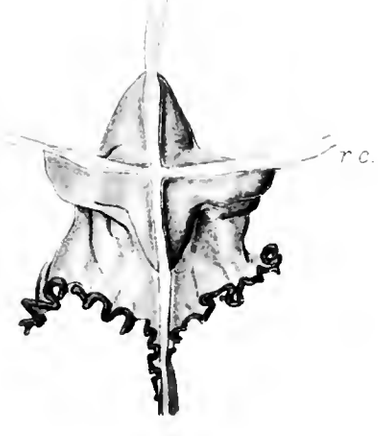

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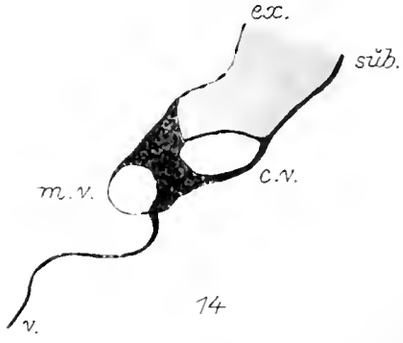

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Plate V.

Plate V.

Figures 1–2. *Phialidium islandicum* nov. spec.

Figure 1. Part of the bell-margin, showing marginal vesicles alternating with the tentacles. — Iceland, "Thor" stat. 176 (04). — × 20.

— 2. Longitudinal section through a tentacular bulb, perpendicularly to the circular vessel. — Iceland, "Thor" stat. 266 (04). — × 50.

— 3. *Phialidium hemisphericum* (Gronovius). — Longitudinal section through a tentacular bulb, perpendicularly to the circular vessel. — Myri Bugt, Iceland. — × 50.

Figures 4—10. *Tima bairdii* (Johnston).

— 4. Dorsall wall of the stomach, showing the four deep grooves and the entrances to the four radial canals; the two entrances to the left are closed, the two others are open, showing the transversal folds in the proximal part of the radial canals. The lateral walls of the stomach have been removed. — From a Danish specimen. — × 8.

— 5. Lateral view of the manubrium and the lower end of the stomachal peduncle; showing the four large, folded lips and the triangular pouches between the dorsal wall of the stomach and the peduncle. The cross-shaped figure, along the arms of which the stomach is attached to the peduncle, is discerned through the jelly of the latter. In this specimen the "cross-arms" do not meet exactly in the centre. — From a Danish specimen. — × 8.

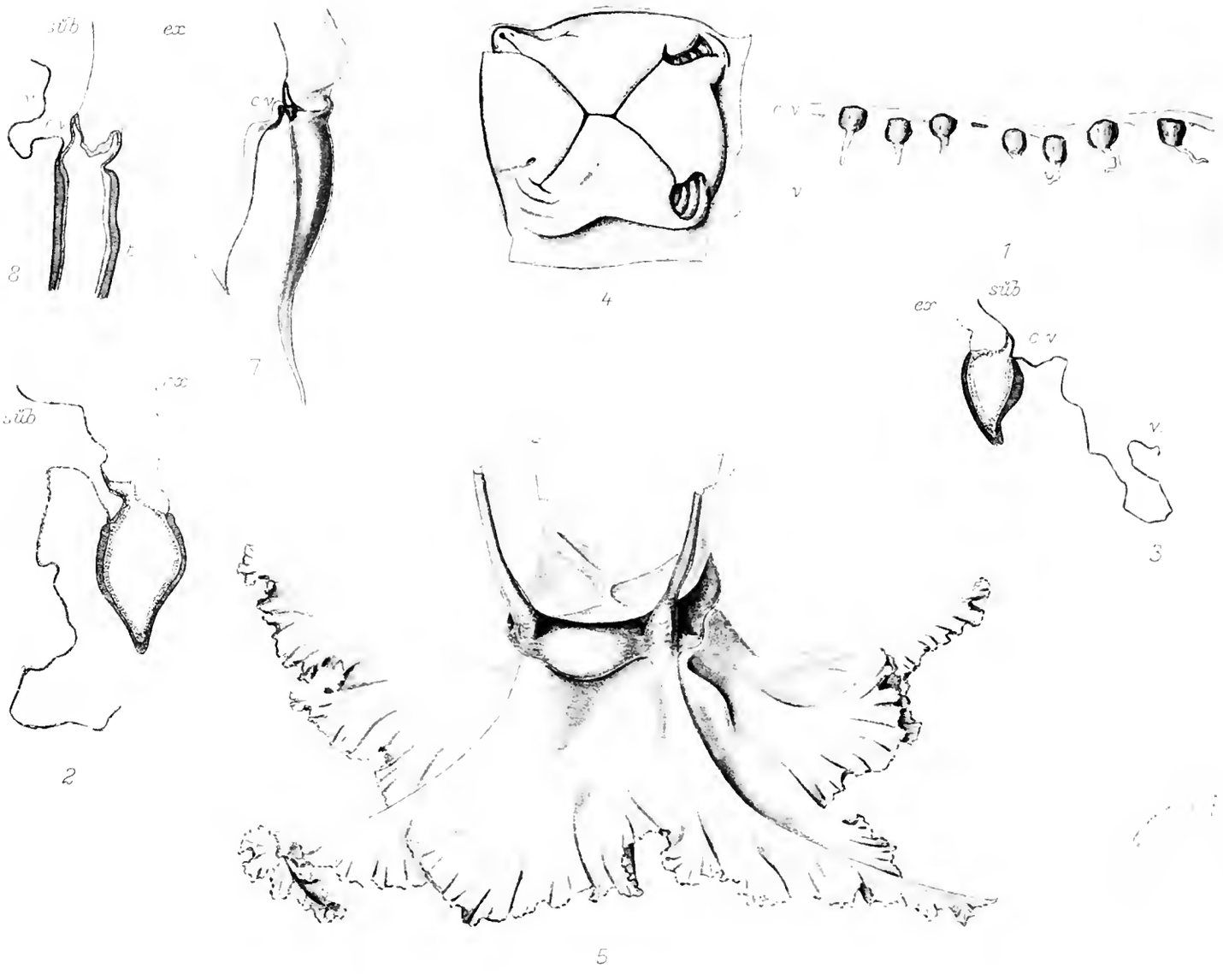
— 6. Part of the bell-margin, seen from the abaxial side, with two tentacles (observe the abaxial spur-like projection at the base of the bulbs) and a number of marginal warts and marginal vesicles. — From a Danish specimen. — × 5.

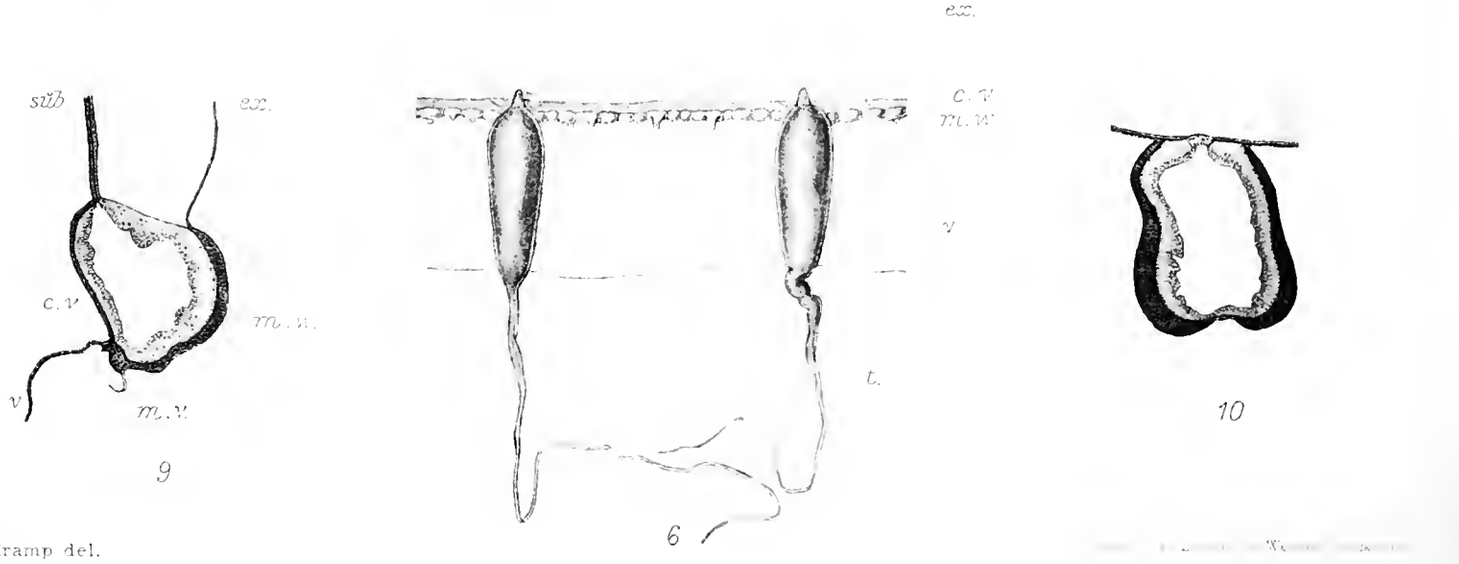
— 7. Lateral view of a tentacular bulb. The margin of the umbrella, the circular vessel, and the velum are seen in section. The basal spur on the tentacular bulb is distinctly visible. Above the tentacle is seen the rounded gelatinous protuberance of the exumbrella. — × 5.

8. Section through the bell-margin and a tentacular bulb; showing the entodermal, basal spur, covered by the epithelium of the exumbrella. — × 12.

9. Section through the bell-margin. The section has passed through the middle of a marginal wart with a marginal vesicle situated on the adaxial side close to the velum. — × 65.

— 10. Transverse section through a radial canal (the part on the stomachal peduncle) with male gonads; showing the mode of attachment to the subumbrella, mentioned in the text, p. 103. — × 65.





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THE INGOLF-EXPEDITION

1895 — 1896.

THE LOCALITIES, DEPTHS, AND BOTTOMTEMPERATURES OF THE STATIONS

Station Nr	Lat. N.	Long W.	Depth in Danish fathoms	Bottom-temp	Station Nr	Lat. N.	Long W	Depth in Danish fathoms	Bottom-temp	Station Nr	Lat. N	Long W	Depth in Danish fathoms	Bottom-temp.
1	62° 30′	8° 21′	132	7°2	24	63° 06′	56° 00′	1190	2°4	45	61° 32′	9° 43′	643	4°17
2	63° 04′	9° 22′	262	5°3	25	63° 30′	54° 25′	582	3°3	46	61° 32′	11° 36′	720	2°40
3	63° 35′	10° 24′	272	0°5		63° 51′	53° 03′	130		47	61° 32′	13° 40′	950	3°23
4	64° 07′	11° 12′	237	2°5	26	63° 57′	52° 41′	34	0°6	48	61° 32′	15° 11′	1150	3°17
5	64° 40′	12° 00′	155			64° 37′	54° 24′	100		49	62° 07′	15° 07′	1120	2°91
6	63° 43′	14° 34′	90	7°0	27	64° 54′	55° 10′	393	3°8	50	62° 43′	15° 07′	1020	3°13
7	63° 13′	15° 41′	600	4°5	28	65° 14′	55° 42′	420	3°5	51	64° 15′	14° 22′	68	7°32
8	63° 56′	24° 40′	130	6°0	29	65° 34′	54° 31′	68	0°2	52	63° 57′	13° 32′	420	7°87
9	64° 18′	27° 00′	295	5°8	30	66° 50′	54° 28′	22	1°05	53	63° 15′	15° 07′	795	3°08
10	64° 24′	28° 50′	788	3°5	31	66° 35′	55° 54′	88	1°6	54	63° 08′	15° 40′	691	3°9
11	64° 34′	31° 12′	1300	1°6	32	66° 35′	56° 38′	318	3°9	55	63° 33′	15° 02′	310	5°9
12	64° 38′	32° 37′	1040	0 3	33	67° 57′	55° 30′	35	0°8	56	64° 00′	15° 09′	68	7°57
13	64° 47′	34° 33′	622	3°0	34	65° 17′	54° 17′	55		57	63° 37′	13° 02′	350	3°4
14	64° 45′	35° 05′	170	4°4	35	65° 10′	55° 05′	302	3°6	58	64° 25′	12° 09′	211	0°8
15	66° 18′	25° 59′	330	—0°75	36	61° 50′	56° 21′	1435	1°5	59	65° 00′	11° 16′	310	—0°1
16	65° 43′	26° 58′	250	6°1	37	60° 17′	54° 05′	1715	1°4	60	65° 09′	12° 27′	124	0°9
17	62° 49′	20° 55′	745	3°4	38	59° 12′	51° 05′	1870	1°3	61	65° 03′	13° 06′	55	0°4
18	61° 44′	30° 29′	1135	3°0	39	62° 00′	22° 38′	865	2°9	62	63° 18′	19° 12′	72	7°92
19	60° 29′	34° 14′	1560	2°4	40	62° 00′	21° 30′	845	3°3	63	62° 40′	19° 05′	800	4°0
20	58° 20′	40° 48′	1695	1°5	41	61° 39′	17° 10′	1245	2°0	64	62° 06′	19° 00′	1041	3°1
21	58° 01′	44° 45′	1330	2°4	42	61° 41′	10° 17′	625	0°4	65	61° 33′	19° 00′	1089	3°0
22	58° 10′	48° 25′	1845	1°4	43	61° 42′	10° 11′	645	0°05	66	61° 33′	20° 43′	1128	3°3
23	60° 43′	56° 00′	Only the Plankton-Net used		44	61° 42′	9° 36′	545	4°8	67	61° 30′	22° 30′	975	3°0

Station Nr	Lat. N	Long. W	Depth in Danish fathoms	Bottom-temp	Station Nr	Lat. N.	Long W.	Depth in Danish fathoms	Bottom-temp.	Station Nr.	Lat. N.	Long. W.	Depth in Danish fathoms	Bottom-temp.
68	62° 06′	22° 30′	843	3°4	92	64° 44′	32° 52′	976	1°4	118	68° 27′	8° 20′	1060	—1°0
69	62° 40′	22° 17′	589	3°9	93	64° 24′	35° 14′	797	1°46	119	67° 53′	10° 19′	1010	—1°0
70	63° 09′	22° 05′	134	7°0	94	64° 56′	36° 19′	204	4°1	120	67° 29′	11° 32′	885	—1°0
71	63° 40′	22° 03′	46			65° 31′	30° 45′	213		121	66° 59′	13° 11′	529	—0°7
72	63° 12′	23° 04′	197	6°7	95	65° 14′	30° 39′	752	2°1	122	66° 42′	14° 44′	115	1°8
73	62° 58′	23° 28′	486	5°5	96	65° 24′	29° 00′	735	1°2	123	66° 52′	15° 40′	145	2°0
74	62° 17′	24° 36′	695	4°2	97	65° 28′	27° 39′	450	5°5	124	67° 40′	15° 40′	495	—0°6
	61° 57′	25° 35′	761		98	65° 38′	26° 27′	138	5°9	125	68° 08′	16° 02′	729	—0°8
	61° 28′	25° 06′	829		99	66° 13′	25° 53′	187	6°1	126	67° 19′	15° 52′	293	—0°5
75	61° 28′	20° 25′	780	4°3	100	66° 23′	14° 02′	59	0°4	127	66° 33′	20° 05′	44	5°6
76	60° 50′	20° 50′	806	4°1	101	66° 23′	12° 05′	537	0°7	128	66° 50′	20° 02′	194	0°6
77	60° 10′	20° 59′	951	3°6	102	66° 23′	10° 26′	750	—0°9	129	66° 35′	23° 47′	117	6°5
78	60° 37′	27° 52′	799	4°5	103	66° 23′	8° 52′	579	0°6	130	63° 00′	20° 40′	338	6°55
79	60° 52′	28° 58′	653	4°4	104	66° 23′	7° 25′	957	—1°1	131	63° 00′	19° 09′	698	4°7
80	61° 02′	29° 32′	935	4°0	105	65° 34′	7° 31′	762	—0°8	132	63° 00′	17° 04′	747	4°6
81	61° 44′	27° 00′	485	6°1	106	65° 34′	8° 54′	447	—0°6	133	63° 14′	11° 24′	230	2°2
82	61° 55′	27° 28′	824	4°1		65° 29′	8° 40′	466		134	62° 34′	10° 26′	299	4°1
83	62° 25′	28° 30′	912	3°5	107	65° 33′	10° 28′	492	—0°3	135	62° 48′	9° 48′	270	0°4
	62° 36′	26° 01′	472		108	65° 30′	12° 00′	97	1°1	136	63° 01′	9° 11′	256	4°8
	62° 30′	25° 30′	401		109	65° 29′	13° 25′	38	1°5	137	63° 14′	8° 31′	297	—0°6
84	62° 58′	25° 24′	633	4°8	110	66° 44′	11° 33′	781	—0°8	138	63° 26′	7° 56′	471	—0°6
85	63° 21′	25° 21′	170		111	67° 14′	8° 48′	860	—0°9	139	63° 36′	7° 30′	702	—0°6
86	65° 03′.6	23° 47′.6	76		112	67° 57′	6° 44′	1267	—1°1	140	63° 29′	6° 57′	780	—0°9
87	65° 02′.8	23° 56′.2	110		113	69° 31′	7° 06′	1309	—1°0	141	63° 22′	6° 58′	679	—0°6
88	64° 58′	24° 25′	76	6°9	114	70° 36′	7° 29′	773	—1°0	142	63° 07′	7° 05′	587	—0°6
89	64° 45′	27° 20′	310	8°4	115	70° 50′	8° 29′	86	0°1	143	62° 58′	7° 09′	388	—0°4
90	64° 45′	29° 06′	568	4°4	116	70° 05′	8° 26′	371	—0°4	144	62° 49′	7° 12′	276	1°6
91	64° 44′	31° 00′	1236	3°1	117	69° 13′	8° 23′	1003	—1°0					

THE DANISH INGOLF-EXPEDITION.

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